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Original scientific paper

A STUDY OF THE VELOCITY DISTRIBUTION FOR A PARTICULAR CASE OF THE SPHERICAL SYMMETRY

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(Received: April 12, 1991)

SUMMARY: A particular case of spherically symmetric stellar systems, characterised by the mass distribution of the type $(1-r^2/r_l^2)$, is studied. It is obtained that, if the mean radial velocity square varies in the same way as the density, then anisotopic velocity distributions with the transverse component prevailing take place. The fraction of the radial component in the total kinetic energy is not high, even in the case of a very high mean radial–velocity square at the centre it is less than 50%.

1. INTRODUCTION

It is well known that in the case of spherical symmetry the velocity distribution in the self–consistent and stationary stellar systems is generally anisotropic, but being isotropic at their centres (e. g. Binney and Tremaine, 1987, p. 242; Ninkovic, 1990, hereinafter referred to as Paper I). Therefore, it is of interest to study the anisotropy degree. In this paper the case of a specific and very simple mass distribution, almost a „school example" will be considered.

2. THEORETICAL BASE

The mass distribution considered in the present paper is given by the following density function where r is the distance to the centre of the system. It is clear

$$\rho = \rho(0)\left(1 - \frac{r^2}{r_l^2}\right) \quad r \leqslant r_l, \; \rho = 0 \quad r > r_l \tag{1}$$

that the amount of the total mass depends on the two parameters: the central density ρ (0) and the limiting radius r_l. Formula (1) is very simple and the density function described by it satisfies the basic conditions imposed on the density of a realistic stellar system, i. e. it decreases radially outwards, the rate of decrease becomes as lower as the distance to the centre is smaller so that the density attains its maximum just at the centre. A mass distribution like (1) has been often mentioned in various studies (e. g. Baranov and Volkov, 1977).

The potential generated by the density (1) is described in the following way

$$\Pi = \Pi(0) - 4\pi G\rho(0)\left(\frac{r^2}{6} - \frac{r^4}{20 r_l^2}\right), \Pi(0) = \pi G\rho(0) r_l^2 \tag{2}$$

where G is the gravitation constant. If the system studied in the present paper is self–consistent, then all the motions within it will be governed by the potential (2). The intention of the present author is to examine the resulting velocity distribution. This will be done in the same way as in Paper I (formulae (1) and (2)). One should also bear in mind that the mean radial–velocity square at the centre is limited, i. e.

$$\overline{v_r^2}(0) < \frac{2}{3}\Pi(0),$$

since all objects of the system are in the potential well.

3. RESULTS

The function f (r) (formula (2) of Paper I) is here composed in a similar way (like that in Paper I). A usable example for the present purpose may be

$$f(r) = \alpha_1 \left(1 - \frac{r}{r_l}\right) + \alpha_2 \left(1 - \frac{r}{r_l}\right)^2 + \alpha_3 \left(1 - \frac{r^2}{r_l^2}\right) \qquad (3)$$

Now, the case of a „transverse" anisotropic velocity distribution, i. e. when it is $\overline{v_t^2} > 2\overline{v_r^2}$ beyond r = 0, is studied. A solution of the type $\alpha_1 = \alpha_2 = 0$(form. (3)) is found. It is seen that in such a situation the dependence of the mean radial–velocity square on the radius has the same form as that of the density. The upper limit of $\overline{v_r^2}$ (0) is about 0.133 Π (0) since then the mean transverse–velocity square becomes negative at the boundary because it is valid–$\overline{v_t^2}$ $(r_l) = u_c^2 (r_l) - 4\alpha_3 \overline{v_r^2}$ (0) (u_c – the circular velocity, as in Paper I).

It is also of interest to examine the case of „radially" anisotropic velocity distributions, i. e. when within some interval $r \in (0, r_i)$, $r_i < r_l$, it is valid $\overline{v_t^2} < 2\overline{v_r^2}$. It is possible to obtain such distributions by assuming $\alpha_1, \alpha_2 > 0$ and examining comparatively higher values of $\overline{v_r^2}$ (0). As already said in Paper I, radially anisotropic velocity distributions are characterised by a minimum in the $\overline{v_t^2}/\overline{v_r^2}$ ratio placed somewhere between r=0 and $r=r_l$. The present examinations indicate that those minima are not very deep, especially when compared to the minima found in Paper I for the case of a different mass distribution. For example, in the extreme case $\overline{v_r^2}$ (0) = 0.66 Π(0), with the coefficients of (3) equal to $\alpha_1 = 0.01$, $\alpha_2 = 0.8$, $\alpha_3 = 0.19$, one obtains that at $r=0.65r_l$ the ratio $\overline{v_t^2}/\overline{v_r^2}$ attains its smallest value of 1.038. Its central value of 2 this ratio attains again as far from the centre as at r = 0.91 r_l. The role of the third term in (3) is to prevent any increase of the mean velocity square $\overline{v^2}$ ($\overline{v^2} = \overline{v_r^2} + \overline{v_t^2}$) towards the boundary of the system, as in Paper I. In the case of a transverse anisotropic velocity distribution the mean velocity square at first increases (beginning to increase immediately from the centre), attains a maximal value and finally decreases towards the boundary. This is not surprising. It is enough to say that in the extreme case $\overline{v_r^2}$ (0) = 0 the mean velocity square behaves exactly like the square of the circular velocity (formulae (1)–(2) of Paper I). If $\overline{v_r^2}$ (0) is different from 0, then the behaviour of $\overline{v^2}$ is no longer identical to that of u_c^2, but it is still similar to it.

4. DISCUSSION AND CONCLUSIONS

A comparison with the results of Paper I shows that the degree of „radial" anisotropy in the case of the mass distribution described by (1) is very different from that corresponding to the mass distribution studied in Paper I. Unlike the deep minima in $\overline{v_t^2}/\overline{v_r^2}$ ratio found in Paper I, here one finds much shallower ones, even in the case of high central mean squares of the radial velocity component, approaching the limit of 2/3Π(0) mentioned above. Certainly, as the best measure of the anisotropy degree appears the fraction of the radial velocity component in the total kinetic energy of the system (see Paper I). This quantity is calculated for the two cases of interest: $\overline{v_r^2}$(0) = 0.13 Π(0), $\alpha_1 = \alpha_2 = 0$, $\alpha_3 = 1$ and $\overline{v_r^2}$ (0) = 0.66 Π(0), $\alpha_1 = 0.01$, $\alpha_2 = 0.8$, $\alpha_3 = 0.19$. In the first case one obtains 20%, in the second one 44%. It is clear that because of the low absolute density gradient (second term on the right–hand side in formula (1) of Paper I) the fraction of the radial component in the total kinetic energy cannot attain high values (say more than 50%). Hence, it is possible to see that a mass distribution like that studied in Paper I, suspected to exist in the dark coronae of spiral galaxies, is „favourable" for giving rise to velocity distributions characterised by the domination of the radial velocity component.

ACKNOWLEDGENENT

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ПРОУЧАВАЊЕ РАСПОДЕЛЕ БРЗИНА ЗА ЈЕДАН КОНКРЕТАН СЛУЧАЈ СФЕРНЕ СИМЕТРИЈЕ

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УДК 524–68
Оригинални научни рад

Проучава се један конкретан случај сферно симетричних звезданих система који карактерише расподела масе облика $(1-r^2/r_1^2)$. Добијено је да, ако се средњи квадрат радијалне брзине мења на исти начин као густина, онда се јављају анизотропне расподеле брзина у којима преовлађује трансверзална компонента. Удео радијалне компоненте у укупној кинетичкој енергији није велик; чак и када је средњи квадрат радијалне брзине у центру врло велик, он не прелази 50%.

Bull. Obs. Astron. Belgrade N^{o} 144 (1991), 5–12.

UDC 550.38
Original scientific paper

GEOMAGNETIC FIELD OBSERVATIONS IN THE KOPAONIK THRUST REGION, YUGOSLAVIA

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(Received: April 4, 1990)

SUMMARY: In the absence of continuous registrations of the geomagnetic field variations in the surveyed region, the nearest permanent observatory records had to be used in the data reduction procedure. The proposed method estimates the differences between the hourly mean values at the particular measuring site, which are not actually known, and at the observatory on the basis of a series of instantaneous total field intensity values measured simultaneously at these two places.

The application of this method to the geomagnetic field data from the wider area of the Kopaonik thrust region has revealed local field changes which show connection with pronounced seismic activity that has been going on in this region since it was affected by the M = 6.0 earthquake on May 18, 1980. The distribution of Sperman's coefficient of rank correlation between the local field changes and the magnitudes of those earthquakes which could have had the influence on the magnetic field behaviour in particular time intervals, exhibits a dipole-like feature clearly defining the Kopaonik source region as an anomalous one. An attempt is made to interpret the observed magnetic effect by modelling the source region with two displaced prisms of appropriate magnetization vectors.

1. INTRODUCTION

Geomagnetic investigations in the wider area of the Kopaonik mountain were initiated after the occurrence of an M = 6.0 earthquake on May 18. 1980, in order to study the local behaviour of the total field intensity in the period which followed the main shock and was characterized by numerous aftershocks of M = = 4. As the Kopaonik epicentral region was continuously showing increased seismic activity, it was decided to go on surveying over this area so that fourteen surveys were carried out up to November 1986. Owing to the fact that we were unable to set up a temporary station for continuous registrations of total field intensity variations in the Kopaonik area, we had to use Grocka observatory records in data reduction procedure. Grocka observatory is situated about 170 km north from the Kopaonik epicentral region and it is obvious that the inequality between the geomagnetic field variations at the observatory and in the Kopaonik area has to be taken into account. Therefore, we proposed a particular method of data reduction which will be discussed in the next section.

2. DATA REDUCTION, ANALYSIS AND DISCUSSION OF RESULTS

Assuming the proportionality between the total field intensity variations in the Kopaonik area (ΔF_K)

and at the observatory (ΔF_O), we can put $F_K = k \cdot \Delta F_O$, where k is the coefficient of proportionality. The instantaneous value of the total field intensity at the observatory can be expressed as

$$F_O = Q_O + \Delta F_O \qquad (1)$$

where Q_O denotes the hourly mean value taken as the basis in respect to which the variation F_O is determined. The respective instantaneous value for the Kopaonik area is

$$F_K = Q_K + \Delta F_K = Q_K + k \cdot \Delta F_O, \qquad (2)$$

where the hourly mean value Q_K is not actually known.

Taking into account relations (1) and (2), the differences between the instantaneous total intensity values can be written as

$$F = F_K - \Delta F_O = Q_K - Q_O + (k-1) \cdot \Delta F_O \text{ or} \qquad (3)$$
$$F = Q + \mathcal{K} \cdot F_O,$$

where $Q = Q_K - Q_O$ and $\mathcal{K} = k - 1$. Setting the condition for the differences $Q_K - Q_O$ to be minimum, expressions

$$\Gamma = (Q + \mathcal{K}\,\Delta F_O - F)^2; \frac{\partial \Gamma}{\partial Q} = 0; \frac{\partial \Gamma}{\partial \mathcal{K}} = 0 \qquad (4)$$

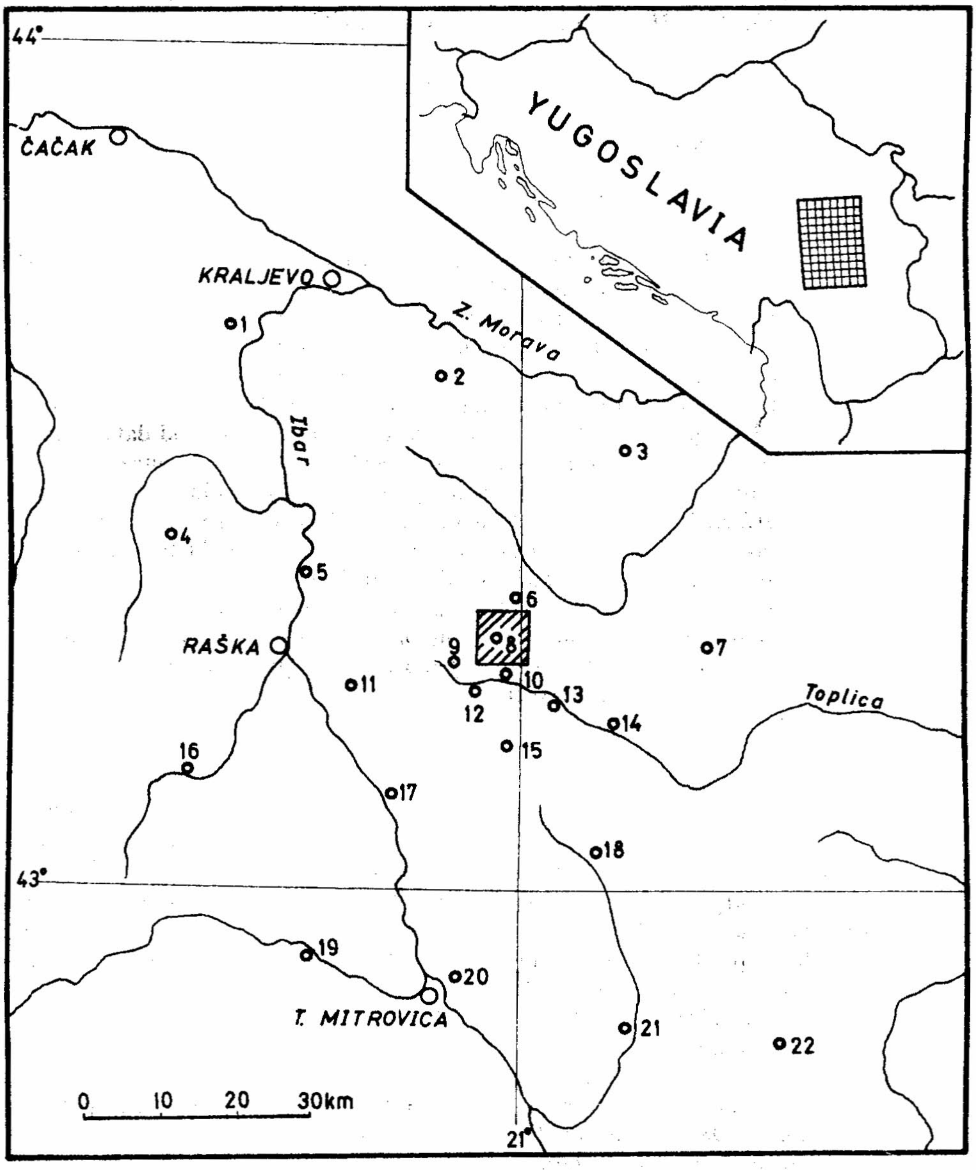

Fig.1 The network of observation sites. Dashed area includes the epicenters of all earthquakes which are considered in this work.

give the system of equations

$$nQ + \mathcal{K} \sum_{i=1}^{n} \Delta F_{Oi} = \Sigma\, \delta F_i$$

$$Q \sum_{i=1}^{n} \Delta F_{Oi} + \mathcal{K} \sum_{i=1}^{n} \Delta F_{Oi}^2 = \sum_{i=1}^{n} \delta F_i \Delta F_{Oi} \qquad (5)$$

The solution of equations (5) gives Q, i.e. Q_K if needed, and the coefficient of proportionality $k = \mathcal{K} + 1$. In the above equations n stands for the number of the instantaneous total-field-intensity values. The results discussed in this work are based on the analysis of the Q values for each measuring site and each particular epoch.

In order to eliminate any possibly existing long-term trend in the Q values because of the difference in the secular variation at the observatory and in the Kopaonik area, both linear and parabolic regressions have been applied to the obtained Q values. Finally, the residuals from parabolic regression (Q_R) are accepted as local-geomagnetic-field changes at the time of the particular survey and their temporal and spatial variation is considered with respect to the seismic activity in the period May 1980 April 1990.

The difference between the hourly mean values at a particular recordine site and at the observatory should be constant in time unless a certain process is going on either in the vicinity of the observatory or at the recording site, which is not identical at the two locations. Under the reasonable assumption that the geomagnetic field in the vicinity of the observatory is of a „normal" character, at least as far as tectonic processes are concerned, all variations in $Q_K - Q_O$ differences (i.e. residuals Q_R) can be, in this case, ascribed to the processes responsible for the increased seismic activity in the Kopaonik area.

The distribution of recording sites is presented in Fig. 1 and the time variation of the Q_R values for a few sites is shown in Fig 2. The dominant feature is not only the magnitude itself of the observed changes from one survey to another at sites which are closer to the epicentral region (No. 12 and 13) in comparison with those which are further away, but rather their better temporal coincidence with earthquake occurrences. In accordance with this, the next step was to rank the Q_R values taking absolute intensities and also to rank the magnitudes of those earthquakes which, due to the time of their occurrence, could have had the influence on the geomagnetic field behaviour at the time of a particular survey. Applying Spearman's formula for rank correlation, the coefficient r has been computed for each site.

Due to the dimensions of the surveyed area, certain sites fall within some seismotectonic units which are characterized by their own regimes of stress accumulation and release. In order to reduce unknown but possibly existing effects of complicated interrelationships and influences between different seismotectonic units, and assuming that it is more probable to detect geomagnetic field changes in connection with the Kopaonik earthquakes at sites closer to the epicentral region than at distant ones, we have used the concept of the so-called strain radius to „filter out" originally obtained values of the correlation coefficients. If the assumption is adopted that the zone of effective manifestation of the precursory deformations is a circle with the center at the epicenter of an immanent earthquake, then the relation

$$\rho(\epsilon) = e^{C(\epsilon)M} \qquad (6)$$

defines the strain radius $\rho(\epsilon)$ for a given deformation of ϵ, where $C(\epsilon)$ is a constant which depends on ϵ and M is the magnitude of the earthquake (Dobrovolsky et al., 1979). In our case, we took the center of the region within which fall the epicenters of all earthquakes in the period concerned. Taking M = 6.0, the strain radius ranging from 1.6 to 73.8 km was obtained, for = 10^{-1} to 10^{-6}, respectively. The calculated coefficients of the rank correlation are reduced with respect to the value of the strain radius corresponding to each site owing to its distance to the epicentral region. The distribution of such a reduced correlation coefficient r* is presented in Fig. 3.

It can be seen that the largest positive and negative values of r* occur in the wider area of the source region so that the pattern of distribution clearly defines the field of a dipole-like character. A very pronounced seismic activity in the period concerned in this work, is the result of activation of the SE boundary of the Kopaonik seismogene block. This triangularly shaped block has the largest seismic potential among several other blocks within the investigated area. Since we are attempting to interpret the charcteristic distribution of the rank correlation coefficient in relation with intensive tectonic processes in the area concerned, it is interesting to notice that the dipole-like field is formed just in the wider area of the source region, i.e. in the vicinity of the NE corner of the Kopaonik seismogene block.

If the connection between the geomagnetic field changes (Q_R), correlation coefficients (r*) and magnitudes of earthquakes (M) holds in the form $Q_R \sim r^*M$, then the physical meaning of the obtained pattern of the distribution shown in Fig. 2 can be searched fo in the light of the assumed relationship. Namely, the distribution of the correlation coefficients might be considered as to reflect the magnetic field changes as characteristic response to the stress variations in this area. A very simple model is applied to explain the observed effect.

In order to gain the picture on the relationship between the surface distribution of the geomagnetic field and stress induced changes of rock magnetization,

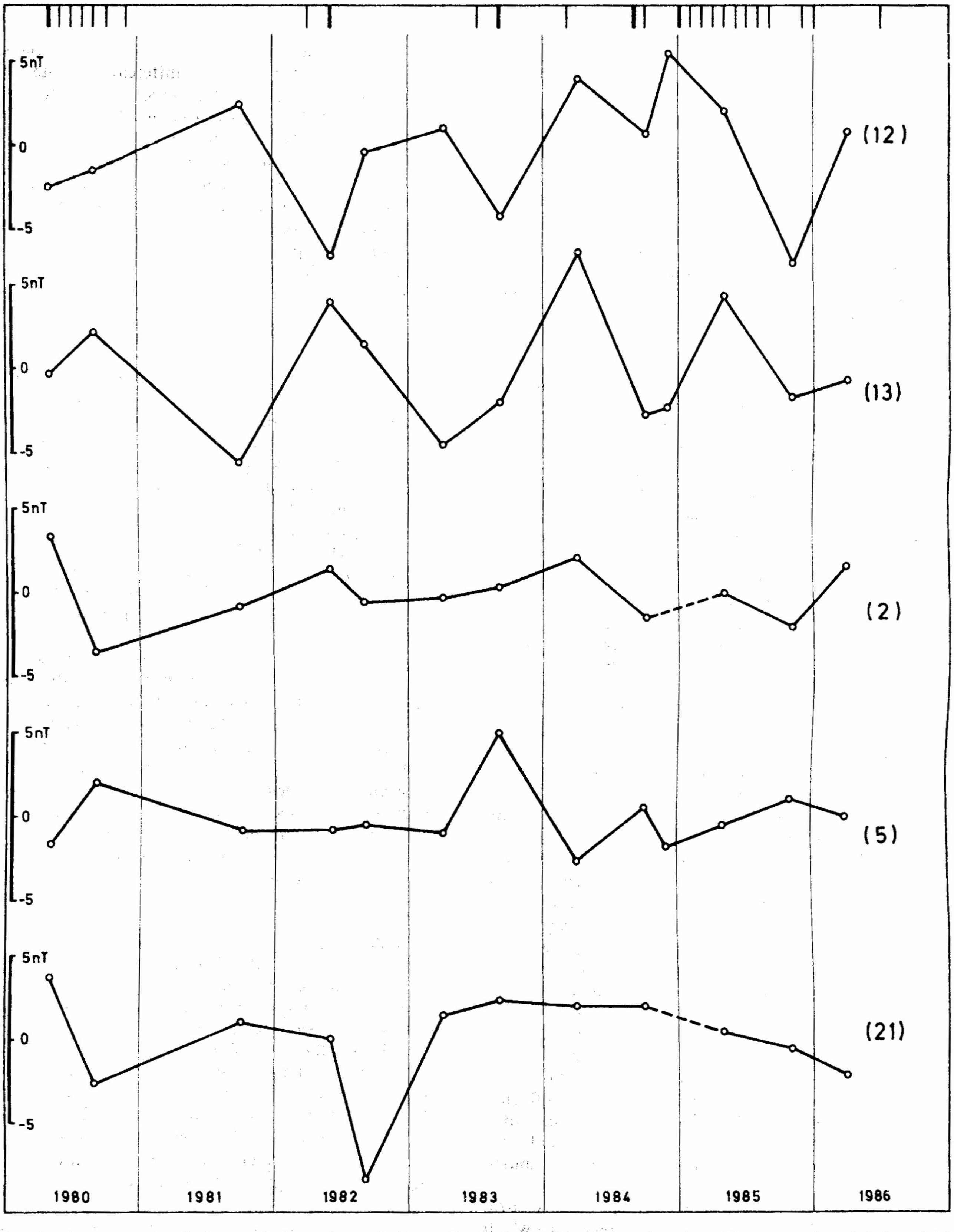

Fig. 2 An example of time-variation of parabolic residuals Q_R at five measuring sites. Those numbered 8,9 and 10 were established during the 8^{th} survey so that they are not representative in a choice of sites which are close to the epicentral region due to incomplete data, and therefore are not presented in this figure.

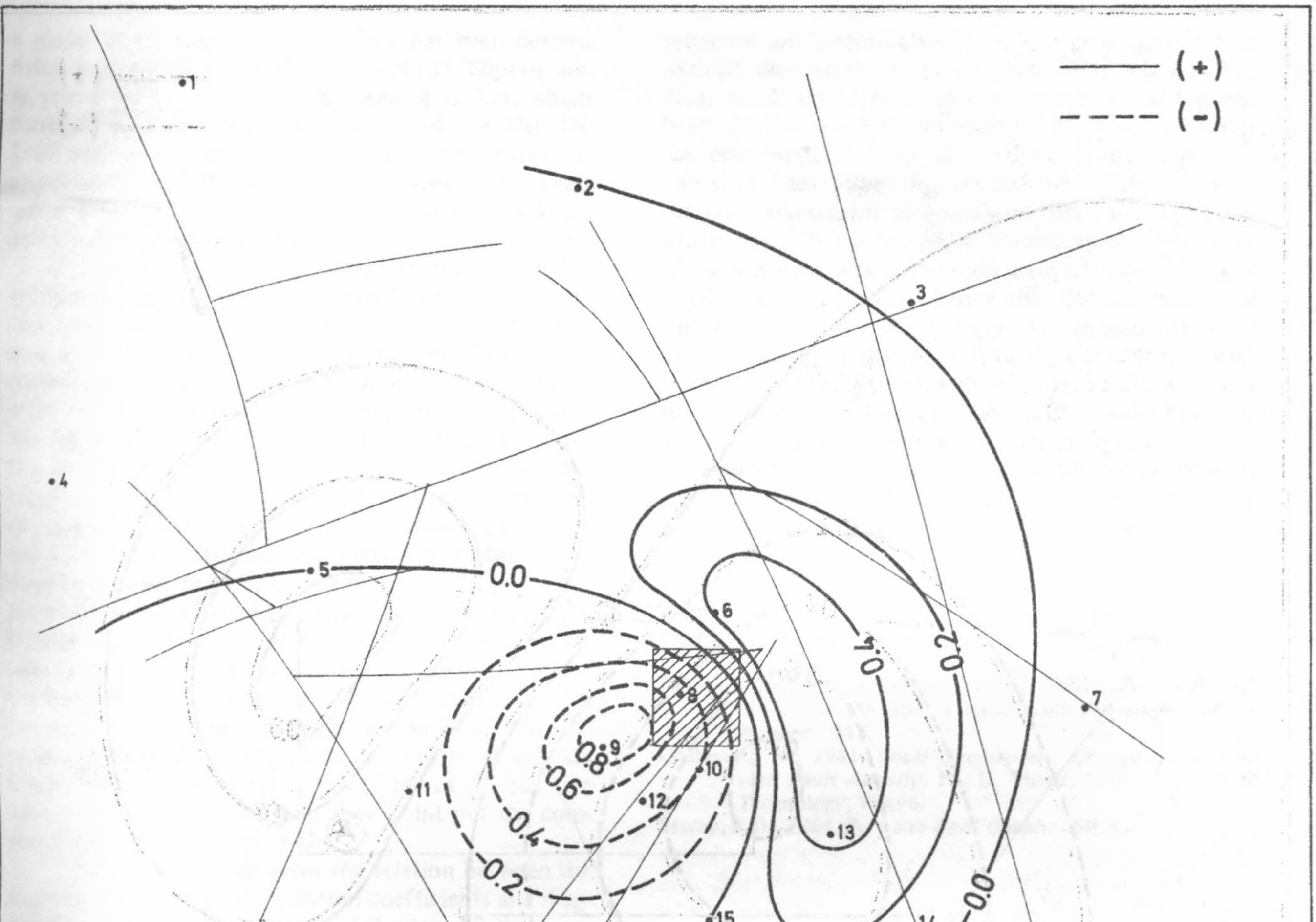

Fig. 3 The distribution of reduced coefficients of rank correlation r^* between Q_R and magnitudes of earthquakes. The main fault system is indicated schematically as well as the epicentral region (dashed area).

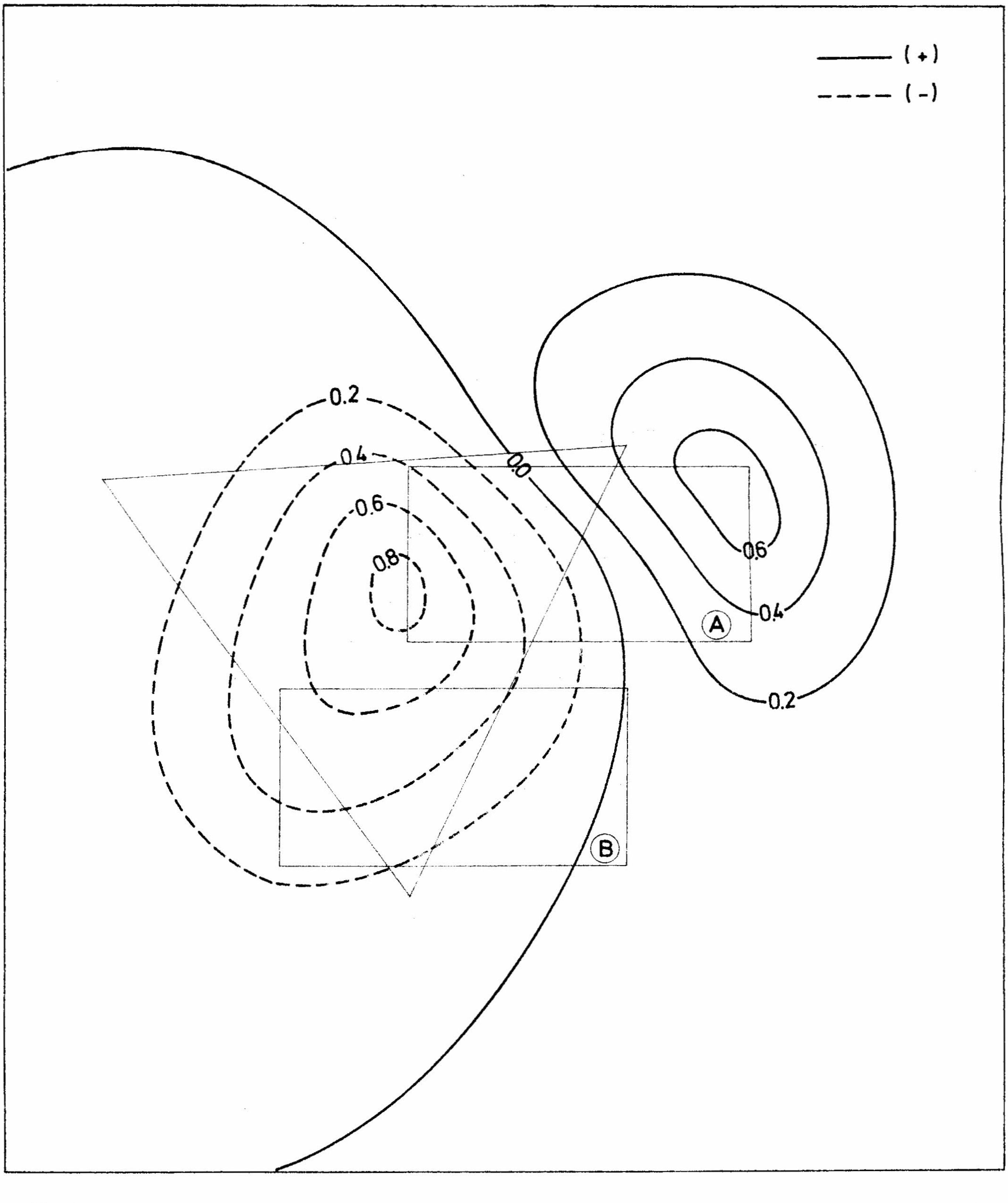

Fig. 4 The distribution of correlation field originating from model calculation based on two prismatic bodies, situated with respect to the Kopaonik seismogene block as indicated in the figure.

a model of geomagnetic field source has been derived based on two prismatic bodies (A) and (B). Tops of these prisms are at the depth of about 8--9 km, which corresponds to the hypocentral depth of the May 18, 1980 earthquake, their width, length and tickness is approximately 10,10 and 3 km, respectively. Their spatial position with respect to the Kopaonik seismogene block is indicated in Fig. 4.

The application of a two-prism model enabled us to get a rough picture on the spatial distributon of the rock magnetization vector, which is cased by the existing stress stage and its relevant changes. Taking into account the average magnitude of earthquakes considered in this period as 4.5, the amplitude of possible seismomagnetic effect can be estimated to 1–4 nT. Due to the addopted model, to get on the surface the magnetic effect of such an order of magnitude, the induced magnetic field (μ_oM) of prism (A) should be –4, 10 and –1 nT in the direction of northward, eastward and downward axis, respectively. The relevant values for the second prism (B) are 0,3 and –1.5 nT. These results indicate that the vector of the rock magnetization rotates from the south towards the north in the counterclockwise direction, while its intensity constantly increases as it approaches the source region. These changes of the rock magnetization vector are likely to indicate the existence of intensive tectonic forces on the one hand and, on the other hand, they point out the complex features of the stress field.

Let us now recall again the relation between the magnetic field changes, correlation coefficients and magnitudes of earthquakes. The distribution of the magnetic field changes which results from the described model colculation can be converted into a corresponding distribution of correlation field by taking into account an appropriate factor, i.e. the average magnitude of earthquakes, yielding the pattern presented in Fig. 3, which is in an obvious accordance with the pattern of the distribution of correlation coefficients in Fig. 2, calculated on the basis of the measured geomagnetic field changes.

Of course, the results of the present model calculations are only of an informatory character. A more complete information can be obtained in the frame of more complex procedures of modelling such as described by Stacey (1964) or Ohshiman (1981), which take into account the geometry of fault surfaces and relates the block structure of geological environment to the surface geomagnetic field changes. However, the solution of such a problem is beyond the scope of this work.

3. CONCLUSION

The analysis of the Q_R values, defined in a manner described in the previous section, has revealed the existence of „information" on the geomagnetic field changes contained in the original total-field-intensity data, which might be related to particular earthquakes from the Kopaonik source region. The same conclusion has been implied from the analysis of the total-field--intensity base values F_B (Popeskov, 1986). However, the Q_R values seem to emphasize just those variations which could be connected with earthquakes. The result of comparative rank-correlation analysis applied both to the Q_R and F_B values on one side and magnitudes of earthquakes on the other, supports this assumption. In the first case, the distribution of the correlation coefficient defines more distinctly the dipole-like anomaly surrounding the epicentral region. The model calculations offer a possible theoretical support but, more complex studies of the observed and established phenomena from the Kopaonik thrust region, which are in progress, will certainly contribute in clarifying some of the points discussed in this work.

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ПОСМАТРАЊА ГЕОМАГНЕТСКОГ ПОЉА У ТРУСНОМ ПОДРУЧЈУ КОПАОНИК, ЈУГОСЛАВИЈА

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УДК 550.38
Оригинални научни рад

Пошто у Истраживаној области није вршена континуална регистрација варијација геомагнетског поља, за редукцију релеватних геомагнетских података коришћени су подаци најближе лоциране геомагнетске опсерваторије. Предочени метод редукционе процедуре омогућава да се на темељу истовремено мерених вредности тоталног интензитета геомагнетског поља на ове различите локације /на терену и опсерваторија/ израчуна разлика непознатих средњечасовних вредности поља за место мерења на терену и одговарајућих опсерваторијских вредности.

Примена ове методе на геомагнетске податке прикупљене у широј околини копаоничке трусне области, јасно указује на повезаност локалних промена поља и наглашене сеизмичке активност ове области изазване земљотресом магнитуде M=6.0 18. маја 1980. године. Територијални распоред Спеарманнових коефицијената корелације ранга између локалних промена геомагнетског поља и оних земљотреса који у датом временском интервалу могу имати утицаја на особине магнетског поља, приказује диполну структурну конфигурацију и указује на аномалну природу извора поља у копаоничкој области. У циљу интерпретације опажаног магнетског ефекта извршено је моделирање извора аномалног поља помоћу два размакнута призматична тела одређене магнетизације.

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UDC 523.83
Review paper

TRIPLE STAR SYSTEMS NEARER THAN 200 pc

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SUMMARY: A survey of 783 triple star systems is presented. All stars listed belong to the IDS Catalogue and are nearer than 200 pc. In addition to the system identification the survey includes Sp_A, π_A and m_A main component), as well as the designation (multiple) of the apparent component configuration in the system. The data concerning the real relationship among the components (dynamical state) are also included; existence of orbits among the components, or a tendency for any orbital motion, is also specified. In order to examine the relationship between this survey on one side and the Leningrad Triple–Star–System Programme and Gliese's Nearby–Star Catalogue on the other side, suitable designations are brought in the survey. As a final step a short recapitulation of the survey data is done.

1. INTRODUCTION

The compilation of a triple–star–system catalogue is a complicated task, not easily performable. The basic difficulty in its realisation is the lack of a complete set of astrometric and astrophysical data concerning triple systems (Anosova & Orlov, 1985; Popović, 1991). The gathering of these data is a long work requiring a coordinated action of several observatories and involving equally the astrometrists and astrophysicists.

One of the most complete surveys of triple star systems is, undoubtedly, given by Anosova (1969) where the systems of Eps Lyrae type from the IDS catalogue (Jeffers et al., 1963) were examined. By applying the dynamical and statistical criteria she found 298 reliably optical systems and 650 possibly physical systems. Anosova's survey could be a basis to formations of many observing programmes and also to the compilation of the future triple–star–system catalogue. However, the treatment of that triple–star–system sample has not been continued afterwards in spite of the advent of new observational data and methods of examination. In the present author's opinion there are two reasons for which Anosova's survey has not been treated beyond her home institution: 1. She presented the systems without an ADS number through an internal designation only, making in this way any object identification extremely difficult. 2. There was no choice of nearby systems and, consequently, systems of all possible parallaxes were taken into consideration which, certainly, has made any gathering of the relevant observational data difficult. In addition, the choice of the system Eps Lyrae, itself, has diminished the atractivity of the sample.

By extending a new procedure for detection of physically triple systems (Anosova & Popović, 1989) Anosova decides to study nearby triple systems within a limited programme containing only 113 triple systems in order to offer a complete information about them.

There are several reasons to carry out the present survey.

1. The present author's intention is to obtain a complete survey of the triple star systems from the IDS Catalogue with known parallaxes, closer than 200 pc, which would serve as a nucleus in the compilation of a triple star–system catalogue. The data concerning

the systems more distant than 200 pc are not considered as reliable enough, nor the gathering of the relevant data in their case is easy to do. Hence they are not included in the present analysis.

2. In the present paper one wants to comprise all triple systems from the IDS Catalogue with known parallax, closer than 200 pc, without regard to the hierarchical type and actual knowledge of the dynamical state of the system components.

3. The intention is also to offer an acceptable framework for the observing programmes with a possibility to choose the systems, weakly examined and of interest, so that the obtaining of a complete set of astrometric and astrophysical data becomes faster.

4. This survey will also serve for the purpose of choosing systems convenient for observations in the framework of the Belgrade observing programme.

5. The systems contained in this survey will be also subjected, depending on the available observational data, to examinations aimed at establishing the dynamical states and, if possible, the statistical conclusions which may be applied also to the systems more distant than 200 pc, or to the systems not comprised by the IDS.

2. THE SURVEY OF TRIPLE SYSTEMS FROM THE IDS CATALOGUE NEARER THAN 200 pc

The first thing which should be done in such a work is to define a triple system, i. e. to decide what triple systems are to be included in the survey. Today we know very few systems for which a physical connection of the components is reliably established. A large number of systems can be, only under certain conditions, accepted as a real triple one. Systems for which nothing can be said about the mutual connections of the components are the most numerous. There are systems where some discordances concerning the optical or physical membership of the components arise, so that only additional observations can solve the problem. With regard that the purpose of the present survey is not to obtain a sample for statistical and dynamical examinations of triple systems, but above all to obtain a basis for observing programmes and a framework from which a representative sample will be formed by filtration, it is decided to include all triple systems registered as visual ones in the IDS (Jeffers et al., 1963), closer than 200 pc. Due to this decision the present survey comprises also the systems which, though visually triple, contain for other reasons more than three components. This is the case when one of the components is a spectroscopic binary, or its magnitude or line–of–sight velocity are variable. In a few cases the fourth component is the dark companion to one of the visual components.

Since the present author has observed double and triple stars for many years, he can find a frequent discordance in the number of components of a multiple star between the catalogues and reality. The real number is always larger which is a consequence of an insufficient interest of observers to register all components of a multiple star. This is the reason that many „triple" systems from the present survey (Table 1) often have more than three detectable components, but it is a quite different question what the true number of components is. It is certain that systems with four or more components contain real triple systems, but such cases are not included here. Exceptions are a few well–known systems where other components can be surely rejected as optical ones.

All said above indicates that at the beginning it is difficult to specify a true triple system and that in such a general survey it is justified not to insist on rigorous definitions. For some systems one even meets analyses with contradictory results concerning the membership of the components, as well as more or less reliable biased conclusions. In the present author's opinion it is better for this survey to avoid the apriori exclusion of any system since the cases when a rejected „uninteresting" system becomes important again are not rare. Hence, in Table 1 appears a new column (column 11) giving „connection multiple" where results of many authors concerning the membership of the components are taken into account. This column offers an insight into the present state of relationship between the system components.

Because of the unreliability in the stellar–parallax determination systems within which the parallaxes of the components are mutually discordant are also not excluded from the survey. All such cases will be subjects to a further analysis.

The thirteen columns of the survey (Table 1) of the triple systems from the IDS Catalogue closer than 200 pc contain the following data:

Column 1 Current number of a triple system in this survey
Column 2 IDS number (epoch 1900)
Column 3 ADS number
Column 4 BD number
Column 5 Spectrum of component A (the source is preferentially from the IDS; it the spectrum designation is followed by an asterisk, then the additional informationis obtainable from Table 2)

Column 6 Visual apparent magnitude of component A (source: mostly the IDS, for orbital ones Couteau's (1986) Ephemeris Catalogue).

Columns 7,8 Parallax of component A (0.001 arc seconds) and its error.

The preference is given to the trigonometric parallax or to the one derived from orbit elements. A significant number of parallaxes is taken from the General Catalogue of dynamical Parallaxes by H. N. Russel

Table 1

1	2	3	4	5	6	7	8	9	10	11	12	13
1	00008N1732	60	N17 5036	K0	9.50	005	8	3	AB-C	AB-C	(AB)	**NO
2	00008S3053	*	S3119595	F8	9.70	028	F:	2	AB-C	*	*	****
3	00054N6635	128	N66 7	G5	9.30	013	*	1	AC-B	*	*	****
4	00082N2626	161	N26 13	G0 *	6.70	007	*	5	AB-C	ABC	AB	**N*
5	00143S0883	*	S09 48	K0	3.80	010	8	3	AC-B	*	*	****
6	00158N6627	293	N66 20	B8 *	5.50	007	*	5	AB-C	ABC	AB	***f
7	00168S2334	302	S23 111	G0	7.60	015	F	2	A-BC	ABÇ	(ABC)	***F
8	00234N3645	382	N36 62	A5	9.00	006	g	2	AB-C	AB-C	*	***O
9	00248N2812	409	N28 75	F3	5.30	029	*	1	AC-B	AC	*	**N*
10	00259S1038	426	S10 89	A3	6.70	008	f	2	A-BC	ABC	(BC)	**N*
11	00276N2744	455	N27 84	G5	6.40	008	*	1	AB-C	AB	*	****
12	00288S5553	*	S56 103	A2	7.90	009	F	2	AB-C	ABC	(AB)	****
13	00298N3617	486	N36 87	K0	7.00	009	p	2	ABC	AB	*	**N*
14	00301S0368	490	S04 62	F8V	5.69	063	5	7	AB-C	AB-C	AB	*GNO
15	00307N2927	497	N29 105	F8	9.00	028	g	2	AB-C	A-B-C	*	**NO
16	00340N3019	548	N30 91	K2	3.50	022	*	1	ABC	AB-C	*	**N*
17	00372N0337	588	N03 93	F8V	7.80	020	*	5	AB-C	AB	AB	****
18	00382N3319	*	N33 99	K5	8.70	054	5	7	AB-C	A-B-C	*	*GN*
19	00383S0086	608	S01 88	G5	9.30	015	*	1	ABC	A-B	*	***o
20	00396N5440	625	N54 143	A0	5.50	010	7	3	AC-B	AC	*	****
21	00437N1624	*	N16 76	F8V	5.08	046	8	3	ABC	A-B-C	*	*GN*
22	00448N5005	684	N49 215	F5V	8.40	018	*	5	AB-C	ABC	AB	**NO
23	00473S2269	716	S23 334	G0	7.70	021	g	2	AB-C	AB-C	(AB)	****
24	00491N5826	748	N58 134	K0	5.00	006	6	3	AC-B	A-C	*	****
25	00493N1839	746	N18 122	A1 *	6.23	007	*	5	AB-C	AB	AB	****
26	00496N2305	755	N22 146	K1IV	6.02	022	*	5	AB-C	AB	AB	****
27	00507N6011	782	N59 144	B0	2.20	034	11	3	AB-C	ABC	(AB)	**Nf
28	00508N5950	784	N59 146	B9 *	6.00	010	*	5	AB-C	ABC	AB	**Nf
29	00543N0015	818	N00 159	K0	8.40	005	1	6	AB-B	A-B	*	A*No
30	00545S0144	822	S01 125	G5	9.30	011	*	5	AB-C	ABC	AB	***f
31	00587N0050	875	N00 174	F0	6.20	026	f	2	AB-C	AB	*	****
32	00599N1218	893	N12 131	G0	9.30	010	5	6	ABC	ABC	*	A*N*
33	01003N2056	899	N20 156	A2	5.60	016	f	2	ABC	AB	*	**N*
34	01015N3807	918	N37 210	F8V	8.30	011	*	5	AB-C	AB	AB	***O
35	01016N4675	*	S47 324	K0	4.00	017	11	3	AB-C	AB	(AB)	****
36	01032N0508	*	N04 190	F0	5.70	033	8	3	ABC	A-B-C	*	****
37	01041S4672	*	S47 333	A5	7.60	007	F:	2	AB-C	AB	(AB)	****
38	C1083N2403	995	N23 158	K0	4.60	014	*	1	AB-C	AB	*	**N*
39	01085N0703	996	N06 174	A5	5.60	012	f	2	A-BC	ABC	(BC)	**Nf
40	01097S0090	*	S01 162	F5	5.80	025	5	3	ABC	*	*	**N*
41	01135S0083	1057	S01 167	K1V	8.00	045	5	7	AB-C	AB	*	*GN*
42	01147S0061	1081	S01 171	F5	6.40	009	g	2	A-BC	ABC	(A)BC	****
43	01160N1101	1097	N10 168	F0	7.40	007	*	5	AB-C	AB-C	AB	****
44	01180S1289	*	S13 249	K0	7.89	046	5	7	A-BC	ABC	*	AGN*
45	01225N0450	1158	N04 251	G0V	7.60	014	*	5	AB-C	AB	AB	****
46	01242N2219	1183	N22 236	A2V	7.40	018	*	5	AB-C	AB	AB	****
47	01249N0537	*	N05 194	K2	5.10	021	6	3	A-BC	A-B	*	****
48	01288N3409	1227	N33 257	*	9.40	008	*	5	A-BC	BC	BC	**Nf
49	01304S2986	*	S30 529	K3V	7.87	056	7	7	AB-C	ABC	ABC	*GN*
50	01310N4054	*	N40 332	F8V	4.10	062	5	7	ABC	*	*	*GN*
51	01331N4033	1287	N40 340	F8	9.70	007	f	2	AB-C	AB	*	***f
52	01336N2626	1294	N26 276	F8	9.80	007	p	2	AB-C	AB	*	****
53	01339N1607	1300	N15 244	G5	7.10	006	*	1	AB-C	AB	(AB)	****
54	01347N3350	*	N33 273	G0	8.10	018	4	6	ABC	A-B	*	A*N*
55	01347N4922	1315	N49 435	K1	9.40	009	*	5	AB-C	ABC	AB	**Nf
56	01357N2514	1326	N25 276	F5	6.30	020	7	3	AB-C	AB	*	**Nf
57	01371N1947	*	N19 279	K1V	5.24	134	6	7	AB-C	A-B-C	*	*GNO
58	01429N5615	1437	N56 357	F8	9.40	006	g	2	AB-C	AB	(AB)	****
59	01432N1548	1431	N15 267	*	9.40	018	*	4	AC-B	AC	AC	***f
60	01474N2906	*	N28 312	F6IV	3.42	050	7	7	ABC	A-B-C	*	*GN*

1	2	3	4	5	6	7	8	9	10	11	12	13
61	01480N1848	1507 N18	243	A0p	4.80	019	g	2	AB-C	AB-C	*	**NO
62	01494N6047	1531 N60	383	A0	8.10	012	g	2	AB-C	AB	*	**NO
63	01494N2818	1522 N28	319	F2	7.70	005	*	5	AB-C	ABC	AB	***f
64	01513N3032	1548 N30	303	F5	8.20	007	*	5	AB-C	AB	AB	****
65	01528N7501	1588 N74	91	A0	6.70	007	6	3	AB-C	AB	(AB)	****
66	01529S0233	1567 S02	330	A0	6.60	011	p	2	AC-B	AC	(AC)	**NO
67	01538N5803	1587 N57	447	F0	8.10	014	p	2	AC-B	ABÇ	*	***f
68	01560N7538	1625 N75	86	G5	5.30	020	10	3	AB-C	*	*	**N*
69	01562N3614	1613 N36	391	G9V	8.90	017	*	5	AB-C	ABC	ABC	***f
70	01578N4151	1630 N41	395	K0	2.30	010	*	5	A-BC	ABC	AB	A*Nf
71	01580N2527	1631 N25	341d	F4	5.90	020	*	5	AB-C	AB	AB	****
72	01587S0049	1634 S01	285	G5	6.00	009	*	1	ABC	*	*	****
73	02010S2451	1652 S24	891	G5	8.70	008	12	3	A-BC	ABC	(BC)	**NF
74	02037N2528	* N25	355	F0	5.10	019	*	1	ABC	*	*	****
75	02042N1852	1678 N19	329	A3	8.30	012	f	2	AB-C	AB	*	***O
76	02059N5644	* N56	449	G0	7.00	021	7	3	ABC	A-B	*	****
77	02077S0252	1703 S03	336	F9	5.67	045	8	7	AB-C	AB	*	*GN*
78	02100N6053	1737 N60	457	G2V	8.70	015	*	5	AB-C	AB	AB	****
79	02104N1018	1727 N10	303	G0	9.70	013	2	6	AB-C	AB	*	A*N*
80	02166N4056	* N40	500	F0	5.90	024	*	1	AC-B	A-C	*	****
81	02189N4950	* N49	656	K5	4.90	009	7	3	AC-B	*	*	****
82	02212S1547	1849 S15	426	A2	5.90	009	9	3	ABC	AB	*	****
83	02248N2448	1904 N24	358	F5	5.90	022	g	2	AB-C	AB	*	****
84	02295N3652	1964 N36	519	K0	5.90	006	*	1	ABC	A-C	*	****
85	02331N6051	2018 N60	541	F0	8.00	026	f	2	AB-C	AB	*	****
86	02355N1822	2042 N18	337	B9	7.50	005	f		AB-C	ABC	*	***f
87	02374N4848	2081 N48	746	F7V	4.13	079	5	7	AB-C	AB-C	AB	*GNO
88	02381N0249	2080 N02	422	A2V	3.56	046	4	7	AB-C	ABC	ABC	*GN*
89	02409N3508	2117 N34	513	F2	6.40	013	f	2	AB-C	AB	(AB)	****
90	02418N1857	2122 N18	347d	F9	7.40	030	*	5	AB-C	AB	AB	****
91	02442N3754	* N37	646	F0	4.30	020	7	3	AC-B	A-B	*	****
92	02458N5235	2185 N52	640	B9	6.50	006	g	2	AB-C	ABC	(AB-C)	***f
93	02472N5221	2202 N52	641	G0	4.10	012	5	3	A-BC	*	*	**NO
94	02497N2628	2218 N26	484	K2	7.60	048	5	7	AB-C	ABC	*	*GN*
95	02528S2482	2242 S25	1169	G5	7.83	050	7	7	A-BC	ABC	BC	AGNF
96	02535N2056	2257 N20	484	A2	5.20	012	g	2	AB-C	AB	(AB)	****
97	02549N1736	2279 N17	471	A0	7.00	008	f	2	AB-C	AB	(AB)	****
98	02576N5307	2324 N52	654	F5	3.10	018	*	1	AB-C	ABC	*	***F
99	03027N7110	2377 N70	230	F8	8.40	019	*	5	AB-C	AB	AB	***O
100	03076N7722	2450 N77	115	F0	5.50	012	5	3	AB-C	AB-C	*	***O
101	03088N6517	2436 N65	338	A3V	6.90	006	g	2	AB-C	AB-C	AB	**N*
102	03089S4448	* S44	1025	F6	6.50	026	*	5	AB-C	ABC	AB(C)	****
103	03141N0300	* N02	518	G5V	4.84	107	6	7	ABC	A-B	*	*GN*
104	03183N2326	* WOR	4	M0	10.64	057	7	7	AB-C	ABC	(AB)	*GN*
105	03198S1560	2524 S16	630	G1V	8.30	013	*	5	AB-C	AB	AB	****
106	03202N5954	2538 N59	657	B9V	6.80	005	*	5	AB-C	AB	AB	****
107	03224N5506	2565 N54	684	A2	5.00	018	5	3	AB-C	AB	*	****
108	03226N2227	2552 N22	495	G5	6.10	021	*	1	AB-C	AB	(AB)	****
109	03247N1946	* N19	547	G5	8.10	035	6	3	ABC	*	*	****
110	03252S1129	2577 S11	673	F5	8.40	017	f	2	AB-C	AB	*	****
111	03268N5942	2612 N59	675	F3V	6.90	020	*	5	AB-C	AB	AB	**N*
112	03285N2408	2616 N23	473	A3V	6.60	006	*	5	AB-C	ABC	AB(C)	***O
113	03327N6931	2678 N69	222	A3	7.90	005	p	2	A-BC	ABC	(BC)	****
114	03352N0448	2681 N04	571	G5	6.80	008	2	6	ABC	ABC	ABC	A*N*
115	03370N4218	* N42	812	G0	7.50	029	8	3	ABC	A-B	*	****
116	03383N6821	* N68	278	K5.5	9.26	036	*	5	A-BC	BC	BC	*GN*
117	03383N3151	2730 N31	643	B5	8.90	006	f	2	AC-B	ABC	(AC)	****
118	03398N7101	* N70	259	A0	4.70	006	5	3	ABC	*	*	****
119	03472S2574	2821 S26	1453	F8	9.80	014	14	3	A-BC	A-BC	*	***O
120	03492N0454	2849 N04	601	F0	7.90	005	*	1	A-BC	ABC	(BC)	****

TRIPLE STAR SYSTEMS NEARER THAN 200 pc

1	2	3	4	5	6	7	8	9	10	11	12	13
121	03483S0275	2850 S03	631	A2	5.00	006	g	2	A-BC	AB	*	****
122	03548N0801	2923 N07	582	K0	9.20	009	f	2	A-BC	ABC	BC	****
123	03550N2255	2926 N22	617	B9	6.90	005	1	6	A-BC	ABC	*	A*Nf
124	03582S3446	* S34	1491	G0	7.20	017	13	3	AB-C	AB-C	(AB)	****
125	03594N2144	* N21	587	G1	5.90	069	5	7	ABC	*	*	*GN*
126	04009N3749	2995 N37	878	K1V	7.40	053	14	6	AB-C	ABC	AB	A*N*
127	04009N1405	* N13	642	F2	7.80	011	2	6	A-BC	ABC	*	A*N*
128	04085N0901	3072 N08	652	G5	5.10	010	*	1	AB-C	AB-C	(AB)	***F
129	04096S1030	3079 S10	867	K0	5.20	011	7	3	AB-C	AB	(AB)	**N*
130	04100N3302	3092 N32	758	*	9.80	007	*	4	AB-C	AB	*	****
131	04101N1509	* N15	603	F5	6.40	018	*	1	ABC	A-B	*	****
132	04108S0749	3093 S07	780	G8	4.43	208	42	6	A-BC	ABC	BC	A*N*
133	04138N2330	3131 N23	672	A0	7.70	029	*	4	AB-C	AB	*	***f
134	04163S0020	3152 S00	687	K2	6.10	005	10	3	AC-B	A-C	*	****
135	04174S2558	3159 S26	1642	F0 *	6.65	033	*	7	AB-C	ABC	AB	*GN*
136	04197N1742	3206 N17	719	A2	4.20	025	*	1	AB-C	ABC	(ABC)	***0
137	04199N1543	* N15	621	F7V	7.20	017	*	5	AB-C	AB	AB	**N*
138	04241N5342	3274 N53	779	B1	5.70	006	f	2	AB-C	AB	*	**Nf
139	04307N0801	3326 N07	671	A0	8.80	006	*	5	AB-C	ABC	AB	***f
140	04318S5515	* S56	663	A0 *	3.80	021	*	5	AB-C	AB-C	AB	****
141	04325N5316	3365 N53	796	A3	9.30	015	*	4	ABC	AB	*	****
142	04326N1218	* N12	618	A3	4.30	018	5	3	ABC	*	*	****
143	04372N2003	3399 N19	764	K2	9.80	036	f	2	AB-C	AB	*	****
144	04389N1058	* N10	621	A3	5.40	020	*	1	A-BC	*	*	****
145	04397N5635	3432 N56	973	A2	5.40	011	7	3	AC-B	AC	*	***0
146	04404N4313	3438 N43	1057	F0	9.50	009	*	5	AB-C	ABC	AB	**N*
147	04412S1168	3428 S12	982	F0	7.70	073	*	4	AC-B	AC-B	*	**N0
148	04440N1544	3464 N15	687	G5	6.30	005	*	1	A-BC	ABC	*	***F
149	04457N1054	3475 N10	654	F6V	7.50	024	*	5	AB-C	AB-C	AB	***0
150	04462N1329	3483 N13	728	F6	6.50	027	*	5	AB-C	AB	AB	**N*
151	04484N5156	3520 N51	999	F8	8.80	009	*	5	AB-C	ABC	AB	***f
152	04488N0713	3514 N07	754	K0	8.50	033	4	3	ABC	AB-C	*	***o
153	04493N5336	3536 N53	829	A1V	4.50	010	*	5	AB-C	ABC	AB	**Nf
154	04508N1322	3540 N13	740	K0	4.30	016	5	3	ABC	A-B-C	*	**N*
155	04545N6018	3615 N60	856	G0	4.20	007	6	3	A-BC	AB	*	***f
156	04546S1632	3588 S16	1013	F3V	5.94	024	*	5	AB-C	AB	AB	***0
157	04556N2631	3608 N26	775	G2V	7.10	019	*	5	AB-C	ABC	AB	***f
158	05022N0921	* N09	736	G0	6.30	033	4	3	ABC	A-B	*	****
159	04462N1329	3483 N13	728d	F6	6.50	027	*	5	AB-C	AB	AB	**N*
160	05038N0942	* N09	743	A2	5.40	006	10	3	ABC	*	*	****
161	05061N7907	3864 N79	169	F6V	5.04	053	5	7	AB-C	A-B	*	*GNo
162	05081N0245	3797 N02	888	K0	4.60	009	*	1	AB-C	AB	*	**N*
163	05083N0151	3799 N01	938	A5V	6.70	007	*	4	AB-C	ABC	AB	**N*
164	05141S0311	3900 S03	1061	K3V	7.75	074	5	7	AC-B	AC	(AC)	*GN*
165	05141S1814	3899 S18	1051	G0	5.95	064	13	7	ABC	A-B	*	*GNo
166	05177S2452	3954 S24	3023	G0	5.50	006	6	6	AB-C	ABC	(ABC)	A*NF
167	05188S0058	3991 S01	882	F5	6.10	021	g	2	A-BC	ABC	(A)BC	**Nf
168	05194S0229	4002 S02	1235	B1	3.80	005	g	2	AB-C	AB	(AB)	**N*
169	05208N2731	4032 N27	771	F8	8.60	010	f	2	AB-C	AB	(AB)	***0
170	05223S3526	* S35	2291	F5	7.70	008	F:	2	ABC	AB	*	****
171	05231N2504	4068 N25	839	A0	5.80	014	g	2	AB-C	AB	(AB)	****
172	05246N4919	4119 N49	1364	F5	7.50	008	1	6	AB-C	ABC	*	A*Nf
173	05246N7916	4189 N79	182	G5	9.30	017	3	6	A-BC	ABC	*	A*Nf
174	05269S0022	4134 S00	983	B0	2.50	009	9	4	ABC	ABC	*	**N*
175	05283S1754	4146 S17	1166	F0	2.70	019	*	1	ABC	AB	*	**N*
176	05307S0455	4196 S04	1188	F0	5.30	019	11	3	ABC	ABC	*	****
177	05394N0347	4329 N03	1022	B9	7.70	006	2	6	AB-C	ABC	*	A*Nf
178	05400N2117	4349 N21	978	F2	8.40	007	g	2	AB-C	AB	(AB)	***0
179	05403S2229	4334 S22	1211	F6V	3.60	123	8	7	ABC	AB	*	*GN*
180	05422N3909	4398 N39	1418	K0	4.60	016	*	1	ABC	AB-C	*	**N*

1	2	3		4	5	6	7	8	9	10	11	12	13
181	05456S0127	4442	S01	1038	G5	8.00	007	*	1	AC-B	ABC	*	***f
182	05457S4857	*	S48	1991	A0	7.50	013	F:	2	AB-C	*	*	****
183	05522N4456	4556	N44	1328	A0n	2.10	063	*	1	AC-B	AB-C	*	**Nf
184	05530N4435	4576	N44	1332	G5	6.40	007	*	1	AC-B	AC-B	(AC)	**NF
185	05534S0439	4557	S04	1310	G0	6.80	026	p	2	AC-B	AC-B	*	**N*
186	05548N3631	4592	N36	1332	A0	8.10	008	f	2	AB-C	AB	*	****
187	05566N5135	4633	N51	1146	A5	6.30	008	*	4	A-BC	ABC	(BC)	**N*
188	05566S3103	*	S31	2902	K5V	8.6	050	7	7	ABC	ABC	BC	*GN*
189	05569N0939	4617	N09	1064	A2V	4.30	025	*	5	AB-C	AB-C	AB	**NO
190	05580N2316	*	N23	1170	G8 *	4.30	019	*	5	AB-C	AB	AB	**N*
191	05592S2617	4645	S26	2675	K2	5.20	009	*	1	AB-C	*	*	****
192	06009N1046	4687	N10	1004	A0	7.50	006	g	2	A-BC	ABC	(BC)	***f
193	06011S4109	*	S41	2205	F5	8.40	007	F	2	AB-C	AB	(AB)	****
194	06018S4505	*	S45	2302	F5	5.94	040	10	6	AC-B	ABC	(AC)	A*N*
195	06108N1218	*	N12	1084	F5	5.10	042	7	3	AC-B	*	*	****
196	06136N2828	4929	N28	1078	A3n	8.00	008	*	5	AB-C	ABC	AB(C)	****
197	06162N2517	4984	N25	1238	*	10.30	018	f	2	AB-C	AB	*	***f
198	06181N5828	5036	N58	927	K2	5.50	008	*	1	ABC	ABC	*	****
199	06185N0439	5012	N04	1236	A5	4.50	024	5	3	AB-C	AB	*	****
200	06209N1535	5062	N15	1197	B9	6.80	011	f	2	A-BC	BC	*	**N*
201	06218N2051	5080	N20	1427	K0	6.60	007	*	1	ABC	A-B	*	****
202	06219N4011	5088	N40	1613	A0	8.00	008	f	2	AB-C	AB	(AB)	***f
203	06254N1660	5146	N17	1275	K0	6.30	034	*	4	AB-C	ABC	*	**NF
204	06260N5232	5178	N52	1087	A3	7.20	017	g	2	AB-C	AB-C	(AB)	**NO
205	06265N1751	5166	N17	1286	F8	7.10	006	f	2	ABC	AB	*	**N*
206	06287N0764	*	N08	1393	F8	8.50	007	2	6	ABC	ABC	*	A*N*
207	06316N4026	*	N40	1663	K0	7.70	040	27	6	ABC	ABC	*	A*N*
208	06319N1629	*	N16	1223	A0	1.90	031	6	3	ABC	*	*	****
209	06319N1216	*	N12	1219	G5	7.60	015	3	6	ABC	A-B-C	*	A*N*
210	06322N4235	*	N42	1585	G5	5.10	011	*	1	ABC	*	*	****
211	06332N4821	5300	N48	1411	F8	8.40	015	3	6	AC-B	AC	*	A*Nf
212	06399N5549	5436	N55	1122	F5	6.30	031	6	3	AB-C	AB	*	**Nf
213	06408S1635	5423	S16	1591	A1V	-1.46	377	4	7	A-BC	ABC	AB	A*N*
214	06443N5934	5514	N59	1028	F5	5.70	006	*	5	ABC	AB	AB	**Nf
215	06462N3365	5532	N34	1481	A2	3.60	021	6	3	ABC	*	*	****
216	06462N3858	5534	N39	1771	F2	6.20	013	*	1	ABC	AB	*	****
217	06478N4841	5555	N48	1450	F2	8.20	006	f	2	AB-C	ABC	*	***f
218	06490N1318	5559	N13	1462	F0Vp	4.74	031	*	5	AB-C	AB	AB	**N*
219	06545N2724	5671	N27	1294	G0	10.20	013	*	4	AB-C	AB	(AB)	****
220	06550N5419	5706	N54	1101	G0	7.70	005	f	2	A-BC	ABC	(BC)	**Nf
221	06577N5254	5746	N52	1165	A2	6.90	017	g	2	AB-C	AB	(AB)	**Nf
222	07009S4328	*	S43	2906	G3V	5.54	057	6	7	AB-C	ABC	*	AGNF
223	07023N1541	*	N15	1473	F8	7.40	021	6	3	ABC	BC	*	****
224	07026N1566	5812	N16	1397	K0	5.60	011	12	3	AB-C	A-B-C	*	**N*
225	07034N2554	5827	N25	1594	G0	7.00	030	*	1	AC-B	A-B-C	*	**NO
226	07040S1350	5824	S13	1842	A2	9.00	010	f	2	ABC	AB	*	****
227	07048N3025	5846	N30	1439	K0	4.50	012	*	1	AB-C	AB	*	**N*
228	07064N4840	5879	N48	1489	A0	7.70	011	p	2	AC-B	AC	(AC)	***f
229	07066N2724	5871	N27	1337	F8V	7.18	030	11	3	AB-C	AB	AB	***O
230	07076N1620	*	N16	1417	Mb	5.30	009	7	3	ABC	*	*	****
231	07078N2511	*	N25	1613	K0	8.40	037	5	3	AB-C	A-C	*	**NO
232	07093N6342	5948	N63	700	K2	9.50	008	2	6	A-BC	ABC	*	A*Nf
233	07103S1518	5925	S15	1720	F8	7.80	007	*	5	AB-C	ABC	AB	***f
234	07113S4429	*	S44	3237	A5	9.60	015	F:	2	A-BC	ABC	*	****
235	07124S1151	5956	S11	1874	F5	7.40	006	*	5	AB-C	ABC	AB	**Nf
236	07154N3657	6009	N37	1707	K0	5.20	021	6	3	ABC	A-C	*	****
237	07182N2139	6038	N21	1589	B9	8.50	008	g	2	AB-C	AB	(AB)	****
238	07206N1842	6073	N18	1616	F0	8.10	007	2	6	ABC	ABC	*	A*N*
239	07218N2139	6089	N21	1602	F5	5.30	030	6	3	ABC	AB	*	**N*
240	07223N4952	*	N49	1630	F5	5.40	044	7	3	ABC	A-B	*	****

1	2	3	4	5	6	7	8	9	10	11	12	13
241	07227N0867	6100	N09 1660	K0	4.60	016	5	3	ABC	A-C	*	****
242	07268S0019	6155	S00 1746	A0	9.80	010	f	2	AB-C	AB	*	***f
243	07282N3166	6175	N32 1581	A1V	1.94	069	4	7	AB-C	ABC	AB	AGN*
244	07323S0353	*	S03 1979	F5	5.20	027	5	3	AC-B	ABC	*	***F
245	07328S0222	6232	S02 2207	A5	8.40	009	f	2	AB-C	ABC	(ABC)	***f
246	07347S2634	6255	S26 4707	B5	4.50	010	F	2	ABC	AB-C	*	****
247	07348N0528	6263	N05 1742	A0	6.40	008	10	3	AB-C	AB	(AB)	****
248	07377N6418	6336	N64 649	A2	6.82	008	2	6	ABC	ABC	*	A*N*
249	07411N3340	6364	N33 1585	K2	5.30	013	5	3	AC-B	A-C	*	**N*
250	07529S0033	6487	S00 1866	K5	7.99	063	10	7	AB-C	AB-C	(AB)	*GNO
251	07543N5454	6516	N55 1240	A0	8.20	006	f	2	AB-C	AB	(AB)	***f
252	07574N2764	*	N28 1532	K0	5.20	014	6	3	ABC	*	*	****
253	07575N4734	6552	N47 1522	F5	8.50	010	f	2	AB-C	ABC	(AB)	***f
254	08009N2549	*	N25 1848	*	10.00	025	13	3	ABC	*	*	****
255	08037N3545	*	N35 1767	F8	6.60	022	6	3	ABC	A-B	*	****
256	08044N2549	*	N25 1865	G5	5.80	029	7	3	ABC	A-B	*	****
257	08054N3246	*	N32 1695	G0	7.00	043	5	3	AB-C	A-B-C	*	****
258	08065N1757	6650	N18 1867	F7	5.60	063	7	6	AB-C	ABC	ABC	A*N*
259	08082N5724	*	N57 1128	G5	8.00	019	6	3	ABC	A-B	*	****
260	08096S3126	*	S31 5719	G0	6.70	019	12	3	ABC	*	*	****
261	08097N7243	6724	N72 409	K5	6.30	006	*	1	ABC	AB	*	****
262	08100N4072	6700	N41 1810	G0	9.00	012	3	6	A-BC	ABC	(ABC)	A*N*
263	08119S3037	*	S30 5946	G5	6.30	009	F	2	AB-C	AB	(AB)	****
264	08173N2020	6776	N20 2070	F5	9.90	022	*	5	AB-C	AB	AB	****
265	08178S1022	6777	S10 2495	G0	9.69	008	3	6	AB-C	ABC	*	A*Nf
266	08194S0049	*	S00 1987	G0	6.90	036	6	3	ABC	*	*	****
267	08207N2452	6811	N25 1920	A3	7.02	012	2	6	A-BC	ABC	(A)BC	A*Nf
268	08226S3844	*	S38 4462	A0	6.70	005	f	2	A-BC	ABC	(BC)	****
269	08234S0211	6828	S02 2581	A5m	7.00	015	*	5	AB-C	ABC	AB	**Nf
270	08288S2416	6871	S24 7089	A8IV	6.90	014	*	5	AB-C	AB	AB	****
271	08344N1154	*	N12 1888	K1V	7.62	050	4	7	A-BC	A-B	*	*GN*
272	08348S2219	6914	S22 6442	G6IV	5.40	062	*	5	AB-C	AB	AB	*GN*
273	08373N0956	*	N10 1857	M0	9.70	064	6	7	AC-B	ABC	(ABC)	*GN*
274	08388S0652	*	S06 2708	G0	4.70	006	*	1	ABC	AB	*	**N*
275	08441N0874	7021	N09 2063	A5	7.90	007	*	5	AB-C	AB	AB	****
276	08449N3147	7042	N31 1891	*	10.30	014	f	2	AB-C	AB	*	****
277	08460N1230	7049	N12 1925	F0	7.90	014	f	2	AB-C	A-B-C	*	***O
278	08460N7071	7067	N71 482	K5V	8.69	091	4	7	AB-C	AB-C	AB	*GNO
279	08482N3057	7071	N31 1907	K0	6.10	007	1	6	AB-C	AB	(AB)	A*Nf
280	08490N2636	7082	N26 1865	G2V	7.00	020	*	5	AB-C	AB-C	AB	***O
281	08524N4826	7114	N48 1707	A7IV	3.14	066	6	7	A-BC	ABC	ABC	AGN*
282	09016N6732	7203	N67 577	F6IV	4.85	052	6	7	AB-C	ABC	AB	AGN*
283	09017N2283	7187	N23 2048	F5	6.90	015	f	2	ABC	AB	*	**N*
284	09029N2662	*	N27 1715	G5	6.00	042	6	3	ABC	A-B	*	****
285	09029S0644	7198	S06 2825	G0	8.50	049	*	4	ABC	AB-C	(AB)	***o
286	09088S4312	*	S43 5041	B8	6.70	005	F	2	AC-B	ABC	(AB)	****
287	09092N0244	7253	N02 2167	A0	3.80	019	6	3	ABC	A-B-C	*	**N*
288	09106S0049	7266	S00 2164	G5	8.70	018	7	3	AB-C	A-B	*	**N*
289	09138N5141	7303	N51 1495	F2	6.10	037	7	3	AC-B	AC-B	(AC)	***O
290	09147N3837	7307	N38 2025	F4V	6.76	020	*	5	AB-C	AB	AB	***f
291	09156S0908	7311	S08 2643	G5	4.80	015	2	6	A-BC	ABC	*	A*NF
292	09159S6816	*	S68 918	F4V	6.20	043	*	5	A-BC	AB	AB	****
293	09180N2780	7344	N28 1745	F5	8.30	010	g	2	AB-C	ABC	(AB)	***O
294	09180S0925	7334	S09 2816	A5p	7.30	023	*	5	AB-C	AB	AB	***f
295	09188N2637	7351	N26 1930	K0	4.60	016	*	1	AB-C	AB	(AB)	**N*
296	09193S2314	7350	S23 8331	F2	7.80	005	F:	2	AB-C	AB	*	****
297	09219N3154	7384	N32 1884	G0	9.40	007	f	2	AB-C	AB	(AB)	****
298	09221N4563	*	N46 1509	G5	5.41	012	3	6	ABC	ABC	(AB)	A*N*
299	09236N6330	7402	N63 845	F0	3.80	034	6	3	ABC	AB-C	*	**NO
300	09247N3366	*	N34 1999	K0	5.85	020	5	6	ABC	ABC	*	A*N*

1	2	3	4	5	6	7	8	9	10	11	12	13
301	09260N6674	7425	N67 597	F5	8.21	011	3	6	AB-C	ABC	*	A*Nf
302	09264N2029	7415	N20 2334	F5	8.50	024	*	4	ABC	AB-C	*	****
303	09291N3984	7438	N40 2226	F2	6.77	014	3	6	AB-C	ABC	*	A*N*
304	09387N4341	7503	N43 1958	F5	8.90	015	f	2	AB-C	AB	*	****
305	09452N3657	7541	N37 2023	F2	8.50	005	*	5	AB-C	AB	AB	****
306	09468N6882	7566	N69 542	F5	9.50	005	f	2	AB-C	AB	*	****
307	09476S0738	7555	S07 2909	A1V	5.58	012	*	5	AB-C	ABC	AB	***O
308	10007N6856	*	N69 558	K0	9.00	024	8	3	ABC	A-B	*	****
309	10036S1915	7655	S19 2926	G0	7.20	015	13	3	AB-C	AB-C	*	****
310	10053N4958	*	N50 1725	K7V	6.59	222	7	7	ABC	A-B	*	*GN*
311	10057S1152	7671	S11 2820	K0	3.80	014	10	3	ABC	A-B-C	*	**N*
312	10070S6812	*	S68 1034	A0	6.80	007	F:	2	AB-C	ABC	(AB)	****
313	10098N7134	7705	N71 534	A3	6.70	007	1	6	ABC	ABC	(AC)	A*N*
314	10137S6050	*	S60 1817	K5	3.40	018	12	3	ABC	*	*	****
315	10172S5532	*	S55 3286	B5p	4.70	008	F	2	AB-C	ABC	*	****
316	10235S2518	7787	S25 8055	G0	8.80	010	*	5	AB-C	ABC	AB(C)	***f
317	10299N2647	7839	N27 1907	G5	10.00	019	f	2	AB-C	AB	*	***O
318	10353S5505	*	S54 3915	G0	4.40	015	11	3	ABC	AB	*	****
319	10382N0476	7902	N05 2384	K0	6.30	007	*	1	AC-B	AC	*	**N*
320	10427S1443	7930	S14 3188	A0	6.80	012	f	2	A-BC	AB	*	**NO
321	10427S1505	*	S14 3184	F8	7.80	016	*	1	ABC	AB	*	****
322	10494S5819	*	S58 2834	K0	3.90	050	11	3	ABC	A-B-C	*	****
323	10596S0341	8048	S03 3040	G5	7.50	026	*	5	A-BC	ABC	(A)BC	**NF
324	11052N6633	*	N66 704	G5	8.25	025	6	6	ABC	A-B-C	*	A*NO
325	11088N7361	8100	N74 456	K5	7.72	074	6	7	AC-B	AC-B	(AC)	*GNO
326	11088N2064	*	N21 2298	A4V	2.56	059	10	7	ABC	A-B	*	*GN*
327	11093N0548	8098	N06 2421	K0	8.40	033	17	6	A-BC	ABC	*	A*N*
328	11104S1734	*	*	M0V	10.10	053	6	6	A-BC	ABC	*	A*N*
329	11104S1736	*	S17 3336	M1	9.96	062	6	7	AB-C	ABC	*	*GN*
330	11179N0441	8145	N04 2454	F5	8.80	005	*	5	AB-C	AB	AB	**Nf
331	11217N0333	8162	N03 2502	K0IV	6.52	057	6	7	ABC	AB	*	*GN*
332	11242S1648	8179	S16 3258	G0	9.10	009	f	2	A-BC	ABC	(BC)	**N*
333	11247S2355	8183	S2310009	F1	5.80	021	p	2	AB-C	AB	*	***f
334	11270S0259	8200	S02 3364	K0	8.70	018	f	2	A-BC	ABC	*	***f
335	11310N2780	8231	N28 2022	A3	6.40	012	g	2	AB-C	ABC	(AB)	***f
336	11382S3853	*	S38 7289	G0	8.40	011	2	6	A-BC	ABC	(BC)	A*N*
337	11397S4852	*	S48 6770	K0	9.20	023	*	5	AB-C	AB	AB	**N*
338	11428N0848	*	N09 2549	A0	5.20	012	7	3	*	AB	*	****
339	11454N0179	*	N02 2489	F8V	3.60	100	5	7	ABC	A-B-C	*	*GN*
340	11511N3560	8355	N36 2225	F2	6.80	020	5	6	AC-B	AC	(AC)	A*N*
341	12010S3224	*	S32 8503	G0	6.70	010	F:	2	ABC	AB	*	****
342	12043S1118	8440	S11 3246	G0	6.90	053	g	2	ABC	AB-C	(AB)	***O
343	12091N3280	8470	N33 2205	K0	6.90	014	p	2	A-BC	AB	*	***f
344	12091S0510	8471	S04 3235	A5	6.50	010	11	3	ABC	A-C	*	***o
345	12100S0642	8477	S06 3532	G5	7.96	031	9	6	AB-C	ABC	(AB)	A*N*
346	12105N5735	*	N57 1363	A3V	3.31	053	5	7	ABC	*	*	*GN*
347	12136N1181	8506	N12 2446	G0	9.40	014	f	2	AB-C	AB	*	****
348	12175N2584	8530	N26 2337	F5	4.81	011	1	6	ABC	ABC	*	A*N*
349	12194N2568	8539	N26 2345	A7V	6.76	011	*	5	AB-C	AB	AB	****
350	12210S6233	*	S62 2745	B1	1.60	008	g	2	AB-C	AC-B	*	****
351	12232S5550	*	S55 5084	K0	6.20	014	11	3	ABC	*	*	****
352	12239N2588	8568	N26 2354	A0	5.40	019	6	3	A-BC	AB	*	***f
353	12245N2964	8570	N30 2281	G5	9.30	011	1	6	AC-B	ABC	*	A*Nf
354	12253N5165	*	N52 1631	F8	6.20	037	7	3	ABC	A-C	*	** O
355	12294N0591	8598	N06 2630	F5	9.20	005	f	2	AB-C	ABC	(AB)	***f
356	12300N0760	8601	N08 2621	F8	7.90	021	g	2	AB-C	AB-C	(AB)	**NO
357	12358N4050	8623	N41 2317	G0	8.65	014	4	6	AB-C	ABC	(AB)	A*N*
358	12360S4825	*	S48 7597	A1IV	3.10	025	*	5	AB-C	AB	AB	****
359	12361S1228	8627	S12 3676	F5	6.00	014	g	2	AB-C	AB	(AB)	**Nf
360	12409N1042	*	N10 2466	G5	9.60	005	1	6	ABC	*	*	A*N*

TRIPLE STAR SYSTEMS NEARER THAN 200 pc

1	2	3	4	5	6	7	8	9	10	11	12	13
361	12462S0948	8684	S09 3569	K0	6.50	008	*	1	AB-C	AB	(AB)	****
362	12470N1943	8690	N19 2613	A8	7.34	018	4	6	AB-C	ABC	*	A*N*
363	12472N1737	*	N17 2551	K5	6.36	008	1	6	AB-C	ABC	*	A*N*
364	12484N2147	8695	N22 2519	F8 *	5.05	015	*	5	AB-C	ABC	AB	**Nf
365	12519N5438	8710	N54 1556	A2	6.00	012	g	2	AB-C	ABC	(AB)	** f
366	12554S0250	8732	S02 3609	K6	6.10	008	*	1	AB-C	AB-C	(AB)	**N*
367	12557N1855	8735	N19 2622	F5	6.23	011	1	6	A-BC	ABC	*	A*Nf
368	12582S0553	8755	S05 3619	F0	8.70	014	f	2	AB-C	AB	*	****
369	13017N7334	8772	N73 583	A5	6.50	011	g	2	AB-C	AB	(AB)	****
370	13048S0500	8801	S04 3430	A0	4.40	005	f	2	AB-C	ABC	*	**NC
371	13051N1763	8804	N18 2697	F6V	5.05	053	4	7	AB-C	AB-C	AB	*GNC
372	13065N3082	8811	N31 2462	G5	9.50	006	*	2	AC-B	ABC	(AC)	***f
373	13090S2345	8831	S2310974	A2	7.30	011	*	5	AB-C	ABC	AB	****
374	13095N5674	*	N57 1425	G1V*	6.84	037	5	7	ABC	A-B	*	*GN*
375	13101N6749	*	N68 720	K0	6.54	007	3	6	ABC	AB-C	*	A*N*
376	13118N1733	8841	N17 2611	K2V	6.58	087	7	7	AB-C	AB	(AB)	*GN*
377	13244N2242	8918	N22 2584	F8	8.10	017	g	2	AB-C	AB	*	****
378	13252N5987	8919	N60 1464	F8	5.41	013	2	6	A-BC	ABC	(BC)	A*Nf
379	13275S1451	*	S14 3739	K0	5.60	010	*	1	AC-B	A-B	*	****
380	13283N3485	8939	N35 2462	A6 *	7.30	008	*	5	AB-C	AB	AB	***f
381	13294S1242	8954	S12 3843	A0Vp	6.50	010	*	5	AB-C	AB-C	AB	**NO
382	13304S6111	*	S61 3841	F6V	6.20	032	*	5	AB-C	AB	AB	****
383	13326N0254	8975	N03 2799	K0	6.90	008	1	6	AB-C	ABC	*	A*N*
384	13330N3648	8974	N37 2433	F7 *	5.01	018	*	5	AB-C	AB	AB	**NO
385	13338N4839	8980	N48 2138	M0ep	10.1	054	8	7	AB-C	ABC	(AB)	*GN*
386	13346N1075	8987	N11 2589	F0V	6.30	016	*	5	AB-C	AB-C	AB	***O
387	13359N1988	8991	N20 2858	A2	5.70	018	g	2	AB-C	AB	(AB)	****
388	13383S0346	9002	S03 3522	K2	7.10	005	*	1	ABC	AB	*	****
389	13397N7681	8997	N77 519	A5	6.70	011	2	6	ABC	ABC	*	A*N*
390	13402N1781	*	N18 2776	M1	9.83	097	7	7	*	A-B-C	*	*GN*
391	13485N6473	9039	N65 963	M3	4.80	008	*	1	ABC	A-C	*	****
392	13485N6849	*	N69 724	K0	6.40	023	11	3	ABC	A-B	*	****
393	13498S5338	*	S53 5805	A2	6.70	012	F	2	AB-C	AB	(AB)	****
394	13548N2544	*	*	K5	10.60	027	8	3	ABC	*	*	**N*
395	13566N0162	9085	N02 2761	A2	4.30	015	5	3	ABC	AB	*	****
396	13586N5742	9089	N57 1478	F5	8.40	009	*	5	AB-C	AB	AB	****
397	14056N2664	9136	N27 2342	G5	8.80	011	f	2	AB-C	AB	(AB)	****
398	14071S2932	9156	S2910904	F2	9.40	019	F:	2	AB-C	AB	(AB)	****
399	14088S0803	9170	S07 3799	F2	9.40	008	f	2	AB-C	AB	(AB)	***f
400	14126N5150	9198	N52 1784	A5	4.90	044	7	3	ABC	*	*	****
401	14133S2522	9212	S2510271	F4	5.86	045	6	7	AC-B	AC-B	*	*GNC
402	14174S0719	9237	S07 3834	G0	7.60	022	g	2	AB-C	AB	(AB)	****
403	14185N0854	9247	N09 2882	A0	5.10	016	*	4	A-BC	ABC	BC	***f
404	14196N4763	9249	N48 2193	G5	9.80	005	g	2	AB-C	AB-C	(AB)	***O
405	14199S1931	9258	S19 3880	A0	6.40	005	g	2	A-BC	ABC	(BC)	**N*
406	14218N5179	*	N52 1804	F7V	4.06	068	6	7	AB-C	ABC	*	*GN*
407	14230S0147	9273	S01 2957	K0	5.00	020	g	2	AB-C	ABC	*	***F
408	14255N5457	9281	N55 1686	K0	8.80	022	f	2	AC-B	AC-B	(AC)	****
409	14258S1511	9291	S14 3970	G5	8.30	035	9	3	AB-C	AB	(AB)	****
410	14277N7568	9286	N76 527	K2	4.40	014	*	1	ABC	AC-B	*	****
411	14290N4937	9306	N49 2308	F5	7.80	036	f	2	AB-C	ABC	*	***f
412	14295N3561	9312	N36 2505	G5	8.00	015	f	2	AB-C	AB-C	*	****
413	14304N2971	*	N30 2536	F2V	4.47	057	7	7	ABC	A-B	*	*GN*
414	14307N0041	9318	N00 3206	G5	8.30	009	f	2	A-BC	BC	(BC)	***O
415	14308N4542	*	S45 9302	K0	6.20	016	9	3	AB-C	ABC	(AB)	****
416	14328S6025	*	S60 5483	G2V	-0.01	743	7	7	AB-C	ABC	AB(C)	AGN*
417	14339N4769	9327	N48 2224	G5	10.00	017	5	6	AC-B	ABC	*	A*N*
418	14360N1651	9338	N17 2768	A0	4.93	011	2	6	AB-C	ABC	(AB)	A*N*
419	14364N1369	9343	N14 2770	A2 *	4.52	012	*	5	AB-C	AB	AB	****
420	14382N5783	9346	N58 1523	K0	7.50	025	g	2	AB-C	AB	(AB)	****

1	2	3	4	5	6	7	8	9	10	11	12	13
421	14406N2730	9372	N27 2417	K0	2.70	007	g	2	AB-C	ABC	(AB)	**NF
422	14411S0658	9379	S06 4071	G0	8.40	013	g	2	AB-C	AB-C	(AB)	****
423	14435S2350	9394	S2311915	K0	5.80	006	*	1	A-BC	A-BC	*	****
424	14535S1044	9456	S10 3999	K0	6.00	007	*	1	AB-C	AB	*	**Nf
425	14565S1953	9475	S19 4004	F8	9.20	005	F	2	AB-C	AB	*	***f
426	14588S4041	*	S40 9257	G5	5.30	013	9	3	ABC	*	*	****
427	15002S0638	9497	S06 4130	G0	8.00	018	g	2	AB-C	AB.	(AB)	****
428	15009N3451	9496	N35 2648	F8	8.80	006	f	2	AB-C	AB	*	****
429	15029N2475	*	N25 2873	F5V	4.93	056	5	7	ABC	A-B	*	*GN*
430	15036S0036	9514	S00 2933	G0	9.10	013	5	6	AB-C	ABC	(AB)	A*N*
431	15139N4370	9573	N44 2444	G5	9.40	017	3	6	AB-C	ABC	(AB)	A*N*
432	15139N1048	9580	N10 2823	F8	7.00	028	g	2	AB-C	AB	(AB)	****
433	15155S3554	*	S3510236	K5	3.60	008	10	3	ABC	*	*	****
434	15159S4420	*	S4410066	B3	4.00	009	F:	2	AB-C	ABC	(AB)	****
435	15180N6036	*	N60 1606	F0	7.40	016	5	6	ABC	AB	*	A*N*
436	15207N3742	9626	N37 2636	F0	4.50	036	3	6	A-BC	ABC	(BC)	A*N*
437	15228S0900	*	S08 3981	K1	6.90	061	6	7	ABC	ABC	*	*GN*
438	15229S2831	`9659	S2811366	F8	8.10	017	F	2	AB-C	ABC	(AB)	***f
439	15230N4421	9639	N44 2465	G5	7.60	018	g	2	AB-C	AB	(AB)	****
440	15250S3329	*	S3310564	A2	7.70	017	F	2	AB-C	ABC	(ABC)	****
441	15266N5747	9672	N57 1590	F8	6.90	024	7	3	AC-B	A-C	*	**N*
442	15272S2409	9689	S2412155	A3	7.50	010	*	5	A-BC	ABC	BC	***f
443	15282N4074	9688	N41 2611	A2	5.80	008	*	5	AB-C	ABC	AB	****
444	15296N2663	9695	N27 2507	G0	9.40	024	f	3	ABC	AB-C	*	****
445	15299S1427	9704	S14 4237	K0	4.00	020	*	4	AB-C	ABC	*	***f
446	15314S5203	*	S51 9324	A0	5.50	009	10	3	A-BC	*	*	****
447	15338N3026	9727	N30 2684	F8	8.80	020	f	2	AB-C	AB	*	****
448	15350N8047	9696	N80 480	G5	6.90	028	7	3	AB-C	AB	*	****
449	15372S1541	9751	S15 4165	G4	7.30	007	p	2	AB-C	AB	(AB)	****
450	15393N0644	9765	N06 3088	K2 *	2.64	049	4	7	ABC	A-B-C	*	*GN*
451	15410S3736	*	S3710500	G6V	6.02	073	6	7	ABC	AB-C	(AB)	*GN*
452	15416N1544	9778	N15 2911	A2	3.67	029	4	6	AB-C	ABC	*	A*N*
453	15464S0541	9810	S05 4182	K0	8.90	008	g	2	AB-C	AB	(AB)	****
454	15508N8137	9798	N81 530	G5	8.70	017	10	3	AC-B	*	*	****
455	15512N6024	9832	N60 1639	G5	9.40	029	*	4	AB-C	AB	(AB)	****
456	15518N1559	*	N16 2849	F6V	3.86	081	8	7	ABC	A-B	*	*GN*
457	15534N2670	9859	N27 2558	K0	4.20	021	6	3	AC-B	AC-B	(AC)	****
458	15535S3807	*	S3810797	B3	3.60	008	F:	2	AB-C	ABC	*	****
459	15540N4157	9861	N42 2653	F5	9.20	013	p	2	AB-C	AB	*	****
460	15554S5730	*	S57 7500	A7IV	5.30	028	*	5	AB-C	ABC	AB	****
461	15556N1158	9872	N12 2930	G0	8.50	006	g	2	AC-B	ABC	(AC)	***f
462	15584N5873	9891	N59 1694	A3	8.20	010	f	2	AC-B	ABC	(ABC)	***O
463	15589S1106	9909	S10 4237	F5IV	4.16	045	3	6	AB-C	ABC	AB(C)	A*Nf
464	15593S3235	*	S3211405	K0V	8.30	026	*	5	AB-C	ABC	AB	****
465	15596S2013	9914	S20 4395	G5	9.50	024	F:	2	AC-B	AC	(AC)	****
466	16014N1336	9922	N13 3064	K0	6.90	007	1	6	AB-C	ABC	(AB)	A*N*
467	16036N1719	9933	N17 2964	G5	5.30	011	8	3	ABC	ABC	(AB)	**N*
468	16054S7827	*	S78 1092	M5	4.80	013	10	3	ABC	AB	*	****
469	16057S2718	9948	S2710836	A5	8.40	014	F:	2	AC-B	AC	*	****
470	16058N4537	9940	N45 2377	F5	8.80	010	p	2	AB-C	AB	*	***f
471	16078N3336	9958	N33 2696	K0	6.40	009	f	2	AB-C	AB	*	****
472	16086N1348	9969	N13 3091	K0	7.39	048	4	7	AB-C	AB-C	(AB)	*GNO
473	16109N3367	9979	N34 2750	G0V	5.58	045	4	7	AB-C	ABC	AB	*GN*
474	16175S3258	*	S3211687	A0	7.10	009	F	2	AB-C	ABC	*	****
475	16175N1923	10022	N19 3086	F0	3.80	015	8	3	ABC	A-B	*	****
476	16179S4855	*	S4810809	G5	8.00	039	F	2	AB-C	AB-C	(AB)	****
477	16198N3335	10036	N33 2722	*	9.60	008	*	4	AB-C	ABC	(ABC)	****
478	16212N4836	*	*	M3	10.27	138	6	7	A-BC	*	*	*GN*
479	16226N6144	10058	N61 1591	G8 *	2.74	046	10	7	AC-B	AC-B	*	AGN*
480	16234N2067	10069	N21 2926	G0	8.30	013	*	1	AC-B	AC-B	*	**NO

1	2	3	4	5	6	7	8	9	10	11	12	13
481	16245N1837	10075	N18 3182	K1V	7.75	053	5	7	AB-C	AB-C	AB	*GN*
482	16254S1624	10086	S16 4298	K0	4.40	009	11	3	ABC	*	*	****
483	16325S4735	*	S4710924	F5	8.10	012	F:	2	AB-C	AB-C	(AB)	****
484	16356N0003	10150	S00 3560	F8	9.40	024	f	2	AB-C	AB	*	****
485	16381S2716	10173	S2711103	A0	6.60	012	F:	2	AB-C	ABC	(AB)	***f
486	16384N2351	10171	N23 2978	G5	9.00	006	f	2	AB-C	AB	*	****
487	16410N0846	*	N08 3271	K2	5.40	007	6	3	ABC	ABC	*	****
488	16412N3555	10193	N35 2864	G5	9.60	005	f	2	AB-C	AB	(AB)	****
489	16420N0832	10206	N08 3275	G0	9.80	005	g	2	AB-C	AB	(AB)	****
490	16435N2549	10216	N25 3136	*	9.30	033	9	6	AB-C	ABC	*	A*N*
491	16475N7741	10214	N77 634	F2	6.10	027	5	3	AB-C	AB-C	*	***O
492	16479N2850	10235	N28 2624	F4V	6.80	018	*	5	AB-C	AB	AB	****
493	16501S0809	*	S08 4352	dM3e	9.76	161	4	7	AB-C	ABC	AB	*GN*
494	16551N4731	10288	N47 2415	K8	7.79	057	6	7	AC-B	ABC	(AB)	AGNf
495	16597S0456	*	S04 4225	K5V	7.73	091	5	7	ABC	AB	*	*GN*
496	17008N2814	10332	N28 2661	K0	7.29	006	1	6	AB-C	AC-B	*	A*No
497	17015N0047	10341	N00 3633	G0	8.70	022	*	5	AB-C	ABC	AB	***f
498	17024S1940	10353	S19 4533	F8	10.10	007	F:	2	AB-C	AB	(AB)	****
499	17033N5436	10345	N54 1857	F7V	5.65	036	*	5	AB-C	ABC	AB	***F
500	17060S2655	10388	S2611990	G5	6.90	007	F	2	AB-C	AB	*	****
501	17078N2121	10394	N21 3063	K0	7.50	018	12	3	AB-C	*	*	**N*
502	17092N4551	*	N45 2505	dM4	9.96	155	5	7	AB-C	AB-C	AB	*GN*
503	17109N5414	10410	N54 1869	F0	6.91	010	1	6	AB-C	ABC	*	A*N*
504	17121S3453	*	S3411626	K3V	6.30	140	5	7	AB-C	ABC	AB(C)	*GN*
505	17128S2353	10452	S2313308	A0	9.50	007	F:	2	AC-B	AC	*	****
506	17140S1739	10465	S17 4773	A0	6.30	012	g	2	AB-C	ABC	*	** f
507	17168N2436	*	N24 3167	A0	5.10	007	7	3	ABC	AB	*	****
508	17169N3236	10488	N32 2896	G2V	5.39	073	5	7	A-BC	A-BC	*	*GNO
509	17182S5032	*	S5011269	K1	5.20	023	10	3	ABC	*	*	****
510	17195S4545	*	S4511531	B9	6.00	009	F	2	AB-C	ABC	(AB)	****
511	17202N3714	10526	N37 2878	A0	4.50	010	g	2	AB-C	AB	(AB)	**N*
512	17255N2929	10585	N29 3029	A3	9.30	046	5	7	A-BC	A-BC	BC	*GNo
513	17282N5223	10611	N52 2065	G0	3.00	011	*	1	AC-B	ABC	*	***F
514	17298N1314	10633	N13 3397	G5	6.70	014	*	1	AB-C	AB	*	****
515	17331N2757	*	N27 2853	*	11.00	031	*	5	A-BC	ABC	BC	**N*
516	17341N0205	*	N02 3373	K0	6.40	008	*	1	ABC	ABC	*	****
517	17370N2434	10715	N24 3225	K0	6.44	008	1	6	AB-C	ABC	*	A*NF
518	17375N1560	10723	N16 3255	F4Vw	5.60	033	*	5	AB-C	ABC	AB	**N*
519	17394S0142	*	S01 3386	K2	8.20	045	14	6	ABC	ABC	*	A*N*
520	17412S0426	10775	S04 4349	G0	9.50	009	11	3	ABC	AB	*	****
521	17415S0111	10781	S01 3389	G0	8.50	018	4	6	AB-C	ABC	(AB)	A*N*
522	17421N1449	10784	N14 3335	G0	8.70	012	f	2	ABC	AB	*	****
523	17425N2747	10786	N27 2888	G5IV	3.42	124	5	7	A-BC	ABC	BC	*GN*
524	17431S3701	*	S3711907	K2	3.20	032	11	3	ABC	*	*	****
525	17476S0753	10858	S07 4517	G2	7.60	013	7	3	AB-C	AB	AB	****
526	17512S3600	*	S3512103	A0	7.00	034	F:	2	ABC	AB	*	****
527	17527S3015	*	S3015035	M0	5.30	005	9	3	AB-C	AB	*	****
528	17528N1058	10916	N10 3337	K5	8.80	006	*	5	AB-C	AB	AB	***f
529	17558S2731	10984	S2712272	B8	8.60	006	F:	2	ABC	AB	*	****
530	17576S0811	11005	S08 4549	F4IV	5.24	045	8	7	AB-C	ABC	AB	*GNf
531	17577N0137	11002	N01 3565	A0	9.10	013	f	2	AC-B	AC	(AC)	***f
532	17581N5251	10988	N52 2125	G0	8.10	022	g	2	AB-C	AB	(AB)	****
533	17584N2620	11003	N26 3151	K0V	7.01	054	6	7	ABC	A-B-C	*	*GN*
534	17592N2603	11012	N26 3157	A3	9.20	006	f	2	AB-C	AB	(AB)	****
535	18004N0232	11046	N02 3482	K0Ve	4.20	195	5	7	AC-B	ABC	ABC	AGN*
536	18011N1200	11056	N12 3383	A0	7.00	009	f	2	AB-C	AB-C	*	****
537	18021N0852	*	N08 3581	F5	7.80	007	8	3	ABC	*	*	****
538	18031S2607	11096	S2612862	G0	7.50	014	12	3	ABC	*	*	****
539	18032N3033	11077	N30 3128	F7V	5.10	061	4	7	AB-C	AB	AB	*GN*
540	18038N2605	11089	N26 3178	A3	5.90	012	f	2	AB-C	AB	*	**N*

1	2	3	4	5	6	7	8	9	10	11	12	13
541	18046N0359	11111	N03 3610	F2V	6.07	018	*	5	AB-C	ABC	AB	**N*
542	18049N0306	11113	N03 3613	F5	5.70	037	5	3	AC-B	AB	*	**N*
543	18076N7959	11061	N79 571	F5	5.80	021	5	3	AB-C	AB	(AB)	**N*
544	18078S1537	11166	S15 4874	F5	7.30	010	f	2	ABC	ABC	(AC)	****
545	18079N0548	11160	N05 3643	B9	8.10	011	g	2	AB-C	AB	*	**N*
546	18081N3325	11148	N33 3044	A2	6.40	013	*	5	AB-C	ABC	ABC	**N*
547	18095N4121	11174	N41 3010	F5	8.60	010	f	2	AB-C	AB	(AB)	****
548	18123N2247	11223	N22 3325	A5	9.60	006	*	4	AB-C	AB	(AB)	****
549	18139N5118	11233	N51 2342	G5	8.90	014	f	2	AB-C	AB-C	*	****
550	18159N0320	11271	N03 3680	G5	4.90	016	5	3	ABC	AB	*	****
551	18199N8434	11163	N84 409	G5	9.70	018	*	4	AB-C	ABC	*	***f
552	18210N2720	11334	N27 3016	A1V	6.50	006	*	5	AB-C	AB-C	AB	**NO
553	18214N5135	11328	N51 2372	G5	8.80	018	4	6	AB-C	ABC	*	A*N*
554	18221N0008	11353	N00 3936	A0	5.40	013	5	3	AC-B	ABC	(AB)	**Nf
555	18227N4842	11344	N48 2692	G5	7.90	007	*	4	ABC	ABC	(AB)	**N*
556	18229N7241	*	N72 839	F7V	3.58	129	5	7	A-BC	A-B	*	*GNO
557	18242S4326	*	S4312591	G5	8.60	009	10	3	ABC	A-C	*	**N*
558	18245S3263	*	S3313281	A3	5.50	017	9	3	ABC	AB	(AB)	****
559	18294N1739	11454	N17 3627	F5	7.70	007	f	2	AB-C	ABC	(AB)	**Nf
560	18314N1654	11483	N16 3560	G2V	6.80	022	*	5	AB-C	AB	AB	**N*
561	18317N5216	11468	N52 2238	K0 *	6.20	005	*	5	AB-C	ABC	AB	**Nf
562	18318N0636	11496	N06 3855	F2	5.40	027	6	3	ABC	A-B-C	*	**No
563	18332S0317	11520	S03 4331	F9IV	7.20	029	*	5	AB-C	ABC	AB(C)	****
564	18342N1627	11530	N16 3572	G5	8.40	008	*	5	AB-C	AB	AB	****
565	18351S5552	*	S55 8807	F5	8.20	016	*	5	AB-C	ABC	AB	****
566	18368S0909	11581	S09 4796	F0	4.70	019	*	1	ABC	*	*	**Nf
567	18369S3825	*	S3813036	A0	5.10	017	9	3	ABC	AB	*	****
568	18385N6702	11568	N67 1087	dG1	8.60	018	*	5	AB-C	AB	AB	****
569	18398N3527	11621	N35 3342	A0 *	8.70	013	f	2	AB-C	AB	*	**Nf
570	18407N5526	*	N55 2107	A0	5.10	007	7	3	ABC	AC	*	****
571	18413S0064	11667	S01 3559	A0	6.10	009	f	2	ABC	AB	*	****
572	18418N5927	11632	N59 1915	dM4	8.90	282	3	7	AB-C	AB-C	AB	*GNO
573	18433N2819	*	N28 3078	G0	8.99	009	2	6	AB-C	ABC	*	A*N*
574	18447N2103	11715	N21 3560	B5	7.10	007	p	2	AB-C	AB	*	****
575	18449N4919	11698	N49 2871	F5	7.40	010	g	2	AB-C	AB	(AB)	**N*
576	18481S2252	11794	S22 4907	K2	5.00	021	10	3	AB-C	ABC	*	** f
577	18505N3715	11811	N37 3276	G0	8.20	014	g	2	AB-C	ABC	(AB)	**NO
578	18505N2231	11820	N22 3524	G0	4.60	013	*	1	ABC	ABC	*	**NF
579	18512N0404	11853	N04 3916	A5	4.60	019	g	2	AB-C	AB	*	A*Nf
580	18517N4128	11840	N41 3177	K0	5.60	010	*	1	ABC	ABC	*	***f
581	18521N4844	11846	N48 2793	F5	5.90	017	8	3	AB-C	AB-C	(AB)	***O
582	18545N1329	11902	N13 3841	F5	5.40	040	*	4	AB-C	A-B	*	**N*
583	18551N1456	*	N14 3736	K0	4.20	025	6	3	ABC	ABC	*	****
584	18552N3233	11908	N32 3286	A0p	3.30	011	5	3	AC-B	AC	(AC)	**Nf
585	18553N1244	11916	N12 3750	K5	7.40	007	f	2	A-BC	BC	*	**N*
586	18562S2961	11950	S3016575	A2 *	2.70	036	4	6	AB-C	ABC	AB	A*N*
587	18563N6216	11901	N62 1669	K0	6.50	008	*	4	AB-C	AB	*	**N*
588	18576S0051	11971	S00 3631	G5	8.50	008	12	3	A-BC	A-BC	BC	**Nf
589	18589N3115	11977	N31 3441	A3	8.40	039	g	2	AB-C	AB	(AB)	**NO
590	18598N5207	11979	N52 2326	K2	6.50	013	p	2	A-BC	ABC	BC	****
591	19004N2311	12010	N23 3549	B3	7.10	013	f	2	AB-C	AB	*	****
592	19008N1343	12026	N13 3899	A0	3.00	036	7	3	AC-B	A-B-C	*	****
593	19009N0624	12029	N06 4014	F5	7.10	012	1	6	ABC	ABC	*	A*N*
594	19023N3017	12040	N30 3413	K0	8.50	012	*	5	A-BC	ABC	AB	****
595	19026N2201	12050	N21 3666	F0	7.40	014	*	4	AB-C	A-B	*	**N*
596	19038S2111	*	S21 5275	F3	3.80	016	6	3	AB-C	ABC	*	****
597	19040N2939	12071	N29 3483	A0	8.50	005	f	2	AB-C	AB	(AB)	****
598	19063N5510	12104	N55 2152	A3	7.40	005	g	2	AC-B	ABC	(ABC)	***f
599	19084S2729	12189	S2713721	A0	8.50	012	F:	2	AB-C	AB	*	****
600	19113S1069	12244	S11 4932	G0	7.00	024	*	1	A-BC	A-B	*	**NO

TRIPLE STAR SYSTEMS NEARER THAN 200 pc

1	2	3	4	5	6	7	8	9	10	11	12	13
601	19119N2113	12243	N21 3713	B5	4.60	016	9	3	ABC	*	*	**N*
602	19127N4954	12240	N49 2968	G5	6.30	008	*	1	AC-B	AC	*	***f
603	19129N3757	*	N37 3398	K0	4.50	010	*	1	ABC	*	*	**N*
604	19134N0054	12289	N00 4168	K0	5.30	012	*	1	AB-C	AB-C	(AB)	**N*
605	19168S0747	12348	S07 4933	F2	9.50	006	f	2	AB-C	ABC	(AB)	***f
606	19178S1012	12368	S10 5058	G5	9.90	016	*	4	AB-C	AB	*	****
607	19202N1143	*	N11 3833	G8IV	5.16	060	7	7	ABC	A-B	*	*GN*
608	19211N1936	12425	N19 4010	K0	5.30	010	*	1	ABC	A-B	*	**N*
609	19230N2028	12464	N20 4146	B9	8.80	009	p	2	AC-B	*	*	***f
610	19240S0715	12503	S07 4968	F8p	6.20	013	6	3	AB-C	*	*	**N*
611	19282N0712	*	N07 4124	G0	9.10	023	g	3	AC-B	*	*	****
612	19293N5247	12580	N52 2450	G0	8.70	016	f	2	AB-C	AB	*	****
613	19309S0007	12644	S00 3788	G5	7.90	013	5	3	AC-B	AC	*	**N*
614	19326N3526	12667	N35 3703	A0	9.30	005	g	2	AB-C	AB	(AB)	***f
615	19331N2235	12697	N22 3746	G0	9.70	012	p	2	AB-C	AB	*	***f
616	19332N0007	12708	N00 4265	A2	7.50	007	f	2	AB-C	AB	(AB)	****
617	19332S1023	12715	S10 5140	A5	6.80	013	g	2	AB-C	ABC	(ABC)	***O
618	19338N4959	12695	N49 3062	F4V	4.47	056	7	7	AC-B	AC-B	(AC)	*GNO
619	19350S1631	12767	S16 5399	K0	5.40	030	9	3	ABC	AB-C	*	****
620	19356N1747	12766	N17 4042	G0	4.40	007	*	1	ABC	A-B	*	**N*
621	19403S6164	*	S62 6108	G0	7.90	015	*	5	AB-C	ABC	AB	**N*
622	19418N4453	12880	N44 3234	B9 *	2.91	020	*	5	AB-C	AB-C	AB	**N*
623	19425N0051	*	N00 4314	G5	6.80	028	6	3	A-BC	*	*	****
624	19426N3330	12913	N33 3587	F5V	4.99	047	4	7	AC-B	AC-B	(AC)	*GNO
625	19440N1134	12962	N11 3994	F2	6.10	005	G	2	AB-C	AB	(AB)	***O
626	19459N3828	12992	N38 3772	G5	6.20	007	*	1	ABC	ABC	*	****
627	19465S1036	13028	S10 5203	F2	7.70	009	g	2	AB-C	AB	(AB)	***f
628	19478N3053	13038	N30 3779	A5	6.90	027	8	3	ABC	AB	*	****
629	19492N0141	*	N01 4134	K0	8.50	028	7	3	ABC	AB	*	**N*
630	19504N0609	13110	N06 4357	G8IV	3.72	070	7	7	AC-B	AC	(AC)	*GN*
631	19507N2457	13109	N24 3926	F5	9.70	007	g	2	AB-C	AB	(AB)	****
632	19518N0139	13147	N01 4145	A0	9.10	023	*	4	AB-C	ABC	(AB)	**Nf
633	19523S5539	*	S55 9275	K0	9.40	020	F:	2	ABC	ABC	(ABC)	****
634	19546N4159	13186	N41 3549	A2	6.70	005	*	4	AB-C	ABC	(AB)	**Nf
635	19556N1720	*	N17 4185	K0	7.10	005	1	6	AB-C	ABC	*	A*N*
636	19568N2933	13251	N29 3845	G5	8.10	042	*	4	AC-B	A-C	*	****
637	19568S1174	13268	S12 5621	A3	9.70	011	*	4	AB-C	AB	*	***f
638	19594S7331	*	S73 1547	G3IV	6.37	046	9	7	AB-C	ABC	(ABC)	*GN*
639	19619N7614	13296	N76 770	G5	6.40	013	*	4	A-BC	A-BC	(BC)	**N*
640	20012N6421	*	N64 1407	G5	6.60	008	*	1	ABC	ABC	*	** F
641	20016N0716	13379	N07 4366	A0	6.90	008	7	3	ABC	A-B	*	**N*
642	20026N3541	*	N35 3959	K0	5.50	030	5	3	ABC	A-B-C	*	****
643	20027N0429	13399	N04 4350	K2	8.80	008	*	4	A-BC	BC	*	**NO
644	20035N6336	13371	N63 1593	A2	6.20	023	f	2	AB-C	ABC	(AB)	**Nf
645	20042N6325	13392	N63 1595	G0	9.60	014	f	2	AB-C	AB-C	(AB)	****
646	20050N1630	13434	N16 4166	K0	7.90	018	7	3	AB-C	AB-C	*	****
647	20053N0809	13443	N08 4358	F8	6.60	019	6	3	AB-C	AB	*	**N*
648	20076N5639	13464	N56 2364	F8	9.42	008	3	6	AB-C	ABC	(AC)	A*N*
649	20097N2155	13553	N21 4109	A0	7.90	006	f	2	AB-C	AB-C	*	**NO
650	20123N7725	13524	N77 764	B9	4.38	008	2	6	AB-C	ABC	*	A*N*
651	20134N4003	13640	N39 4114	K5	5.50	007	6	3	AB-C	AB	*	****
652	20138N1943	13661	*	*	9.80	008	1	6	A-BC	ABC	*	A*N*
653	20157S4222	*	S4214836	A0V	5.59	045	10	7	ABC	*	*	*GN*
654	20166N3905	13728	N38 4021	A1V	6.33	006	*	5	AB-C	ABC	AB(C)	***f
655	20219N3946	13847	N39 4180	G5	8.00	020	f	2	AB-C	AB	(AB)	**N*
656	20237N1826	13886	N18 4505	G5	6.80	013	6	3	AC-B	AC-B	*	**N*
657	20268N3501	13939	N34 4056	A2	8.90	007	*	4	A-BC	ABC	(BC)	***f
658	20269S0972	13960	S10 5423	G5	5.80	029	4	3	AC-B	AC-B	(AC)	**N*
659	20282N1336	13986	N13 4435	*	8.90	007	g	2	AB-C	AB	(AB)	****
660	20286N0506	13997	N04 4484	A2	8.30	005	f	2	AB-C	AB	*	****
661	20305S4738	*	S4713477	G2	3.20	040	7	7	ABC	*	*	****

1	2	3	4	5	6	7	8	9	10	11	12	13
662	20343N0944	14101	N09 4600	G5	5.20	022	5	3	AB-C	A-B	*	**N*
663	20343N0008	14108	S00 4064	K0	5.40	007	6	3	ABC	A-B-C	*	****
664	20345N8105	*	N80 659	K0	5.60	011	12	3	ABC	ABC	*	****
665	20353N8044	*	N80 660	K0	6.10	044	11	3	ABC	ABC	*	***F
666	20357N6024	14102	N60 2142	G0	7.12	007	1	6	AB-C	ABC	(AB)	A*N*
667	20370N3157	14158	N31 4181	K0	5.90	007	*	4	AB-C	AB	*	**N*
668	20378N1222	14184	N12 4440	F5	8.26	011	1	6	AB-C	ABC	*	A*N0
669	20390S3142	*	S3117815	M0Ve	8.61	113	6	7	A-BC	ABC	(BC)	AGN*
670	20402N1157	14233	N11 4368	A0	6.90	009	g	2	A-BC	ABC	(AB)	***f
671	20422N3336	14274	N33 4018	K0 *	2.46	046	6	7	ABC	A-B	*	**N*
672	20432N3400	14290	N33 4028	K0	5.20	010	*	1	ABC	AB	*	**N*
673	20432S2059	14313	S21 5839	G5	9.30	022	15	4	AB-C	AB	*	****
674	20435N3607	14296	N35 4267	B5Ve	4.85	006	*	5	AB-C	ABC	AB	****
675	20446N1102	14333	N10 4385d	K8	10.20	028	*	5	AB-C	AB-C	AB	***0
676	20513N6148	*	N61 2068	K2	8.60	137	4	7	ABC	A-B	*	*GN*
677	20515S0964	14449	S10 5553	K2	5.70	008	*	1	AC-B	AC	*	****
678	20536N1027	*	N10 4425	K0	5.60	012	*	1	A-BC	*	*	****
679	20580N0108	14573	N00 4648	F5V	6.74	013	*	5	AB-C	AB	AB	**N*
680	20585N3907	14567	N38 4321	K2	6.50	005	*	1	ABC	AB	*	****
681	20588S7334	*	S73 2192	K6	6.60	040	8	3	AB-C	AB-C	AB	****
682	21004N0642	*	N06 4741	K6V	8.28	063	8	7	ABC	A-B-C	*	*GN*
683	21016S1379	14638	S14 5936	K0	7.20	029	f	2	ABC	AB-C	(AB)	**N0
684	21024N3815	14636	N38 4343	K5V	5.22	296	4	7	AC-B	ABC	AB	AGN*
685	21032N6005	14635	N59 2315	A3	9.40	007	*	4	AB-C	AB	(AB)	****
686	21033N6145	14634	N61 2092	A0	8.10	014	f	2	A-BC	ABC	(BC)	** f
687	21096N0936	14773	N09 4746	F7V	5.20	055	4	7	AB-C	AB-C	AB	*GN0
688	21100S1046	14786	S10 5630	K0	8.80	022	4	6	A-BC	ABC	*	A*Nf
689	21108N3737	14787	N37 4240	F2IV	3.82	050	4	7	AB-C	ABC	AB	*GN*
690	21128S0015	*	S00 4195	K6	8.23	046	4	7	A-BC	A-B	*	*GN*
691	21130N3521	14822	N35 4461	A2	8.40	008	f	2	AB-C	AB	*	****
692	21166N3202	14889	N31 4425	G5	6.90	018	g	2	AB-C	AB	(AB)	****
693	21168N5233	14878	N52 2916	G5	7.70	014	g	2	AB-C	AB	(AB)	**N*
694	21175N1923	14909	N19 4691	K0	4.30	013	6	3	ABC	AB	*	**N*
695	21180S4126	*	S4114503	A0p	6.40	006	F:	2	AB-C	AB	(AB)	****
696	21202N0857	14954	N08 4671	A2	8.20	005	*	4	AB-C	ABC	(AB)	***f
697	21240N1039	15007	N10 4554	F2	7.50	016	*	5	AB-C	AB	AB	**N*
698	21263S0561	15050	S06 5770	G0	3.10	008	*	1	ABC	A-B-C	*	****
699	21284N2016	15076	N20 4955	F5	7.60	015	7	3	AB-C	AB	(AB)	**N*
700	21324N6617	*	N66 1415	K0	7.00	010	7	3	ABC	AB	*	****
701	21344S0030	15176	S00 4245	F7V	7.30	025	*	5	AB-C	ABC	AB(C)	***0
702	21363N4249	15208	N42 4177	K5	5.40	007	p	2	AC-B	ABC	(AB)	**NF
703	21369S5747	*	S57 9940	G0	6.80	018	2	6	ABC	ABC	*	A*N*
704	21375N4021	*	N40 4611	A0	6.00	011	6	3	ABC	A-B	*	****
705	21385N4035	15251	N40 4617	F0	8.30	005	*	4	AB-C	AB	(AB)	**N*
706	21393N0925	15268	N09 4891	K0	2.50	011	*	1	ABC	*	*	****
707	21401N2511	15281	N24 4463	F5IV	4.80	034	*	5	AB-C	AB-C	AB	**NF
708	21410N1125	15300	N11 4653	G0V	9.40	008	*	5	AB-C	AB-C	AB	***0
709	21415S1635	15314	S16 5943	A6M	2.83	069	14	7	ABC	A-C	*	*GN*
710	21419S2073	15323	S21 6093	A2	9.90	006	*	4	AB-C	AB	*	***f
711	21449N6135	15339	N61 2199	A3	9.10	007	*	4	AB-C	AB	(AB)	****
712	21466N3211	15377	N31 4560	A0	8.50	009	*	4	AC-B	AB	*	**N*
713	21491N6517	15407	N65 1664	A2	7.10	010	g	2	AB-C	AB	(AB)	**Nf
714	21506N1025	15447	N10 4659	G5	8.40	021	*	5	AB-C	AB	AB	****
715	21515N2352	15461	N23 4428	A0	8.20	012	f	2	AB-C	AB	*	***f
716	21570S1687	15562	S17 6422	A2	7.20	007	*	4	AB-C	AB	*	****
717	21619N8223	15571	N82 673	F5	7.10	028	9	8	AB-C	AB	(AB)	**N*
718	22009N6408	15600	N63 1802	A3	4.60	038	g	2	AB-C	ABC	(AB)	***F
719	22018S5143	*	S5113182	K7	11.20	048	12	7	A-BC	ABC	*	*GN*
720	22027N3536	15645	N35 4712	A3	7.90	006	f	2	AB-C	ABC	(AB)	***f
721	22051N0728	15685	N07 4806	G0	8.30	005	f	2	ABC	AB	*	****
722	22096N3914	15758	N38 4711	K2	4.60	011	*	1	ABC	A-B	*	****

TRIPLE STAR SYSTEMS NEARER THAN 200 pc

1	2	3	4	5	6	7	8	9	10	11	12	13
723	22188N2021	15896	N20 5139	F5	6.20	033	4	3	AC-B	AC-B	(AC)	**NO
724	22215N0353	15935	N03 4705	G0	5.80	038	5	3	AB-C	AB	(AB)	****
725	22228N0412	*	N03 4710	K0	4.90	021	5	3	ABC	A-B	*	****
726	22232N1144	15962	N11 4804	K0	7.30	016	g	2	AB-C	AB	(AB)	****
727	22254N5754	15987	N57 2548	G0	4.2	009	*	4	ABC	ABC	*	**N*
728	22287N5316	*	N53 2911	M0	10.82	039	5	7	AB-C	ABC	(AB)	*GN*
729	22289S0165	*	S02 5781	K0	5.90	009	*	1	ABC	*	*	****
730	22327N2325	16116	N23 4575	K8	9.80	026	*	4	AB-C	ABC	(AB)	****
731	22342S1268	16145	S13 6235	G9e	8.55	034	*	7	AB-C	ABC	(AB)	*GN*
732	22342S2852	16149	S2817873	G0	6.30	010	*	F	A-BC	ABC	(BC)	**Nf
733	22359N1401	16173	N13 4971	G4V	6.26	029	*	5	AB-C	AB-C	AB	****
734	22380N2316	16205	N23 4595	G5	10.00	011	*	4	AB-C	AB	(AB)	***f
735	22388N4638	16214	N46 3803	B9	6.40	005	*	4	ABC	ABC	(ABC)	**N*
736	22396N3856	16228	N38 4855	K5	6.20	005	f	2	ABC	ABC	*	**Nf
737	22398S0271	16235	S03 5501	F8	8.70	009	*	5	A-BC	ABC	(BC)	***f
738	22417N6736	16252	N67 1463	A2	8.90	006	2	6	AB-C	ABC	*	A*Nf
739	22417N1139	16261	N11 4875	F6	* 4.19	048	7	7	AC-B	AC-B	(AC)	*GNF
740	22426N4349	*	N43 4305	M4	*10.20	195	3	7	A-BC	A-BC	(BC)	*GN*
741	22456N6802	16291	N67 1468	F5	7.20	027	5	3	AB-C	AB	(AB)	**N*
742	22464N1326	*	N13 5006	K0	8.00	040	6	3	A-BC	A-B	*	****
743	22466N2552	16314	N25 4828	A1V	7.50	006	*	5	AB-C	ABC	AB	***f
744	22474N6109	16317	N60 2450	G0	6.10	010	g	2	AB-C	ABC	(AB)	** f
745	22492N4413	16345	N43 4331	A3m	5.80	020	*	5	AB-C	AB-C	AB	****
746	22580N4213	16467	N41 4665	A3Vn	5.10	009	*	5	AB-C	AB	AB	**N*
747	22589N2732	16483	N27 4480	M0	2.60	015	5	3	ABC	A-B-C	*	**N*
748	23000S0774	16497	S08 6018	F2IV	6.40	016	*	5	AB-C	ABC	AB	****
749	23012S4364	*	S4415149	F4	4.50	012	8	3	AB-C	ABC	(AB)	** F
750	23028N1208	16524	N11 4940	F0	7.90	007	f	2	AB-C	AB	(AB)	***f
751	23037N7007	16525	N69 1307	K0	7.70	012	11	3	AB-C	AB	*	****
752	23047N7451	16538	N74 1006	G3	* 4.70	018	*	5	AB-C	AB	AB	**N*
753	23070N2619	*	N26 4580	K0	6.40	024	5	3	AC-B	A-B-C	*	****
754	23083N3927	16599	N39 5033	A3	7.60	025	f	2	ABC	AB	*	****
755	23086S1357	16608	S14 6424	K2	7.40	005	f	2	AB-C	ABC	(AC)	**NF
756	23088S0889	16611	S09 6149	G0	8.30	014	8	3	AB-C	AB-C	*	**NO
757	23106S0938	16633	S09 6156	K0	* 4.25	033	6	7	A-BC	ABC	(BC)	*GN*
758	23125S0164	16649	S02 5920d	G4	8.40	035	*	5	AB-C	AB	AB	****
759	23125N1619	16648	N16 4896	F5	8.40	008	*	4	A-BC	ABC	(BC)	** f
760	23145N6734	16666	N67 1514	G8	* 4.86	022	*	5	AB-C	AB	AB	**N*
761	23161N3739	*	N37 4817	F5	5.80	029	*	1	ABC	A-B	*	****
762	23164N3453	16693	N34 4904	K5	9.10	054	*	4	AB-C	A-B	*	****
763	23178N2001	16713	N19 5093	G0	6.70	052	11	3	AC-B	AC-B	(AC)	**NO
764	23187N4514	16720	N44 4399	K0	8.50	005	11	3	ABC	AB	*	**N*
765	23194N1356	16735	N13 5105	F8	8.10	015	f	2	AB-C	AB	(AB)	***O
766	23218N0042	*	N00 4998	A3	4.90	036	6	3	ABC	A-B	*	**N*
767	23237N7333	16775	N73 1035	F0	7.50	010	g	2	AB-C	A-B	*	****
768	23264N1540	16812	N15 4837	F8	8.10	016	f	2	AB-C	AB	*	****
769	23323N0704	16873	N06 5178	F5	9.30	006	*	5	AB-C	AB	AB	****
770	23355N4347	16916	N43 4522	A0	4.30	012	7	3	ABC	AB-C	(AB)	**N*
771	23358N1949	16923	N19 5135	K2	8.70	045	12	7	AB-C	AB	(AB)	*GN*
772	23363N3201	16928	N31 4952	A0	7.40	006	G	2	AB-C	AB	(AB)	****
773	23370N1945	16937	N19 5138	F8	8.10	024	6	3	AB-C	AB	*	****
774	23428S0279	*	S03 5707	K0	5.60	010	*	1	A-BC	*	*	***F
775	23437S2841	17021	S2818353	A0	4.60	033	9	3	AC-B	ABC	(AC)	***O
776	23438N6420	17020	N64 1861	A0p	6.90	007	*	5	AB-C	AB-C	AB	***O
777	23478N3808	17078	N37 4901	*	8.80	027	f	2	AC-B	ABC	*	** f
778	23513S0963	17107	S10 6203	G5	9.00	021	*	3	AB-C	AB	(AB)	**N*
779	23530N2347	17131	N23 4830	G5	8.50	030	7	3	AB-C	AB-C	*	A*NO
780	23539N5512	17140	N54 3082	B2	5.00	006	f	2	AB-C	AB	*	***O
781	23544N3310	17149	N32 4747	G0V	6.60	051	*	5	AB-C	ABC	AB	****
782	23575N6532	1	N65 1987	G0	6.00	010	*	1	AB-C	AB	*	****
783	23576N0135	9	N01 4820	G0	7.80	019	7	2	AB-C	AB-C	AB	***O

Table 2

001	ADS:dp=0.024arcsec(R&M);0.025arcsec (J&F);cpm:AB;HERTZSPRUNG E.1964: Mouv.relatif lineaire AB.
004	Sp(A)=G0 III;p:orbit (SCARDIA;1980) ADS:C probably belongs to the system.
006	Sp(A)=B8.5V
009	JENKINS L.P.1952:p(tr.)=-0.002±007arcsec.
010	p:pair BC.
013	ADS:The p.m. of A is given as 0.024 arcsec in 243.1 degrees.If correct the star C is moving with it
014	ADS:A is a spec.bynary. GLIESE W.1969:No 23;iden. p for AB.
015	ADS:C is independent.HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
016	ADS:B is moving with A through space.p(sp.)=0.029arcsec(MtW) or(DAO).
018	GLIESE W.1969:No30.
021	GLIESE G.1969:A is spec.bynary;No34.1
022	BAIZE P.1962:...une binaire a eclipses (?).
025	Sp(A)=A1Vn
027	BAIZE P.1962:A certainement var.
028	Sp(A)=B9IVn.ADS:Frost announced the primary to be a spec.bynary.
029	ANOSOVA J.P.1988:prob.phys.system (No1).POPOVIC G.:AB is optical.
032	ANOSOVA J.P.1988 real phys.system (No2).
033	HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
038	JENKINS L.F.1952:p(tr.)=0.002arcsec.
039	ADS:RV of AB var.
040	IDS:C is a faint diffused nebula:Dreyer 42.
041	GLIESE W.1969:No56.3;iden.p for AB.
044	ANOSOVA J.P.1988:real phys.system (No3).GLIESE W.1969:No57.1;iden. p for ABC.
048	p:orbit (ERCEG;BC;1976).
049	IDS:Mul.:ABCD.GLIESE W.1969:No60;iden. p for ABC.
050	GLIESE W.1969:No61.
054	ANOSOVA J.P.1988:real phys.system (No4).
055	p:orbit (SCARDIA;1982).
056	ADS:A is a spec.binary.
057	GLIESE W.1969:No68.
060	JENKINS L.P.1952:Alf Tri spec.binary; 2 days.GLIESE W.1969:No78.1
061	HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
062	ADS:cpm AB.
066	ADS:The close pair is undoubtedly a physical one.
068	ADS:RV=0.0 km/sec with a suspicion of var.
070	ANOSOVA J.P.1988:No7;real phys.system.
073	ADS:cpm ABC.POPOVIC G.:p:pair BC.
077	GLIESE W.1969:No87.1;iden.p for AB.
079	ADS:cpm AB.ANOSOVA J.P.1988:real phys.system (No8).
087	GLIESE W.1969:No107;iden. p for AB.
088	IDS:Mult.:AB;GLIESE W.1969:No 106.1;iden.p for ABC.
093	ADS:RV var.
094	IDS:Mult.:AB;GLIESE W.1969:No 118.2;iden.p for ABC.
095	ANOSOVA J.P.1988:real phys.system No 9.GLIESE W.1969:No120.1; iden. p for ABC.
101	p(orb.)=0.004 arcsec (HEINTZ;1963).
102	Sp(A)=F6 III.
103	GLIESE W.1969:No137.
104	IDS:Mult.:AB;GLIESE W.1969:No 140;iden.p for ABC.
111	p:orbit (SCARDIA;1980).
114	ANOSOVA J.P.1988:prob.phys.system No10.
116	GLIESE W.1969:No153;iden.p for ABC.
123	ADS:AB a phys.one.ANOSOVA J.P.1988:prob.phys.No12.BAIZE P.1962:C var.
125	GLIESE W.1969:No160.
126	ANOSOVA J.P.1988:real phys.system No 13.
127	ANOSOVA J.P.1988:prob.phys.system No 14. No BD is according to the comp.B.

129 ADS:cpm for AB.
132 ANOSOVA J.P.1988:real phys.system (No 16).IDS:Components P and Q exist too.
135 Sp(A)=F0IV-V.IDS:Mult.:ABCD.GLIESE W.1969:No 168.3;phys. components:ABD
137 p:orbit(Finsen W.S.1978).
138 HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
140 Sp(A)=A0IIIp
146 p:orbit (ERCEG V.1978).
147 ADS:AB optical.
150 p:orbit (HEINTZ;1983).
153 ADS:cpm for ABC. A is a spec.binary.
154 ADS:An optical group.IDS:AB optical.
159 p:orbit (HEINTZ;1983)
161 ADS:AB optical pair.GLIESE W.1069:No196.
162 JENKINS L.F.1952:p(tr.)=0.014±0.014 arcsec.
163 RUSSEL H.N.& MOORE CH.1946:p(dyn)=0.002 arcsec.
164 ADS:cpm for ABC.GLIESE W.1969:No 200;p(A)=p(C).
165 A is a spec.binary.GLIESE W.1969:No198.
166 ANOSOVA J.P.1988:prob.physical;No 19.
167 p(orb.)=0.015 arcsec (BOS;orbit I;1962).
168 ADS:H Ori.is a spec.binary.
172 ANOSOVA J.P.1988:prob.phys.system; No 20.
173 ANOSOVA J.P.1988:real phys.system; No 22.
174 ADS:δOrionis is a spec.binary.
175 JENKINS L.F.1952:p(tr.)=0.002±0.007 arcsec.
177 ANOSOVA J.P.1988:prob.physical system; No 23.
179 GLIESE 69:A faint star(VBs;AJ61;528)to be a star of sim.p.m.Phys. conn. with AB uncer.No216;iden.p for AB.
180 JENKINS L.F.1952:p(tr.)=0.004±0.006 arcsec.
183 ADS:spec.binary.
184 ADS:cpm for AC.
185 ADS:cpm for AC but B is independent.
187 ADS:prob.cpm for ABC.
188 IDS:Mult.:ABCD.GLIESE W.1969:No 225.2;identical parall.for ABC.
189 ADS:A is short spec.binary star (FROST).
190 Sp(A)=G8III.IDS:A & B spec.binarys.
194 ANOSOVA J.P.1988:real phys.system; No 24.
200 No BD refer to the component B.
203 ADS:cpm for ABC.
204 ADS:cpm for AB.HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
205 ADS:The micrometer measures however favor the hypothesis that 20 Gem.is a phys.pair..
206 ANOSOVA J.P.1988:prob.phys.system; No 26.
207 ANOSOVA J.P.1988:real phys.system; No 27.
209 ANOSOVA J.P.1988:prob.phys.system; No 28.
211 ANOSOVA J.P.1988:prob.phys.system; No 29.
212 HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
213 ANOSOVA J.P.1988:real phys.system;No 30.
214 Sp(A)=G4III+A2V;p:orbit (HEINTZ;1963).
218 p:orbit (HOPMANN;1952).HERTZSPRUNG E.1964:Mouv.relatif lineare AB
220 RUSSEL H.N. & MOORE CH.1946:p:pair BC.
221 IDS:cpm for AB.HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
222 ANOSOVA J.P.1988:real phys.system;No31.GLIESE W.1969:No264.1-264.
224 AREND S.1959:optical.
225 ADS:A is a spec.binary.p:orbit (BAIZE;1979)cal.by ZULEVIC D.
227 ADS:p(tr.)=0.005±0.010 arcsec.
231 ANOSOVA J.P.1969:optical system.
232 ANOSOVA J.P.1988:prob.phys.system;No 32.
235 p:orbit (SCARDIA;1983).
238 ANOSOVA J.P.1988:prob.phys.system;No 33.

239 ADS:RV is var.(LO);two spectra being visible.
243 ADS:cpm:ABC;all comp.spec.ANOSOVA 1988:real phys.system;No34.GLIESE W.1969: No278;iden.p for ABC.
248 ANOSOVA J.P.1988:real phys.system; No 35.
249 ADS:C is an independent star.POPOVIC G.:mag.(A)=mag.(B).
250 GLIESE W.1969:No293.1;common p for AB.
258 ANOSOVA 1988:real phys.system;No37.ADS:.an invis.comp.to C;WORLEY&HEINTZ 83:There are orbits AB AB-Cc Cc-P.
262 The measur.reported in B.O.A.Belg.No140;83 don't fit well.ANOSOVA 1988:real phys.system;No38.
265 ANOSOVA J.P.1988:prob.phys.system;No39.
267 ANOSOVA J.P.1988:real phys.system No 40.
269 ADS:cpm for all components.
271 GLIESE W.1969:No 315.
272 No BD different in ADS and GLIESEs Cat. GLIESE W.1969:No314.ADS:RV var.?
273 GLIESE W.1969:No319;identical parallaxes for ABC.IDS:Mult.:AB.
274 JENKINS L.F.1952:p=0.002±0.010 arcsec.
278 Orbit exists(HEINTZ;1974).GLIESE W.1969:No 325;ident.parall.for AB.
279 ANOSOVA J.P.1988:prob.phys.system;No41.
281 ANOSOVA 1988:real phys.system;No42.GLIESE W.1969:No331;iden.parall.for ABC.
282 ANOSOVA 1988:prob.phys.system;No43.GLIESE W.1969:No335;ident.parall.for AB.
283 JENKINS L.F.1952:p(tr.)=0.001±0.005 arcsec.
287 ADS:A is a spec.binary.Component D exists (BOS:AJ 68;8).
288 ADS & IDS:An optical pair A-B.
291 ANOSOVA J.P.1988:real physical system;No44
295 ADS:The pair AB is doubtless a binary. p(tr.)=-0.005±0.005 arcsec (Yale).
298 ANOSOVA J.P.1988:prob.phys.system;No45.
299 ADS:AB is a phys.pair.
300 ANOSOVA J.P.1988:real phys.system;No46.
301 ANOSOVA J.P.1988:prob.phys.system;No47.
303 ANOSOVA J.P.1988:real physical system;No48.
310 GLIESE W.1969:No 380.
311 ADS:B & C independent stars.
313 ANOSOVA J.P.1988:prob.phys.system;No49.
319 ADS:dp=0.003 arcsec (R.& M.).
320 p:pair BC.
323 ADS:p.m.=0.21 arcsec in 238.5 degrees.If real this applies to all three comp.
324 ANOSOVA J.P.1988:real phys.system;No50.
325 GLIESE W.1969:iden.p for AC.ADS:AC phys.pair;B an optical comp.
326 GLIESE W.1969:No419;Del Leo.
327 ANOSOVA J.P.1988:real phys.system;No51.
328 ANOSOVA J.P.1988:real phys.system;No52.
329 GLIESE W.1969:No421;iden.parall.for ABC.B is a spec.binary.
330 p:orbit (ZULEVIC D;1980).
331 GLIESE W.1969:No429;iden.parall.for AB.HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
332 BAIZE P.1962:B probablement var.
336 ANOSOVA J.P.1988:prob.phys.system;No53.
337 p:orbit(HEINTZ;1985)calc.by POPOVIC G.
339 GLIESE W.1969:No449.
340 ANOSOVA J.P.1988:real phis.system;No54.POPOVIC G:Comp.C exist ?
345 ANOSOVA J.P.1988:real phys.system;No55.
346 GLISE W.1969:No 459
348 ADS:It is a spec.bynary.p(sp)=0.036(DAO).ANOSOVA J.P.1988:prob. phys.system;No 56.
353 ANOSOVA J.P.L988:real phys.system;No57.
356 ADS:C is independent.
357 ANOSOVA J.P.1988:prob.phys.system;No 58.
359 RUSSEL H.N. & MOORE CH.1946:A & B spec. binaries.

360 ANOSOVA J.P.1988:prob.phys.system;No59.

362 ANOSOVA J.P.1988:prob.phys.system;No60.

363 ANOSOVA J.P.1988:prob.phys.system;No61.

364 p:orbit (SCHMEIDLER;1939).Sp(A)=G8III.ADS:C is prob.phys.connected with the close pair.

366 ADS:d(AC)=33.9(1878);36.0(1912)arcsec.IDS:d(AC)=3.4(1878);3.6(1912)arcsec.

367 ANOSOVA J.P.1988:prob.phys.system;No62.

370 ADS:RV of θVirginis var.

371 GLIESE W.1969:No501;common p for AB.

374 GLIESE W.1969:No503.2;Sp(A)=G1.5 V.

375 ANOSOVA J.P.1988:prob.phys.system;No63.POPOVIC G.:C independent star.

376 The character of motion (elliptical hyperbolic or parabolic)uncertain. GLIESE W.1969:No505;common p for AB

378 ANOSOVA J.P.1988:real physical system;No64.

380 Sp(A)=A6III.

381 BAIZE P.1962:C independent star;mag.(A) or mag.(B) var.

383 IDS:C is A of STF 1765 rej.ANOSOVA J.P.1988:prob.phys.system;No65.

384 IDS:Posit.angle of C:140(1918);240(1959)degrees;POPOVIC G.:Posit.angle of C:321(1981)degrees.Sp(A)=A7III.

385 GLIESE W.1969:No520;V(AB)=9.76.Range of mag.diff.estim.from 0.2 to 1.4.RV var.;iden.p:ABC.

389 ANOSOVA J.P.1988:prob.phys.system;No66.

390 GLIESE W.1969:No525.

394 The identification of this system in JENKINS Gen.Cat.(1951)uncertain.

401 GLIESE W.1969:No542.1;common p for AC.

405 p:pair BC.ADS:cpm for all stars.

406 GLIESE W.1969:No549;AB:182degrees;69.2arcsec(1854-1918);Approx.cpm with C about 1.5degrees N of AB.

413 GLIESE W.1969:No 557.

416 Alf Cen & Prox Cen.ANOSOVA J.P.1988:real phys.system;No67.

417 ANOSOVA J.P.1988:real phys.system;No68.

418 ADS:The pair prob.a phys.one.ANOSOVA 1988:prob.phys.system.HERTZSPRUNG 1964 :Mouv.relatif lin.AB.

419 Sp(A)=A2 III.

421 Russel&Moore 1946:Treated as a giant in calc.of dp.HERTZSPRUNG 1964: Mouv.rel.lin.AB.

424 ADS:cpm for AB.

429 GLIESE W.1969:p(C)=0.075 ± 0.006 arcsec;No578.

430 ANOSOVA J.P.1988:real phys.system;No71.

431 ANOSOVA J.P.1988:real phys.system;No72.

435 ANOSOVA J.P.1988:prob.phys.system;No73.

436 ANOSOVA 1988:real ph.syst.;No74.ADS:BC& the bright starμBoo phys.connec. HERTZSPRUNG 1964:Mouv.rel.lin.BC

437 GLIESE W.1969:No586;iden.parall.for ABC.

441 BDS:It is probable that this is only an optical pair as the change corresponds very nearly to p.m.ofAB

450 GLIESE W.1969:Sp(A)=K2III E;No596.2.

451 GLIESE W.1969:No599;iden.p.for AB.

452 ANOSOVA J.P.1988:real phys.system;No75.

456 GLIESE W.1969:No 603.

463 ANOSOVA J.P.1988:real physical system;No 77.

466 ANOSOVA J.P.1988:prob.phys.system;No 78.POPOVIC G.:rectilinear traj.AB.

467 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.

472 POPOVIC G.&TRAJKOVSKA V.1989:optical AC.

473 GLIESE W.1969:No 615.2;cpm AB with component C about 11 minarc distant.

478 GLIESE W.1969:No 623.JENKINS L.F.1952:No 3733 ?

479 ANOSOVA J.P.1988:real optical system.GLIESE W.1969:Sp(A)=G8III.BAIZE P. 1962:C parait varier sur 2 mag.

480 ADS:cpm AB.

481 GLIESE W.1969:No 627;iden.parall.for AB.

490 ANOSOVA J.P.1988:real phys.system;No 81.
493 GLIESE W.1969:No644;iden.p for ABC & Wolf 629;POPOVIC G.:C is a spec. binary;B has a unseen comp.
494 ANOSOVA J.P.1988:real phys.system;No82.
495 GLIESE W.1969:No653;common p for AB.
496 ANOSOVA J.P.1988:prob.phys.system;No83.
501 POPOVIC G.&TRAJKOVSKA V.1989:optical? HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
502 GLIESE W.1969:No 661;iden.parall.for AB.
503 ANOSOVA J.P.1988:real phys.system;No84.
504 GLIESE W.1969:No 667;iden.parall.for ABC.
508 ADS:The pair BC independant.GLIESE W.1969:No84.
511 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
512 GLIESE W.1969:No 677;iden. p to B and C.
515 WORLEY C.E.& HEINTZ W.D.;1983:Star A (9 arcsec)is physical.
517 ANOSOVA J.P.1988:prob.phys.system;No85.
518 p:orbit (BAIZE;1956).
519 ANOSOVA J.P.1988:prob.phys.system;No86.
521 ANOSOVA J.P.1988:real phys.system;No87.
523 GLIESE W.1969:No695;iden.p for ABC.A perturb.by orbit BC:P about 8 or 18y. IDS:Mult.:ABCD.
530 ADS:RV(A)=var.GLIESE W.1969:No700.1;iden.p for ABC.B is a spec.binary.
533 ADS:C (or B accor.ADS)is independent.GLIESE W.1969:No700.2.
535 ANOSOVA 88:real ph.s.No88.GLIESE 69:No702;iden.p for AB.IDS:Mult.:ABPQ RSTUVWX.POPOVIC:C is unseen comp.
539 GLIESE W.1969:No704;iden.p for AB.
540 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
541 p:orbit (VALBOUSQUET;1981).
542 ADS:cpm for A and B.
543 ADS:..it is probable that two stars are physically connected..B is a spec.binary.RV(A)=var.
545 Mag.(C)=?:here designate mult.of the apparent configuration maybe in error!
546 p:calculation by POPOVIC G.
552 p.m. of C ~0.6 arcsec/y.
553 ADS:cpm for AB;it prob.applies to C also.ANOSOVA J.P.1988:prob.phys. system;No89.
554 ADS:59 Serpentis var.in mag. and RV.Two spectra visible.BAIZE P.1962: certainement variable.
555 ADS:The trree stars form a remarkably close visual triple system. GLIESE W.1969:No713.
556 GLIESE W.1969:No713.
557 The observed relative motion of AC is resulting from the p.m. of A!
559 ADS:cpm for ABC.
560 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
561 p:orb.(WIERZB.58).ADS:p.m.(AB)=0.008 of C 0.068arcsec.The micr.meas.do not confirm this.Sp(A)=KO III.
562 ADS:RV(A)=var.
566 ADS:RV(A)=var.
569 Sp(A)=A
572 POPOVIC G.&TRAJKOVSKA V.1989:AC optical.POPOPVIC G.:exists orbit (KISELEV A.1987).
573 ANOSOVA J.P.1988:prob.phys.system;No 90.
575 ADS:The primary is a spec.binary.
577 POPOVIC G. & TRAJKOVSKA V.1989:optical ?
578 ANOSOVA J.P.1969:phys.system(Contrib.I);phys.(Contrib.II).ADS:A long-period spec.binary.
579 ANOSOVA J.P.1988:real physical system;No91.HERTZSPRUNG E.1964:Mouv. relatif lineaire AB.
582 POPOVIC G.& TRAJKOVSKA V.1989:optical.ADS:An optical pair.
584 ADS:RV var.;two spectra ?

585 RUSSEL H.N.&MOORE CH.1946:Treated as a giant in calculation of p.
586 ANOSOVA J.P.1988:real phys.system;No92.Sp(A)=A2 III.
587 ADS:p.m...indicating the physical connection of AB.
588 ADS:The change in AB is a result of the differences in the p.m.
589 IDS:cpm for AB.
593 ANOSOVA J.P.1988:real phys.system.No93.
595 ADS:Burnham regards the change as due to the relative p.m. of the two stars and this may be correct.
600 POPOVIC G.:AB optical!
601 ADS:A var.
603 p=-0.006±0.006 arcsec (Yale).
604 ADS:p=0.007 arcsec (R.& M.1946).Yale:p(tr.)=0.003±0.006 arcsec
607 GLIESE W.1969:No759
608 Yale:p(tr.)=-0.003±0.007arcsec.POPOVIC G.:The relative change in AB is not only due to p.m. of A.
610 ADS:U Aquilae is a Cepheid var. star.
613 ADS:cpm for AC.
618 GLIESE W.1969:No765;common p for AC.
620 p(tr.)=-0.004±0.005 arcsec (Yale).POPOVIC G.:The change in AB is not due to p.m. of A.
621 p:orbit (KNIPE;1961)
622 Sp(A)=B9.5IV.BAIZE P.1962:B prob.var.
624 GLIESE 69:No767.1;Comm.motion and p with No765.4(ADS12889AB).POPOVIC& TRAJKOVSKA 1989:optical.
629 JENKINS L.F.1952:No4697;d(AB)=161.8 arcsec.IDS:d(AB)=61.8 arcsec.
630 ADS:The pair AC is a physical one.B:optical.GLIESE W.1969:No771; common p for AC.
632 R.& M.1946:p=0.002 arcsec.
634 R.& M.1946:p=0.003 arcsec.
635 Component D exists too.
638 GLIESE W.1969:No818.1;common p for ABC.POPOVIC G.:IDS No does not exist.
639 p:pair BC.ANOSOVA J.P.1969:p(A)=0.003.
641 p(B)=0.020±0.007 arcsec(JENKINS L.F.1952).
643 p:pair BC.
644 BDS:The change (for AB) is due to p.m.
647 ADS:cpm for AB.
648 ANOSOVA J.P.1988:prob.phys.system;No96.POPOVIC G.:AB is phys.pair; C is independent.
649 HERTZSPRUNG E.1964:Mouv.relatif lineare AB.
650 ANOSOVA J.P.1988:prob.phys.system;No 97.
652 ANOSOVA J.P.1988:prob.phys.system;No98.
653 GLIESE W.1969:No788.3;VR(A)=var.
655 ADS:cpm for AB.
656 ADS:cpm for AB.POPOVIC G.:C is independent.
658 ADS:cpm for AB.
662 ADS:An optical pair.
666 ANOSOVA J.P.1988:prob.phys.system;No99.
667 R.& M.1946:p=0.004 arcsec.
668 ANOSOVA J.P.1988:real phys.system;No100.
669 ANOSOVA J.P.1988:real phys.system;No102.GLIESE W.1969:No803-799;common p for ABC;C is flare star.
671 ADS:An optical pair.RV(A) var.GLIESE W.1969:Sp(A):K0 III.
672 ADS:p(tr.)=0.001 arcsec;The star has been suspected of var.in brightness. JENKINS 1952:p=0.004±0.006 arcsec.
676 GLIESE W.1969:No809.
679 p:orbit (POPOVIC G.1969)
682 GLIESE W.1969:No818.
683 ADS:C is evidently independent.
684 ANOSOVA J.P.1988:prob.phy.;No105.GLIESE W.1969:No820;common p for AB; astromet.binary (STRAND;AJ 62;1957)

687 ADS:The Struve companion (C) is evidently independent.
688 ANOSOVA J.P.1988:prob.phys.system;No106.
689 C=Q(IDS);IDS:Mult.:ABCDPQR.GLIESE W.1969:No822.1;common p for ABC.
690 GLIESE W.1969:No825.3.
693 ADAMS W.S.& al.1935:p(sp.)=0.022 arcsec.JENKINS L.F.1952: p(tr.)=0.001±0.005 arcsec.
694 ADS:cpm for AB.
697 p:orbit (POPOVIC G.;1987)
699 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
702 R.& M.1946:Treated as a giant in calculation of p.ANOSOVA J.P.1969: physical;optical.
703 ANOSOVA J.P.1988:prob.phys.system;No107.
705 R.& M.1946:p:0.004 arcsec.
707 ADS:A or B spec.binary.
709 ADS:A is spec.binary.
712 ADS:cpm to AB.p:according to component B.
713 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
717 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
719 GLIESE W.1969:No848.1;common p for ABC.
723 POPOVIC G.& TRAJKOVSKA V.1989:optical.
727 ADS:δCephei is the typ star of the Cepheid var.
728 IDS:Mult.:ABCDP.GLIESE 69:No863.1;common p for ABC.POPOVIC G.:C by (GLIESE 69) is not ident.to the C in IDS.
731 GLIESE 69:No867.1;comm.p for ABC.POPOVIC:C by GLIESE maybe not ident.with C in IDS.HERTZSP.1964:Mouv.rel.lin.AB
732 p:pair BC.
735 ADS:This is a remerkably close triple system. R.& M.;1946:p=0.002 arcsec.
736 R.& M.1946:Treated as a giant in calculation of p.
738 IDS:ZZ Cephei eclipsing binary 9.3-10.1;2.14 days.ANOSOVA J.P.& al.1989: No110;physical.
739 ADS:cpm for AC.GLIESE W.1969:No872;common p for AC;Sp(A)=F6IV-V.
740 GLIESE W.1969:No873.
741 HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
746 ADS:RV(A)=var.
747 ADS:The components of β Pegasi are simply optical;RV(A)=var?
752 Sp(A)=G3 III.ADS:A is a spectr.binary.
755 R.& M.1946:Treated as a giant in calculation of p.
756 ADS:A&B constitute a physical pair.RV(B)=var.POPOVIC G.:Mult.:ABb phys.?
757 GLIESE W.1969:No893.2;common p for ABC.ADS:91 Aquarii & BC constitute a phys.system.IDS:Mult.:ABCDE.
760 Sp(A)=G8 III.HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
763 ADS:RV(A)=var.HERTZSPRUNG E.1964:Mouv.relatif lineaire AB.
764 ADS:cpm for A & B.
766 IDS:An optical pair.
770 BDS:The change in the distan.of C is due to the p.m.of A.ADS:The nearer comp.appar.shares the motion with A
771 GLIESE W.1969:No904.1;common p for AB.
778 p:p(AB)(Yale).
779 ANOSOVA J.P.1988:prob.phys.system;No113.

and Ch. Moor; some spectroscopic parallaxes are from Adams et al. (1946). In cases when the parallax of A is unknown, that of B is presented which is followed by a note (Table 2). The orbital parallaxes, as a rule, are based on the most recent orbital elements presented in the Ephemeris Catalogue (Couteau et al., 1986). If the orbital parallax is based on another orbit (not present in the Ephemeris Catalogue), then a corresponding note follows.

In the case of the parallaxes from Russel–Moor's catalogue instead of the error appears the grade as done in the original catalogue.

Column 9 Sources of parallaxes:

1 – (Adams, W.S. at al., 1935)
2 – (Russell H. N, Moore Ch, 1946)
3 – (Jenkins L. F., 1952)
4 – (Aitken R. G., 1932)
5 – Autors of orbits

6 – (Anosova J. P., 1988)
7 – (Gliese W., 1969)

Column 10 Apparent multiplicity of the system.

This designation offers an insight into the apparent configuration of the components in the system. If there is a close pair AB and a distant component C, then the corresponding multiplicity is AB–C. If the apparent distances among the components are comparable, the multiplicity is ABC. In other words, the multiplicity allows to distinguish two types of triple systems: hierarchical and nonhierarchical, where the ratio of the smallest to the largest apparent distances among the components of 1:4 separates these two types of triple systems. Here, the designations A, B and C follow the magnitudes, so that A is always the brightest star. This was not always the case in the literature and, therefore, for many triple systems listed here corrections were necessary.

Column 11 Multiplicity of the physical connection among the components.

If it is necessary to emphasize that all three components are in a mutual physical connection, the designation ABC is used. If such a connection is absent, then the corresponding designation is A–B–C. Shortly speaking the letters written together without spacing means presence of a physical connection; the dashes between them means no physical connection.

The designations concerning the physical connection used here are based on numerous notes and conclusions of a number of authors from the system discovery up to nowadays. They do not follow from the application of a unique criterion of physical–component detection. Exceptions are almost all systems from the Leningrad Triple–System–Programme (Anosova, 1989) present here where a relatively rigorous dynamical criterion (Anosova &Popović, 1989) is applied. The systems from the Leningrad Programme are divided into four classes: 1=physical, 2=probably physical, 3=probably optical, 4=surely optical. In this column the first two classes are denoted as ABC and the other two as optical system.

Column 12 Multiplicity of component orbital motion in the system.

If a system, or a part of it (a subsystem) is known to be gravitationally bound, then this column gives the specification: for example BC means that the subsystem BC is bound with known orbital elements, (BC) means that the subsystem is bound but the orbital elements are still unknown; finally ABC means that the orbital elements are known for all three components.

Column 13 This column offers a possibility to write four signs in a row.

1. Letter A (Anosova) means that the system belongs to the Leningrad Programme of 113 Triple Systems (Anosova, 1989).

2. Letter G(Gliese) means that the system can be found in the Catalogue of Nearby Stars (Gliese, 1969).

3. Letter N means that there is a note (Table 2).

4. For the purpose of informing about a triple system according to Anosova (1969) four letters are used: F=physical system, f=probably physical system, O=optical system, o=probably optical system.

3. RECAPITULATION OF SOME DATA FROM TABLE 1

Column 11 of Table 1 allows to establish that out of 783 systems contained in the present survey there are 253 systems with physically connected components, denoted as ABC. In the case of 189 systems there is at leaset one independent component and for 341 systems it is uncertain whether they should be classified as physical or as optical systems. If among the 341 dynamically uncertain systems the rate of optical and physical systems (0.57:0.43), following from the data mentioned above, were preserved, then the number of 253 physical systems would be enlarged by other 194 systems, so that in this survey after a final analysis of dynamical states one could find about 450 physical systems.

The data mentioned above are sumarised in Table 3.

Table 3. Distribution of systems of this survey according to their dynamical state

Dinamical state	n_i	%	phys./opt.=0.57/0.43
physical systems	253	32.3	+ 194 = 447
optical systems	189	24.1	
?	341	43.6	
	N = 783	100.0%	

A. Physical Systems. From Columns 10 and 11 of the survey one can obtain the distribution of 253 physical systems according to their apparent configuration, Table 4:

Table 4. Distribution of 253 physical systems according to ther apparent configuration

Mult. of apparent configuration	n_i	%
AB – C	142	56.1
A – BC	55	21.7
AC – B	21	8.3
ABC	35	13.8
	N = 253	99.9%

Table 5. Distribution of Orbital Multiplicaties for the 168 Physical Systems according to the apparent configuration multiplicities

orbit. mult.	ABC	AB	BC	(ABC)	(AB)	(BC)	(AC)	AB(C)	A(BC)
app.–conf.mult.									
AB – C	5	41	–	8	38	–	2	10	–
A – BC	1	4	8	2	1	21	–	–	4
AC – B	1	1	–	3	4	–	5	–	–
ABC	1	–	1	2	3	–	2	–	–
total:	8	46	9	15	46	21	9	10	4

The hierarchical configuration type AB–C is also here very confirmed.

Out of the 253 physical systems there are 168 systems in the present survey with orbital motion (Column 13). The distribution of the orbital multiplicities with the apparent–configuration multiplicaty is presented in Table 5.

As could be expected, the orbital motion is clearly expressed between the components forming close subsystems: in the case AB–C between A and B, in the case A–BC between B and C. There are only eight systems where the orbital elements are known for all three components.

The parallaxes of the physical systems listed here enable to conclude that the spatial density of triple systems is maximal in the immediate vicinity (up to 20 pc). This finding can be, certainly, explained by the selective effect–the more distant a triple system is the more difficult is to prove the existence of a physical connection of its components. Assuming the volume of a heliocentric sphere whose radius 20 pc as unit volume Vo the variation in the number of triple systems with increasing volume is calculated (Fig. 1) for the systems closer than 74 pc. The rate of increase in the number of systems clearly decreases with increasing volume. The dashed line corresponds to the case of a constant spatial density, i. e. what the number of triple systems would be if the density preserved its value from the sphere of 20 pc.

B. Optical Systems. An optical system is here defined as any system having at least one physically independent component. Column 11 of this survey allows obtaining an insight into the connection and independence of components within this class of triple stars (Table 6).

Table 6. Distribution of 189 optical systems according to connection multiplicity (Column 11)

Connection multiplicity	n_i
all three components independent: A – B – C	28
two components dependent, third independent: AB – C, AC – B, A – BC	97
connection known for two system components only: A–B, B–C, A–C	64

N = 189

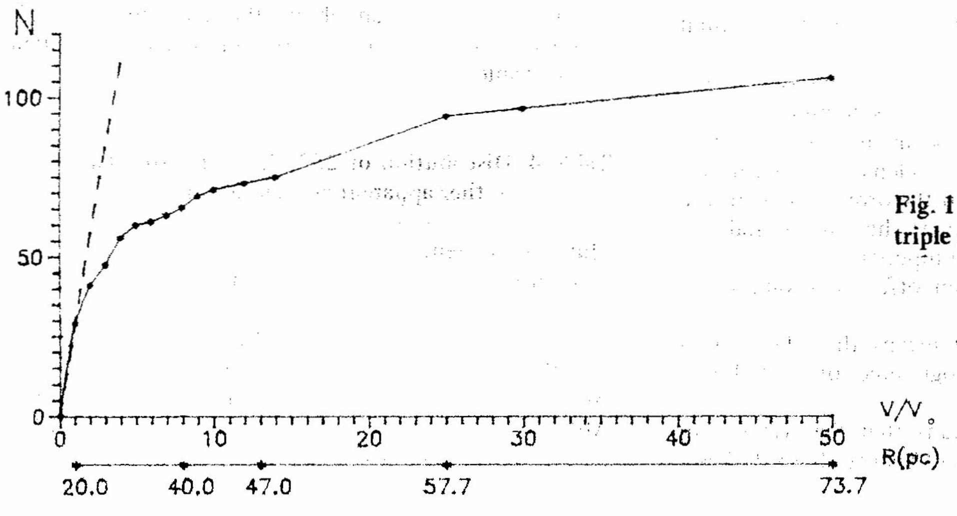

Fig. 1. The variation in number of triple systems with increasing volume

On the basis of Table 6 one may say: 1. the most frequent situation within the class of optical systems is a close physically double system with a distant independent component; 2. the probability of appearance of three independent components is very rare. Its value in the present paper is 0.036.

C. Systems of undetermined Dynamical State. The insufficient interest of observers in triple star systems is a consequence of a high percentage of systems for which has been impossible to conclude whether they are physical or optical.

Out of 341 such systems there are 284 ones for which the mutual connection of two components is known, while for the third one there is no conclusion. Any additional observations in these cases are necessary and urgent. The distribution of the bound components for the 284 systems mentioned above according to the apparent configuration is presented in Table 7.

Table 7.

Apparent configuration	bound components AB	AC	BC	n_i
AB – C	206	–	–	206
AC – B	11	10	–	21
A – BC	7	.	5	12
ABC	40	1	1	42
?	3	–	–	3
				N = 284

D. Systems from the Leningrad Programme of 113 Triple Stars. Out of 113 triple systems of the Leningrad Programme (Anosova, 1989) there are 93 in this survey, the rest of 20 systems is omitted due to the parallax limit.

Out of 93 common systems there are 79 coinciding in the dynamical–state specification with Anosova (78 physical and 1 optical), while in the case of 14 systems either there is no complete accordance, or the specifications of their dynamical states are discordant with those of Anosova. A comparable view of dynamical–state classification for these 14 systems by Anosova and in the present paper is presented in Table 8. The designations used in the table are: I = real physical system, II – probable physical system.

The analysis of these systems will be subject of another paper.

Table 8

No	ADS or IDS	Dinamical state according to Anosova	Physical connection according to this paper
1.	818	II	A – B
2.	01347N3350	I	A – B
3.	1727	I	AB
4.	06319N1216	II	A – B – C
5.	5300	II	AC
6.	7071	II	AB
7.	11052N6633	I	A – B – C
8.	8355	I	AC
9.	12409N1042	II	*
10.	13101N6749	II	AB – C
11.	15180N6036	II	AB
12.	10332	II	AC – B
13.	11853	I	AB
14.	17131	II	AB – C

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ТРОСТРУКИ ЗВЕЗДАНИ СИСТЕМИ БЛИЖИ ОД 200 pc

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УДК 523.83
Прегледни чланак

Саопштава се Преглед 783 тројна звездана система Каталога IDS са растојањем главне компоненте до 200 парсека. Такође се саопштава ознака привидне конфигурације компонената у систему, податак о реалној повезаности компонената /динамичко стање/ а назначено је и постојање орбита међу компонентама система или тенденција ка орбиталном кретању. У циљу повезаности овог Прегледа са Лењинградским програмом тројних звезданих система и Каталогом блиских звезда Глизеа унете су у Преглед пригодне ознаке. Најпосле извршена је кратка рекапитулација података Прегледа. Констатовано је да Преглед садржи 253 система физички повезаних компонената уз констатацију да би се овај број после анализе система овог Прегледа могао увећати на око 450.

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Preliminary report

MICROMETER MEASUREMENTS OF DOUBLE STARS

(Series 45)

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SUMMARY: The author presents the mean values of micrometer measurements for 149 systems (176 pairs) of double and multiple stars performed with the refractor Zeiss 65/1055 cm of Belgrade Astronomical Observatory. A total of 325 measurements is averaged.

This is the 45th series of micrometer measurements performed in Belgrade with the refractor Zeiss 65/1055 cm at the Astronomical Observatory. It is also a continuation of my measurements published in Series No 43(Popović and Zulević, 1989). Here the individual measurements are omitted from the series because they, have been sent to the Astronomical Data Center at Washington (Popović, 1990). Like the earlier ones, the present measurements were, as a rule, carried out together with my colleague Zulević. Therefore, many observations have only one or two measurements. No doubt, this series and Zulević's Series No 46(Zulević, 1991) are with regard to the choice of stars one entity.

The mean values are obtained, as earlier, taking into account the weights of individual measurements.

The present series contains 60 orbital pairs and also 26 triple systems from the Belgrade Survey of Triple Systems nearer than 200 pc(in the case of 13 systems all three components have been measured, in the case of the other 13 only pair AB has been measured).

In Table 1 a list of the mean values in the standard form is presented; notes and O–C for those pairs, for which in the last column of Table 1 existence of a note (N) or a comparison with the orbit (O) is indicated, are presented in Table 2. The observational comparisons for orbital pairs are based on the ephemeris (Couteau et al., 1986).

The duplicity of the A component in the system ADS 13648 is here for the first time visually detected.

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Table 1. Micrometer Measurements of Double Stars

IDS	ADS	Name		Mult.	t	P	d	m or dm	n	N
						°	″	m		
00010N5753	61	STF	3062		89.924	307.3	1.49	0.8	4n	O
00057N5717	134	KR	1		89.975	188.2	1.56	0.3	1n	
00106N7624	207	STF	13		86.866	55.9	0.87	0.3	2n	O
00154N6707	283	HJ	1018		86.639	87.0	1.57	0.5	4n	O
00234N3645	382	A	1504	AB	86.791	39.3	0.58	0.0	1n	N
00496N2305	755	STF	73	AB	89.802	285.4	0.90	0.3	2n	O
00597S0561	888	STF	86	AB	87.539	141.0	15.81	0.4	5n	
01003N2056	899	STF	88	AB	88.975	159.0	30.13	0.2	1n	
01003N2056	899	STF	88	AC	88.975	123.4	91.30		1n	
01344N3813	1310	BU	1167		85.981	55.0	1.34	1.0	1n	
01507N0121	1538	STF	186		86.588	56.7	1.27	0.0	4n	O
02042N1952	1678	STF	221	AB	88.986	143.5	8.24	1.0	2n	
02042N1952	1678	STF	221	AC	88.997	227.9	66.41	4.0	1n	
02216N4102	1859	A	658		84.837	216.4	2.19	9.0-10.5	1n	
02418N1857	2122	STF	305	AB	89.639	309.5	3.47	0.5	3n	O
02418N1857	2122	STF	305	AC	89.997	26.3	94.33		1n	
03113N3816	2446	STT	53		85.973	259.4	0.75	0.8	1n	O
03272N4817	2609	BU	787	AB	88.091	287.1	3.72	8.0-12.0	1n	
03285N2408	2616	STF	412	AB	89.021	0.6	0.86	0.1	2n	O
03285N2408	2616	STF	412	ABXC	88.998	55.3	22.45	5.8-10.0	1n	
03306N4747	2643	HLD	9	AB	89.975	53.9	1.20	9.0- 9.0	1n	
03317N0016	2644	STF	422		87.936	268.1	6.51	8.2-10.0	3n	O
03572N3742	2956	ES	2085		90.136	269.8	3.73	9.5-15.0	1n	
04008N3745	2992	BU	545	AB	90.136	316.7	0.99	9.0-11.0	1n	N
04009N3749	2995	STT	531	AB	89.018	5.5	1.69	2.2	4n	O
05097S0819	3823	STF	668	AB	90.046	203.2	8.32		1n	
05097N0819	3827	STF	664		90.082	176.6	4.87	0.5	2n	N
05179N0058	3968	STF	700		89.214	5.1	4.82	8.1- 8.4	2n	
05254N0552	4115	STF	728		90.101	44.5	1.03	0.7	1n	O
05304S0527	4186	STF	748	AE	90.216	349.0	4.13		1n	
05304S0527	4186	STF	748	CF	90.216	121.7	3.93		1n	
05304S0524		HJ	1157		90.216	305.6	7.98	13.1-13.0	1n	N
05357S0160	4263	STF	774	AB	90.097	166.3	2.52	3.5	2n	O
05357S0160	4263	STF	774	AC	90.093	10.0	57.66	2.0-10.0	1n	N
05426N0625	4390	STF	795		90.216	217.1	1.44	0.0	1n	N
05584N1015	4644	J	310		90.105	320.5	2.32	9.0- 9.2	2n	
06088N2232	4841	BU	1008		90.136	253.2	1.38	3.0- 8.0	1n	O
06286N1449	5197	STF	932		88.403	311.2	1.74	0.2	3n	O
06374N5933	5400	STF	948	AB	90.133	75.7	1.80	0.4	3n	O
06374N5933	5400	STF	948	AC	90.130	309.3	8.65	1.5	3n	
06399N5549	5436	STF	958	AB	90.105	257.2	4.57	0.0	2n	
06399N5549	5436	STF	958	AC	90.103	268.0	175.32	6.0-10.0	1n	
06466N2465	5535	A	513	AB	90.136	221.3	0.50	10.0-10.1	1n	O
07066N2724	5871	STF	1037	AB	90.190	317.6	1.18	7.5-7.5	2n	O
07066N2724	5871	STT	166	AC	90.183	83.5		7.0-12.0	1/0n	
07162N3425	6019	HJ	757		90.193	107.0	5.23	9.4- 9.8	3n	N

Table 1. (continued)

IDS	ADS	Name	Mult.	t	P	d	m or dm	n	N
					o	"	m		
07275N3552	6170	HJ 3294		90.136	184.4	4.62	0.2	1n	N
07282N3166	6175	STF 1110	AB	90.105	75.8	2.98	0.8	2n	O
07282N3166	6175	STF 1110	AC	90.106	163.8	71.24	- 9.0	1n	
07595N2749	6569	STF 1177		88.552	351.1	3.35	0.4	2n	N
08032N3231	6623	STF 1187		90.231	26.6	2.74	0.7	2n	
08460N7071	7067	STF 1280	AB	90.210	163.5	0.93	0.4	2n	O
08481N4358	7075	STF 1289		90.107	6.7	3.84	8.0- 8.5	1n	
08494N4364	7092	STF 3120	AB	89.642	359.2	1.31	1.0	2n	
08553N3239	7137	STF 1298	AB	90.172	136.7	4.40	7.0- 9.0	1n	
09092N0244	7253	HJ 2489	AB	88.321	220.4	21.12	4.0-12.0	1n	
09147N3837	7307	STF 1338	AB	90.154	269.5	0.97	7.7- 7.8	2n	O
10075N2755	7685	STT 213		90.211	131.4	0.95	9.0-10.5	1n	O
10091N1783	7692	L 10		90.150	360.8	1.21	9.2- 9.4	2n	N
10108N1774	7704	STT 215		90.039	181.3	1.39	0.4	5n	O
10137N2064	7721	STF 1423		90.211	2.2	0.77	9.0-10.0	1n	O
10145N1981	7724	STF 1424	AB	88.208	123.2	4.62	0.8	2n	O
10174N1551	7744	STT 216		90.180	244.5	1.39	8.5-11.0	1n	O
10506N0076	7982	BU 1076		90.216	61.6	1.03	4.0	1n	O
10576N5464	8032	A 1590		90.211	339.7	1.38	8.5- 9.0	1n	O
11128N3166	8119	STF 1523	AB	90.313	55.8	1.34	0.5	3n	O
11128N3166	8119		AC	90.213	313.5	54.31	-15.0	1n	N
11138N1449	8128	STF 1527		90.211	46.6	1.01	8.5- 8.8	1n	O
11187N1065	8148	STF 1536		90.211	124.2	1.39	2.5	1n	O
11254N4150	8189	STT 234		87.429	130.3	0.48	8.0- 8.2	1n	O
11336N4142	8252	STT 237		87.103	248.0	1.88	8.6- 9.7	5n	N
12058N3987	8446	STF 1606		84.369	245.1	0.50		1n	O
12402N4358	8655	A 1783		87.244	217.3	1.73	0.1	5n	N
12458N2065	8680	HU 640		85.428	150.1	0.71	-0.3	1n	O
12458N2065	8680	HU 640		87.360	164.4	0.50	0.2	1n	O
12517N4333	8709	A 2000		88.401	53.9	0.96	0.7	1n	
13118N1733	8841	BU 800	AB	90.385	103.9	6.97	7.7-10.0	3n	
13118N1733	8841	BU 800	AC	90.385	341.5	116.23	7.7-10.5	3n	
13118N1733	8841		AD	90.413	88.4	50.79	7.0-11.0	1n	N
13518N3536		ALI 126		85.448	106.0	4.99	9.0- 9.4	1n	N
14095N2934	9174	STF 1816		88.193	86.3	0.74	0.2	2n	
14364N1369	9343	STF 1865	AB	89.474	300.1	1.17	-0.3	1n	O
14364N1369	9343	H 104	AC	89.474	258.9	103.80	-10.0	1n	
14468N1931	9413	STF 1888	AB	87.448	328.3	7.22	6.5- 8.5	3n	O
14479N1869	9423	BU 31	AB	87.476	218.0	1.83	8.7-10.1	5n	N
14479N1869	9423	BU 31	AC	87.445	169.2	8.05	8.5-14.5	2n	
15122N3440	9563	A 1366		86.993	79.0	3.38	9.0-10.8	3n	
15126N3361	9566	STF 1929		87.437	9.9	6.40	8.5- 9.6	2n	
15300N1052	9701	STF 1954	AB	90.524	176.9	3.98	0.9	3n	O
15562N1333	9880	STT 303	AB	89.811	172.4	1.39	0.2	2n	N
15562N1333	9880	BU	AC	88.354	13.4	82.03		1n	N
15569N1041		FOX		90.520	18.5	10.96	9.5- 9.6	1n	
15584N1416	9904	STF 2000		88.423	227.4	2.43	0.6	4n	N

Table 1. (continued)

IDS	ADS	Name		Mult.	t	P	d	m or dm	n	N
						o	"	m		
15586N1042	9905	J	446		88.502	181.4	4.20	10.2-10.0	2n	
15589S1110	9910	STF	1999	AB	87.429	99.4	11.79	8.0- 8.5	1n	
16539N0367	10285	STF	3107	AB	88.291	76.0	1.45	0.1	3n	N
16539N0367	10285	STF	3107	AD	88.571	42.6	73.36	0.2	2n	
16559N6511	10279	STF	2118		87.224	69.1	1.15	0.2	2n	O
17114S0020	10429	A	2984		87.751	360.9	1.04	3.0	2n	N
17155N3227	10472	BU	630		87.506	225.4	1.52	9.0-10.5	2n	N
17181N2611	10504	HO	414	AB	87.987	101.0	0.80	0.3	2n	N
17181N2611	10504	HO	414	AC	90.539	303.6	30.62	9.0-11.0	1n	
17270N1115	10612	AG			90.233	53.2	2.32	0.4	2n	
17584N4011	11001	STF	2267		88.571	261.7	0.73	0.1	2n	N
17596N4414	11010	BU	1127		89.485	73.0	0.81	8.5-10.0	1n	O
18011N1200	11056	STF	2276	AB	89.634	256.9	6.88	0.1	3n	N
18011N1200	11056	STF	2276	AC	89.634	305.4	63.03	-10.1	3n	N
18072N5023	11128	HU	674		85.519	228.8	0.78	0.7	1n	N
18094N0009	11186	STF	2294		88.467	91.4	1.18	0.3	4n	
18148N4348	11247	A	578	AB	86.708	262.7	0.3		1n	O
18272N0643	11432	STT	354		86.706	201.3	0.77	8.8- 9.0	1n	N
18314N2331	11479	STT	359		86.709	12.2	0.87	0.3	1n	O
18314N1654	11483	STT	358	AB	90.082	159.1	1.66	0.2	2n	O
18455N5913	11697	STF	2410		88.665	86.4	1.65	8.2- 8.6	2/1n	
18490N3254	11788	BAR		AB	90.539	320.3	2.15	11.5-11.5	1n	
18499N3721	11805	HO	89		88.573	173.4	4.64	8.0-10.5	1n	N
18576S0051	11971	STF	2434	AB	89.696	96.0	26.08	8.5- 9.0	1n	N
18576S0051	11971	STF	2434	BC	89.572	316.8	0.58	9.0-10.7	3n	N
19029N2226	12053	STF	2457		89.708	201.1	9.92	1.5	2n	
19225N2707	12447	STF	2525		89.696	290.6	1.88	8.5- 8.6	1n	O
19305N4208	12618	A	597		86.791	96.9	1.59	2.0	1n	N
19418N3322	12889	STF	2576		87.830	170.0	2.23	8.5- 8.6	1n	O
19450N3504	12972	STT	387		88.737	154.3	0.71	7.5- 8.5	1n	O
19462N1010	13012	J	124	AC	85.716	223.5	21.58		1n	N
19540N2152	13184	AG	244	AB	86.706	271.4	1.54	9.0-10.2	1n	
19547N2150	13200	HO	583		85.702	257.4	1.26	9.0-10.5	1n	
20025N3437	13383	SEI	870		87.711	307.1	6.34	12.0-12.5	1n	N
20134N2850	13648			AP	89.696	216.5	0.40		1n	N
20134N2604	13649	BU	984		86.776	251.9	0.68	0.3	2n	N
20141N2854	13665	A	1205		88.355	99.6	0.87	8.9- 9.4	3n	O
20151N2856		COU	1477		88.590	104.6	0.56	0.1	3n	
20173N2327	13750	STF	2672		89.619	336.2	0.82	9.0- 9.5	1n	N
20217N3943	13842	MLB	22		89.682	225.9	5.70	11.2-12.2	2n	
20219N3946	13847	D	22	AB	89.675	157.7	2.78	7.8- 8.8	3n	N
20219N3946	13847	D	22	AC	89.649	98.3	73.37	7.5- 9.0	1n	
20222N0948	13863	J	1343		88.748	94.9	2.26	10.0-10.5	1n	N
20223N0928	13866	J	559		86.777	272.0	2.25	11.0-11.2	1n	N
20231N0938	13878	AG	256	AB	88.748	355.0	5.00	9.0-10.0	1n	
20247N3945		COU	2538		89.691	32.4	0.97	9.6- 9.7	3n	
20259N1344	13928	AG			85.803	288.5			1/0n	N

Table 1. (continued)

IDS	ADS	Name		Mult.	t	P	d	m or dm	n	N
						o	"	m		
20261N1327	13929	STF	2688		85.735	176.1	6.78	8.0- 9.0	1n	
20403N1222	14238	BU	64	AB	89.783	168.6	0.69	0.2	1n	O
20416N1532	14270	STF	2725		87.672	10.5	5.98	0.5	2n	O
20508N2743	14424	BU	367	AB	86.865	120.0	0.52	0.1	1n	O
20508N2743	14424	BU	367	AB	89.778	126.3	0.61	0.3	1n	O
20541N0355	14499	STF	2737	AB	86.944	285.5	0.98	0.3	5n	O
20541N0355	14499	STF	2737	AC	87.123	66.0	10.27	0.8	2n	
20580N0108	14573	STF	2744	AB	89.686	124.5	1.43	0.8	2n	O
21036N3522	14667	ES	2254		85.814	276.5	8.16	9.2-10.0	1n	N
21112N3519	14792	SEI	1475		89.788	267.4	5.31	10.0-10.6	2n	
21130N3521	14822	BU	162	AB	89.721	251.6	1.34	0.4	4n	
21130N3521	14822	BU	162	AC	89.742	133.6	15.71	8.0-13.3	2n	
21159N0242	14880	BU	838		88.094	141.1	1.43	8.2-10.7	2n	N
21166N3202	14889	STT	437	AB	89.752	24.6	2.16	0.1	2n	N
21166N3202	14889	STT	437	AC	89.752	141.8	81.11	7.0-11.0	2n	
21397N2817	15270	STF	2822	AB	87.953	300.1	1.98	1.6	5n	O
21397N2817	15270	STF	2822	AC	87.814	289	68.2		1n	N
21506N1025	15447	BU	75	AB	89.797	7.0	0.64	8.5- 8.8	1n	O
22052N5848	15670	STF	2872	BC	88.248	302.3	0.96	-0.1	2n	N
22100N2905	15769	STF	2881		87.035	78.5	1.33	0.5	6n	N
22231N1154	15961	J	580		86.774	108.7	4.14	0.5	2n	
22235N2301	15966	STF	2910		89.778	332.7	5.23		1n	N
22237S0032	15971	STF	2909		87.536	208.4	1.95	0.1	3n	O
22249N0355	15988	STF	2912		88.424	117.2	0.64	0.9	3n	O
22365S0265	16183	BU	709		85.817	3.6	2.35	9.0- 9.5	1n	
22370N2054	16185	STF	2934	AB	89.794	69.9	0.94	8.5- 9.2	1n	O
22405N1040	16242	BU	711		89.720	357.3	2.12	10.0-11.2	1n	O
22474N6109	16317	STF	2950	AB	89.811	283.8	1.63	1.0	1n	N
22492N4413	16345	BU	382	AB	89.808	214.7	1.09	7.0- 8.0	1n	O
22492N4413	16345	HJ	1828	AC	89.808	358.7	29.06	7.0- 8.5	1n	
22498N1740	16360	J	621	AB	86.777	123.2	1.96	11.7-12.0	1n	N
23138N0452	16665	BU	80	AB	89.797	324.9	0.69	8.5- 9.0	1n	O
23370N1945	16937	STT	503	AB	89.786	132.5	1.24	0.4	2n	
23404N1952	16970	STT	505		89.625	62.4	2.12	7.5-11.0	1n	
23544N3310	17149	STF	3050		89.797	318.6	1.82	0.0	2n	O
23563N3905	17178	HLD	60		89.797	176.6	1.06	9.8-10.1	2n	O
23596N3737	34	BU	862		89.800	14.2	0.57	9.6-10.1	2n	O
23597N4325	39	A	203		89.894	344.6	1.77	8.7- 9.5	2n	

Table 2. Notes

	° "
61	Baize, 1957: -0.9, +0.02
207	Heintz, 1960: +0.8, 0.00
283	Muller, 1957: +0.7, +0.06
382 AB	The angle has increased by 41° in 80 years. Orbital motion.
755	Muller, 1957: -6.4, +0.15
1538	Mourao, 1976: +0.7, -0.04
2122 AB	Rabe, 1961: +1.2, -0.21
2446	Rabe, 1948: -2.9, -0.09
2616 AB	Luyten, 1934: -3.4, +0.16
2644	Hopmann, 1964: +0.6, -0.13
2992 AB	The measurements in the posi - tion angle are discordant.
2995 AB	Heintz, 1985: +2.0, -0.13
3827	The angle has decreased by only 10° in 60 years but there is some reduction in distance.
4115	Siegrist, 1951: +2.3, +0.04
05304S0524	Place according to ADS 4186:+4.
4263 AB	Hopmann, 1967: +2.0, +0.19
4263 AC	No material change in this pair
4390	Slow motion in angle and dis - tance decreasing.
4841	Baize, 1980: -5.3, -0.18
5197	Hopmann, 1960: +2.1, 0.00
5400 AB	Brosche, 1957: +2.0, +0.11
5535 AB	Heintz, 1963: -3.6, -0.04
5871 AB	Karmel, 1939: +0.7, -0.11
6019	ADS 6019 is not the star BD+34 1589, but the brighter star NE from it.
6170	Slow direct motion in angle. Position angle AC:312°.6.
6175 AB	Muller, 1956: -2.7, -0.20 Rabe, 1958: +2.0, -0.01
6569	No change.
7067	Heintz, 1974: -0.9, -0.13
7307	Arend, 1953: -2.3, -0.08
7685	Heintz, 1962: +7.7, +0.02
7692	Slow retrograde motion.
7704	Wierzbinski, 1956: -0.2, -0.05
7721	Heintz, 1960: +1.5, -0.24
7724 AB	Rabe, 1958: -0.9, +0.27
7744	Heintz, 1978: -1.3, -0.28
7982	Morel, 1970: +2.7, -0.07
8032	Baize, 1985: +2.4, +0.15
8119 AB	Heintz, 1967: -2.4, +0.10
8119 AC	This is the first measure of companion C.

Table 2. (continued)

8128	Hopmann, 1960:+10.7, -0.17
8148	Heintz, 1985: -0.3, -0.06
8189	Couteau, 1965:-10.1, +0.07
8252	The angle has decreased by 39° since 1845.
8446	V.d.Wiele, 1974: -5.6, +0.17
8655	No change.
8680	Baize, 1983: -6.3, +0.14
8680	Baize, 1983: +4.2, -0.06
8841 AD	First measure of the pair AD.
13518N3536	Identification uncertain.
9343 AB	Wierzbinski, 1956: -2.5, +0.19
9413	Wielen, 1962: +0.7, +0.12
9423 AB	The angle has increased by 36° since 1874.
9701 AB	Hopmann, 1973: +0.4, -0.24
9880 AB	With increase in distance the angle has increased by 61° since 1846.
9880 AC	In ADS a triple system, but in IDS only a double star. Incre- ase in distance.
9904	No change.
10285 AB	The angle has decreased by 37° since 1831.
10279	Scardia, 1981: -0.1, -0.05
10429	The angle has increased by 63° since 1915.
10472	No change.
10504 AB	The angle has increased by 16° since 1891.
11001	The angle has increased by 28° since 1830.
11010	Popovic, 1970: -2.3, -0.29
11056 AB	No change.
11056 AC	No change.
11128	Decrease in angle of 50 since 1904 with little change in distance.
11247 AB	Zulevic, 1977: -3.0, -
11432	Increase in angle of 47° since 1846.
11479	Symms, 1963: +3.9, +0.23
11483	Heintz, 1954: +4.6, +0.21
11805	Identification uncertain.
11971 AB	The angle has decreased by 51° since 1831.
11971 BC	The angle has decreased by 128 since 1831 and the distance has decreased.

Table 2. (continued)

12447	Tamburini, 1967: -1.3, -0.07
12618	The angle has decreased by 57° since 1903.
12889	Rabe, 1948: +0.2, -0.06
12972	Rabe, 1948: +1.9, +0.15
13012 AC	AB: a very difficult pair.
13383	Place according to ADS 13391: -22 s, +1 .
13648 AP	First visual measurement.
13649	The angle has increased by 48° since 1880.
13665	Heintz, 1978: +1.0, +0.17
13750	The angle has increased by 58 since 1831.
13847 AB	Direct motion.
13863	The angle has increased by 49° since 1914. Probably optical!
13866	The angle has increased by 56° since 1911.
13928	Clouds.
14238 AB	Baize, 1957: +0.3, +0.14
14270	Hopmann, 1973: +1.2, +0.01
14424 AB	Heintz, 1962: -4.1, +0.02
14424 AB	Heintz, 1962: -0.3, +0.11
14499 AB	Van den Bos, 1933: +0.4, -0.04
14573 AB	Hopmann, 1960: +2.6, -0.01
14667	Certainly dm > 0.2 .
14880	The angle has increased by 51° since 1881.

Table 2. (continued)

14889 AB	The angle has decreased by 43 since 1845.
15270 AB	Heintz, 1966: -4.6, +0.38
15270 AC	C probably optical!
15447 AB	Baize, 1974: +4.1, +0.09
15670 BC	The angle has decreased by 32 since 1833.
15769	The angle has decreased by 33 since 1830.
15966	The angle has decreased by 14 since 1832.
15971	Harrington, 1968: -3.8, +0.10
15988	Knipe, 1960: -0.4, -0.31
16185 AB	Heintz, 1981: +2.2, -0.16
16242	Popovic-Ćatović 90: +0.4, -0.18
16317 AB	The angle has decreased by 35 since 1832.
16345 AB	Rabe, 1961: -0.7, +0.06
16360 AB	The angle has increased by 78 since 1911 but the distance is closing in. Optical or physical pair ?
16665 AB	Couteau, 1984: -7.4, +0.04
17149	Heintz, 1974: -3.8, +0.18
17178	Heintz, 1963: -1.4, -0.06
34	Couteau, 1986: +0.3, -0.05

МИКРОМЕТАРСКА МЕРЕЊА ДВОЈНИХ ЗВЕЗДА

(Серија 45)

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Југославија

УДК 524.383
Претходно саопштење

Саопштавају се средње вредности 325 микрометарских мерења за 149 двојних или вишеструких звезда (176 парова) добијених на рефрактору Zeiss 65/1055 cm Астрономске опсерваторије у Београду. Појединачна мерења послата су Центру за астрономске податке у Вашингтону.

Bull. Obs. Astron. Belgrade N° 144 (1991), 47–60.

UDC 524.383
Preliminary report

MICROMETER MEASUREMENTS OF DOUBLE STARS

(Series 46)

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(Received: October 22, 1990)

SUMMARY: Here are presented 250 measurements of 132 double stars made with 65/1055 cm refractor of Belgrade Observatory.

The present series of measurements is the continuation of my own measurements published under Series 44 (D.J. Zulević, 1989). The measurements were made with the 65/1055 cm refractor of the Belgrade Observatory between 1989 January 17 and 1990 Mars 20. In Table I the columns give ADS number, double star designation, position for 1900 (IDS), multiple, epoch omitting the century, position angle, separation, estimated magnitudes, number of nights and notes. In notes comparisons have been made with the latest available orbits (P. Couteau et al., 1986).

In the present work the distribution of 250 measurements of distance is as follows:

Distances	Number of measurements
0".00 to 0".50	4
0.51 to 1.00	53
1.01 to 1.50	54
1.51 to 2.00	53
2.01 or greater	76
	250

ACKNOWLEDGEMENTS

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Jeffers, H.M., Van den Bos, W.H., Greeby, F.M.: 1963, *Index catalogue of visual double stars, 1961. O.* Publ. of the Lick Obs. **21**.
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Table I Micrometer Measurements of Double Stars

ADS	Disc. IDS	mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
34	BU 862		89.797	13.6	0.60	9.5-10.0	1	
	23596N3737		89.808	9.7	0.53	9.0-9.5	1	
			------	----	----		---	
			89.802	11.6	0.56		2	
39	A 203		89.811	348.2	1.67	8.3-8.7	1	
	23597N4325		89.936	343.1	1.70	8.5-9.0	1	
			------	-----	----		---	
			89.873	345.6	1.69		2	
61	STF 3062		89.778	305.5	1.55	6.0-7.0	1	
	00010N5753		89.947	310.1	1.49	7.0-8.0	1	
			89.953	311.0	1.49	7.0-8.0	1	
			89.969	309.2	1.54	6.5-7.5	1	
			89.972	309.4	1.63	7.0-8.0	1	
			-----	-----	----		---	° "
			89.924	309.0	1.54		5	Baize,57:+0.8;+0.07
134	KR 1		89.972	190.4	1.95	9.0-9.4	1	
	00057N5717							
263	KR 4		89.947	182.1	1.96	8.5-9.3	1	
	00138N5909							
755	STF 73	AB	89.764	289.1	0.77	6.0-6.4	1	
	00496N2305		89.797	286.2	0.74	6.5-6.7	1	
			89.808	286.0	0.74	6.0-6.4	1	
			------	-----	----	-------	---	° "
			89.791	286.9	0.75		3	Muller,57:-4.8; 0.00
888	STF 86	AB	89.936	140.8	18.36	8.5-8.8	1	
	00597S0561		89.972	140.4	15.93	8.0-8.3	1	
			------	-----	-----		---	
			89.954	140.6	15.15		2	
953	AG 15		89.969	250.6	2.63	9.0-9.1	1	
	01042N3939							
2122	STF 305	AB	89.729	309.5	3.58	7.5-8.2	1	
	02418N1857		89.945	311.4	3.45	7.5-8.0	1	
			89.969	309.3	3.54	7.5-8.2	1	
			89.972	309.4	3.46	7.5-8.0	1	
			------	-----	----		---	° "
			89.904	309.9	3.51		4	Rabe,61:+1.9;-0.17
2257	STF 333	AB	89.969	208.3	1.18	6.0-6.3	1	
	02535N2056							

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
2397	STT 51		89.969	327.0	1.00	8.0-8.3	1	
	03062N4355							
2491	STF 380		89.969	21.4	0.99	8.5-9.5	1	
	03164N0824							
2643	HLD 9	AB	89.969	51.7	1.52	8.5-8.6	1	
	03306N4747		89.972	51.4	1.45	9.0-9.0	1	
			------	----	----		---	
			89.970	51.6	1.49		2	
								° "
2644	STF 422		89.972	268.9	6.42	7.0-9.0	1	Hopmann,61:+1.3;+0.23
	03317N0016							
2956	Es 2085		90.136	267.6	4.50	7.9-10.5	1	
	03572N3742							
2992	BU 545	AB	90.136	312.5	1.01	9.0-11.5	1	
	04008N3745							
2995	STT 531	AB	89.047	6.5	1.73	7.0-9.0	1	
	04009N3727		89.945	4.5	1.76	7.5-10.5	1	
			89.970	2.5	1.94	6.9-8.5	1	
			90.136	3.8	1.77	8.5-10.5	1	
			------	---	----		---	° "
			89.774	4.3	1.80		4	Heintz,85:+1.3;-0.04
3082	STT 77	AB	89.047	276.2	0.83	8.0-8.0	1	
	04096N3127							
								° "
3264	STF 554		89.970	17.4	1.66	6.5-9.0	1	Baize,80:-0.7;-0.09
	04244N1525							Kuiper,37:+2.0;-0.13
3390	STF 557		89.047	194.4	1.10	8.5-8.5	1	Hock,Flinner,70:
	04355N3719							+4.1;-0.01
3823	STF 668	AB	90.046	201.8	8.85	0.3-10.0	1	
	05097S0819							
3827	STF 664		90.046	174.7	4.83	7.5-8.0	1	
	05097N0819		90.106	175.2	4.85	7.5-7.7	1	
			------	-----	----		---	
			90.075	175.9	4.84		2	
								° "
4115	STF 728		90.101	42.7	1.08	5.2-6-7	1	Siegr.,51:+0.5;+0.09
	05254N0552							
								° "
4200	STF 742		90.092	270.8	3.98	7.5-7.8	1	Hopmann,73:-1.5;-0.07
	05304N2156							

Table I (Continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
4208	STF 749 05309N2652	AB	89.970	325.7	1.22	7.1-7.0	1	
4263	STF 774 05357S0160	AB	90.093	164.5	2.47	2.6-4.0	1	
			90.101	166.0	2.32	2.0-4.0	1	
			------	-----	----		---	° "
			90.097	165.2	2.40		2	Hopmann,67:+0.9;+0.07
4349	STF 781 05400N2117	AB	90.104	55.7	_	8.1-8.5	1	
4644	J 310 05584N1015		90.104	312.1	2.16	8.6-9.0	1	
			90.106	318.8	2.19	8.6-8.7	1	
			------	-----	----		---	
			90.105	315.4	2.18		2	
4841	BU 1008 06088N2232		90.136	259.3	1.58	3.5-8.5	1	
			90.183	263.4	1.53	3.8-8.0	1	
			------	-----	----		---	° "
			90.160	261.4	1.55		2	Baize,80:+2.9;-0.01
5197	STF 932 06286N1449		90.101	311.6	1.56	8.0-8.2	1	
			90.183	312.4	1.57	8.0-8.2	1	
			90.199	312.0	1.66	8.3-8.5	1	
			------	-----	----		---	° "
			90.161	312.0	1.60		3	Hopmann,60:+3.3;-0.01
								° "
5234	STT 149 06302N2722		90.183	310.4	0.60	6.5-8.8	1	Heintz,67:+2.6;-0.0[illegible]
5400	STF 948 06374N5933	AB	90.101	77.1	1.68	5.2-5.7	1	
			90.106	75.9	1.73	5.5-6.0	1	
			90.183	76.9	1.66	5.2-6.1	1	
			------	----	----		---	° "
			90.130	76.6	1.69		3	Broche,57:+2.8; 0.00
5400	STF 948 06374N5933	AC	90.101	308.6	8.75	5.2-6.4	1	
			90.106	309.0	8.46	_	1	
			90.183	301.1	8.43	7.2-8.5	1	
			------	-----	----		---	
			90.130	309.2	8.55		3	
5436	STF 958 06399N3549	AB	90.104	258.7	4.72	7.0-7.0	1	
			90.106	257.2	4.51	6.0-6.0	1	
			------	-----	----		---	
			90.105	258.0	4.61		2	

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			° "
5469	A 2731		90.210	61.5	1.00	8.5-9.5	1	Muller,57:-4.1;-0.06
	06432N0744							
								° "
5535	A 513	AB	90.136	222.0	0.45	9.7-9.8	1	Heintz,63:-2.9;-0.09
	06466N2465							
								° "
5559	STF 982	AB	90.207	147.1	6.78	8.5-8.5	1	Hopmann,74:-25.0;1.39
	06490N1318							
5871	STF 1037	AB	89.700	317.4	1.21	7.0-7.0	1	
	07066N2724		90.183	317.3	1.21	7.5-7.5	1	
			90.191	317.7	1.21	7.5-7.5	1	
			90.197	317.5	1.26	8.0-8.0	1	
			------	-----	----		---	° "
			90.068	317.5	1.22		4	Karmel,39:+0.5;-0.07
								° "
5983	STF 1066		90.207	220.5	5.80	3.5-8.5	1	Hopmann,60:-3.2;-0.13
	07142N2170							
6170	HJ 3294		90.136	182.4	4.87	9.8-9.9	1	
	07275N3552							
6175	STF 1110	AB	90.104	80.0	2.95	2.7-4.7	1	
	07282N3166		90.106	77.7	2.91	2.7-3.7	1	
			90.191	76.3	2.94	2.7-3.7	1	° "
			------	----	----		--	Muller,56:-0.5;-0.18
			90.134	78.0	2.93		3	Rabe,58:+4.2;-0.08
6532	STF 1175		90.191	230.8	1.13	8.0-9.5	1	
	07572N0426		90.210	273.5	1.22	7.9-9.5	1	
			------	-----	----		---	° "
			90.200	272.1	1.20		2	Hopmann,64:-5.7;+0.02
6569	STF 1177		90.106	350.1	3.21	6.5-7.0	1	
	07591N2749							
6582	A 1971		90.191	11.6	0.87	9.0-9.2	1	
	08010S0029		90.210	12.6	0.84		1	
			------	----	----		---	° "
			90.200	12.1	0.85		2	Zulevic,90:0.0;-0.06
6623	STF 1187		90.213	25.5	2.64	7.5-8.5	1	
	08032N3231							

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
7044	VDK 3		90.191	138.9	2.20	8.8-9.0	1	
	08453N0774		90.207	139.8	2.19	9.5-9.7	1	
			------	-----	----		---	° "
			90.199	139.4	2.00		2	Wiele,74:+2.7;-0.33
7067	STF 1280	BC	90.200	163.1	0.95	8.5-8.7	1	
	08460N7071		90.216	162.2	0.95	8.1-8.3	1	
			------	-----	----	-------	---	° "
			90.208	162.6	0.95		2	Heintz,74:-2.1;-0.11
7075	STF 1284		90.107	5.2	3.75	8.0-8.5	1	
	08481N4358							
7092	STF 3120	AB	90.107	357.5	1.44	7.8-8.3	1	
	08494N4364							
7139	STF 1300		90.208	182.3	5.08	8.8-8.8	1	
	08558N1540							
7307	STF 1338	AB	90.136	270.6	0.91	7.5-7.6	1	
	09147N3837		90.178	270.6	1.03	7.0-7.0	1	
			------	-----	----		---	° "
			90.157	270.6	0.97		2	Arend,53:+0.7;-0.08
7685	STT 213		90.191	129.0	0.83	8.0-10.0	1	
	10075N2755		90.211	128.2	0.84	8.5-9.5	1	
			------	-----	----		---	° "
			90.20	128.6	0.84		2	Heintz,62:+4.8;-0.08
7692	L 16		90.136	357.9	1.34	9.0-9.3	1	
	10091N1783		90.181	357.1	1.29	9.5-9.7	1	
			------	-----	----		---	
			90.158	357.5	1.32		2	
7704	STT 215		90.136	181.8	1.35	7.5-7.6	1	
	10108N1774		90.178	181.3	1.33	8.0-8.2	1	
			90.181	181.0	1.49	7.5-7.7	1	
			90.191	181.5	1.38	7.5-7.7	1	
			90.213	181.3	1.42	7.5-7.7	1	
			------	-----	----		---	Wierzbinski,56:
			90.180	181.4	1.39		5	-0.1;-0.05
7721	STF 1423		90.192	359.7	0.92	8.6-9.2	1	
	10137N2064		90.210	0.9	0.93	8.5-9.2	1	
			------	----	----		---	° "
			90.201	0.3	0.93		2	Heintz,60:-0.4;-0.08

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
7724	STF 1424	AB	90.178	124.1	4.46	2.2-3.5	1	
	10195N1981		90.208	125.0	4.41	2.2-3.5	1	
			------	-----	----		---	° "
			90.193	124.6	4.43		2	Rabe,58:+0.3;+0.07
7744	STT 216		90.180	248.5	1.31	7.0-9.5	1	
	10174N1551		90.192	245.0	1.50	8.0-10.5	1	
			------	-----	----		---	° "
			90.186	247.7	1.40		2	Heintz,78:+0.9;-0.27
								° "
7758	STF 1429		90.192	173.0	0.61	8.7-8.7	1	Zulevic,81:-3.0;-0.02
	10195N2468							
7929	STT 229		90.208	275.3	0.76	7.0-7.1	1	
	10423N4138							
								° "
7982	BU 1076		90.216	66.4	0.80	6.0-9.5	1	Morel,70:+7.5;-0.30
	10506N0076							
8032	A 1590		90.208	341.1	1.43	8.7-9.2	1	
	10576N5464		90.211	341.2	1.40	8.0-8.5	1	° "
			------	-----	----		---	Heintz,63:+3.9:+0.18
			90.210	341.2	1.41		2	Baize,85:-0.2;-0.01
8119	STF 1523		90.213	54.8	1.24	4.5-5.0	1	
	11128N3166		90.216	56.7	1.21		1	
			------	----	----		---	° "
			90.215	55.7	1.22		2	Heintz,67:-1.9;-0.01
8128	STF 1527		90.208	45.2	1.01	6.9-8.0	1	
	11138N1449		90.211	44.9	1.06	7.5-8.5	1	
			------	----	----		---	° "
			90.210	45.0	1.03		2	Hopmann,60:+9.1;-0.15
								° "
8148	STF 1536		90.211	128.1	1.39	3.9-7.1	1	Heintz,85:+3.6;-0.06
	11187N1065							
								° "
8949	STF 1757	AB	89.453	120.1	2.36	8.9-9.9	1	Heintz,56:-1.0;+0.42
	13292N0012							
								° "
9031	STF 1785		89.453	165.3	3.30	8.0-8.2	1	Strand,55:-0.9;-0.12
	13445N2689							
9174	STF 1815		89.441	84.0	0.86	7.5-7.6	1	
	14095N2934							
9343	STF 1865	AB	89.474	304.9	1.14	3.5-3.9	1	Wierzbinski,56:
	14364N1369							+2.3;+0.16

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				o	"			o "
9425	STT 288 14487N1567		89.453	170.5	1.40	7.5-8.2	1	Heintz,56:+5.8;+0.35 Zulevic,90:+0.7;+0.02
9578	STF 1932 15140N2672		89.453	255.3	-	7.2-7.5	1	Heintz,65:+0.3;---
9626	STF 1938 15207N3742	BC	89.515	12.4	2.10	8.0-8.8	1	
			89.542	11.0	2.28		1	
			------	----	----		---	
			89.528	11.7	2.19		2	Baize,52:-0.3;-0.04
9904	STF 2000 15584N1416		89.441	228.6	2.51	8.0-8.4	1	
			89.474	228.2	2.46	8.4-9.0	1	
			------	-----	----		---	
			89.457	228.4	2.48		2	
10075	STF 2052 16245N1837	AB	89.549	128.8	1.49	7.8-7.8	1	
			89.553	130.0	1.65	7.8-7.8	1	
			------	-----	----		---	
			89.551	129.4	1.57		2	Scardia,84:+6.0;-0.17
10188	D 15 16408N4340		89.549	131.7	0.89	9.1-9.2	1	
			89.553	132.9	0.88	9.1-9.2	1	
			------	-----	----		---	
			89.551	132.3	0.88		2	Wierzbinski,57: -0.4;-0.08
10235	STF 2107 16479N2850	AB	89.515	99.6	1.31	7.2-8.7	1	
			89.542	96.5	1.27	7.0-8.5	1	
			------	----	----		---	
			89.528	98.0	1.29		2	Rabe,27:+5.1;-0.12
10279	STF 2118 16559N6511		89.549	69.0	1.10	7.0-7.5	1	
			89.553	67.1	1.17	7.0-7.3	1	
			------	----	----		---	
			89.551	68.0	1.13		2	Scardia,81:-0.9;-0.09
10345	STF 2130 17033N5436	AB	89.549	32.9	2.15	6.0-6.0	1	
			89.553	31.6	2.10	6.0-6.0	1	
			------	----	----		---	
			89.551	32.2	2.12		2	Heintz,81:+0.5;+0.01
10429	A 2984 17114S0020		89.485	0.7	1.04	Δm=3.0	1	
10472	BU 630 17155N3227		89.485	223.8	1.49	9.0-10.8	1	
			89.562	222.7	1.45	9.0-11.0	1	
			------	-----	----		---	
			89.523	223.2	1.47		2	

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
11010	BU 1127		89.485	70.3	1.01	8.5-10.0	1	
	17596N4414		89.562	69.1	0.97	7.5-9.5	1	
			------	----	----		---	° "
			89.523	69.7	0.99		2	Popovic,70:-5.1;-0.11
11046	STF 2272	AB	89.515	235.9	1.77	4.0-6.5	1	
	18004N0232		89.542	237.3	1.80	4.1-6.3	1	
			89.556	237.3	1.78	4.1-6.3	1	
			------	-----	----		---	° "
			89.538	236..8	1.78		3	Heintz,73:+4.8;+0.25
11483	STT 358	AB	89.474	158.9	1.81	7.5-7.6	1	
	18314N1654		89.515	158.9	1.84	6.9-7.0	1	
			89.542	157.0	1.75	7.0-7.3	1	
			89.556	157.6	1.71	7.0-7.4	1	
			------	-----	----		---	° "
			89.522	158.1	1.78		4	Heintz,54:+3.3;+0.33
11635	STF 2382	AB	89.515	352.1	2.68	5.0-6.0	1	
	18410N3934		89.542	351.0	2.69	5.1-6.1	1	
			89.548	353.1	2.52	5.1-6.1	1	
			------	-----	----		---	
			89.535	352.1	2.63		3	Guntzel-Lingner,56: -0.7; 0.00
11635	STF 2383	CD	89.515	88.6	2.44	5.2-5.3	1	
	18410N3934		89.543	86.9	2.51	5.2-5.2	1	
			89.548	87.5	2.35	5.2-5.2	1	
			------	----	----		---	Guntzel-Lingner,56:
			89.535	87.7	2.43		3	+1.4;+0.14
11897	STF 2438		89.556	1.6	0.81	7.0-7.3	1	
	18558N5805		89.562	1.5	0.90	6.8-7.4	1	
			------	---	----		---	Jastrzebski,59:
			89.558	1.5	0.85		2	+1.0;-0.07
11971	STF 2434	BC	89.474	307.7	0.49	8.4-10.3	1	
	18576S0051		89.485	331.6	0.60	8.9-10.5	1	
			89.696	307.4	0.53	8.5-10.0	1	
			------	-----	----		---	
			89.552	315.6	0.54		3	
								° "
12040	STF 2454	AB	89.780	285.8	1.22	8.0-9.0	1	Baize,76:+3.8;-0.03
	19023N3017							
12053	STF 2457		89.701	200.6	9.77	7.0-8.1	1	
	19029N2226		89.715	200.1	10.06	7.5-9.0	1	
			------	-----	-----		---	
			89.708	200.3	9.91		2	

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
12201	STF 2484		89.728	236.9	2.18	8.5-9.5	1	
	19099N1854		89.764	237.6	2.17	8.5-9.5	1	
			------	-----	----		--	
			89.746	237.2	2.17		2	Hopmann,73:?;+0.50"
12447	STF 2525		89.543	292.5	1.80	8.5-8.7	1	
	19225N2707		89.548	293.4	1.83	8.5-8.7	1	
			89.696	291.8	1.82	8.5-8.6	1	
			89.726	292.8	1.79	8.5-8.9	1	
			------	-----	----		---	
			89.648	292.6	1.81		4	
12618	A 597		89.562	98.0	1.56	8.4-10.5	1	
	19305N4208							
12880	STF 2579		89.549	231.3	2.25	3.0-7.9	1	
	19418N4453		89.553	230.4	2.33	3.0-7.9	1	
			------	-----	----		---	
			89.551	230.8	2.29		2	Baize,73:+3.6°;-0.13"
12889	STF 2576	AB	89.543	171.2	2.35	9.0-9.0	1	
	19418N3322		89.548	169.1	2.42	9.0-9.0	1	
			89.549	170.9	2.47	9.3-9.3	1	
			------	-----	----		--	
			89.547	170.4	2.41		3	Rabe,48:+1.8°;+0.06"
12930	HU 758		89.562	148.6	0.85	9.7-9.9	1	
	19432N3307							
12972	STT 387		89.780	155.8	0.69	7.2-7.7	1	Rabe,48:+5.4°;+0.13"
	19450N3504							Baize,61:+4.2;+0.09
13665	A 1205		89.696	105.2	0.91	9.5-10.0	1	
	20141N2854		89.720	104.4	0.80	9.0-9.6	1	
			------	-----	----		---	
			89.708	104.8	0.86		2	Heintz,78:+6.6°;+0.14"
39° 4203	COU 2538		89.696	31.9	1.04	9.5-9.6	1	
	20247N3945		89.715	29.9	0.93	9.5-9.6	1	
			------	----	----		---	
			89.706	30.9	0.98		2	
28° 3703	COU 1477		89.696	106.0	0.45	10.0-10.6	1	
	20151N2856		89.720	104.3	0.59	11.0-11.5	1	
			------	-----	----		---	
			89.708	105.1	0.52		2	
13648	BU 441	AB	89.696	220.0	0.44	-	1	
	20134N2850							

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
13842	MLB 22 20217N3943		89.715	226.8	-	10.0-12.0	1	
13847	D 22 20219N3946	AB	89.685	160.0	2.77	7.9-9.0	1	
			89.696	159.1	2.81	8.5-9.3	1	
			89.690	159.6	2.79		2	
13878	AG 256 20231N0938	AB	89.726	351.3	5.01	9.5-9.8	1	
14194	ARG 39 20393N4854	AB`	89.723	174.3	12.43	8.5-8.6	1	
			89.728	174.3	12.45	8.5-8.7	1	
			89.726	174.3	12.44		2	
14238	BU 64 20403N1222	AB	89.783	167.1	0.66	9.0-9.1	1	Baize,57:-1.2°;+0.11"
14270	STF 2725 20416N1532		89.728	9.7	5.94	8.0-8.5	1	
			89.764	9.5	5.88	8.0-8.5	1	
			89.756	9.6	5.91		2	Hopmann,73:+0.1°;-0.07"
14296	STT 413 20435N3607		89.549	15.0	0.97	4.8-6.1	1	
			89.553	14.5	0.98	5.0-6.2	1	
			89.728	13.0	0.85	5.0-6.0	1	
			89.610	14.2	0.93		3	Baize,83:+1.6°;+0.02"
14424	BU 367 20508N2743	AB	89.764	132.0	0.57	8.9-9.3	1	
			89.778	128.6	0.61	9.0-9.5	1	
			89.771	130.3	0.59		2	Heintz,62:+3.7°;+0.09"
14499	STF 2737 20541N0355	AB	89.553	284.8	0.99	6.0-6.5	1	
			89.562	287.3	0.96	5.8-6.0	1	
			89.729	286.7	1.01	6.0-6.5	1	
			89.615	286.3	0.99		3	Bos,33:+1.3°;-0.01"
14573	STF 2744 20580N0108	AB	89.543	125.1	1.30	7.0-7.3	1	
			89.548	123.2	1.24	7.0-7.3	1	
			89.549	123.0	1.21	7.0-7.5	1	
			89.778	124.5	1.25	7.5-8.0	1	
			89.604	124.0	1.25		4	Hopmann,60:+2.1°;-0.19"

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
14792	SEI 1475		89.783	267.7	4.88	9.5-10.5	1	
	21112N3519		89.794	264.0	5.15	9.5-10.5	1	
			------	-----	----		---	
			89.789	265.8	5.01		2	
14822	BU 162	AB	89.715	250.0	1.26	8.5-8.7	1	
	21130N3521		89.783	253.2	1.38	9.0-9.5	1	
			89.794	249.9	1.23	8.0-8.5	1	
			------	-----	----		---	
			89.764	251.0	1.28		3	
14889	STT 437	AB	89.720	24.3	2.16	7.0-7.3	1	
	21166N3202		89.723	25.0	2.24	7.0-7.2	1	
			89.783	23.1	2.20	7.0-7.2	1	
			------	----	----		---	
			89.742	24.1	2.20		3	
14926	A 764		89.764	8.7	1.03	8.5-9.5	1	Baize,81:+0.3°;+0.08"
	21194N5708							
15270	STF 2822		89.543	299.6	1.70	4.7-6.1	1	
	21397N2817		89.548	299.6	1.78	5.0-6.3	1	
			89.549	300.0	1.69	5.0-6.3	1	
			89.726	300.7	1.77	5.0-6.0	1	
			89.764	302.0	1.87	4.7-6.1	1	
			89.778	299.9	1.76	4.7-6.1	1	
			------	-----	----		---	
			89.651	300.3	1.76		6	Heintz,66:-6.0°;+0.22"
15331	HO 466		89.808	139.7	1.97	8.5-9.5	1	
	21431N3425							
34°4536	COU		89.808	127.4	0.53	9.3-9.5	1	
	21471N3437							
15447	BU 75	AB	89.764	7.6	0.68	8.5-8.9	1	
	21506N1025		89.797	7.5	0.56	8.5-8.3	1	
			------	---	----		---	
			89.780	7.6	0.62		2	Baize,74:+4.7°;+0.06"
15670	STF 2872	BC	89.715	302.4	0.92	8.1-8.2	1	
	22052N5848		89.729	302.6	0.89	8.0-8.0	1	
			------	-----	----		---	
			89.722	302.5	0.90		2	
15769	A 2599		89.726	80.0	1.32	7.7-8.2	1	
	22100N2905		89.729	80.4	1.45	8.0-8.4	1	
			------	----	----		---	
			89.728	80.2	1.38		2	

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
15966	STF 2910		89.726	334.6	5.35	8.3-8.8	1	
	22235N2301		89.778	334.1	5.37	8.5-8.8	1	
			89.808	334.1	5.43	8.0-8.2	1	
			------	-----	----		---	
			89.770	334.3	5.38		3	
15971	STF 2909	AB	89.548	205.7	1.90	4.4-4.6	1	
	22237S0032		89.718	204.1	1.90	4.4-4.6	1	
			89.726	206.2	1.93	4.4-4.6	1	
			------	-----	----		---	
			89.664	205.3	1.91		3	Harrington,68: -2.6;+0.03
16131	HO 479		89.764	109.2	0.50	8.2-9.7	1	Zulevic,79:+4.6;-0.05
	22334N0147							
16185	STF 2910	AB	89.729	64.6	1.08	8.2-9.2	1	
	22370N2301		89.764	66.0	1.14	8.8-9.2	1	
			89.794	67.0	1.11	8.5-9.3	1	
			------	----	----		---	° "
			89.762	65.9	1.11		3	Heintz,81:-1.9;+0.01
16242	BU 711		89.720	354.0	2.32	8.6-10.0	1	
	22405N1040		89.808	354.4	2.32	8.5-9.5	1	
			------	-----	----		---	
			89.764	354.2	2.32		2	
16317	STF 2950	AB	89.811	285.6	1.50	6.1-7.1	1	
	22474N6109							° "
16345	BU 382		89.808	212.1	0.91	6.0-8.5	1	Muller,54:-2.4;-0.07
	22492N4413							° "
16665	BU 80	AB	89.797	326.1	0.62	8.5-9.0	1	Couteau,84:-6.2;-0.03
	23138N0452							
16666	STF 3001	AB	89.726	221.1	2.85	5.2-7.8	1	Wierzbinski,56: +1.3;+0.00
	23145N6734							
16686	STT 494		89.726	82.8	3.25	7.4-8.1	1	
	23158N2124							° "
16914	HU 1325		89.764	359.7	0.65	9.5-10.5	1	Zulevic,69:+2.1;-0.06
	23350N1225							

Table I (continued)

ADS	Disc. IDS	Mult.	Epoch 1900+	P	r	Est.Mag.	Night	Notes
				°	"			
17149	STF 3050	AB	89.726	320.3	1.86	6.5-6.5	1	
	23544N3310		89.729	320.2	1.78	6.5-6.8	1	
			89.764	320.3	1.66	6.5-6.7	1	
			89.794	318.4	1.75	6.5-6.6	1	
			89.800	319.3	1.71	6.8-7.0	1	
			------	-----	----		---	° "
			89.763	319.7	1.75		5	Heintz,74:-2.8;-0.11
17178	HLD 60		89.729	175.5	1.18	8.5-8.9	1	
	23563N3905		89.794	177.2	1.25	9.0-9.2	1	
			89.800	177.4	1.27	9.0-9.2	1	
			------	-----	----		---	° "
			89.774	176.7	1.23		3	Heintz,63:-1.3;+0.11

РЕЗУЛТАТИ МИКРОМЕТАРСКИХ МЕРЕЊА ДВОЈНИХ ЗВЕЗДА

(Серија 46)

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УДК 524.383
Предходно саопштење

У раду су саопштена 250 мерења релативних поларних координата за 132 визуелно двојне звезде. Мерења су извршена са рефрактором (65/1055 cm) Београдске Опсерваторије између 17 јануара 1989. год. и 20 марта 1990. год. За орбиталне парове извршена је анализа њихових положаја за посматрачки тренутак. За сваку компоненту визуелно двојне звезде измерена је привидна звездана величина.

Bull. Obs. Astron. Belgrade N^{o} 144(1991), 61–63.

UDC 520.252–14/–323.2
Preliminary report

THE COMPARISON OF THE ACCURACY OF THE DETERMINATION OF RIGHT ASCENSION BY MEANS OF TRANSIT INSTRUMENTS OF DIFFERENT TYPES

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SUMMARY: A special series of observations of the groups of stars performed in Pulkovo, Chile, Kharkov and Belgrade were used to compare the mean errors of the right ascension by means of the method eliminating the influence of the errors of the source catalogue. The results show the advantage of the small transit instruments over transit circles of the classical type.

The optical instruments formerly used for the determination of Earth rotation (OIER) are considered in Tolchel'nikova -Murri (1989) to be the most efficient for the simultaneous solution of two problems: the determination of absolute coordinates of bright stars (α,δ) and those of the instruments (λ,φ). This statement has no serious objections as far as the δ and φ coordinates are concerned, but for the coordinates α and λ the solution is more complicated since the method of determination of their values depends on the solution of the time problem as is shown in Tolchel'nikova–Murri, Krejnin (1980), Krejnin Tolchel'nikova–Murri (1981) and Eichhorn (1987).

Due to the changes firstly in the practice of the transmission and determination of time and later in the practice of timekeeping, changes in the methods for the determination of R.A. in Fundamental Astrometry (FA) became inevitable. As far back as 1936 Kopff wrote (p 724) that a sufficiently good clock might help in obtaining independent (absolute) R.A. if the stars are devided into groups, if the groups are connected with each other and if their observations are connected by adjustment.

At Pulkovo the group method of observation and the chain method of reduction gained a foothold in FA thanks to A.A. Nemiro. Nevertheless, as is shown in Tolchel'nikova–Murri (1986), many new methods of FA do not satisfy the definition of an absolute method since the derived R.A. s deviate from their absolute values by $C+C_1 f(\delta)$, where C and C_1 depend on the source catalogue.

Up to now the contribution to Fundamental Catalogues of astrolabes and transit circles (TC) of the Time service is of no importance in comparison with instruments of classical type. Which type of instrument is more efficient for the new epoch of absolute observations?

To ansver this question, the special series of 4-hour observations of the groups of stars within 70° of the zenith were performed in Pulkovo, Kharkov and Belgrade. It was possible to use observations in Chile corrected for azimuth by means of observations of

Instrument	Number of stars	Number of observations	Number of series	Their duration	Period	μ
TC, Pulkovo	68	316	5	$3^h.3$	1960	$0^s.010$
	62	280	5	4	1984	16
	73	360	7	4	1986	11
TC, Kharkov	64	896	12	4	1985	14
			5	1.5		13
	68	585	8	4	1986	12
			4	2		12
Large TC Chile–Pulkovo	68	340	5	4	1972	26
MC of Belgrade	78	310	4	4	1987	39
MC of Pulkovo	25	70	8	3	1962	50

marks since there was a similar group program. It was difficult to use observations of the Küstner series with Pulkovo meridian circle (MC) for the purpose since the stars were changed from night to night there. The results are shown in the table.

The method proposed by Varina et all (1985) was used for the determination of the error of unit weight by means of the least square solution, were μ is independent of the source catalogue; it depends on the program: on the distribution of stars in Z and the duration of the observations. Since the programs are similar the Table shows the advantages of smaller instruments (OIER) over instruments of FA (see also Kopff, 1936, p 717).

The Belgrade and Pulkovo MCs are sutable for differential observations in narrow zones; our are was 140°. Since μ is not an error of absolute coordinates our results are not enought indicate definitely which of the instruments is better for absolute observations. If one has to return to Struve's method the use of OIER is out of the question, but if one prefers new methods which require a stability of the instrument and of the atmosphere for two hours or less (see Tolchel'nikova, Krejnin, 1980), then the superiority of OIER over the instruments of FA is obvious from our results.

We want to stress that the shain method of reduction is valid for current determinations of changes in Earth rotation only, and might be replaced by global least square solution of the observational equations for coordinate determination. The solution is greatly simplified if group observations are secured.

We express our gratitude to M.P. Varin, V.A. Varina, A.P. Chelombit'ko, P.M. Afanas'eva and A.A. Popov whose observations were used.

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Varina, V.A., Tolchel'nikova–Murri, S.A., Fomin, V,A.: 1985, in: *Physical Aspects of Modern Astronomy*, Leningrad, 52.

THE COMPARISON OF THE ACCURACY OF THE DETERMINATION OF RIGHT ASCENSION BY MEANS OF TRANSIT INSTRUMENTS OF DIFFERENT TYPES

ПОРЕЂЕЊЕ ТАЧНОСТИ ОДРЕЂИВАЊА РЕКТАСЦЕНЗИЈЕ ПОМОЋУ ПАСАЖНИХ ИНСТРУМЕНАТА РАЗЛИЧИТИХ ТИПОВА

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УДК 520.252–14/–323.2
Претходно саопштење

Коришћене су специјалне серије посматрања група звезда обављених у Пулкову, Чилеу, Харкову и Београду за поређење средњих грешака у ректасцензији методом која елиминише утицај грешака изворног каталога. Резултати показују предност малих пасажних инструмената над пасажним инструментима класичног типа.

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UDC 52–355.3
Preliminary report

STARK BROADENING PARAMETER TABLES FOR SPECTRAL LINES OF MULTICHARGED IONS OF ASTROPHYSICAL INTEREST. I: C IV LINES

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SUMMARY: Using a semiclassical approach, we have calculated electron–, proton–, and ionized helium–impact line widths and shifts for 39 C IV multiplets as a function of temperature for perturber densities 10^{15} cm^{-3} and 10^{18}–10^{21} cm^{-3}.

1. INTRODUCTION

This paper is the first one of a series devoted to the calculation of Stark broadening parameters of isolated spectral lines of multicharged ions. As a matter of fact, Stark broadening of spectral lines has been taking a new interest in astrophysics (Seaton, 1987), owing to the recent development of researches on the physics of stellar interiors: in subphotospheric layers, the modellisation of energy transport needs the knowledge of radiative opacities and thus, certain atomic processes must be known with accuracy. At these high temperatures (10^5 K or more) and densities (10^{17} – 10^{22} cm^{-3}) the matter is mostly ionized: therefore Stark broadening of strong multicharged ionic lines plays a non-negligible role in the calculation of the opacities, especially in the UV.

The present paper concerns triply ionized carbon. Beyond the interest for the modellisation of stellar interiors, the knowledge of C IV Stark broadening parameters is of great importance for a number of problems in astrophysics and plasma physics, since carbon has a high cosmical abundance and is present as impurity in many laboratory plasma sources. In order to provide reliable data for C IV lines broadened by collisions with charged perturbers in stellar plasmas, we have calculated electron–, proton–, and ionized helium–impact line widths and shifts for 39 C IV multiplets, using the semiclassical–perturbation formalism (Sahal–Bréchot, 1969ab).

The obtained results for perturber density of 10^{17} cm^{-3}, together with discussion, analysis and comparison with existing experimental and theoretical data will be published in the principal article elsewhere (Dimitrijević, Sahal–Bréchot, Bommier, 1991). Since data are not linear with perturber density (N), due to the Debye screening effect, which is often important at high densities of interest for subphotospheric layers, we will present here the data for N = 10^{18} – 10^{21} cm^{-3}. Moreover, we will give also the data for N = 10^{15} cm^{-3}, of particular interest for stellar atmospheres.

2. RESULTS AND DISCUSSION

All details of the calculation procedure has been described in details in Dimitrijević, Sahal–Bréchot, Bommier (1991) and will not be repeated here. Energy levels for C IV lines have been taken from Bashkin and Stoner (1975). Oscillator strengths have been calculated using the method of Bates and Damgaard (1949) and tables of Oertel and Shomo (1968). For higher levels, the method described by Van Regemorter et al. (1979) has been used.

In addition to the electron–impact full halfwidths and shifts, Stark broadening parameters due to proton–, and ionized helium–impact have been calculated. In such a way we provide Stark broadening data for all important charged perturbers in stellar plasma. Our results are shown in Table 1 for a perturber density 10^{15} cm^{-3} and temperatures of T = 10,000; 20,000; 50,000; 100,000; 150,000 and 200,000 K. We also specify a parameter c (Dimitrijević and Sahal–Bréchot, 1984) which gives an estimate for the maximum perturber density for which the line may be treated as isolated when it is divided by 2W. In Table 2 are given the corresponding results for $N = 10^{18} - 10^{21}$ cm^{-3} and temperatures from 20,000 to 800,000 K.

For each value given in Table 1, the collision volume (V) multiplied by the perturber density (N) is much less than one and the impact approximation is valid (Sahal–Bréchot, 1969ab). Values for $NV > 0.5$ are not given in Table 1; values for $0.1 < NV \leqslant 0.5$ are denoted by an asterisk. When the impact approximation is not valid, the ion broadening contribution may be estimated by using quasistatic formulae (cf. Dimitrijević, Sahal–Bréchot and Bommier (1991)).

The analysis of present results and comparison with available experimental and theoretical data is given in Dimitrijević, Sahal – Bréchot and Bommier (1991).

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Table 1. This table gives electron–, proton–, and ionized–helium– impact broadening parameters for C IV lines, for perturber densities of 10^{15} cm^{-3} and temperatures from 10,000 K to 200,000 K. Transitions and averaged wavelengths for the multiplet (in Å) are also given. By dividing c and 2W, we obtain an estimate for the maximum perturber density for which the line may be treated as isolated and tabulated data may be used. The asterisk identifies cases for which the collision volume multiplied by the perturber denity (the condition for validity of the impact approximation) lies between 0.1 and 0.5.

PERTURBER DENSITY = 0.1D+16

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
CIV 2S-2P	10000.	0.234E-03	0.546E-04	0.545E-07	-0.196E-06	0.981E-07	-0.196E-06
1549.1 A	20000.	0.114E-03	0.205E-05	0.158E-06	-0.395E-06	0.279E-06	-0.395E-06
C= 0.15D+19	50000.	0.723E-04	-0.179E-05	0.642E-06	-0.967E-06	0.992E-06	-0.943E-06
	100000.	0.520E-04	-0.179E-05	0.152E-05	-0.170E-05	0.199E-05	-0.159E-05
	150000.	0.432E-04	-0.192E-05	0.226E-05	-0.222E-05	0.254E-05	-0.195E-05
	200000.	0.382E-04	-0.216E-05	0.268E-05	-0.253E-05	0.304E-05	-0.226E-05
CIV 2S-3P	10000.	0.243E-04	0.782E-07	0.947E-07	0.214E-06	0.157E-06	0.212E-06
312.4 A	20000.	0.178E-04	0.249E-06	0.269E-06	0.405E-06	0.367E-06	0.381E-06
C= 0.47D+16	50000.	0.121E-04	0.398E-06	0.679E-06	0.724E-06	0.757E-06	0.644E-06
	100000.	0.929E-05	0.328E-06	0.108E-05	0.990E-06	0.105E-05	0.829E-06
	150000.	0.804E-05	0.313E-06	0.126E-05	0.110E-05	0.119E-05	0.927E-06
	200000.	0.730E-05	0.310E-06	0.138E-05	0.118E-05	0.128E-05	0.993E-06
CIV 2S-4P	10000.	0.432E-04	0.537E-06	0.761E-06	0.123E-05	0.985E-06	0.115E-05
244.9 A	20000.	0.331E-04	0.152E-05	0.155E-05	0.186E-05	0.169E-05	0.166E-05
C= 0.12D+16	50000.	0.240E-04	0.141E-05	0.281E-05	0.267E-05	0.265E-05	0.227E-05
	100000.	0.192E-04	0.134E-05	0.353E-05	0.320E-05	0.323E-05	0.270E-05
	150000.	0.169E-04	0.128E-05	0.400E-05	0.354E-05	0.349E-05	0.298E-05
	200000.	0.155E-04	0.116E-05	0.444E-05	0.387E-05	0.377E-05	0.320E-05
CIV 2S-5P	10000.	0.749E-04	0.326E-05	0.335E-05	0.414E-05	0.357E-05	0.369E-05
222.8 A	20000.	0.616E-04	0.449E-05	0.558E-05	0.573E-05	0.530E-05	0.479E-05
C= 0.51D+15	50000.	0.487E-04	0.396E-05	0.794E-05	0.728E-05	0.711E-05	0.609E-05
	100000.	0.407E-04	0.369E-05	0.973E-05	0.877E-05	0.824E-05	0.709E-05
	150000.	0.366E-04	0.317E-05	0.106E-04	0.931E-05	0.924E-05	0.782E-05
	200000.	0.338E-04	0.279E-05	0.117E-04	0.976E-05	0.104E-04	0.825E-05
CIV 2P-3S	10000.	0.408E-04	-0.232E-05	0.199E-07	0.294E-06	0.331E-07	0.291E-06
419.6 A	20000.	0.241E-04	0.128E-05	0.122E-06	0.563E-06	0.169E-06	0.538E-06
C= 0.30D+17	50000.	0.153E-04	0.144E-05	0.605E-06	0.106E-05	0.583E-06	0.924E-06
	100000.	0.114E-04	0.171E-05	0.109E-05	0.145E-05	0.107E-05	0.124E-05
	150000.	0.980E-05	0.160E-05	0.146E-05	0.162E-05	0.129E-05	0.137E-05
	200000.	0.883E-05	0.159E-05	0.166E-05	0.176E-05	0.142E-05	0.148E-05
CIV 2P-4S	10000.	0.442E-04	0.641E-05	0.290E-06	0.113E-05	0.364E-06	0.105E-05
296.9 A	20000.	0.318E-04	0.472E-05	0.947E-06	0.182E-05	0.967E-06	0.159E-05
C= 0.61D+16	50000.	0.225E-04	0.404E-05	0.220E-05	0.273E-05	0.202E-05	0.227E-05
	100000.	0.180E-04	0.375E-05	0.308E-05	0.327E-05	0.266E-05	0.277E-05
	150000.	0.158E-04	0.359E-05	0.363E-05	0.363E-05	0.300E-05	0.304E-05
	200000.	0.144E-04	0.345E-05	0.395E-05	0.388E-05	0.351E-05	0.325E-05
CIV 2P-5S	10000.	0.761E-04	0.178E-04	0.182E-05	0.361E-05	0.192E-05	0.317E-05
262.6 A	20000.	0.568E-04	0.139E-04	0.352E-05	0.507E-05	0.348E-05	0.438E-05
C= 0.24D+16	50000.	0.433E-04	0.115E-04	0.630E-05	0.664E-05	0.543E-05	0.558E-05
	100000.	0.358E-04	0.963E-05	0.790E-05	0.798E-05	0.673E-05	0.670E-05
	150000.	0.321E-04	0.892E-05	0.935E-05	0.856E-05	0.750E-05	0.711E-05
	200000.	0.297E-04	0.846E-05	0.954E-05	0.923E-05	0.847E-05	0.751E-05
CIV 2P-3D	10000.	0.229E-04	-0.911E-06	0.473E-07	-0.218E-06	0.812E-07	-0.216E-06
384.1 A	20000.	0.164E-04	-0.412E-06	0.165E-06	-0.419E-06	0.241E-06	-0.403E-06
C= 0.71D+16	50000.	0.109E-04	-0.280E-06	0.581E-06	-0.803E-06	0.610E-06	-0.701E-06
	100000.	0.815E-05	-0.198E-06	0.985E-06	-0.111E-05	0.995E-06	-0.950E-06
	150000.	0.696E-05	-0.196E-06	0.125E-05	-0.125E-05	0.116E-05	-0.106E-05
	200000.	0.628E-05	-0.158E-06	0.140E-05	-0.135E-05	0.127E-05	-0.114E-05
CIV 2P-4D	10000.	0.644E-04	0.626E-06	0.917E-05	0.135E-04	0.895E-05	0.117E-04
289.2 A	20000.	0.495E-04	0.217E-05	0.154E-04	0.172E-04	0.137E-04	0.145E-04
C= 0.80D+14	50000.	0.368E-04	0.156E-05	0.217E-04	0.220E-04	0.189E-04	0.185E-04
	100000.	0.296E-04	0.105E-05	0.286E-04	0.256E-04	0.231E-04	0.210E-04
	150000.	0.261E-04	0.866E-06	0.297E-04	0.272E-04	0.265E-04	0.216E-04
	200000.	0.238E-04	0.713E-06	0.306E-04	0.284E-04	0.292E-04	0.239E-04

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 2P-5D	10000.	0.153E-03	0.712E-05	0.405E-04	0.437E-04	0.357E-04	0.366E-04
259.5 A	20000.	0.123E-03	0.725E-05	0.524E-04	0.540E-04	0.453E-04	0.445E-04
C= 0.34D+14	50000.	0.935E-04	0.484E-05	0.693E-04	0.656E-04	0.586E-04	0.551E-04
	100000.	0.756E-04	0.340E-05	0.788E-04	0.755E-04	0.700E-04	0.591E-04
	150000.	0.665E-04	0.242E-05	0.900E-04	0.799E-04	0.714E-04	0.699E-04
	200000.	0.605E-04	0.191E-05	0.994E-04	0.876E-04	0.767E-04	0.653E-04
CIV 3S-3P	10000.	0.123E-01	0.280E-03	0.287E-04	0.209E-04	0.490E-04	0.209E-04
5801.0 A	20000.	0.893E-02	-0.135E-03	0.724E-04	0.416E-04	0.109E-03	0.408E-04
C= 0.16D+19	50000.	0.603E-02	-0.995E-04	0.172E-03	0.878E-04	0.206E-03	0.811E-04
	100000.	0.463E-02	-0.181E-03	0.251E-03	0.128E-03	0.277E-03	0.113E-03
	150000.	0.402E-02	-0.166E-03	0.290E-03	0.154E-03	0.302E-03	0.130E-03
	200000.	0.366E-02	-0.162E-03	0.309E-03	0.167E-03	0.319E-03	0.141E-03
CIV 3S-4P	10000.	0.748E-03	0.161E-04	0.110E-04	0.173E-04	0.143E-04	0.161E-04
948.1 A	20000.	0.569E-03	0.172E-04	0.225E-04	0.264E-04	0.245E-04	0.235E-04
C= 0.18D+17	50000.	0.407E-03	0.151E-04	0.405E-04	0.382E-04	0.381E-04	0.323E-04
	100000.	0.324E-03	0.122E-04	0.515E-04	0.460E-04	0.468E-04	0.383E-04
	150000.	0.286E-03	0.120E-04	0.587E-04	0.506E-04	0.516E-04	0.420E-04
	200000.	0.263E-03	0.103E-04	0.627E-04	0.551E-04	0.544E-04	0.447E-04
CIV 3S-5P	10000.	0.761E-03	0.337E-04	0.314E-04	0.388E-04	0.335E-04	0.345E-04
684.9 A	20000.	0.620E-03	0.393E-04	0.523E-04	0.537E-04	0.499E-04	0.449E-04
C= 0.48D+16	50000.	0.485E-03	0.341E-04	0.746E-04	0.683E-04	0.668E-04	0.570E-04
	100000.	0.404E-03	0.307E-04	0.907E-04	0.819E-04	0.782E-04	0.663E-04
	150000.	0.363E-03	0.261E-04	0.990E-04	0.870E-04	0.862E-04	0.733E-04
	200000.	0.335E-03	0.226E-04	0.110E-03	0.919E-04	0.981E-04	0.775E-04
CIV 3P-4S	10000.	0.975E-03	0.534E-04	0.476E-05	0.163E-04	0.644E-05	0.154E-04
1230.0 A	20000.	0.715E-03	0.578E-04	0.147E-04	0.269E-04	0.160E-04	0.237E-04
C= 0.73D+17	50000.	0.514E-03	0.603E-04	0.337E-04	0.411E-04	0.322E-04	0.344E-04
	100000.	0.411E-03	0.571E-04	0.481E-04	0.493E-04	0.419E-04	0.411E-04
	150000.	0.363E-03	0.548E-04	0.549E-04	0.542E-04	0.486E-04	0.459E-04
	200000.	0.333E-03	0.525E-04	0.601E-04	0.583E-04	0.505E-04	0.493E-04
CIV 3P-5S	10000.	0.777E-03	0.159E-03	0.164E-04	0.324E-04	0.175E-04	0.285E-04
798.1 A	20000.	0.584E-03	0.124E-03	0.318E-04	0.456E-04	0.315E-04	0.396E-04
C= 0.22D+17	50000.	0.446E-03	0.102E-03	0.568E-04	0.599E-04	0.487E-04	0.503E-04
	100000.	0.370E-03	0.855E-04	0.706E-04	0.714E-04	0.606E-04	0.604E-04
	150000.	0.332E-03	0.787E-04	0.836E-04	0.783E-04	0.680E-04	0.641E-04
	200000.	0.308E-03	0.736E-04	0.864E-04	0.823E-04	0.774E-04	0.692E-04
CIV 3P-3D	10000.	0.125	0.375E-02	0.397E-03	-0.160E-02	0.627E-03	-0.157E-03
20754.0 A	20000.	0.924E-01	-0.228E-02	0.135E-02	-0.289E-02	0.168E-02	-0.270E-02
C= 0.21D+20	50000.	0.630E-01	-0.300E-02	0.366E-02	-0.491E-02	0.383E-02	-0.433E-03
	100000.	0.486E-01	-0.241E-02	0.612E-02	-0.635E-02	0.556E-02	-0.536E-02
	150000.	0.423E-01	-0.236E-02	0.713E-02	-0.708E-02	0.641E-02	-0.597E-02
	200000.	0.385E-01	-0.227E-02	0.789E-02	-0.763E-02	0.712E-02	-0.642E-02
CIV 3P-4D	10000.	0.105E-02	0.237E-04	0.133E-03	0.196E-03	0.130E-03	0.171E-03
1107.6 A	20000.	0.822E-03	0.282E-04	0.224E-03	0.251E-03	0.200E-03	0.212E-03
C= 0.12D+16	50000.	0.608E-03	0.165E-04	0.316E-03	0.321E-03	0.275E-03	0.269E-03
	100000.	0.489E-03	0.102E-04	0.415E-03	0.374E-03	0.338E-03	0.307E-03
	150000.	0.431E-03	0.759E-05	0.436E-03	0.396E-03	0.393E-03	0.317E-03
	200000.	0.394E-03	0.530E-05	0.448E-03	0.412E-03	0.423E-03	0.351E-03
CIV 3P-5D	10000.	0.141E-02	0.664E-04	0.356E-03	0.384E-03	0.314E-03	0.323E-03
770.3 A	20000.	0.113E-02	0.618E-04	0.461E-03	0.475E-03	0.399E-03	0.391E-03
C= 0.30D+15	50000.	0.857E-03	0.395E-04	0.609E-03	0.578E-03	0.515E-03	0.485E-03
	100000.	0.693E-03	0.273E-04	0.692E-03	0.665E-03	0.617E-03	0.521E-03
	150000.	0.609E-03	0.188E-04	0.793E-03	0.704E-03	0.627E-03	0.615E-03
	200000.	0.555E-03	0.143E-04	0.875E-03	0.773E-03	0.676E-03	0.575E-03

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	SHIFT(A)	PROTONS WIDTH(A)	SHIFT(A)	IONIZED HELIUM WIDTH(A)	SHIFT(A)
CIV 3P-4F	10000.	0.662E-03	-0.279E-04	0.101E-03	-0.159E-03	0.988E-04	-0.140E-03
1106.5 A	20000.	0.511E-03	-0.321E-04	0.183E-03	-0.207E-03	0.159E-03	-0.175E-03
C= 0.12D+16	50000.	0.371E-03	-0.234E-04	0.266E-03	-0.264E-03	0.222E-03	-0.223E-03
	100000.	0.296E-03	-0.176E-04	0.324E-03	-0.306E-03	0.266E-03	-0.259E-03
	150000.	0.260E-03	-0.132E-04	0.355E-03	-0.335E-03	0.303E-03	-0.279E-03
	200000.	0.237E-03	-0.101E-04	0.407E-03	-0.365E-03	0.315E-03	-0.304E-03
CIV 3D-4P	10000.	0.110E-02	0.680E-05	0.174E-04	0.311E-04	0.222E-04	0.290E-04
1198.6 A	20000.	0.835E-03	0.403E-04	0.366E-04	0.467E-04	0.392E-04	0.418E-04
C= 0.29D+17	50000.	0.603E-03	0.381E-04	0.677E-04	0.670E-04	0.631E-04	0.566E-04
	100000.	0.482E-03	0.352E-04	0.872E-04	0.815E-04	0.780E-04	0.674E-04
	150000.	0.426E-03	0.340E-04	0.973E-04	0.897E-04	0.868E-04	0.753E-04
	200000.	0.391E-03	0.308E-04	0.112E-03	0.954E-04	0.954E-04	0.806E-04
CIV 3D-5P	10000.	0.101E-02	0.438E-04	0.434E-04	0.548E-04	0.459E-04	0.488E-04
806.6 A	20000.	0.827E-03	0.605E-04	0.728E-04	0.758E-04	0.688E-04	0.633E-04
C= 0.67D+16	50000.	0.651E-03	0.538E-04	0.104E-03	0.961E-04	0.927E-04	0.807E-04
	100000.	0.545E-03	0.498E-04	0.129E-03	0.116E-03	0.108E-03	0.943E-04
	150000.	0.489E-03	0.430E-04	0.138E-03	0.123E-03	0.121E-03	0.103E-03
	200000.	0.452E-03	0.379E-04	0.152E-03	0.129E-03	0.138E-03	0.109E-03
CIV 3D-4F	10000.	0.657E-03	-0.484E-04	0.111E-03	-0.174E-03	0.108E-03	-0.154E-03
1169.0 A	20000.	0.502E-03	-0.314E-04	0.200E-03	-0.228E-03	0.174E-03	-0.193E-03
C= 0.13D+16	50000.	0.365E-03	-0.182E-04	0.292E-03	-0.292E-03	0.242E-03	-0.245E-03
	100000.	0.290E-03	-0.130E-04	0.364E-03	-0.338E-03	0.293E-03	-0.283E-03
	150000.	0.255E-03	-0.799E-05	0.391E-03	-0.368E-03	0.334E-03	-0.306E-03
	200000.	0.233E-03	-0.468E-05	0.440E-03	-0.400E-03	0.339E-03	-0.334E-03
CIV 3D-5F	10000.	0.136E-02	-0.139E-04	0.797E-03	0.793E-03*	0.681E-03*	0.663E-03
799.7 A	20000.	0.113E-02	-0.407E-05	0.101E-02	0.977E-03	0.860E-03	0.810E-03
C= 0.55D+14	50000.	0.866E-03	-0.295E-05	0.125E-02	0.118E-02	0.103E-02	0.939E-03
	100000.	0.697E-03	-0.490E-05	0.153E-02	0.135E-02	0.114E-02	0.111E-02
	150000.	0.609E-03	-0.568E-05	0.172E-02	0.145E-02	0.131E-02	0.113E-02
	200000.	0.553E-03	-0.684E-05	0.164E-02	0.148E-02	0.161E-02	0.127E-02
CIV 4S-4P	10000.	0.222	-0.290E-02	0.188E-02	0.189E-02	0.264E-02	0.181E-02
14343.7 A	20000.	0.170	-0.256E-02	0.374E-02	0.318E-02	0.434E-02	0.283E-02
C= 0.42D+19	50000.	0.125	-0.386E-02	0.649E-02	0.491E-02	0.651E-02	0.416E-02
	100000.	0.101	-0.372E-02	0.797E-02	0.592E-02	0.773E-02	0.499E-02
	150000.	0.897E-01	-0.361E-02	0.891E-02	0.659E-02	0.840E-02	0.548E-02
	200000.	0.826E-01	-0.374E-02	0.968E-02	0.715E-02	0.898E-02	0.589E-02
CIV 4S-5P	10000.	0.826E-02	0.216E-03	0.281E-03	0.339E-03	0.300E-03	0.299E-03
2104.7 A	20000.	0.670E-02	0.247E-03	0.463E-03	0.471E-03	0.448E-03	0.395E-03
C= 0.46D+17	50000.	0.525E-02	0.171E-03	0.666E-03	0.600E-03	0.603E-03	0.509E-03
	100000.	0.439E-02	0.153E-03	0.795E-03	0.703E-03	0.712E-03	0.589E-03
	150000.	0.394E-02	0.112E-03	0.905E-03	0.748E-03	0.767E-03	0.631E-03
	200000.	0.365E-02	0.839E-04	0.949E-03	0.827E-03	0.836E-03	0.690E-03
C IV 4P-5S	10000.	0.117E-01	0.137E-02	0.150E-03	0.270E-03	0.179E-03	0.244E-03
2698.0 A	20000.	0.900E-02	0.104E-02	0.296E-03	0.389E-03	0.304E-03	0.341E-03
C= 0.15D+18	50000.	0.691E-02	0.927E-03	0.522E-03	0.525E-03	0.470E-03	0.443E-03
	100000.	0.577E-02	0.786E-03	0.665E-03	0.626E-03	0.573E-03	0.527E-03
	150000.	0.520E-02	0.740E-03	0.745E-03	0.701E-03	0.625E-03	0.567E-03
	200000.	0.482E-02	0.714E-03	0.829E-03	0.739E-03	0.702E-03	0.599E-03
CIV 4P-5D	10000.	0.156E-01	0.594E-03	0.345E-02	0.372E-02	0.303E-02	0.312E-02
2405.0 A	20000.	0.125E-01	0.467E-03	0.445E-02	0.459E-02	0.386E-02	0.379E-02
C= 0.29D+16	50000.	0.953E-02	0.270E-03	0.589E-02	0.557E-02	0.493E-02	0.469E-02
	100000.	0.772E-02	0.156E-03	0.666E-02	0.638E-02	0.606E-02	0.508E-02
	150000.	0.680E-02	0.774E-04	0.764E-02	0.684E-02	0.597E-02	0.594E-02
	200000.	0.620E-02	0.452E-04	0.844E-02	0.749E-02	0.659E-02	0.557E-02

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 4D-5P	10000.	0.136E-01	0.290E-03	0.497E-03	-0.682E-03	0.519E-03	-0.607E-03
2595.1 A	20000.	0.111E-01	0.435E-03	0.864E-03	-0.927E-03	0.787E-03	-0.775E-03
C= 0.64D+16	50000.	0.876E-02	0.419E-03	0.124E-02	-0.118E-02	0.107E-02	-0.991E-03
	100000.	0.730E-02	0.422E-03	0.154E-02	-0.139E-02	0.138E-02	-0.115E-02
	150000.	0.654E-02	0.366E-03	0.173E-02	-0.151E-02	0.142E-02	-0.123E-02
	200000.	0.603E-02	0.328E-03	0.180E-02	-0.160E-02	0.146E-02	-0.129E-02
CIV 4D-5P	10000.	0.136E-01	0.290E-03	0.497E-03	-0.682E-03	0.519E-03	-0.607E-03
2595.1 A	20000.	0.111E-01	0.435E-03	0.864E-03	-0.927E-03	0.787E-03	-0.775E-03
C= 0.64D+16	50000.	0.876E-02	0.419E-03	0.124E-02	-0.118E-02	0.107E-02	-0.991E-03
	100000.	0.730E-02	0.422E-03	0.154E-02	-0.139E-02	0.138E-02	-0.115E-02
	150000.	0.654E-02	0.366E-03	0.173E-02	-0.151E-02	0.142E-02	-0.123E-02
	200000.	0.603E-02	0.328E-03	0.180E-02	-0.160E-02	0.146E-02	-0.129E-02
CIV 4D-5F	10000.	0.163E-01	-0.504E-03	0.757E-02	0.760E-02	*0.653E-02	*0.632E-02
2524.4 A	20000.	0.135E-01	-0.228E-03	0.946E-02	0.941E-02	0.815E-02	0.774E-02
C= 0.55D+15	50000.	0.105E-01	-0.164E-03	0.121E-01	0.113E-01	0.103E-01	0.884E-02
	100000.	0.845E-02	-0.139E-03	0.141E-01	0.128E-01	0.111E-01	0.104E-01
	150000.	0.741E-02	-0.132E-03	0.166E-01	0.141E-01	0.123E-01	0.111E-01
	200000.	0.674E-02	-0.130E-03	0.154E-01	0.141E-01	0.151E-01	0.127E-01
CIV 4F-5D	10000.	0.159E-01	0.906E-03	0.415E-02	0.449E-02	0.367E-02	0.373E-02
2534.5 A	20000.	0.128E-01	0.860E-03	0.554E-02	0.548E-02	0.467E-02	0.464E-02
C= 0.33D+16	50000.	0.982E-02	0.561E-03	0.700E-02	0.676E-02	0.634E-02	0.555E-02
	100000.	0.797E-02	0.395E-03	0.811E-02	0.797E-02	0.681E-02	0.633E-02
	150000.	0.702E-02	0.277E-03	0.918E-02	0.836E-02	0.783E-02	0.706E-02
	200000.	0.640E-02	0.211E-03	0.104E-01	0.894E-02	0.768E-02	0.709E-02
CIV 5S-5P	10000.	1.94	-0.612E-01	0.381E-01	0.367E-01	0.437E-01	0.325E-01
28649.2 A	20000.	1.56	-0.388E-01	0.599E-01	0.517E-01	0.643E-01	0.453E-01
C= 0.84D+19	50000.	1.24	-0.481E-01	0.857E-01	0.687E-01	0.823E-01	0.580E-01
	100000.	1.06	-0.439E-01	0.106	0.824E-01	0.962E-01	0.680E-01
	150000.	0.955	-0.472E-01	0.115	0.901E-01	0.108	0.752E-01
	200000.	0.887	-0.493E-01	0.119	0.936E-01	0.106	0.784E-01
CIV 5S-6P	10000.	0.581E-01	0.159E-02	0.307E-02	0.329E-02	0.315E-02	0.283E-02
3936.0 A	20000.	0.484E-01	0.139E-02	0.439E-02	0.414E-02	0.400E-02	0.345E-02
C= 0.92D+17	50000.	0.400E-01	0.106E-02	0.585E-02	0.521E-02	0.526E-02	0.440E-02
	100000.	0.345E-01	0.637E-03	0.705E-02	0.615E-02	0.606E-02	0.492E-02
	150000.	0.314E-01	0.301E-03	0.759E-02	0.662E-02	0.610E-02	0.539E-02
	200000.	0.292E-01	0.159E-03	0.822E-02	0.716E-02	0.676E-02	0.563E-02
CIV 5P-6S	10000.	0.744E-01	0.137E-01	0.172E-02	0.214E-02	0.183E-02	0.191E-02
5022.2 A	20000.	0.634E-01	0.108E-01	0.288E-02	0.296E-02	0.271E-02	0.247E-02
C= 0.26D+18	50000.	0.536E-01	0.810E-02	0.406E-02	0.375E-02	0.364E-02	0.315E-02
	100000.	0.468E-01	0.649E-02	0.508E-02	0.452E-02	0.423E-02	0.369E-02
	150000.	0.429E-01	0.606E-02	0.546E-02	0.484E-02	0.477E-02	0.405E-02
	200000.	0.400E-01	0.564E-02	0.596E-02	0.505E-02	0.543E-02	0.425E-02
CIV 5P-5D	10000.	31.7	0.463	5.37	5.84	4.75	4.89
97210.1 A	20000.	26.1	0.153	7.00	7.14	6.19	6.00
C= 0.48D+19	50000.	20.4	-0.877E-01	9.24	8.69	7.78	7.26
	100000.	16.8	-0.235	10.7	9.94	9.68	8.10
	150000.	14.9	-0.274	12.4	10.9	9.26	9.07
	200000.	13.7	-0.274	13.1	11.9	10.9	8.94
CIV 5P-6D	10000.	0.122	0.437E-02	0.322E-01	0.319E-01	*0.277E-01	*0.268E-01
4441.8 A	20000.	0.101	0.347E-02	0.414E-01	0.399E-01	*0.335E-01	*0.331E-01
C= 0.64D+16	50000.	0.783E-01	0.191E-02	0.557E-01	0.476E-01	*0.444E-01	*0.406E-01
	100000.	0.641E-01	0.759E-03	0.603E-01	0.525E-01	0.532E-01	0.447E-01
	150000.	0.566E-01	0.301E-03	0.618E-01	0.538E-01	0.484E-01	0.511E-01
	200000.	0.517E-01	0.122E-03	0.691E-01	0.659E-01	0.600E-01	0.460E-01

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 5D-6P	10000.	0.107	0.259E-02	0.115E-01	-0.121E-01	0.102E-01	-0.103E-01
4789.0 A	20000.	0.906E-01	0.262E-02	0.152E-01	-0.150E-01	0.128E-01	-0.124E-01
C= 0.12D+17	50000.	0.734E-01	0.313E-02	0.203E-01	-0.187E-01	0.171E-01	-0.153E-01
	100000.	0.620E-01	0.278E-02	0.239E-01	-0.201E-01	0.205E-01	-0.178E-01
	150000.	0.557E-01	0.249E-02	0.255E-01	-0.230E-01	0.214E-01	-0.184E-01
	200000.	0.513E-01	0.234E-02	0.261E-01	-0.235E-01	0.249E-01	-0.197E-01
CIV 5D-6F	10000.	0.158	-0.542E-02				
4647.0 A	20000.	0.133	-0.221E-02				
C= 0.64D+15	50000.	0.102	-0.158E-02	*0.198	*0.198		
	100000.	0.821E-01	-0.216E-02	*0.282	*0.219		
	150000.	0.716E-01	-0.183E-02	*0.237	*0.248	*0.227	*0.197
	200000.	0.648E-01	-0.147E-02	*0.286	*0.251	*0.252	*0.175
CIV 5F-6D	10000.	0.148	0.764E-02	0.160E-01	0.168E-01	0.138E-01	0.141E-01
4665.0 A	20000.	0.122	0.608E-02	0.207E-01	0.205E-01	0.175E-01	0.171E-01
C= 0.19D+16	50000.	0.947E-01	0.404E-02	0.278E-01	0.254E-01	0.225E-01	0.205E-01
	100000.	0.768E-01	0.268E-02	0.331E-01	0.293E-01	0.265E-01	0.235E-01
	150000.	0.674E-01	0.197E-02	0.350E-01	0.302E-01	0.302E-01	0.259E-01
	200000.	0.612E-01	0.164E-02	0.390E-01	0.328E-01	0.282E-01	0.258E-01

Table 2. Same as Table 1 but for perturber denities $10^{18} - 10^{21}$ cm^{-3} and temperatures from 20,000 K to 800,000 K.

PERTURBER DENSITY = 0.1D+19

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
CIV 2S-2P	20000.	0.117	0.679E-02	0.155E-03	-0.323E-03	0.275E-03	-0.323E-03
1549.1 A	50000.	0.723E-01	-0.181E-02	0.641E-03	-0.924E-03	0.990E-03	-0.900E-03
C= 0.15D+22	80000.	0.577E-01	-0.192E-02	0.120E-02	-0.143E-02	0.161E-02	-0.134E-02
	100000.	0.520E-01	-0.176E-02	0.152E-02	-0.168E-02	0.199E-02	-0.157E-02
	150000.	0.432E-01	-0.196E-02	0.226E-02	-0.222E-02	0.254E-02	-0.195E-02
	200000.	0.382E-01	-0.217E-02	0.268E-02	-0.252E-02	0.304E-02	-0.226E-02
CIV 2S-3P2	20000.	0.179E-01	0.126E-03	0.265E-03	0.325E-03	0.360E-03	0.301E-03
312.4 A	50000.	0.121E-01	0.352E-03	0.678E-03	0.677E-03	0.755E-03	0.597E-03
C= 0.47D+19	80000.	0.101E-01	0.321E-03	0.943E-03	0.886E-03	0.980E-03	0.762E-03
	100000.	0.929E-02	0.308E-03	0.108E-02	0.970E-03	0.105E-02	0.809E-03
	150000.	0.804E-02	0.309E-03	0.126E-02	0.110E-02	0.119E-02	0.923E-03
	200000.	0.730E-02	0.306E-03	0.138E-02	0.118E-02	0.128E-02	0.990E-03
CIV 2S-4P	20000.	0.331E-01	0.825E-03	*0.152E-02	*0.134E-02	*0.163E-02	*0.114E-02
244.9 A	50000.	0.239E-01	0.109E-02	*0.281E-02	*0.237E-02	*0.265E-02	*0.198E-02
C= 0.12D+19	80000.	0.205E-01	0.120E-02	*0.332E-02	*0.290E-02	*0.300E-02	*0.241E-02
	100000.	0.192E-01	0.120E-02	*0.352E-02	*0.307E-02	*0.325E-02	*0.258E-02
	150000.	0.169E-01	0.126E-02	0.400E-02	0.351E-02	*0.349E-02	*0.295E-02
	200000.	0.155E-01	0.114E-02	0.444E-02	0.384E-02	*0.377E-02	*0.318E-02
CIV 2S-5P	20000.	0.611E-01	0.147E-02				
222.8 A	50000.	0.484E-01	0.240E-02				
C= 0.51D+18	80000.	0.429E-01	0.313E-02				
	100000.	0.405E-01	0.305E-02				
	150000.	0.364E-01	0.304E-02				
	200000.	0.337E-01	0.268E-02				
CIV 2P-3S	20000.	0.242E-01	0.858E-03	0.122E-03	0.454E-03	0.169E-03	0.429E-03
419.6 A	50000.	0.153E-01	0.138E-02	0.605E-03	0.993E-03	0.583E-03	0.859E-03
C= 0.30D+20	80000.	0.125E-01	0.162E-02	0.903E-03	0.129E-02	0.880E-03	0.112E-02
	100000.	0.114E-01	0.168E-02	0.109E-02	0.142E-02	0.107E-02	0.121E-02
	150000.	0.980E-02	0.160E-02	0.146E-02	0.162E-02	0.129E-02	0.137E-02
	200000.	0.884E-02	0.158E-02	0.166E-02	0.175E-02	0.142E-02	0.147E-02
CIV 2P-4S	20000.	0.318E-01	0.423E-02	0.946E-03	0.136E-02	0.966E-03	0.114E-02
296.9 A	50000.	0.225E-01	0.378E-02	0.220E-02	0.246E-02	*0.203E-02	*0.201E-02
C= 0.61D+19	80000.	0.193E-01	0.370E-02	0.285E-02	0.295E-02	*0.245E-02	*0.247E-02
	100000.	0.180E-01	0.362E-02	0.308E-02	0.315E-02	0.265E-02	0.265E-02
	150000.	0.158E-01	0.356E-02	0.363E-02	0.361E-02	0.300E-02	0.302E-02
	200000.	0.144E-01	0.342E-02	0.395E-02	0.386E-02	0.351E-02	0.323E-02
CIV 2P-5S	20000.	0.568E-01	0.118E-01	*0.350E-02	*0.330E-02		
262.6 A	50000.	0.433E-01	0.105E-01	*0.634E-02	*0.563E-02		
C= 0.24D+19	80000.	0.381E-01	0.962E-02	*0.746E-02	*0.695E-02		
	100000.	0.358E-01	0.919E-02	*0.795E-02	*0.755E-02		
	150000.	0.321E-01	0.883E-02	*0.935E-02	*0.847E-02	*0.750E-02	*0.702E-02
	200000.	0.297E-01	0.838E-02	*0.954E-02	*0.915E-02	*0.848E-02	*0.743E-02
CIV 2P-3D	20000.	0.166E-01	-0.404E-03	0.163E-03	-0.339E-03	0.237E-03	-0.322E-03
384.1 A	50000.	0.109E-01	-0.232E-03	0.580E-03	-0.757E-03	0.609E-03	-0.654E-03
C= 0.71D+19	80000.	0.892E-02	-0.177E-03	0.831E-03	-0.981E-03	0.866E-03	-0.858E-03
	100000.	0.815E-02	-0.178E-03	0.984E-03	-0.109E-02	0.996E-03	-0.931E-03
	150000.	0.696E-02	-0.186E-03	0.125E-02	-0.124E-02	0.116E-02	-0.106E-02
	200000.	0.628E-02	-0.152E-03	0.140E-02	-0.135E-02	0.127E-02	-0.113E-02
CIV 2P-4D	20000.	0.402E-01	-0.175E-02				
289.2 A	50000.	0.311E-01	-0.744E-03				
C= 0.80D+17	80000.	0.273E-01	-0.213E-03				
	100000.	0.256E-01	-0.204E-03				
	150000.	0.228E-01	0.475E-03				
	200000.	0.210E-01	0.379E-03				

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	SHIFT(A)	PROTONS WIDTH(A)	SHIFT(A)	IONIZED HELIUM WIDTH(A)	SHIFT(A)
CIV 2P-5D	20000.	0.842E-01	-0.342E-02				
259.5 A	50000.	0.692E-01	-0.202E-02				
C= 0.34D+17	80000.	0.619E-01	-0.498E-03				
	100000.	0.586E-01	-0.453E-03				
	150000.	0.526E-01	0.108E-02				
	200000.	0.485E-01	0.727E-03				
CIV 3S-3P	20000.	8.95	-0.126	0.710E-01	0.339E-01	0.106	0.330E-01
5801.0 A	50000.	6.03	-0.105	0.172	0.832E-01	0.205	0.766E-01
C= 0.16D+22	80000.	5.02	-0.163	0.223	0.113	0.260	0.994E-01
	100000.	4.63	-0.183	0.251	0.126	0.277	0.111
	150000.	4.02	-0.166	0.290	0.153	0.302	0.130
	200000.	3.66	-0.162	0.309	0.167	0.319	0.140
CIV 3S-4P	20000.	0.569	0.828E-02	*0.220E-01	*0.191E-01	*0.236E-01	*0.162E-01
948.1 A	50000.	0.407	0.105E-01	*0.402E-01	*0.339E-01	*0.376E-01	*0.279E-01
C= 0.18D+20	80000.	0.348	0.108E-01	*0.479E-01	*0.412E-01	*0.437E-01	*0.342E-01
	100000.	0.324	0.104E-01	*0.514E-01	*0.441E-01	*0.465E-01	*0.364E-01
	150000.	0.286	0.116E-01	0.586E-01	0.503E-01	*0.516E-01	*0.416E-01
	200000.	0.263	0.995E-02	0.627E-01	0.548E-01	*0.544E-01	*0.444E-01
CIV 3S-5P	20000.	0.615	0.115E-01				
684.9 A	50000.	0.482	0.195E-01				
C= 0.48D+19	80000.	0.426	0.258E-01				
	100000.	0.402	0.248E-01				
	150000.	0.361	0.250E-01				
	200000.	0.334	0.216E-01				
CIV 3P-4S	20000.	0.716	0.503E-01	0.146E-01	0.204E-01	0.159E-01	0.173E-01
1230.0 A	50000.	0.514	0.565E-01	0.337E-01	0.373E-01	0.322E-01	0.306E-01
C= 0.73D+20	80000.	0.441	0.560E-01	0.435E-01	0.446E-01	0.388E-01	0.372E-01
	100000.	0.411	0.552E-01	0.481E-01	0.476E-01	0.419E-01	0.395E-01
	150000.	0.363	0.544E-01	0.549E-01	0.539E-01	0.486E-01	0.456E-01
	200000.	0.333	0.522E-01	0.601E-01	0.580E-01	0.505E-01	0.490E-01
CIV 3P-5S	20000.	0.584	0.105	*0.315E-01	*0.298E-01		
798.1 A	50000.	0.446	0.923E-01	*0.565E-01	*0.510E-01		
C= 0.22D+20	80000.	0.393	0.856E-01	*0.681E-01	*0.632E-01		
	100000.	0.370	0.816E-01	*0.708E-01	*0.677E-01		
	150000.	0.332	0.779E-01	*0.836E-01	*0.774E-01	*0.680E-01	*0.633E-01
	200000.	0.308	0.729E-01	*0.864E-01	*0.816E-01	*0.774E-01	*0.685E-01
CIV 3P-4D	20000.	0.684	-0.263E-01				
1107.6 A	50000.	0.524	-0.166E-01				
C= 0.12D+19	80000.	0.459	-0.842E-02				
	100000.	0.430	-0.801E-02				
	150000.	0.383	0.189E-02				
	200000.	0.353	0.445E-03				
CIV 3P-5D	20000.	0.789	-0.309E-01				
770.3 A	50000.	0.643	-0.207E-01				
C= 0.30D+18	80000.	0.574	-0.702E-02				
	100000.	0.542	-0.648E-02				
	150000.	0.486	0.701E-02				
	200000.	0.449	0.389E-02				
CIV 3P-4F	20000.	0.413	0.144E-01				
1106.5 A	50000.	0.312	0.435E-02				
C= 0.12D+19	80000.	0.271	-0.323E-02				
	100000.	0.254	-0.300E-02				
	150000.	0.226	-0.880E-02				
	200000.	0.208	-0.633E-02				

PERTURBER DENSITY = 0.1D+19

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
CIV 3D-4P	20000.	0.834	0.217E-01	*0.360E-01	*0.334E-01	*0.381E-01	*0.285E-01
1198.6 A	50000.	0.603	0.298E-01	*0.678E-01	*0.591E-01	*0.632E-01	*0.489E-01
C= 0.29D+20	80000.	0.517	0.318E-01	*0.808E-01	*0.728E-01	*0.736E-01	*0.605E-01
	100000.	0.482	0.318E-01	*0.871E-01	*0.781E-01	*0.783E-01	*0.640E-01
	150000.	0.426	0.333E-01	*0.973E-01	*0.890E-01	*0.867E-01	*0.746E-01
	200000.	0.391	0.302E-01	*0.112	*0.948E-01	*0.954E-01	*0.800E-01
CIV 3D-5P	20000.	0.820	0.203E-01				
806.6 A	50000.	0.647	0.331E-01				
C= 0.67D+19	80000.	0.574	0.424E-01				
	100000.	0.542	0.414E-01				
	150000.	0.487	0.413E-01				
	200000.	0.450	0.365E-01				
CIV 3D-4F	20000.	0.393	0.169E-01				
1169.0 A	50000.	0.299	0.116E-01				
C= 0.13D+19	80000.	0.260	0.259E-02				
	100000.	0.244	0.274E-02				
	150000.	0.217	-0.325E-02				
	200000.	0.200	-0.587E-03				
CIV 3D-5F	20000.	0.555	0.159E-01				
799.7 A	50000.	0.499	0.690E-02				
C= 0.55D+17	80000.	0.458	-0.116E-02				
	100000.	0.437	-0.223E-02				
	150000.	0.397	-0.496E-02				
	200000.	0.369	-0.572E-02				
CIV 4S-5P	20000.	6.65	0.845E-02				
2104.7 A	50000.	5.22	0.448E-01				
C= 0.46D+20	80000.	4.63	0.108				
	100000.	4.37	0.103				
	150000.	3.93	0.102				
	200000.	3.63	0.752E-01	*0.949	*0.819		
C IV 4P-5S	20000.	9.00	0.894	*0.292	*0.264		
2698.0 A	50000.	6.91	0.853	*0.524	*0.451		
C= 0.15D+21	80000.	6.12	0.818	*0.623	*0.559	*0.536	*0.456
	100000.	5.77	0.754	*0.668	*0.593	*0.569	*0.498
	150000.	5.20	0.733	*0.745	*0.695	*0.625	*0.561
	200000.	4.82	0.708	*0.829	*0.733	*0.702	*0.594
CIV 4P-5D	20000.	9.21	-0.377				
2405.0 A	50000.	7.44	-0.287				
C= 0.29D+19	80000.	6.62	-0.166				
	100000.	6.25	-0.161				
	150000.	5.61	-0.350E-0				
	200000.	5.17	-0.541E-0				
CIV 4D-5P	20000.	10.3	0.332				
2595.1 A	50000.	8.25	0.392				
C= 0.64D+19	80000.	7.35	0.448				
	100000.	6.95	0.437				
	150000.	6.25	0.381				
	200000.	5.78	0.340				
CIV 4D-5F	20000.	7.10	0.264				
2524.4 A	50000.	6.36	0.112				
C= 0.55D+18	80000.	5.83	-0.483E-02				
	100000.	5.56	-0.159E-01				
	150000.	5.05	-0.947E-01				
	200000.	4.69	-0.933E-01				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 2P-4D	50000.	0.257	-0.318E-02				
289.2 A	80000.	0.230	-0.422E-02				
C= 0.80D+18	100000.	0.218	-0.454E-02				
	150000.	0.197	-0.354E-02				
	200000.	0.183	-0.102E-02				
	300000.	0.164	0.171E-02				
CIV 2P-5D	50000.	0.515	0.230E-03				
259.5 A	80000.	0.478	-0.424E-02				
C= 0.34D+18	100000.	0.458	-0.468E-02				
	150000.	0.421	-0.522E-02				
	200000.	0.395	-0.312E-02				
	300000.	0.357	0.433E-02				
CIV 3S-4P	50000.	3.98	-0.316E-01				
948.1 A	80000.	3.42	-0.100E-01				
C= 0.18D+21	100000.	3.18	0.173E-02				
	150000.	2.82	0.326E-01				
	200000.	2.59	0.568E-01				
	300000.	2.30	0.662E-01				
CIV 3S-5P	50000.	4.36	-0.922E-01				
684.9 A	80000.	3.91	-0.702E-02				
C= 0.48D+20	100000.	3.71	0.114E-01				
	150000.	3.36	0.429E-01				
	200000.	3.13	0.989E-01				
	300000.	2.81	0.162				
CIV 3P-4S	50000.	5.14	0.449	*0.336	*0.277		
1230.0 A	80000.	4.41	0.463	*0.430	*0.355		
C= 0.73D+21	100000.	4.11	0.469	*0.480	*0.394		
	150000.	3.62	0.476	*0.544	*0.471		
	200000.	3.32	0.487	*0.604	*0.545		
	300000.	2.95	0.498	*0.695	*0.636		
CIV 3P-5S	50000.	4.40	0.620				
798.1 A	80000.	3.89	0.598				
C= 0.22D+21	100000.	3.66	0.585				
	150000.	3.29	0.601				
	200000.	3.05	0.640				
	300000.	2.74	0.646				
CIV 3P-4D	50000.	4.46	-0.839E-01				
1107.6 A	80000.	3.96	-0.987E-01				
C= 0.12D+20	100000.	3.74	-0.102				
	150000.	3.37	-0.910E-01				
	200000.	3.13	-0.604E-01				
	300000.	2.81	-0.227E-01				
CIV 3P-5D	50000.	4.87	-0.171E-01				
770.3 A	80000.	4.49	-0.559E-01				
C= 0.30D+19	100000.	4.30	-0.592E-01				
	150000.	3.94	-0.653E-01				
	200000.	3.69	-0.499E-01				
	300000.	3.33	0.149E-01				
CIV 3P-4F	50000.	2.61	0.107				
1106.5 A	80000.	2.30	0.823E-01				
C= 0.12D+20	100000.	2.17	0.779E-01				
	150000.	1.96	0.650E-01				
	200000.	1.82	0.195E-01				
	300000.	1.64	-0.263E-01				

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 4F-5D	20000.	8.63	-0.389				
2534.5 A	50000.	7.19	-0.235				
C= 0.33D+19	80000.	6.47	-0.509E-01				
	100000.	6.12	-0.475E-01				
	150000.	5.51	0.127				
	200000.	5.09	0.788E-01				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 2S-2P	50000.	0.723	-0.164E-01	0.635E-02	-0.819E-02	0.979E-02	-0.794E-02
1549.1 A	80000.	0.577	-0.181E-01	0.120E-01	-0.133E-01	0.161E-01	-0.124E-01
C= 0.15D+23	100000.	0.520	-0.167E-01	0.151E-01	-0.159E-01	0.198E-01	-0.148E-01
	150000.	0.432	-0.185E-01	0.226E-01	-0.215E-01	0.253E-01	-0.188E-01
	200000.	0.382	-0.211E-01	0.268E-01	-0.249E-01	0.304E-01	-0.222E-01
	300000.	0.323	-0.224E-01	0.355E-01	-0.308E-01	0.369E-01	-0.266E-01
CIV 2S-3P	50000.	0.121	0.197E-02	0.667E-02	0.559E-02*	0.737E-02*	0.481E-02
312.4 A	80000.	0.101	0.196E-02	0.938E-02	0.775E-02*	0.966E-02*	0.650E-02
C= 0.47D+20	100000.	0.928E-01	0.197E-02	0.108E-01	0.873E-02*	0.104E-01*	0.710E-02
	150000.	0.804E-01	0.220E-02	0.127E-01	0.102E-01*	0.119E-01*	0.843E-02
	200000.	0.729E-01	0.263E-02	0.138E-01	0.114E-01*	0.128E-01*	0.948E-02
	300000.	0.640E-01	0.278E-02	0.153E-01	0.131E-01*	0.142E-01*	0.108E-01
CIV 2S-4P	50000.	0.234	0.117E-02				
244.9 A	80000.	0.201	0.360E-02				
C= 0.12D+20	100000.	0.188	0.473E-02				
	150000.	0.166	0.663E-02				
	200000.	0.153	0.833E-02				
	300000.	0.136	0.901E-02				
CIV 2S-5P	50000.	0.434	-0.692E-02				
222.8 A	80000.	0.392	0.285E-02				
C= 0.51D+19	100000.	0.373	0.508E-02				
	150000.	0.338	0.825E-02				
	200000.	0.314	0.143E-01				
	300000.	0.283	0.210E-01				
CIV 2P-3S	50000.	0.153	0.120E-01	0.604E-02	0.833E-02	0.580E-02	0.700E-02
419.6 A	80000.	0.125	0.145E-01	0.905E-02	0.114E-01	0.882E-02	0.968E-02
C= 0.30D+21	100000.	0.114	0.153E-01	0.109E-01	0.129E-01	0.106E-01	0.107E-01
	150000.	0.980E-01	0.149E-01	0.147E-01	0.151E-01	0.130E-01	0.126E-01
	200000.	0.883E-01	0.153E-01	0.167E-01	0.170E-01	0.142E-01	0.142E-01
	300000.	0.769E-01	0.154E-01	0.195E-01	0.195E-01	0.166E-01	0.161E-01
CIV 2P-4S	50000.	0.225	0.296E-01				
296.9 A	80000.	0.193	0.302E-01				
C= 0.61D+20	100000.	0.180	0.304E-01				
	150000.	0.158	0.308E-01*	0.360E-01*	0.316E-01		
	200000.	0.144	0.318E-01*	0.398E-01*	0.363E-01		
	300000.	0.127	0.325E-01*	0.451E-01*	0.414E-01		
CIV 2P-5S	50000.	0.427	0.708E-01				
262.6 A	80000.	0.377	0.674E-01				
C= 0.24D+20	100000.	0.354	0.661E-01				
	150000.	0.318	0.684E-01				
	200000.	0.294	0.739E-01				
	300000.	0.264	0.732E-01				
CIV 2P-3D	50000.	0.109	-0.747E-03	0.575E-02	-0.637E-02*	0.600E-02	-0.535E-02
384.1 A	80000.	0.891E-01	-0.509E-03	0.828E-02	-0.869E-02*	0.867E-02	-0.749E-02
C= 0.71D+20	100000.	0.814E-01	-0.648E-03	0.984E-02	-0.986E-02*	0.992E-02	-0.825E-02
	150000.	0.696E-01	-0.103E-02	0.124E-01	-0.115E-01	0.114E-01	-0.969E-02
	200000.	0.628E-01	-0.108E-02	0.140E-01	-0.131E-01	0.127E-01	-0.109E-01
	300000.	0.547E-01	-0.733E-03	0.160E-01	-0.149E-01	0.143E-01	-0.125E-01

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
PERTURBER DENSITY = 0.1D+20							
CIV 3D-4P	50000.	5.89	0.495E-01				
1198.6 A	80000.	5.06	0.105				
C= 0.29D+21	100000.	4.72	0.132				
	150000.	4.18	0.182				
	200000.	3.85	0.225				
	300000.	3.42	0.238				
CIV 3D-5P	50000.	5.83	-0.814E-01				
806.6 A	80000.	5.26	0.455E-01				
C= 0.67D+20	100000.	4.99	0.750E-01				
	150000.	4.52	0.119				
	200000.	4.21	0.198				
	300000.	3.78	0.285				
CIV 3D-4F	50000.	2.42	0.150				
1169.0 A	80000.	2.15	0.124				
C= 0.13D+20	100000.	2.03	0.121				
	150000.	1.84	0.117				
	200000.	1.71	0.760E-01				
	300000.	1.55	0.258E-01				
CIV 3D-5F	50000.	3.45	0.105				
799.7 A	80000.	3.30	0.968E-01				
C= 0.55D+18	100000.	3.20	0.983E-01				
	150000.	3.00	0.806E-01				
	200000.	2.84	0.280E-01				
	300000.	2.61	-0.410E-01				
PERTURBER DENSITY = 0.1D+21							
CIV 2S-2P	100000.	5.20	-0.141	0.149	-0.137	0.194	-0.126
1549.1 A	150000.	4.32	-0.162	0.224	-0.194	0.250	-0.167
C= 0.15D+24	200000.	3.82	-0.191	0.267	-0.228	0.304	-0.202
	300000.	3.23	-0.208	0.355	-0.292	0.368	-0.250
	500000.	2.68	-0.193	0.438	-0.353	0.423	-0.297
	800000.	2.29	-0.190	0.508	-0.410	0.481	-0.343
CIV 2S-3P	100000.	0.898	-0.905E-02				
312.4 A	150000.	0.780	-0.227E-02				
C= 0.47D+21	200000.	0.710	0.294E-02				
	300000.	0.624	0.824E-02				
	500000.	0.535	0.119E-01				
	800000.	0.468	0.156E-01	*0.195	*0.164		
CIV 2S-4P	100000.	1.60	-0.363E-01				
244.9 A	150000.	1.44	-0.104E-01				
C= 0.12D+21	200000.	1.34	-0.318E-02				
	300000.	1.21	0.669E-02				
	500000.	1.06	0.292E-01				
	800000.	0.936	0.583E-01				
CIV 2S-5P	100000.	*2.69	*-0.481E-01				
222.8 A	150000.	*2.54	*-0.297E-01				
C= 0.51D+20	200000.	2.43	-0.206E-01				
	300000.	2.25	0.757E-02				
	500000.	2.02	0.710E-01				
	800000.	1.83	0.129				
CIV 2P-3S	100000.	1.14	0.111	*0.108	*0.956E-01		
419.6 A	150000.	0.979	0.113	*0.144	*0.119		
C= 0.30D+22	200000.	0.882	0.119	*0.167	*0.140		
	300000.	0.768	0.127	*0.194	*0.169		
	500000.	0.653	0.135	*0.231	*0.211		
	800000.	0.568	0.130	*0.274	*0.237		

PERTURBER DENSITY = 0.1D+21

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
CIV 2P-4S	100000.	1.71	0.122				
296.9 A	150000.	1.51	0.156				
C= 0.61D+21	200000.	1.38	0.176				
	300000.	1.23	0.211				
	500000.	1.06	0.233				
	800000.	0.926	0.235				
CIV 2P-5S	100000.	2.80	0.112				
262.6 A	150000.	2.61	0.209				
C= 0.24D+21	200000.	2.49	0.269				
	300000.	2.28	0.332				
	500000.	2.00	0.402				
	800000.	1.77	0.478				
CIV 2P-3D	100000.	0.786	0.231E-01	*0.967E-01	-0.745E-01		
384.1 A	150000.	0.674	0.147E-01	*0.124	*-0.931E-01		
C= 0.71D+21	200000.	0.609	0.129E-01	*0.139	*-0.109		
	300000.	0.533	0.125E-01	*0.161	*-0.131		
	500000.	0.456	0.557E-02	*0.187	*-0.162		
	800000.	0.399	0.225E-02	*0.218	*-0.189		
CIV 2P-4D	100000.	1.63	0.452E-01				
289.2 A	150000.	1.52	0.314E-01				
C= 0.80D+19	200000.	1.44	0.271E-01				
	300000.	1.32	0.150E-01				
	500000.	1.18	0.438E-03				
	800000.	1.05	-0.414E-02				
CIV 2P-5D	100000.	*2.98	*0.108				
259.5 A	150000.	2.87	0.799E-01				
C= 0.34D+19	200000.	2.77	0.629E-01				
	300000.	2.60	0.376E-01				
	500000.	2.37	-0.185E-01				
	800000.	2.15	-0.513E-01				

PERTURBER DENSITY = 0.1D+22

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)
CIV 2S-3P	100000.	*7.38	*-0.212
312.4 A	150000.	6.59	-0.152
C= 0.47D+22	200000.	6.09	-0.117
	300000.	5.45	-0.669E-01
	500000.	4.76	-0.403E-01
	800000.	4.22	0.199E-01
CIV 2P-3S	100000.	10.3	-0.313
419.6 A	150000.	9.02	0.255E-01
C= 0.30D+23	200000.	8.20	0.258
	300000.	7.19	0.486
	500000.	6.17	0.778
	800000.	5.40	0.985
CIV 2P-4S	100000.	*10.2	*-1.74
296.9 A	150000.	9.89	-0.840
C= 0.61D+22	200000.	9.54	-0.414
	300000.	8.95	0.169
	500000.	8.12	0.709
	800000.	7.31	1.28
CIV 2P-3D	100000.	6.59	0.449
384.1 A	150000.	5.76	0.351
C= 0.71D+22	200000.	5.28	0.332
	300000.	4.69	0.320
	500000.	4.08	0.245
	800000.	3.61	0.174

ТАБЛИЦЕ ЗА ПАРАМЕТРЕ ШТАРКОВОГ ШИРЕЊА ЛИНИЈА ВИШЕСТРУКО НАЕЛЕКТРИСАНИХ ЈОНА ОД АСТРОФИЗИЧКОГ ИНТЕРЕСА. I: ЛИНИЈЕ C IV

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УДК 52–355.3
Претходно саопштење

У оквиру семикласичне теорије израчунате су ширине и помаци услед судара са електронима, протонима и јонизованим хелијумом за спектралне линије у оквиру 39 мултиплета C IV. Резултати су дати у функцији електронске температуре и густине.

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Preliminary report

STARK BROADENING PARAMETER TABLES FOR SPECTRAL LINES OF MULTICHARGED IONS OF ASTROPHYSICAL INTEREST. II: Si IV LINES

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SUMMARY: Using a semiclassical approach, we have calculated electron–, proton–, and ionized helium–impact line widths and shifts for 39 Si IV multiplets as a function of temperature for perturber densities 10^{15} cm^{-3} and 10^{18}–10^{21} cm^{-3}.

1. INTRODUCTION

This is the second paper in a series devoted to the calculation of Stark broadening parameters of isolated spectral lines of multicharged ions. The astrophysical importance of multicharged ion lines Stark broadening data for the investigation of stellar interiors and stellar atmospherae is discussed in Dimitrijević, Sahal–Bréchot and Bommier (1991a,b). The present paper concerns triply ionized silicon: Beyond the interest for the modellisation of stellar interiors, the knowledge of Si IV Stark broadening parameters is of great importance for a number of problems in astrophysics and plasma physics, since silicon has a high cosmical abundance and is present as impurity in many laboratory plasma sources. In order to provide reliable data for Si IV lines broadened by collisions with charged perturbers in stellar plasmas, we have calculated electron–, proton–, and ionized helium–impact line widths and shifts for 39 Si IV multiplets, using the semiclassical–perturbation formalism (Sahal–Bréchot, 1969a,b).

The obtained results for perturber density of 10^{17}cm^{-3}, together with discussion, analysis and comparison with existing experimental and theoretical data will be published in the principal article elsewhere (Dimitrijević, Sahal–Bréchot, Bommier, 1991b). Since data are not linear with perturber density (N), due to the Debye screening effect, which is often important at high densities of interest for subphotospheric layers, we will present here the data for N = 10^{18}–10^{21} cm^{-3}. Moreover, we will give also the data for N = 10^{15} cm^{-3}, of particular interest for stellar atmospheres.

2. RESULTS AND DISCUSSION

All details of the calculation procedure has been described in details in Dimitrijević, Sahal–Bréchot, Bommier (1991c) and will not be repeated here. Energy levels for Si IV lines have been taken from Bashkin and Stoner (1975). Oscillator strengths have been calculated using the method of Bates and Damgaard (1949) and tables of Oertel and Shomo (1968). For higher levels, the method described by Van Regemorter et al. (1979) has been used.

In addition to the electron–impact full halfwidths and shifts, Stark broadening parameters due to proton–, and ionized helium–impact have been calculated. In such a way we provide Stark broadening data for all important charged perturbers in stellar plasma. Our results are shown in Table 1 for a perturber density 10^{15} cm^{-3} and temperatures of T = 10,000; 20,000; 50,000; 100,000; 150,000 and 200,000 K. We also specify a parameter c (Dimitrijević and Sahal–Bréchot, 1984) which gives an estimate for the maximum perturber density for which the line may be treated as isolated when it is divided by 2W. In Table 2 are given the corresponding results for N = 10^{18} – 10^{21} cm^{-3} and temperatures from 20,000 to 800,000 K.

For each value given in Table 1, the collision volume (V) multiplied by the perturber density (N) is much less than one and the impact approximation is valid (Sahal–Bréchot, 1969a,b). Values for NV > 0.5 are not given in Table 1; values for $0.1 < NV \leqslant 0.5$ are denoted by an asterisk. When the impact approximation is not valid, the ion broadening contribution may be estimated by using quasistatic formulae (cf. Dimitrijević, Sahal–Bréchot and Bommier (1991c).

The analysis of present results and comparison with available experimental and theoretical data is given in Dimitrijević, Sahal–Bréchot and Bommier (1991b).

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Table 1. This table gives electron–, proton–, and ionized–helium impact broadening parameters for Si IV lines, for perturber densities of 10^{15} cm^{-3} and temperatures from 10,000 K to 200,000 K. Transitions and averaged wavelengths for the multiplet (in Å) are also given. By dividing c and 2W, we obtain an estimate for the maximum perturber density for which the line may be treated as isolated and tabulated data may be used. The asterisk identifies cases for which the collision volume multiplied by the perturber density (the condition for validity of the impact approximation) lies between 0.1 and 0.5.

PERTURBER DENSITY = 0.1D+16

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 3S-3P	10000.	0.244E-03	0.712E-05	0.333E-06	-0.160E-06	0.624E-06	-0.160E-06
1396.7 A	20000.	0.174E-03	-0.333E-06	0.909E-06	-0.323E-06	0.159E-05	-0.323E-06
C= 0.14E+19	50000.	0.112E-03	-0.180E-05	0.272E-05	-0.790E-06	0.389E-05	-0.767E-06
	100000.	0.812E-04	-0.122E-05	0.462E-05	-0.139E-05	0.571E-05	-0.129E-05
	150000.	0.684E-04	-0.161E-05	0.571E-05	-0.181E-05	0.670E-05	-0.157E-05
	200000.	0.612E-04	-0.187E-05	0.649E-05	-0.205E-05	0.707E-05	-0.181E-05
SIIV 3S-4P	10000.	0.630E-04	-0.150E-05	0.644E-06	0.931E-07	0.106E-05	0.930E-07
457.9 A	20000.	0.452E-04	0.565E-06	0.138E-05	0.186E-06	0.195E-05	0.183E-06
C= 0.51E+17	50000.	0.307E-04	0.725E-06	0.253E-05	0.405E-06	0.306E-05	0.376E-06
	100000.	0.240E-04	0.680E-06	0.328E-05	0.603E-06	0.354E-05	0.533E-06
	150000.	0.212E-04	0.849E-06	0.354E-05	0.737E-06	0.378E-05	0.627E-06
	200000.	0.195E-04	0.769E-06	0.371E-05	0.819E-06	0.396E-05	0.669E-06
SIIV 3S-5P	10000.	0.720E-04	0.349E-06	0.249E-05	0.330E-06	0.351E-05	0.325E-06
361.6 A	20000.	0.558E-04	0.194E-05	0.407E-05	0.617E-06	0.505E-05	0.573E-06
C= 0.15E+17	50000.	0.429E-04	0.160E-05	0.588E-05	0.108E-05	0.635E-05	0.951E-06
	100000.	0.365E-04	0.211E-05	0.666E-05	0.146E-05	0.710E-05	0.120E-05
	150000.	0.335E-04	0.189E-05	0.710E-05	0.163E-05	0.746E-05	0.134E-05
	200000.	0.316E-04	0.186E-05	0.739E-05	0.175E-05	0.756E-05	0.144E-05
SIIV 3S-6P	10000.	0.111E-03	0.716E-05	0.707E-05	0.841E-06	0.877E-05	0.803E-06
327.2 A	20000.	0.885E-04	0.466E-05	0.993E-05	0.143E-05	0.111E-04	0.127E-05
C= 0.64E+16	50000.	0.721E-04	0.409E-05	0.121E-04	0.224E-05	0.130E-04	0.189E-05
	100000.	0.646E-04	0.389E-05	0.135E-04	0.274E-05	0.140E-04	0.225E-05
	150000.	0.608E-04	0.380E-05	0.141E-04	0.302E-05	0.145E-04	0.250E-05
	200000.	0.583E-04	0.362E-05	0.144E-04	0.323E-05	0.147E-04	0.269E-05
SIIV 3P-4S	10000.	0.199E-03	-0.404E-05	0.187E-06	0.124E-05	0.330E-06	0.123E-05
817.1 A	20000.	0.129E-03	0.687E-05	0.768E-06	0.236E-05	0.109E-05	0.223E-05
C= 0.16E+18	50000.	0.805E-04	0.743E-05	0.291E-05	0.433E-05	0.290E-05	0.378E-05
	100000.	0.600E-04	0.822E-05	0.504E-05	0.596E-05	0.484E-05	0.493E-05
	150000.	0.517E-04	0.846E-05	0.630E-05	0.663E-05	0.561E-05	0.547E-05
	200000.	0.471E-04	0.794E-05	0.705E-05	0.717E-05	0.625E-05	0.590E-05
SIIV 3P-5S	10000.	0.134E-03	0.329E-04	0.748E-06	0.299E-05	0.991E-06	0.280E-05
515.9 A	20000.	0.974E-04	0.206E-04	0.249E-05	0.488E-05	0.263E-05	0.423E-05
C= 0.30E+17	50000.	0.706E-04	0.166E-04	0.590E-05	0.740E-05	0.546E-05	0.609E-05
	100000.	0.578E-04	0.148E-04	0.846E-05	0.887E-05	0.712E-05	0.730E-05
	150000.	0.518E-04	0.131E-04	0.957E-05	0.985E-05	0.818E-05	0.807E-05
	200000.	0.478E-04	0.124E-04	0.106E-04	0.107E-04	0.914E-05	0.881E-05
SIIV 3P-6S	10000.	0.174E-03	0.707E-04	0.349E-05	0.778E-05	0.398E-05	0.686E-05
438.4 A	20000.	0.136E-03	0.536E-04	0.742E-05	0.110E-04	0.718E-05	0.955E-05
C= 0.12E+17	50000.	0.108E-03	0.398E-04	0.139E-04	0.148E-04	0.117E-04	0.122E-04
	100000.	0.937E-04	0.321E-04	0.175E-04	0.178E-04	0.153E-04	0.144E-04
	150000.	0.853E-04	0.278E-04	0.207E-04	0.192E-04	0.173E-04	0.160E-04
	200000.	0.800E-04	0.255E-04	0.232E-04	0.204E-04	0.179E-04	0.165E-04

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3P-3D	10000.	0.156E-03	0.121E-05	0.239E-06	0.441E-07	0.447E-06	0.441E-07
1126.4 A	20000.	0.114E-03	0.249E-06	0.648E-06	0.890E-07	0.113E-05	0.890E-07
C= 0.74E+18	50000.	0.751E-04	0.516E-06	0.190E-05	0.221E-06	0.271E-05	0.219E-06
	100000.	0.548E-04	0.344E-06	0.317E-05	0.417E-06	0.394E-05	0.392E-06
	150000.	0.465E-04	0.460E-06	0.390E-05	0.562E-06	0.457E-05	0.518E-06
	200000.	0.418E-04	0.472E-06	0.440E-05	0.681E-06	0.481E-05	0.594E-06
SIIV 3P-4D	10000.	0.136E-03	0.801E-06	0.135E-05	0.226E-05	0.205E-05	0.217E-05
560.5 A	20000.	0.101E-03	0.405E-05	0.319E-05	0.388E-05	0.390E-05	0.348E-05
C= 0.13E+17	50000.	0.703E-04	0.504E-05	0.640E-05	0.614E-05	0.656E-05	0.520E-05
	100000.	0.554E-04	0.472E-05	0.869E-05	0.754E-05	0.805E-05	0.625E-05
	150000.	0.488E-04	0.462E-05	0.971E-05	0.833E-05	0.894E-05	0.687E-05
	200000.	0.450E-04	0.461E-05	0.107E-04	0.901E-05	0.960E-05	0.742E-05
SIIV 3P-5D	10000.	0.188E-03	0.931E-05	0.648E-05	0.792E-05	0.769E-05	0.702E-05
454.7 A	20000.	0.154E-03	0.133E-04	0.110E-04	0.113E-04	0.119E-04	0.976E-05
C= 0.46E+16	50000.	0.120E-03	0.133E-04	0.172E-04	0.152E-04	0.159E-04	0.125E-04
	100000.	0.101E-03	0.123E-04	0.209E-04	0.181E-04	0.196E-04	0.150E-04
	150000.	0.911E-04	0.120E-04	0.243E-04	0.203E-04	0.213E-04	0.166E-04
	200000.	0.850E-04	0.110E-04	0.262E-04	0.214E-04	0.225E-04	0.172E-04
SIIV 3P-6D	10000.	0.295E-03	0.328E-04	0.185E-04	0.197E-04	0.205E-04	0.172E-04
412.7 A	20000.	0.252E-03	0.331E-04	0.287E-04	0.262E-04	0.270E-04	0.217E-04
C= 0.22E+16	50000.	0.211E-03	0.295E-04	0.380E-04	0.335E-04	0.343E-04	0.273E-04
	100000.	0.184E-03	0.277E-04	0.458E-04	0.385E-04	0.397E-04	0.316E-04
	150000.	0.170E-03	0.248E-04	0.511E-04	0.415E-04	0.442E-04	0.348E-04
	200000.	0.160E-03	0.227E-04	0.530E-04	0.450E-04	0.437E-04	0.372E-04
SIIV 3D-4P	10000.	0.884E-03	-0.301E-04	0.693E-05	0.146E-05	0.117E-04	0.146E-05
1724.1 A	20000.	0.635E-03	0.839E-05	0.154E-04	0.292E-05	0.222E-04	0.287E-05
C= 0.73E+18	50000.	0.428E-03	0.120E-04	0.295E-04	0.628E-05	0.362E-04	0.582E-05
	100000.	0.332E-03	0.108E-04	0.395E-04	0.926E-05	0.426E-04	0.816E-05
	150000.	0.292E-03	0.135E-04	0.427E-04	0.113E-04	0.457E-04	0.957E-05
	200000.	0.270E-03	0.127E-04	0.450E-04	0.125E-04	0.478E-04	0.102E-04
SIIV 3D-5P	10000.	0.397E-03	0.160E-05	0.129E-04	0.191E-05	0.183E-04	0.188E-05
860.7 A	20000.	0.310E-03	0.114E-04	0.214E-04	0.356E-05	0.265E-04	0.330E-05
C= 0.83E+17	50000.	0.239E-03	0.965E-05	0.313E-04	0.619E-05	0.338E-04	0.546E-05
	100000.	0.204E-03	0.123E-04	0.355E-04	0.839E-05	0.378E-04	0.688E-05
	150000.	0.187E-03	0.111E-04	0.379E-04	0.937E-05	0.397E-04	0.771E-05
	200000.	0.177E-03	0.110E-04	0.395E-04	0.100E-04	0.405E-04	0.829E-05
SIIV 3D-6P	10000.	0.487E-03	0.326E-04	0.302E-04	0.374E-05	0.375E-04	0.357E-05
688.3 A	20000.	0.389E-03	0.212E-04	0.426E-04	0.636E-05	0.476E-04	0.566E-05
C= 0.28E+17	50000.	0.317E-03	0.186E-04	0.522E-04	0.996E-05	0.558E-04	0.838E-05
	100000.	0.284E-03	0.176E-04	0.582E-04	0.122E-04	0.604E-04	0.999E-05
	150000.	0.268E-03	0.172E-04	0.611E-04	0.134E-04	0.623E-04	0.111E-04
	200000.	0.257E-03	0.164E-04	0.621E-04	0.144E-04	0.632E-04	0.120E-04

PERTURBER DENSITY = 0.1D+16

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 3D-4F	10000.	0.398E-03	-0.275E-04	0.213E-05	-0.510E-05	0.343E-05	-0.495E-05
1066.6 A	20000.	0.288E-03	-0.667E-05	0.579E-05	-0.903E-05	0.768E-05	-0.838E-05
C= 0.47E+17	50000.	0.195E-03	-0.603E-05	0.136E-04	-0.151E-04	0.145E-04	-0.130E-04
	100000.	0.150E-03	-0.601E-05	0.203E-04	-0.190E-04	0.189E-04	-0.159E-04
	150000.	0.131E-03	-0.426E-05	0.234E-04	-0.213E-04	0.212E-04	-0.177E-04
	200000.	0.120E-03	-0.396E-05	0.260E-04	-0.230E-04	0.229E-04	-0.190E-04
SIIV 3D-5F	10000.	0.771E-03	0.181E-04	0.927E-04	0.125E-03	0.910E-04	0.105E-03
749.9 A	20000.	0.605E-03	0.249E-04	0.145E-03	0.155E-03	0.125E-03	0.128E-03
C= 0.67E+15	50000.	0.455E-03	0.161E-04	0.200E-03	0.195E-03	0.169E-03	0.160E-03
	100000.	0.370E-03	0.119E-04	0.252E-03	0.227E-03	0.199E-03	0.183E-03
	150000.	0.328E-03	0.904E-05	0.280E-03	0.251E-03	0.226E-03	0.206E-03
	200000.	0.301E-03	0.716E-05	0.299E-03	0.264E-03	0.230E-03	0.208E-03
SIIV 3D-6F	10000.	0.234E-03	-0.788E-05	0.251E-04	-0.512E-07	0.312E-04	-0.512E-07
645.8 A	20000.	0.171E-03	-0.561E-06	0.355E-04	-0.103E-06	0.400E-04	-0.103E-06
C= 0.89E+17	50000.	0.118E-03	-0.596E-06	0.437E-04	-0.248E-06	0.469E-04	-0.239E-06
	100000.	0.924E-04	-0.656E-06	0.488E-04	-0.424E-06	0.508E-04	-0.383E-06
	150000.	0.822E-04	-0.646E-06	0.509E-04	-0.530E-06	0.521E-04	-0.464E-06
	200000.	0.764E-04	-0.678E-06	0.518E-04	-0.610E-06	0.530E-04	-0.532E-06
SIIV 4S-4P	10000.	0.695E-02	0.126E-03	0.521E-04	-0.225E-04	0.859E-04	-0.224E-04
4097.9 A	20000.	0.497E-02	-0.824E-04	0.113E-03	-0.436E-04	0.158E-03	-0.418E-04
C= 0.41E+19	50000.	0.336E-02	-0.939E-04	0.209E-03	-0.843E-04	0.250E-03	-0.728E-04
	100000.	0.265E-02	-0.132E-03	0.274E-03	-0.117E-03	0.290E-03	-0.989E-04
	150000.	0.235E-02	-0.125E-03	0.299E-03	-0.132E-03	0.312E-03	-0.110E-03
	200000.	0.218E-02	-0.117E-03	0.316E-03	-0.143E-03	0.328E-03	-0.118E-03
SIIV 4S-5P	10000.	0.958E-03	0.157E-04	0.279E-04	0.112E-05	0.393E-04	0.112E-05
1211.0 A	20000.	0.734E-03	0.812E-05	0.455E-04	0.221E-05	0.565E-04	0.215E-05
C= 0.16E+18	50000.	0.556E-03	0.319E-05	0.656E-04	0.458E-05	0.710E-04	0.412E-05
	100000.	0.470E-03	0.689E-05	0.742E-04	0.655E-05	0.792E-04	0.568E-05
	150000.	0.431E-03	0.377E-05	0.790E-04	0.777E-05	0.832E-04	0.639E-05
	200000.	0.407E-03	0.487E-05	0.820E-04	0.833E-05	0.848E-04	0.694E-05
SIIV 4S-6P	10000.	0.915E-03	0.169E-04	0.529E-04	0.500E-05	0.657E-04	0.482E-05
895.3 A	20000.	0.721E-03	0.224E-04	0.743E-04	0.863E-05	0.828E-04	0.785E-05
C= 0.48E+17	50000.	0.581E-03	0.201E-04	0.906E-04	0.139E-04	0.970E-04	0.119E-04
	100000.	0.517E-03	0.184E-04	0.101E-03	0.172E-04	0.105E-03	0.142E-04
	150000.	0.486E-03	0.182E-04	0.105E-03	0.192E-04	0.108E-03	0.159E-04
	200000.	0.465E-03	0.179E-04	0.107E-03	0.207E-04	0.109E-03	0.171E-04
SIIV 4P-5S	10000.	0.277E-02	0.379E-03	0.228E-04	0.487E-04	0.321E-04	0.456E-04
2125.0 A	20000.	0.205E-02	0.230E-03	0.568E-04	0.799E-04	0.630E-04	0.695E-04
C= 0.50E+18	50000.	0.150E-02	0.205E-03	0.116E-03	0.122E-03	0.111E-03	0.100E-03
	100000.	0.125E-02	0.206E-03	0.156E-03	0.146E-03	0.139E-03	0.120E-03
	150000.	0.114E-02	0.191E-03	0.175E-03	0.161E-03	0.157E-03	0.132E-03
	200000.	0.106E-02	0.183E-03	0.189E-03	0.173E-03	0.169E-03	0.145E-03

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	SHIFT(A)	PROTONS WIDTH(A)	SHIFT(A)	IONIZED HELIUM WIDTH(A)	SHIFT(A)
SIIV 4P-6S	10000.	0.154E-02	0.536E-03	0.295E-04	0.607E-04	0.341E-04	0.535E-04
1230.0 A	20000.	0.120E-02	0.394E-03	0.605E-04	0.863E-04	0.597E-04	0.745E-04
C= 0.91E+17	50000.	0.943E-03	0.284E-03	0.111E-03	0.116E-03	0.947E-04	0.957E-04
	100000.	0.820E-03	0.230E-03	0.139E-03	0.139E-03	0.122E-03	0.113E-03
	150000.	0.752E-03	0.205E-03	0.167E-03	0.151E-03	0.137E-03	0.125E-03
	200000.	0.709E-03	0.189E-03	0.183E-03	0.161E-03	0.142E-03	0.129E-03
SIIV 4P-4D	10000.	0.511E-02	0.136E-03	0.386E-04	0.674E-04	0.593E-04	0.648E-04
3160.3 A	20000.	0.380E-02	0.101E-03	0.923E-04	0.116E-03	0.115E-03	0.105E-03
C= 0.41E+18	50000.	0.267E-02	0.118E-03	0.189E-03	0.185E-03	0.196E-03	0.157E-03
	100000.	0.214E-02	0.113E-03	0.259E-03	0.229E-03	0.240E-03	0.188E-03
	150000.	0.190E-02	0.997E-04	0.296E-03	0.253E-03	0.272E-03	0.210E-03
	200000.	0.177E-02	0.102E-03	0.319E-03	0.271E-03	0.290E-03	0.224E-03
SIIV 4P-5D	10000.	0.183E-02	0.897E-04	0.528E-04	0.709E-04	0.630E-04	0.630E-04
1367.6 A	20000.	0.149E-02	0.113E-03	0.927E-04	0.101E-03	0.987E-04	0.876E-04
C= 0.42E+17	50000.	0.116E-02	0.111E-03	0.149E-03	0.137E-03	0.136E-03	0.112E-03
	100000.	0.967E-03	0.103E-03	0.181E-03	0.162E-03	0.168E-03	0.135E-03
	150000.	0.877E-03	0.992E-04	0.211E-03	0.182E-03	0.185E-03	0.149E-03
	200000.	0.819E-03	0.910E-04	0.229E-03	0.192E-03	0.195E-03	0.154E-03
SIIV 4P-6D	10000.	0.198E-02	0.175E-03	0.114E-03	0.127E-03	0.126E-03	0.111E-03
1046.7 A	20000.	0.168E-02	0.207E-03	0.180E-03	0.168E-03	0.168E-03	0.139E-03
C= 0.14E+17	50000.	0.139E-02	0.184E-03	0.240E-03	0.215E-03	0.215E-03	0.175E-03
	100000.	0.122E-02	0.173E-03	0.292E-03	0.247E-03	0.251E-03	0.203E-03
	150000.	0.112E-02	0.154E-03	0.326E-03	0.267E-03	0.279E-03	0.224E-03
	200000.	0.106E-02	0.140E-03	0.339E-03	0.289E-03	0.275E-03	0.238E-03
SIIV 4D-5P	10000.	0.101E-01	-0.850E-04	0.201E-03	-0.673E-04	0.289E-03	-0.652E-04
3766.0 A	20000.	0.786E-02	0.185E-04	0.348E-03	-0.119E-03	0.429E-03	-0.110E-03
C= 0.58E+18	50000.	0.604E-02	-0.420E-04	0.529E-03	-0.197E-03	0.565E-03	-0.170E-03
	100000.	0.512E-02	0.289E-04	0.609E-03	-0.247E-03	0.640E-03	-0.206E-03
	150000.	0.469E-02	0.128E-04	0.661E-03	-0.278E-03	0.675E-03	-0.230E-03
	200000.	0.442E-02	0.133E-04	0.685E-03	-0.298E-03	0.694E-03	-0.248E-03
SIIV 4D-6P	10000.	0.386E-02	0.409E-04	0.185E-03	0.273E-05	0.231E-03	0.272E-05
1796.6 A	20000.	0.307E-02	0.869E-04	0.264E-03	0.538E-05	0.299E-03	0.521E-05
C= 0.13E+18	50000.	0.248E-02	0.699E-04	0.326E-03	0.110E-04	0.350E-03	0.982E-05
	100000.	0.221E-02	0.694E-04	0.364E-03	0.156E-04	0.381E-03	0.135E-04
	150000.	0.207E-02	0.696E-04	0.380E-03	0.184E-04	0.391E-03	0.151E-04
	200000.	0.198E-02	0.657E-04	0.387E-03	0.196E-04	0.395E-03	0.164E-04
SIIV 4D-4F	10000.	0.327	-0.164E-01	0.224E-02	-0.662E-02	0.308E-02	-0.619E-02
24271.1 A	20000.	0.243	-0.112E-01	0.642E-02	-0.108E-01	0.690E-02	-0.938E-02
C= 0.24E+20	50000.	0.170	-0.124E-01	0.141E-01	-0.164E-01	0.132E-01	-0.135E-01
	100000.	0.135	-0.119E-01	0.196E-01	-0.196E-01	0.168E-01	-0.162E-01
	150000.	0.120	-0.107E-01	0.221E-01	-0.218E-01	0.192E-01	-0.179E-01
	200000.	0.111	-0.105E-01	0.244E-01	-0.236E-01	0.214E-01	-0.195E-01

PERTURBER DENSITY = 0.1D+16

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 4D-5F	10000.	0.803E-02	0.132E-03	0.841E-03	0.114E-02	0.825E-03	0.966E-03
2287.0 A	20000.	0.629E-02	0.162E-03	0.133E-02	0.142E-02	0.114E-02	0.117E-02
C= 0.62E+16	50000.	0.472E-02	0.675E-04	0.184E-02	0.180E-02	0.155E-02	0.146E-02
	100000.	0.385E-02	0.329E-04	0.229E-02	0.210E-02	0.181E-02	0.168E-02
	150000.	0.342E-02	0.914E-05	0.252E-02	0.230E-02	0.202E-02	0.191E-02
	200000.	0.314E-02	-0.800E-05	0.274E-02	0.244E-02	0.212E-02	0.191E-02
SIIV 4D-6F	10000.	0.859E-02	0.399E-03	0.156E-02	0.167E-02	0.135E-02	0.137E-02
1533.2 A	20000.	0.696E-02	0.355E-03	0.203E-02	0.203E-02	0.173E-02	0.167E-02
C= 0.18E+16	50000.	0.535E-02	0.216E-03	0.264E-02	0.255E-02	0.223E-02	0.200E-02
	100000.	0.438E-02	0.146E-03	0.312E-02	0.298E-02	0.257E-02	0.232E-02
	150000.	0.389E-02	0.103E-03	0.353E-02	0.309E-02	0.290E-02	0.257E-02
	200000.	0.357E-02	0.688E-04	0.385E-02	0.330E-02	0.291E-02	0.252E-02
SIIV 4F-5D	10000.	0.754E-02	0.452E-03	0.204E-03	0.296E-03	0.237E-03	0.260E-03
2675.2 A	20000.	0.607E-02	0.502E-03	0.362E-03	0.419E-03	0.382E-03	0.362E-03
C= 0.16E+18	50000.	0.467E-02	0.489E-03	0.594E-03	0.560E-03	0.533E-03	0.463E-03
	100000.	0.387E-02	0.454E-03	0.739E-03	0.674E-03	0.653E-03	0.543E-03
	150000.	0.349E-02	0.432E-03	0.841E-03	0.729E-03	0.741E-03	0.602E-03
	200000.	0.325E-02	0.396E-03	0.921E-03	0.760E-03	0.748E-03	0.628E-03
SIIV 4F-6D	10000.	0.524E-02	0.499E-03	0.292E-03	0.330E-03	0.320E-03	0.288E-03
1672.6 A	20000.	0.443E-02	0.563E-03	0.462E-03	0.437E-03	0.429E-03	0.362E-03
C= 0.37E+17	50000.	0.366E-02	0.498E-03	0.625E-03	0.562E-03	0.555E-03	0.460E-03
	100000.	0.318E-02	0.469E-03	0.751E-03	0.650E-03	0.639E-03	0.529E-03
	150000.	0.292E-02	0.417E-03	0.817E-03	0.695E-03	0.709E-03	0.576E-03
	200000.	0.275E-02	0.381E-03	0.884E-03	0.761E-03	0.719E-03	0.623E-03
SIIV 5S-5P	10000.	0.625E-01	-0.208E-02	0.158E-02	-0.720E-03	0.220E-02	-0.683E-03
8977.4 A	20000.	0.493E-01	-0.247E-02	0.261E-02	-0.121E-02	0.319E-02	-0.106E-02
C= 0.90E+19	50000.	0.395E-01	-0.266E-02	0.385E-02	-0.187E-02	0.406E-02	-0.156E-02
	100000.	0.346E-01	-0.250E-02	0.446E-02	-0.226E-02	0.459E-02	-0.187E-02
	150000.	0.321E-01	-0.246E-02	0.486E-02	-0.251E-02	0.491E-02	-0.208E-02
	200000.	0.304E-01	-0.235E-02	0.513E-02	-0.273E-02	0.495E-02	-0.220E-02
SIIV 5S-6P	10000.	0.758E-02	-0.516E-04	0.407E-03	-0.227E-04	0.505E-03	-0.221E-04
2483.7 A	20000.	0.611E-02	-0.367E-04	0.571E-03	-0.410E-04	0.637E-03	-0.380E-04
C= 0.37E+18	50000.	0.510E-02	-0.571E-04	0.696E-03	-0.694E-04	0.746E-03	-0.606E-04
	100000.	0.462E-02	-0.753E-04	0.776E-03	-0.897E-04	0.808E-03	-0.750E-04
	150000.	0.436E-02	-0.627E-04	0.808E-03	-0.100E-03	0.829E-03	-0.827E-04
	200000.	0.419E-02	-0.616E-04	0.825E-03	-0.108E-03	0.839E-03	-0.888E-04
SIIV 5P-6S	10000.	0.211E-01	0.507E-02	0.559E-03	0.724E-03	0.662E-03	0.641E-03
4323.5 A	20000.	0.170E-01	0.384E-02	0.966E-03	0.103E-02	0.103E-02	0.891E-03
C= 0.11E+19	50000.	0.142E-01	0.285E-02	0.154E-02	0.139E-02	0.141E-02	0.114E-02
	100000.	0.128E-01	0.244E-02	0.187E-02	0.166E-02	0.174E-02	0.137E-02
	150000.	0.119E-01	0.210E-02	0.219E-02	0.185E-02	0.189E-02	0.150E-02
	200000.	0.113E-01	0.199E-02	0.235E-02	0.195E-02	0.200E-02	0.155E-02

PERTURBER DENSITY = 0.1D+16

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 5P-5D	10000.	0.477E-01	0.211E-02	0.124E-02	0.163E-02	0.150E-02	0.146E-02
6689.8 A	20000.	0.397E-01	0.227E-02	0.218E-02	0.235E-02	0.233E-02	0.203E-02
C= 0.99E+18	50000.	0.321E-01	0.231E-02	0.350E-02	0.317E-02	0.323E-02	0.262E-02
	100000.	0.277E-01	0.192E-02	0.436E-02	0.377E-02	0.395E-02	0.314E-02
	150000.	0.254E-01	0.193E-02	0.488E-02	0.424E-02	0.425E-02	0.347E-02
	200000.	0.239E-01	0.172E-02	0.529E-02	0.445E-02	0.449E-02	0.354E-02
SIIV 5P-6D	10000.	0.138E-01	0.111E-02	0.698E-03	0.821E-03	0.760E-03	0.717E-03
2676.6 A	20000.	0.116E-01	0.128E-02	0.113E-02	0.109E-02	0.104E-02	0.902E-03
C= 0.94E+17	50000.	0.974E-02	0.114E-02	0.152E-02	0.139E-02	0.135E-02	0.114E-02
	100000.	0.858E-02	0.104E-02	0.188E-02	0.160E-02	0.159E-02	0.132E-02
	150000.	0.794E-02	0.933E-03	0.211E-02	0.175E-02	0.176E-02	0.146E-02
	200000.	0.750E-02	0.844E-03	0.218E-02	0.188E-02	0.173E-02	0.154E-02
SIIV 5D-6P	10000.	0.738E-01	-0.183E-02	0.266E-02	-0.161E-02	0.322E-02	-0.145E-02
7055.2 A	20000.	0.613E-01	-0.143E-02	0.394E-02	-0.234E-02	0.434E-02	-0.204E-02
C= 0.11E+19	50000.	0.511E-01	-0.144E-02	0.523E-02	-0.322E-02	0.528E-02	-0.265E-02
	100000.	0.454E-01	-0.122E-02	0.610E-02	-0.382E-02	0.591E-02	-0.315E-02
	150000.	0.424E-01	-0.114E-02	0.645E-02	-0.417E-02	0.610E-02	-0.343E-02
	200000.	0.404E-01	-0.963E-03	0.672E-02	-0.444E-02	0.650E-02	-0.367E-02
SIIV 5D-5F	10000.	3.80	-0.269E-01	0.293	0.411	0.290	0.349
45016.9 A	20000.	3.08	-0.427E-01	0.469	0.516	0.407	0.425
C= 0.24E+19	50000.	2.39	-0.717E-01	0.659	0.656	0.567	0.541
	100000.	1.99	-0.771E-01	0.791	0.764	0.676	0.604
	150000.	1.78	-0.842E-01	0.894	0.819	0.683	0.672
	200000.	1.65	-0.815E-01	0.933	0.891	0.771	0.698

Table 2. Same as Table 1 but for perturber densities $10^{18} - 10^{21}$ cm^{-3} and temperatures from 20,000 K to 800,000 K.

PERTURBER DENSITY = 0.1D+19

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 3S-3P	20000.	0.176	0.312E-03	0.893E-03	-0.264E-03	0.156E-02	-0.264E-03
1396.7 A	50000.	0.112	-0.170E-02	0.272E-02	-0.755E-03	0.388E-02	-0.732E-03
C= 0.14E+22	80000.	0.899E-01	-0.156E-02	0.404E-02	-0.117E-02	0.507E-02	-0.108E-02
	100000.	0.812E-01	-0.119E-02	0.462E-02	-0.137E-02	0.571E-02	-0.127E-02
	150000.	0.684E-01	-0.163E-02	0.571E-02	-0.181E-02	0.670E-02	-0.156E-02
	200000.	0.612E-01	-0.187E-02	0.649E-02	-0.205E-02	0.707E-02	-0.181E-02
SIIV 3S-4P	20000.	0.453E-01	0.391E-03	0.135E-02	0.152E-03	0.188E-02	0.149E-03
457.9 A	50000.	0.307E-01	0.717E-03	0.252E-02	0.385E-03	0.305E-02	0.356E-03
C= 0.51E+20	80000.	0.258E-01	0.549E-03	0.311E-02	0.539E-03	0.338E-02	0.464E-03
	100000.	0.240E-01	0.668E-03	0.328E-02	0.594E-03	0.354E-02	0.524E-03
	150000.	0.212E-01	0.838E-03	0.354E-02	0.735E-03	0.378E-02	0.625E-03
	200000.	0.195E-01	0.764E-03	0.371E-02	0.818E-03	0.396E-02	0.668E-03
SIIV 3S-5P	20000.	0.558E-01	0.168E-02	*0.389E-02	*0.494E-03	*0.471E-02	*0.450E-03
361.6 A	50000.	0.429E-01	0.153E-02	*0.583E-02	*0.100E-02	*0.626E-02	*0.880E-03
C= 0.15E+20	80000.	0.384E-01	0.191E-02	*0.640E-02	*0.132E-02	*0.682E-02	*0.110E-02
	100000.	0.365E-01	0.210E-02	0.665E-02	0.143E-02	*0.707E-02	*0.116E-02
	150000.	0.335E-01	0.188E-02	0.710E-02	0.162E-02	*0.745E-02	*0.134E-02
	200000.	0.316E-01	0.185E-02	0.739E-02	0.175E-02	*0.756E-02	*0.143E-02
SIIV 3S-6P	20000.	0.886E-01	0.435E-02				
327.2 A	50000.	0.721E-01	0.389E-02				
C= 0.64E+19	80000.	0.668E-01	0.406E-02	*0.130E-01	*0.246E-02		
	100000.	0.646E-01	0.380E-02	*0.135E-01	*0.266E-02		
	150000.	0.608E-01	0.378E-02	*0.141E-01	*0.300E-02		
	200000.	0.583E-01	0.360E-02	*0.144E-01	*0.322E-02		
SIIV 3P-4S	20000.	0.128	0.605E-02	0.763E-03	0.190E-02	0.108E-02	0.177E-02
817.1 A	50000.	0.806E-01	0.716E-02	0.291E-02	0.406E-02	0.289E-02	0.351E-02
C= 0.16E+21	80000.	0.655E-01	0.767E-02	0.415E-02	0.528E-02	0.425E-02	0.453E-02
	100000.	0.600E-01	0.801E-02	0.503E-02	0.584E-02	0.485E-02	0.481E-02
	150000.	0.517E-01	0.840E-02	0.630E-02	0.660E-02	0.561E-02	0.545E-02
	200000.	0.471E-01	0.791E-02	0.705E-02	0.715E-02	0.625E-02	0.588E-02
SIIV 3P-5S	20000.	0.977E-01	0.194E-01	0.249E-02	0.369E-02	*0.261E-02	*0.305E-02
515.9 A	50000.	0.706E-01	0.159E-01	0.590E-02	0.672E-02	0.546E-02	0.541E-02
C= 0.30E+20	80000.	0.612E-01	0.143E-01	0.761E-02	0.807E-02	0.661E-02	0.660E-02
	100000.	0.578E-01	0.144E-01	0.845E-02	0.856E-02	0.711E-02	0.699E-02
	150000.	0.518E-01	0.130E-01	0.957E-02	0.979E-02	0.818E-02	0.800E-02
	200000.	0.478E-01	0.124E-01	0.106E-01	0.106E-01	0.914E-02	0.876E-02
SIIV 3P-6S	20000.	0.136	0.492E-01	*0.738E-02	*0.740E-02		
438.4 A	50000.	0.108	0.377E-01	*0.138E-01	*0.127E-01		
C= 0.12E+20	80000.	0.983E-01	0.337E-01	*0.165E-01	*0.157E-01	*0.139E-01	*0.128E-01
	100000.	0.937E-01	0.312E-01	*0.174E-01	*0.169E-01	*0.151E-01	*0.134E-01
	150000.	0.853E-01	0.276E-01	*0.207E-01	*0.190E-01	*0.173E-01	*0.158E-01
	200000.	0.800E-01	0.253E-01	*0.232E-01	*0.202E-01	*0.179E-01	*0.163E-01

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3P-3D	20000.	0.116	0.350E-03	0.636E-03	0.727E-04	0.111E-02	0.727E-04
1126.4 A	50000.	0.751E-01	0.503E-03	0.190E-02	0.212E-03	0.270E-02	0.209E-03
C= 0.74E+21	80000.	0.604E-01	0.371E-03	0.279E-02	0.339E-03	0.350E-02	0.327E-03
	100000.	0.548E-01	0.337E-03	0.317E-02	0.412E-03	0.394E-02	0.387E-03
	150000.	0.465E-01	0.460E-03	0.390E-02	0.561E-03	0.457E-02	0.517E-03
	200000.	0.418E-01	0.472E-03	0.440E-02	0.681E-03	0.481E-02	0.593E-03
SIIV 3P-4D	20000.	0.101	0.276E-02	0.313E-02	0.300E-02	*0.379E-02	*0.261E-02
560.5 A	50000.	0.703E-01	0.451E-02	0.639E-02	0.563E-02	0.654E-02	0.469E-02
C= 0.13E+20	80000.	0.596E-01	0.460E-02	0.793E-02	0.680E-02	0.753E-02	0.563E-02
	100000.	0.554E-01	0.449E-02	0.869E-02	0.732E-02	0.805E-02	0.603E-02
	150000.	0.488E-01	0.457E-02	0.971E-02	0.828E-02	0.894E-02	0.682E-02
	200000.	0.450E-01	0.456E-02	0.107E-01	0.897E-02	0.960E-02	0.738E-02
SIIV 3P-5D	20000.	0.154	0.875E-02	*0.107E-01	*0.763E-02		
454.7 A	50000.	0.120	0.110E-01	*0.169E-01	*0.130E-01		
C= 0.46E+19	80000.	0.107	0.115E-01	*0.199E-01	*0.161E-01		
	100000.	0.101	0.113E-01	*0.207E-01	*0.171E-01		
	150000.	0.911E-01	0.118E-01	*0.243E-01	*0.201E-01		
	200000.	0.849E-01	0.109E-01	*0.262E-01	*0.212E-01	*0.225E-01	*0.170E-01
SIIV 3P-6D	20000.	0.251	0.178E-01				
412.7 A	50000.	0.210	0.215E-01				
C= 0.22E+19	80000.	0.192	0.248E-01				
	100000.	0.184	0.245E-01				
	150000.	0.169	0.242E-01				
	200000.	0.160	0.221E-01				
SIIV 3D-4P	20000.	0.636	0.499E-02	0.151E-01	0.238E-02	0.215E-01	0.233E-02
1724.1 A	50000.	0.428	0.117E-01	0.294E-01	0.596E-02	0.360E-01	0.550E-02
C= 0.73E+21	80000.	0.358	0.942E-02	0.369E-01	0.828E-02	0.407E-01	0.713E-02
	100000.	0.332	0.106E-01	0.395E-01	0.912E-02	0.425E-01	0.802E-02
	150000.	0.292	0.134E-01	0.427E-01	0.113E-01	0.457E-01	0.954E-02
	200000.	0.270	0.126E-01	0.449E-01	0.124E-01	0.478E-01	0.102E-01
SIIV 3D-5P	20000.	0.310	0.985E-02	*0.205E-01	*0.284E-02	*0.248E-01	*0.259E-02
860.7 A	50000.	0.239	0.924E-02	*0.310E-01	*0.577E-02	*0.333E-01	*0.505E-02
C= 0.83E+20	80000.	0.214	0.113E-01	0.341E-01	0.757E-02	*0.363E-01	*0.633E-02
	100000.	0.204	0.123E-01	0.354E-01	0.822E-02	*0.377E-01	*0.669E-02
	150000.	0.187	0.111E-01	0.379E-01	0.933E-02	*0.396E-01	*0.767E-02
	200000.	0.177	0.110E-01	0.395E-01	0.998E-02	*0.404E-01	*0.826E-02
SIIV 3D-6P	20000.	0.389	0.199E-01				
688.3 A	50000.	0.317	0.177E-01	*0.512E-01	*0.912E-02		
C= 0.28E+20	80000.	0.294	0.184E-01	*0.561E-01	*0.109E-01		
	100000.	0.284	0.172E-01	*0.580E-01	*0.118E-01		
	150000.	0.268	0.171E-01	*0.610E-01	*0.133E-01		
	200000.	0.257	0.163E-01	*0.621E-01	*0.143E-01		

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3D-4F	20000.	0.288	-0.587E-02	0.571E-02	-0.710E-02	0.752E-02	-0.645E-02
1066.6 A	50000.	0.195	-0.485E-02	0.136E-01	-0.140E-01	0.145E-01	-0.119E-01
C= 0.47E+20	80000.	0.162	-0.585E-02	0.187E-01	-0.176E-01	0.174E-01	-0.143E-01
	100000.	0.150	-0.557E-02	0.203E-01	-0.185E-01	0.189E-01	-0.154E-01
	150000.	0.131	-0.419E-02	0.234E-01	-0.212E-01	0.212E-01	-0.176E-01
	200000.	0.120	-0.388E-02	0.260E-01	-0.229E-01	0.229E-01	-0.189E-01
SIIV 3D-5F	20000.	0.502	-0.214E-01				
749.9 A	50000.	0.392	-0.117E-01				
C= 0.67E+18	80000.	0.346	-0.378E-02				
	100000.	0.326	-0.311E-02				
	150000.	0.292	0.451E-02				
	200000.	0.270	0.335E-02				
SIIV 3D-6F	20000.	0.171	-0.116E-02				
645.8 A	50000.	0.117	-0.579E-03	*0.430E-01	*-0.237E-3		
C= 0.89E+20	80000.	0.993E-01	-0.636E-03	*0.469E-01	*-0.356E-3		
	100000.	0.924E-01	-0.649E-03	*0.486E-01	*-0.419E-3		
	150000.	0.822E-01	-0.650E-03	*0.508E-01	*-0.529E-3		
	200000.	0.764E-01	-0.678E-03	*0.518E-01	*-0.610E-3		
SIIV 4S-4P	20000.	4.97	-0.706E-01	0.110	-0.352E-01	0.152	-0.334E-01
4097.9 A	50000.	3.36	-0.887E-01	0.208	-0.794E-01	0.248	-0.679E-01
C= 0.41E+22	80000.	2.85	-0.123	0.259	-0.103	0.276	-0.891E-01
	100000.	2.65	-0.128	0.274	-0.115	0.290	-0.968E-01
	150000.	2.35	-0.124	0.299	-0.131	0.312	-0.110
	200000.	2.18	-0.116	0.316	-0.143	0.328	-0.118
SIIV 4S-5P	20000.	0.734	0.698E-02	*0.435E-01	*0.180E-02	*0.527E-01	*0.174E-02
1211.0 A	50000.	0.556	0.293E-02	*0.651E-01	*0.434E-02	*0.700E-01	*0.388E-02
C= 0.16E+21	80000.	0.495	0.593E-02	*0.713E-01	*0.571E-02	*0.763E-01	*0.503E-02
	100000.	0.470	0.717E-02	0.740E-01	0.645E-02	*0.789E-01	*0.558E-02
	150000.	0.431	0.379E-02	0.790E-01	0.775E-02	*0.832E-01	*0.637E-02
	200000.	0.407	0.488E-02	0.820E-01	0.831E-02	*0.848E-01	*0.692E-02
SIIV 4S-6P	20000.	0.722	0.205E-01				
895.3 A	50000.	0.581	0.189E-01				
C= 0.48E+20	80000.	0.536	0.205E-01	*0.971E-01	*0.156E-01		
	100000.	0.517	0.179E-01	*0.101	*0.167E-01		
	150000.	0.486	0.181E-01	*0.105	*0.191E-01		
	200000.	0.465	0.177E-01	*0.107	*0.206E-01		
SIIV 4P-5S	20000.	2.05	0.211	0.560E-01	0.606E-01	*0.614E-01	*0.502E-01
2125.0 A	50000.	1.50	0.193	0.116	0.111	*0.110	*0.891E-01
C= 0.50E+21	80000.	1.32	0.211	0.142	0.132	*0.129	*0.108
	100000.	1.25	0.201	0.155	0.141	*0.139	*0.115
	150000.	1.14	0.190	0.175	0.160	*0.157	*0.131
	200000.	1.06	0.182	0.189	0.172	0.169	0.144

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 4P-6S	20000.	1.20	0.361	*0.600E-01	*0.579E-01		
1230.0 A	50000.	0.942	0.267	*0.110	*0.996E-01		
C= 0.91E+20	80000.	0.857	0.251	*0.131	*0.122		
	100000.	0.820	0.222	*0.138	*0.132	*0.122	*0.105
	150000.	0.752	0.203	*0.167	*0.149	*0.137	*0.124
	200000.	0.709	0.188	*0.183	*0.159	*0.142	*0.127
SIIV 4P-4D	20000.	3.80	0.717E-01	0.907E-01	0.898E-01	0.112	0.786E-01
3160.3 A	50000.	2.67	0.102	0.189	0.170	0.195	0.142
C= 0.41E+21	80000.	2.29	0.114	0.238	0.206	0.227	0.171
	100000.	2.14	0.106	0.259	0.222	0.240	0.182
	150000.	1.90	0.985E-01	0.296	0.252	0.272	0.208
	200000.	1.77	0.101	0.319	0.270	0.290	0.223
SIIV 4P-5D	20000.	1.49	0.734E-01	*0.902E-01	*0.686E-01		
1367.6 A	50000.	1.16	0.907E-01	*0.147	*0.117		
C= 0.42E+20	80000.	1.02	0.971E-01	*0.173	*0.145		
	100000.	0.967	0.948E-01	*0.180	*0.153		
	150000.	0.876	0.975E-01	*0.211	*0.180	*0.185	*0.147
	200000.	0.819	0.894E-01	*0.229	*0.191	*0.195	*0.153
SIIV 4P-6D	20000.	1.67	0.109				
1046.7 A	50000.	1.39	0.132				
C= 0.14E+20	80000.	1.27	0.155				
	100000.	1.21	0.153				
	150000.	1.12	0.150				
	200000.	1.06	0.137				
SIIV 4D-5P	20000.	7.87	0.421E-01	0.335	-0.931E-01	*0.404	*-0.843E-01
3766.0 A	50000.	6.04	-0.264E-01	0.526	-0.182	*0.558	*-0.155
C= 0.58E+21	80000.	5.39	0.128E-01	0.584	-0.228	*0.612	*-0.186
	100000.	5.12	0.376E-01	0.608	-0.241	*0.638	*-0.200
	150000.	4.69	0.141E-01	0.661	-0.276	*0.675	*-0.229
	200000.	4.42	0.147E-01	0.685	-0.297	*0.694	*-0.247
SIIV 4D-6P	20000.	3.07	0.879E-01				
1796.6 A	50000.	2.48	0.691E-01	*0.321	*0.104E-01		
C= 0.13E+21	80000.	2.29	0.760E-01	*0.350	*0.136E-01		
	100000.	2.21	0.689E-01	*0.363	*0.154E-01		
	150000.	2.07	0.696E-01	*0.380	*0.183E-01		
	200000.	1.98	0.655E-01	*0.387	*0.196E-01		
SIIV 4D-5F	20000.	5.33	-0.249				
2287.0 A	50000.	4.14	-0.183				
C= 0.62E+19	80000.	3.65	-0.111				
	100000.	3.44	-0.103				
	150000.	3.09	-0.321E-01				
	200000.	2.86	-0.428E-01				

PERTURBER DENSITY = 0.1D+19

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 4D-6F	20000.	5.07	-0.267				
1533.2 A	50000.	4.18	-0.175				
C= 0.18E+19	80000.	3.76	-0.761E-01				
	100000.	3.57	-0.743E-01				
	150000.	3.23	0.303E-01				
	200000.	2.99	0.701E-02				
SIIV 4F-5D	20000.	6.07	0.335	*0.353	*0.280		
2675.2 A	50000.	4.67	0.403	*0.591	*0.481		
C= 0.16E+21	80000.	4.10	0.427	*0.693	*0.591		
	100000.	3.87	0.418	*0.744	*0.642		
	150000.	3.49	0.425	*0.841	*0.722		
	200000.	3.25	0.390	*0.921	*0.754	*0.748	*0.622
SIIV 4F-6D	20000.	4.41	0.305				
1672.6 A	50000.	3.64	0.365				
C= 0.37E+20	80000.	3.32	0.420				
	100000.	3.17	0.415				
	150000.	2.92	0.406				
	200000.	2.74	0.371				
SIIV 5S-6P	20000.	6.11	-0.270E-01				
2483.7 A	50000.	5.10	-0.523E-01	*0.684	*-0.644E-01		
C= 0.37E+21	80000.	4.76	-0.671E-01	*0.747	*-0.826E-01		
	100000.	4.62	-0.728E-01	*0.772	*-0.876E-01		
	150000.	4.36	-0.621E-01	*0.807	*-0.997E-01		
	200000.	4.19	-0.614E-01	*0.824	*-0.108		
SIIV 5P-6S	20000.	17.0	3.45	*0.937	*0.696		
4323.5 A	50000.	14.2	2.66	*1.51	*1.19		
C= 0.11E+22	80000.	13.2	2.27	*1.78	*1.47		
	100000.	12.8	2.34	*1.86	*1.57		
	150000.	11.9	2.08	*2.19	*1.83		
	200000.	11.3	1.97	*2.35	*1.93	*2.00	*1.54
SIIV 5P-6D	20000.	11.6	0.641				
2676.6 A	50000.	9.71	0.810				
C= 0.94E+20	80000.	8.92	0.930				
	100000.	8.56	0.909				
	150000.	7.93	0.907				
	200000.	7.48	0.820				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3S-3P	50000.	1.12	-0.164E-01	0.268E-01	-0.669E-02	0.380E-01	-0.646E-02
1396.7 A	80000.	0.899	-0.148E-01	0.401E-01	-0.108E-01	0.503E-01	-0.999E-02
C= 0.14E+23	100000.	0.812	-0.115E-01	0.461E-01	-0.130E-01	0.568E-01	-0.120E-01
	150000.	0.684	-0.156E-01	0.570E-01	-0.175E-01	0.668E-01	-0.150E-01
	200000.	0.612	-0.183E-01	0.648E-01	-0.202E-01	0.706E-01	-0.178E-01
	300000.	0.530	-0.171E-01	0.715E-01	-0.251E-01	0.765E-01	-0.213E-01
SIIV 3S-4P	50000.	0.307	0.649E-02	*0.243E-01	*0.335E-02		
457.9 A	80000.	0.258	0.500E-02	*0.306E-01	*0.491E-02	*0.328E-01	0.416E-02
C= 0.51E+21	100000.	0.240	0.630E-02	*0.325E-01	*0.551E-02	*0.347E-01	0.480E-02
	150000.	0.212	0.810E-02	*0.352E-01	*0.700E-02	*0.374E-01	0.591E-02
	200000.	0.195	0.745E-02	*0.371E-01	*0.800E-02	*0.394E-01	0.650E-02
	300000.	0.176	0.695E-02	*0.396E-01	*0.908E-02	*0.415E-01	0.748E-02
SIIV 3S-5P	50000.	0.429	0.132E-01				
361.6 A	80000.	0.383	0.173E-01				
C= 0.15E+21	100000.	0.365	0.190E-01				
	150000.	0.335	0.176E-01				
	200000.	0.316	0.178E-01				
	300000.	0.293	0.175E-01	*0.765E-01	*0.192E-01		
SIIV 3S-6P	50000.	0.720	0.334E-01				
327.2 A	80000.	0.668	0.355E-01				
C= 0.64E+20	100000.	0.646	0.341E-01				
	150000.	0.608	0.347E-01				
	200000.	0.583	0.341E-01				
	300000.	0.548	0.349E-01				
SIIV 3P-4S	50000.	0.805	0.636E-01	0.288E-01	0.338E-01	*0.286E-01	*0.284E-01
817.1 A	80000.	0.655	0.693E-01	0.412E-01	0.463E-01	*0.426E-01	*0.390E-01
C= 0.16E+22	100000.	0.600	0.751E-01	0.507E-01	0.526E-01	*0.482E-01	*0.421E-01
	150000.	0.517	0.793E-01	0.627E-01	0.608E-01	*0.553E-01	*0.497E-01
	200000.	0.471	0.766E-01	0.706E-01	0.691E-01	*0.626E-01	*0.564E-01
	300000.	0.416	0.753E-01	0.825E-01	0.790E-01	*0.717E-01	*0.653E-01
SIIV 3P-5S	50000.	0.706	0.138	*0.583E-01	*0.496E-01		
515.9 A	80000.	0.612	0.125	*0.754E-01	*0.644E-01		
C= 0.30E+21	100000.	0.578	0.129	*0.838E-01	*0.708E-01		
	150000.	0.518	0.118	*0.952E-01	*0.856E-01		
	200000.	0.478	0.117	*0.105	*0.998E-01		
	300000.	0.429	0.115	*0.125	*0.113		
SIIV 3P-6S	50000.	1.08	0.309				
438.4 A	80000.	0.981	0.282				
C= 0.12E+21	100000.	0.936	0.263				
	150000.	0.852	0.236				
	200000.	0.799	0.234				
	300000.	0.728	0.230				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	SHIFT(A)	PROTONS WIDTH(A)	SHIFT(A)	IONIZED HELIUM WIDTH(A)	SHIFT(A)
SIIV 3P-3D	50000.	0.751	0.466E-02	0.187E-01	0.188E-02	0.265E-01	0.185E-02
1126.4 A	80000.	0.604	0.348E-02	0.277E-01	0.316E-02	0.347E-01	0.304E-02
C= 0.74E+22	100000.	0.548	0.320E-02	0.316E-01	0.392E-02	0.392E-01	0.367E-02
	150000.	0.465	0.445E-02	0.389E-01	0.544E-02	0.456E-01	0.500E-02
	200000.	0.418	0.463E-02	0.439E-01	0.672E-02	0.480E-01	0.585E-02
	300000.	0.367	0.432E-02	0.480E-01	0.821E-02	0.518E-01	0.720E-02
SIIV 3P-4D	50000.	0.701	0.284E-01	*0.623E-01	*0.435E-01		
560.5 A	80000.	0.595	0.321E-01	*0.790E-01	*0.561E-01		
C= 0.13E+21	100000.	0.552	0.326E-01	*0.854E-01	*0.623E-01		
	150000.	0.487	0.362E-01	*0.980E-01	*0.743E-01		
	200000.	0.449	0.408E-01	*0.107	*0.849E-01		
	300000.	0.402	0.403E-01	*0.117	*0.992E-01		
SIIV 3P-5D	50000.	1.17	0.410E-01				
454.7 A	80000.	1.04	0.554E-01				
C= 0.46E+20	100000.	0.986	0.623E-01				
	150000.	0.894	0.764E-01				
	200000.	0.835	0.876E-01				
	300000.	0.759	0.926E-01				
SIIV 3P-6D	50000.	1.91	0.197E-01				
412.7 A	80000.	1.78	0.756E-01				
C= 0.22E+20	100000.	1.71	0.917E-01				
	150000.	1.59	0.114				
	200000.	1.51	0.152				
	300000.	1.39	0.178				
SIIV 3D-4P	50000.	4.28	0.108	*0.285	*0.517E-01	*0.343	*0.471E-01
1724.1 A	80000.	3.58	0.865E-01	*0.364	*0.754E-01	*0.397	*0.638E-01
C= 0.73E+22	100000.	3.32	0.100	*0.391	*0.845E-01	*0.418	*0.737E-01
	150000.	2.92	0.129	*0.425	*0.107	*0.455	*0.900E-01
	200000.	2.70	0.123	0.449	0.122	*0.477	*0.993E-01
	300000.	2.43	0.115	0.481	0.138	*0.505	*0.114
SIIV 3D-5P	50000.	2.39	0.805E-01				
860.7 A	80000.	2.14	0.103				
C= 0.83E+21	100000.	2.04	0.111				
	150000.	1.87	0.104				
	200000.	1.77	0.106				
	300000.	1.64	0.104	*0.411	*0.110		
SIIV 3D-6P	50000.	3.17	0.153				
688.3 A	80000.	2.94	0.161				
C= 0.28E+21	100000.	2.84	0.154				
	150000.	2.68	0.157				
	200000.	2.57	0.155				
	300000.	2.41	0.157				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3D-4F	50000.	1.94	-0.113E-01	*0.133	*-0.111	*0.140	*-0.906E-01
1066.6 A	80000.	1.62	-0.274E-01	*0.187	*-0.149	*0.171	*-0.116
C= 0.47E+21	100000.	1.50	-0.275E-01	*0.205	*-0.162	*0.187	*-0.129
	150000.	1.31	-0.201E-01	*0.230	*-0.190	*0.209	*-0.156
	200000.	1.20	-0.287E-01	*0.260	*-0.219	*0.230	*-0.179
	300000.	1.08	-0.353E-01	*0.290	*-0.252	*0.266	*-0.208
SIIV 3D-5F	50000.	3.24	-0.656E-01				
749.9 A	80000.	2.92	-0.643E-01				
C= 0.67E+19	100000.	2.78	-0.629E-01				
	150000.	2.53	-0.581E-01				
	200000.	2.36	-0.300E-01				
	300000.	2.14	0.708E-02				
SIIV 3D-6F	50000.	1.17	-0.553E-02				
645.8 A	80000.	0.992	-0.610E-02				
C= 0.89E+21	100000.	0.923	-0.627E-02				
	150000.	0.821	-0.625E-02				
	200000.	0.764	-0.669E-02				
	300000.	0.701	-0.725E-02				
SIIV 4S-5P	50000.	5.56	0.232E-01				
1211.0 A	80000.	4.95	0.551E-01				
C= 0.16E+22	100000.	4.70	0.603E-01				
	150000.	4.31	0.343E-01				
	200000.	4.07	0.468E-01				
	300000.	3.77	0.453E-01	*0.846	*0.927E-01		
SIIV 4S-6P	50000.	5.80	0.158				
895.3 A	80000.	5.35	0.176				
C= 0.48E+21	100000.	5.17	0.156				
	150000.	4.86	0.163				
	200000.	4.65	0.167				
	300000.	4.37	0.176				
SIIV 4P-5S	50000.	15.0	1.60				
2125.0 A	80000.	13.2	1.82				
C= 0.50E+22	100000.	12.5	1.76				
	150000.	11.3	1.70	*1.73	*1.40		
	200000.	10.6	1.72	*1.88	*1.61		
	300000.	9.65	1.71	*2.19	*1.88		
SIIV 4P-6S	50000.	9.41	2.15				
1230.0 A	80000.	8.56	2.08				
C= 0.91E+21	100000.	8.19	1.84				
	150000.	7.52	1.72				
	200000.	7.08	1.72				
	300000.	6.50	1.70				

PERTURBER DENSITY = 0.1D+20

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 4P-4D	50000.	26.7	0.525	*1.85	*1.31		
3160.3 A	80000.	22.8	0.721	*2.35	*1.71		
C= 0.41E+22	100000.	21.3	0.692	*2.57	*1.89		
	150000.	19.0	0.700	*2.94	*2.26		
	200000.	17.6	0.865	*3.20	*2.57		
	300000.	16.0	0.881	*3.52	*2.93		
SIIV 4P-5D	50000.	11.3	0.289				
1367.6 A	80000.	10.0	0.437				
C= 0.42E+21	100000.	9.49	0.492				
	150000.	8.61	0.601				
	200000.	8.06	0.706				
	300000.	7.34	0.758				
SIIV 4P-6D	50000.	12.7	0.705E-01				
1046.7 A	80000.	11.8	0.443				
C= 0.14E+21	100000.	11.3	0.545				
	150000.	10.6	0.676				
	200000.	9.99	0.923				
	300000.	9.21	1.10				

PERTURBER DENSITY = 0.1D+21

TRANSITION	T(K)	ELECTRONS WIDTH(A)	ELECTRONS SHIFT(A)	PROTONS WIDTH(A)	PROTONS SHIFT(A)	IONIZED HELIUM WIDTH(A)	IONIZED HELIUM SHIFT(A)
SIIV 3S-3P	100000.	8.12	-0.916E-01	0.447	-0.112	*0.542	*-0.102
1396.7 A	150000.	6.84	-0.136	0.560	-0.158	*0.650	*-0.133
C= 0.14E+24	200000.	6.12	-0.166	0.644	-0.186	*0.696	*-0.162
	300000.	5.30	-0.159	0.713	-0.237	*0.762	*-0.199
	500000.	4.53	-0.158	0.792	-0.285	*0.834	*-0.237
	800000.	3.99	-0.155	0.860	-0.332	*0.893	*-0.273
SIIV 3S-4P	100000.	2.40	0.497E-01				
457.9 A	150000.	2.12	0.707E-01				
C= 0.51E+22	200000.	1.95	0.650E-01				
	300000.	1.76	0.611E-01				
	500000.	1.57	0.639E-01				
	800000.	1.42	0.663E-01				
SIIV 3S-5P	100000.	*3.62	*0.144				
361.6 A	150000.	3.33	0.136				
C= 0.15E+22	200000.	3.14	0.142				
	300000.	2.91	0.145				
	500000.	2.66	0.158				
	800000.	2.45	0.150				
SIIV 3S-6P	100000.	*6.11	*0.196				
327.2 A	150000.	*5.81	*0.227				
C= 0.64E+21	200000.	*5.60	*0.225				
	300000.	5.30	0.264				
	500000.	4.92	0.280				
	800000.	4.57	0.265				

PERTURBER DENSITY = 0.1D+21

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 3P-4S	100000.	6.00	0.573				
817.1 A	150000.	5.16	0.646				
C= 0.16E+23	200000.	4.71	0.631				
	300000.	4.16	0.647	*0.824	*0.685		
	500000.	3.60	0.662	*0.973	*0.838		
	800000.	3.20	0.664	*1.07	*0.973		
SIIV 3P-5S	100000.	5.70	0.800				
515.9 A	150000.	5.11	0.774				
C= 0.30E+22	200000.	4.72	0.788				
	300000.	4.24	0.850				
	500000.	3.74	0.922				
	800000.	3.34	0.883				
SIIV 3P-6S	100000.	8.47	1.20				
438.4 A	150000.	7.83	1.17				
C= 0.12E+22	200000.	7.40	1.21				
	300000.	6.81	1.38				
	500000.	6.12	1.52				
	800000.	5.50	1.51				
SIIV 3P-3D	100000.	5.48	0.256E-01	0.306	0.342E-01	*0.373	*0.318E-01
1126.4 A	150000.	4.65	0.390E-01	0.382	0.498E-01	*0.443	*0.454E-01
C= 0.74E+23	200000.	4.18	0.416E-01	0.435	0.627E-01	*0.472	*0.540E-01
	300000.	3.67	0.394E-01	0.478	0.784E-01	*0.513	*0.683E-01
	500000.	3.19	0.415E-01	0.527	0.102	*0.563	*0.840E-01
	800000.	2.85	0.413E-01	0.569	0.118	*0.595	*0.972E-01
SIIV 3P-4D	100000.	5.23	0.280E-01				
560.5 A	150000.	4.64	0.107				
C= 0.13E+22	200000.	4.29	0.162				
	300000.	3.87	0.196				
	500000.	3.41	0.248				
	800000.	3.06	0.281				
SIIV 3P-5D	100000.	*8.27	*-0.167				
454.7 A	150000.	7.69	0.647E-01				
C= 0.46E+21	200000.	7.29	0.136				
	300000.	6.74	0.254				
	500000.	6.08	0.419				
	800000.	5.51	0.610				
SIIV 3P-6D	100000.	*12.4	*-0.411				
412.7 A	150000.	*12.1	*-0.135				
C= 0.22E+21	200000.	*11.8	*0.223E-01				
	300000.	11.2	0.236				
	500000.	10.4	0.681				
	800000.	9.58	1.13				

PERTURBER DENSITY = 0.1D+21

		ELECTRONS		PROTONS		IONIZED HELIUM	
TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV 3D-4P	100000.	33.2	0.795				
1724.1 A	150000.	29.2	1.12				
C= 0.73E+23	200000.	26.9	1.08				
	300000.	24.3	1.02				
	500000.	21.7	1.05				
	800000.	19.7	1.08	*5.32	*1.77		
SIIV 3D-5P	100000.	*20.2	*0.845				
860.7 A	150000.	18.6	0.810				
C= 0.83E+22	200000.	17.6	0.847				
	300000.	16.3	0.864				
	500000.	14.9	0.935				
	800000.	13.7	0.884				
SIIV 3D-6P	100000.	*26.9	*0.897				
688.3 A	150000.	*25.6	*1.03				
C= 0.28E+22	200000.	*24.7	*1.03				
	300000.	23.4	1.20				
	500000.	21.7	1.26				
	800000.	20.1	1.20				

PERTURBER DENSITY = 0.1D+22

TRANSITION	T(K)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)	WIDTH(A)	SHIFT(A)
SIIV3S2S-4P	100000.	*23.2	*-0.970E-02				
457.9 A	150000.	*20.6	*0.327				
C= 0.51E+23	200000.	*19.1	*0.314				
	300000.	17.3	0.350				
	500000.	15.4	0.449				
	800000.	14.0	0.567				

ТАБЛИЦЕ ЗА ПАРАМЕТРЕ ШТАРКОВОГ ШИРЕЊА СПЕКТРАЛНИХ ЛИНИЈА ВИШЕСТРУКО НАЕЛЕКТРИСАНИХ ЈОНА ОД АСТРОФИЗИЧКОГ ЗНАЧАЈА: ЛИНИЈЕ Si IV

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УДК 52–355.3
Претходно саопштење

У оквиру семикласичне теорије израчунате су ширине и помаци услед судара са електронима, протонима и јонизованим хелијумом за спектралне линије у оквиру 39 мултиплета Si IV. Резултати су дати у функцији електронске температуре и густине.

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Preliminary report

CORRELATION BETWEEN VERTICAL MOVEMENTS AND GEOLOGICAL FEATURES OF BELGRADE AREA

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SUMMARY: **In this paper the relation between some geological, geophysical and geodetic parameters on the aspect of monitoring of recent crustal movement of Belgrade area is discussed. There were not measured data which are projected only for such as purposes. Although used data were not sufficient, the relation between some investigated parameters was proved by their correlation coefficient.**

INTRODUCTION

In Project „Changing of the mean Latitude of Belgrade" which leads Astronomical Opservatory in Belgrade, contribute several Institutes specialized for some problems, such as: Geodesy, Geology, Geophysics and Seismology. This Project is not finished yet, but there are some preliminary results that can be compared. This paper presents the level of correlation between geodetic and some geologic parameters: gravity and tectonic.

The investigated area is about 42 km^2. Its topography is shown in Fig. 1. The heights above the sea level are between 80 m and 250 m.

METHOD OF INVESTIGATION

Gravity investigations are made by WORDEN Gravity meters on irregular grid with a mean distance of 500 m. The Bouguer anomaly map is shown in Fig. 2. The increasing trend of anomalies is evident from the east to the southwest, with small deviation of anomaly lines to the west in the northern part of the area.

On the base of the Bouguer data, by Griffin method, a regional Bouguer map is derived (Fig. 3). This map shows regional trend of geological structures in the deepest part of the area.

The residual anomaly map (Fig. 4), was given as the difference of Bouguer values and regional anomalies. Considering the methodology of calculation of residuals, it can be assumed that this map gives a real picture of tectonic relations in the investigated area.

On the base of the geophysical and geological investigations (Sadžakov et al. 1990; Mladenović, 1989) the preliminary tectonic map was created (Fig. 5). Blocks which are in process of moving up or down, are marked by „+" and „–" respectively. A stable block is marked by „0". These movements are relative (tendency of motion). It is distintictive that the central block goes relatively up, while the west and the east blocks go realtively down. In the southwest part, the block marked by „0" is relatively stable. Of course, it is not possible to realize the quantification of these movements on the base of geophysical and geological data. This can be done by comparing the results of repeated geodetic levelling.

On the investigated area, up to date two levelling campaignes have been done: 1930. and 1959. year.

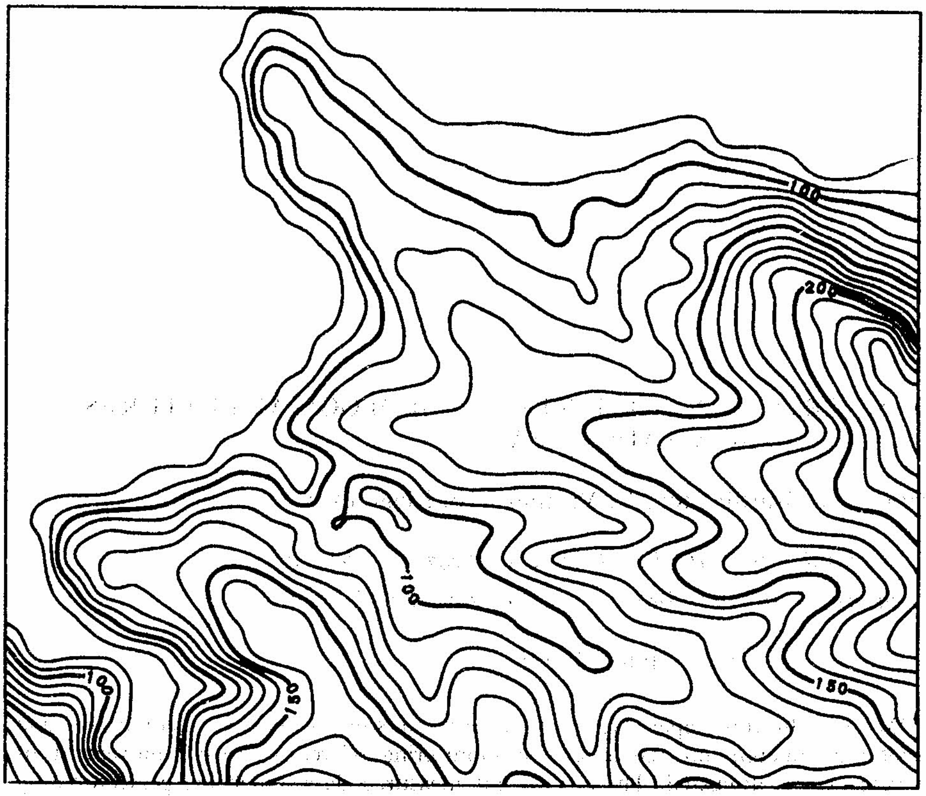

Fig. 1. Topography. Contour interval 10 m

0 1 km

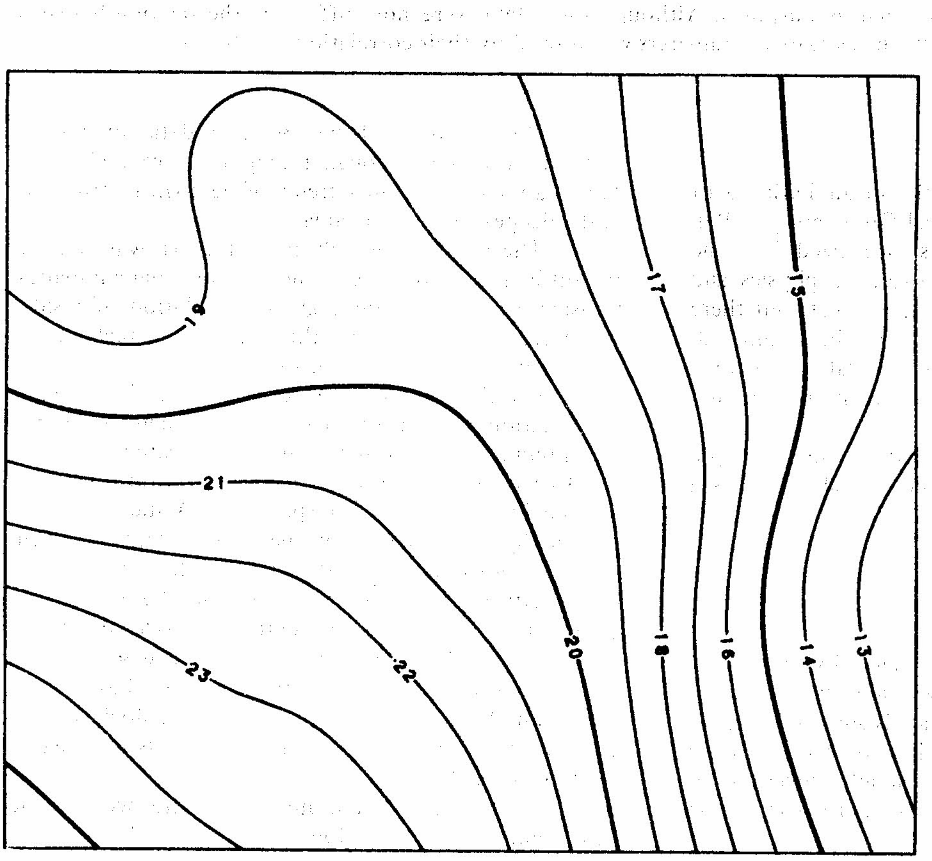

Fig. 2. Bouguer anomaly map Contour interval 1 mgal

0 1 km

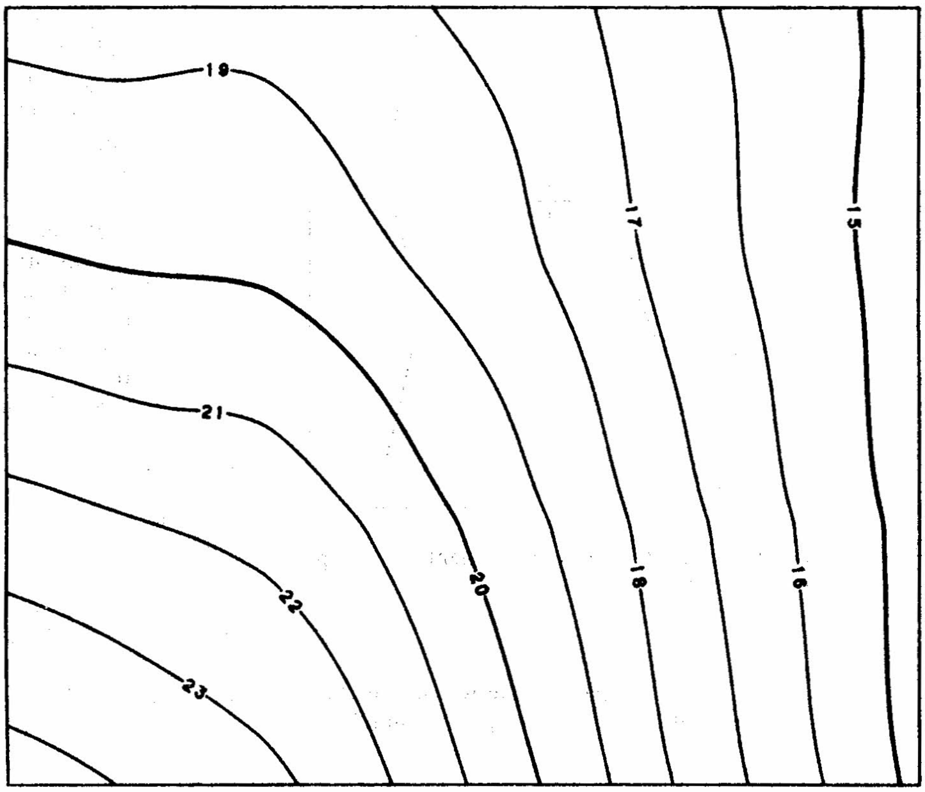

Fig. 3. Bouguer regional map
Contour interval 1 mgal

0 1 km

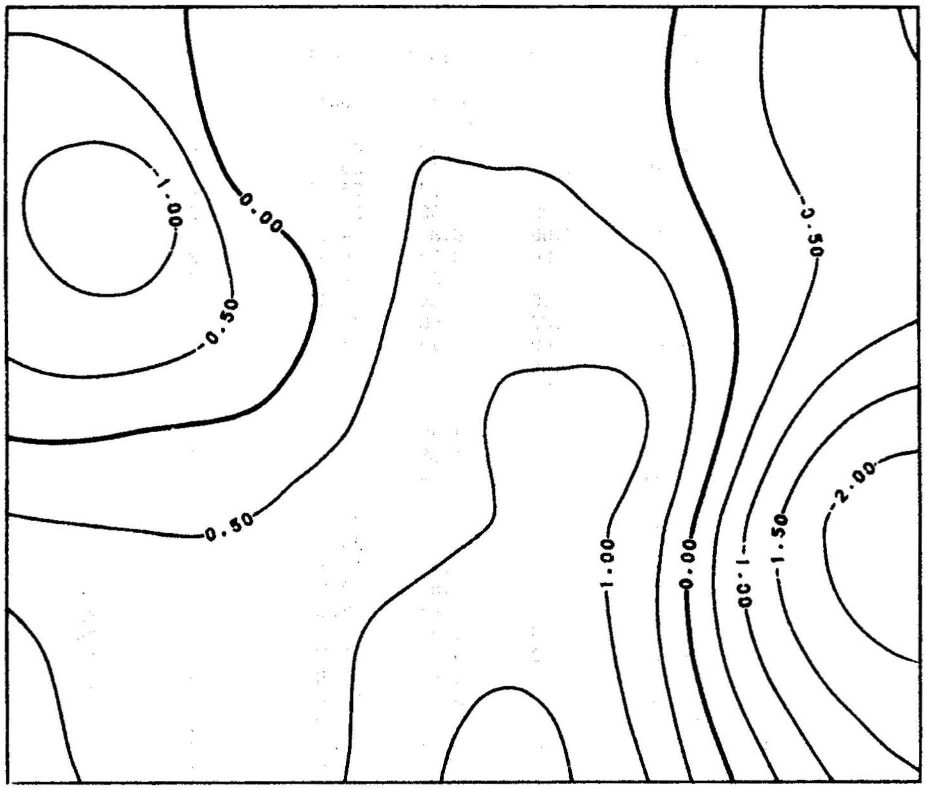

Fig. 4. Residual map.
Contour interval 0.5 mgal

0 1 km

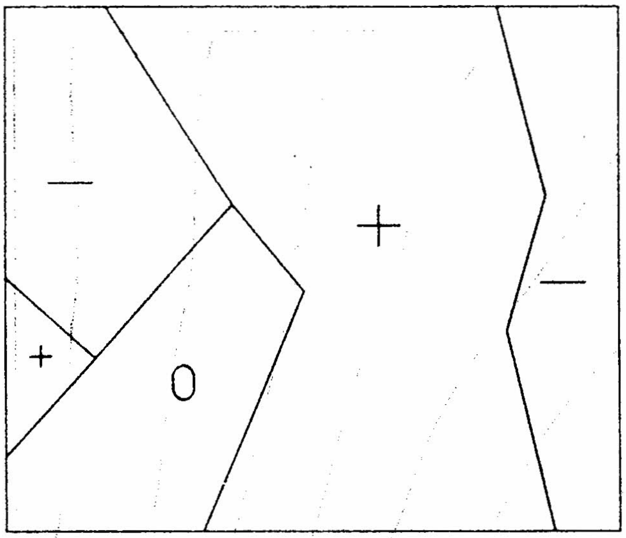

Fig. 5. Map of predicted tectonic movement + → Up, — → Down, 0 → Neutral

0 1 km

The accuracy of both compaignes are within the class of a first order leveling network ($\sigma_0 \approx 1$ mm/km).

The vertical movement of tectonic blocks was determined by using two methods (Bratuljević et al, 1991).

- Adjustment and comparison of the obtained heights and
- Multiquadratic analysis (MQ).

In this paper we want to compare trends of vertical movements, only so we used parameters derived by MQ method.

All relevant data which are presented in Figures 1 to 5 are transformed into a regular grid of 250 m x 250 m. These data are given in Table 1.

Using the method of regression analysis, the coefficients of correlation between geophysical, geological and geodetic values were derived.

The correlation ceofficients are given in Table 2.

Table 2.

Regression of	on	Fig.	R	F
Bouguer	dH (MQ)	6	0.68	723
Residual	dH (MQ)	7	0.58	723
Tectonic	dH (MQ)	8	0.14	723
Tectonic	Residual	9	0.66	723

Table 1.

ROW	COLUMN	dH(MQ) [mm]	TECTONIC	RESIDUAL [mgal]	BOUGUER [mgal]
1	1	-2.58	0.00	1.26	25.71
1	2	-0.48	0.00	1.15	25.47
1	3	1.38	0.00	1.03	25.22
1	4	2.96	0.00	0.92	24.97
1	5	4.17	0.00	0.82	24.71
1	6	4.96	0.00	0.73	24.47
1	7	5.24	0.00	0.68	24.25
1	8	4.98	0.00	0.65	24.06
1	9	4.11	0.00	0.66	23.89
1	10	2.64	0.00	0.78	23.75
1	11	0.56	1.00	0.94	23.61
1	12	-2.07	1.00	1.12	23.44
1	13	-5.20	1.00	1.30	23.22
1	14	-8.75	1.00	1.46	22.96
1	15	-12.60	1.00	1.59	22.64
1	16	-16.67	1.00	1.64	22.25
1	17	-20.84	1.00	1.62	21.78
1	18	-25.00	1.00	1.54	21.26
1	19	-29.02	1.00	1.37	20.62
1	20	-32.81	1.00	1.15	19.90
1	21	-36.29	1.00	0.89	19.10
1	22	-39.43	1.00	0.47	18.26
1	23	-42.21	1.00	0.07	17.41
1	24	-44.67	1.00	-0.30	16.59
1	25	-46.85	1.00	-0.63	15.82
1	26	-48.82	-1.00	-0.92	15.10
1	27	-50.63	-1.00	-1.16	14.44
1	28	-52.34	-1.00	-1.34	13.83
1	29	-53.99	-1.00	-1.46	13.26

... Continue Table 1

ROW	COLUMN	dH(MQ) [mm]	TECTONIC	RESIDUAL [mgal]	BOUGUER [mgal]
2	1	-1.09	0.00	1.23	25.44
2	2	1.21	0.00	1.12	25.21
2	3	3.28	0.00	0.98	24.95
2	4	5.07	0.00	0.86	24.69
2	5	6.50	0.00	0.76	24.44
2	6	7.49	0.00	0.67	24.19
2	7	7.96	0.00	0.60	23.97
2	8	7.82	0.00	0.58	23.79
2	9	7.04	0.00	0.61	23.65
2	10	5.58	0.00	0.73	23.53
2	11	3.46	0.00	0.91	23.41
2	12	0.72	1.00	1.09	23.25
2	13	-2.55	1.00	1.27	23.04
2	14	-6.28	1.00	1.43	22.78
2	15	-10.35	1.00	1.55	22.46
2	16	-14.64	1.00	1.61	22.08
2	17	-19.04	1.00	1.59	21.62
2	18	-23.42	1.00	1.51	21.11
2	19	-27.65	1.00	1.33	20.47
2	20	-31.61	1.00	1.08	13.73
2	21	-35.22	1.00	0.78	18.90
2	22	-38.42	1.00	0.34	18.04
2	23	-41.22	1.00	-0.08	17.17
2	24	-43.67	1.00	-0.46	16.34
2	25	-45.81	1.00	-0.80	15.56
2	26	-47.73	-1.00	-1.10	14.84
2	27	-49.50	-1.00	-1.33	14.19
2	28	-51.17	-1.00	-1.50	13.59
2	29	-52.79	-1.00	-1.60	13.05
3	1	0.09	1.00	1.21	25.17
3	2	2.58	0.00	1.09	24.94
3	3	4.86	0.00	0.96	24.69

... Continue Table 1

3	4	6.88	0.00	0.83	24.43
3	5	8.54	0.00	0.71	24.17
3	6	9.75	0.00	0.61	23.92
3	7	10.41	0.00	0.54	23.71
3	8	10.43	0.00	0.52	23.54
3	9	9.76	0.00	0.58	23.43
3	10	8.34	0.00	0.72	23.34
3	11	6.20	0.00	0.90	23.23
3	12	3.40	1.00	1.08	23.08
3	13	0.01	1.00	1.24	22.86
3	14	-3.86	1.00	1.39	22.60
3	15	-8.10	1.00	1.50	22.28
3	16	-12.58	1.00	1.56	21.91
3	17	-17.17	1.00	1.54	21.46
3	18	-21.74	1.00	1.47	20.96
3	19	-26.14	1.00	1.28	20.32
3	20	-30.25	1.00	1.00	19.56
3	21	-33.96	1.00	0.68	18.72
3	22	-37.22	1.00	0.21	17.83
3	23	-40.04	1.00	-0.25	16.94
3	24	-42.46	1.00	-0.65	16.09
3	25	-44.57	1.00	-0.99	15.31
3	26	-46.45	-1.00	-1.29	14.59
3	27	-48.19	-1.00	-1.50	13.96
3	28	-49.84	-1.00	-1.66	13.38
3	29	-51.45	-1.00	-1.75	12.85
4	1	0.90	1.00	1.18	24.89
4	2	3.56	1.00	1.06	24.67
4	3	6.05	0.00	0.93	24.43
4	4	8.28	0.00	0.80	24.17
4	5	10.17	0.00	0.68	23.92
4	6	11.61	0.00	0.58	23.68
4	7	12.48	0.00	0.51	23.47
4	8	12.69	0.00	0.51	23.33
4	9	12.15	0.00	0.58	23.24
4	10	10.81	0.00	0.73	23.17
4	11	8.70	0.00	0.91	23.07
4	12	5.87	0.00	1.06	22.90
4	13	2.42	1.00	1.21	22.68
4	14	-1.53	1.00	1.33	22.40
4	15	-5.88	1.00	1.44	22.09
4	16	-10.48	1.00	1.49	21.72
4	17	-15.20	1.00	1.48	21.29
4	18	-19.90	1.00	1.41	20.80
4	19	-24.43	1.00	1.22	20.17
4	20	-28.65	1.00	0.93	19.41
4	21	-32.43	1.00	0.59	18.55
4	22	-35.73	1.00	0.08	17.64
4	23	-38.56	1.00	-0.41	16.72
4	24	-40.97	1.00	-0.84	15.85
4	25	-43.07	1.00	-1.19	15.07
4	26	-44.94	-1.00	-1.48	14.36
4	27	-46.67	-1.00	-1.69	13.74
4	28	-48.33	-1.00	-1.83	13.18
4	29	-49.96	-1.00	-1.90	12.67
5	1	1.28	1.00	1.12	24.59
5	2	4.09	1.00	1.02	24.39
5	3	6.75	1.00	0.90	24.16
5	4	9.18	0.00	0.78	23.92
5	5	11.28	0.00	0.67	23.68
5	6	12.95	0.00	0.57	23.45
5	7	14.05	0.00	0.51	23.26
5	8	14.45	0.00	0.53	23.14
5	9	14.07	0.00	0.61	23.08
5	10	12.85	0.00	0.77	23.02
5	11	10.81	0.00	0.91	22.90
5	12	8.02	0.00	1.03	22.71
5	13	4.58	1.00	1.15	22.47
5	14	0.62	1.00	1.26	22.18
5	15	-3.73	1.00	1.36	21.87
5	16	-8.36	1.00	1.42	21.52
5	17	-13.12	1.00	1.41	21.11

... Continue Table 1

5	18	-17.87	1.00	1.35	20.64
5	19	-22.46	1.00	1.16	20.02
5	20	-26.72	1.00	0.87	19.27
5	21	-30.55	1.00	0.51	18.40
5	22	-33.88	1.00	-0.03	17.46
5	23	-36.72	1.00	-0.55	16.52
5	24	-39.14	1.00	-1.00	15.64
5	25	-41.25	-1.00	-1.37	14.85
5	26	-43.15	-1.00	-1.66	14.15
5	27	-44.91	-1.00	-1.86	13.54
5	28	-46.62	-1.00	-1.99	13.00
5	29	-48.31	-1.00	-2.05	12.51
6	1	1.19	1.00	1.04	24.27
6	2	4.11	1.00	0.95	24.08
6	3	6.91	1.00	0.85	23.88
6	4	9.50	1.00	0.75	23.66
6	5	11.78	0.00	0.65	23.44
6	6	13.64	0.00	0.57	23.24
6	7	14.95	0.00	0.54	23.08
6	8	15.55	0.00	0.57	22.98
6	9	15.35	0.00	0.65	22.92
6	10	14.29	0.00	0.79	22.85
6	11	12.38	0.00	0.90	22.71
6	12	9.71	0.00	0.99	22.49
6	13	6.39	0.00	1.08	22.23
6	14	2.53	1.00	1.17	21.94
6	15	-1.72	1.00	1.26	21.63
6	16	-6.26	1.00	1.33	21.30
6	17	-10.95	1.00	1.33	20.91
6	18	-15.65	1.00	1.28	20.47
6	19	-20.19	1.00	1.11	19.88
6	20	-24.43	1.00	0.84	19.15
6	21	-28.25	1.00	0.47	18.28
6	22	-31.59	1.00	-0.09	17.33
6	23	-34.46	1.00	-0.64	16.36
6	24	-36.93	1.00	-1.13	15.45
6	25	-39.10	-1.00	-1.52	14.65
6	26	-41.06	-1.00	-1.82	13.96
6	27	-42.91	-1.00	-2.01	13.37
6	28	-44.70	-1.00	-2.13	12.85
6	29	-46.49	-1.00	-2.17	12.38
7	1	0.58	1.00	0.93	23.91
7	2	3.58	1.00	0.85	23.74
7	3	6.45	1.00	0.78	23.56
7	4	9.15	1.00	0.70	23.37
7	5	11.56	1.00	0.63	23.18
7	6	13.58	0.00	0.57	23.01
7	7	15.05	0.00	0.55	22.88
7	8	15.84	0.00	0.59	22.80
7	9	15.84	0.00	0.66	22.74
7	10	14.98	0.00	0.78	22.65
7	11	13.28	0.00	0.86	22.48
7	12	10.82	0.00	0.92	22.24
7	13	7.72	0.00	0.98	21.96
7	14	4.10	0.00	1.06	21.67
7	15	0.07	1.00	1.15	21.38
7	16	-4.26	1.00	1.22	21.06
7	17	-8.74	1.00	1.24	20.70
7	18	-13.26	1.00	1.22	20.30
7	19	-17.66	1.00	1.08	19.75
7	20	-21.81	1.00	0.83	19.05
7	21	-25.57	1.00	0.47	18.20
7	22	-28.91	1.00	-0.12	17.23
7	23	-31.81	1.00	-0.70	16.24
7	24	-34.35	1.00	-1.21	15.31
7	25	-36.62	-1.00	-1.63	14.50
7	26	-38.70	-1.00	-1.93	13.82
7	27	-40.68	-1.00	-2.12	13.24
7	28	-42.60	-1.00	-2.23	12.74
7	29	-44.52	-1.00	-2.26	12.29
8	1	-0.55	1.00	0.76	23.50
8	2	2.45	1.00	0.72	23.36

... Continue Table 1

8	3	5.35	1.00	0.66	23.20
8	4	8.09	1.00	0.62	23.04
8	5	10.57	1.00	0.58	22.89
8	6	12.67	1.00	0.55	22.75
8	7	14.27	0.00	0.54	22.65
8	8	15.23	0.00	0.58	22.58
8	9	15.42	0.00	0.63	22.51
8	10	14.80	0.00	0.72	22.40
8	11	13.39	0.00	0.79	22.22
8	12	11.25	0.00	0.82	21.96
8	13	8.49	0.00	0.87	21.68
8	14	5.22	0.00	0.94	21.39
8	15	1.54	1.00	1.03	21.11
8	16	-2.43	1.00	1.11	20.82
8	17	-6.59	1.00	1.15	20.49
8	18	-10.82	1.00	1.16	20.13
8	19	-14.98	1.00	1.07	19.64
8	20	-18.94	1.00	0.86	18.99
8	21	-22.60	1.00	0.52	18.17
8	22	-25.90	1.00	-0.07	17.20
8	23	-28.84	1.00	-0.68	16.19
8	24	-31.48	1.00	-1.22	15.24
8	25	-33.88	-1.00	-1.66	14.42
8	26	-36.12	-1.00	-1.98	13.73
8	27	-38.27	-1.00	-2.19	13.15
8	28	-40.36	-1.00	-2.30	12.66
8	29	-42.45	-1.00	-2.32	12.23
9	1	-2.22	1.00	0.56	23.05
9	2	0.73	1.00	0.52	22.92
9	3	3.59	1.00	0.50	22.79
9	4	6.30	1.00	0.48	22.66
9	5	8.78	-1.00	0.47	22.54
9	6	10.91	-1.00	0.47	22.44
9	7	12.58	-1.00	0.47	22.36
9	8	13.67	0.00	0.49	22.30
9	9	14.06	0.00	0.55	22.24
9	10	13.72	0.00	0.62	22.12
9	11	12.64	0.00	0.68	21.93
9	12	10.91	0.00	0.72	21.68
9	13	8.60	0.00	0.76	21.40
9	14	5.80	0.00	0.83	21.12
9	15	2.61	1.00	0.92	20.86
9	16	-0.90	1.00	1.01	20.60
9	17	-4.62	1.00	1.08	20.31
9	18	-8.45	1.00	1.11	19.98
9	19	-12.27	1.00	1.07	19.54
9	20	-15.98	1.00	0.91	18.95
9	21	-19.48	1.00	0.60	18.17
9	22	-22.72	1.00	0.04	17.24
9	23	-25.69	1.00	-0.58	16.22
9	24	-28.43	-1.00	-1.16	15.25
9	25	-30.99	-1.00	-1.63	14.41
9	26	-33.41	-1.00	-1.97	13.70
9	27	-35.75	-1.00	-2.19	13.12
9	28	-38.05	-1.00	-2.31	12.63
9	29	-40.33	-1.00	-2.34	12.21
10	1	-4.40	1.00	0.37	22.55
10	2	-1.55	1.00	0.35	22.43
10	3	1.21	1.00	0.35	22.32
10	4	3.83	1.00	0.35	22.21
10	5	6.23	-1.00	0.37	22.12
10	6	8.33	-1.00	0.39	22.05
10	7	10.02	-1.00	0.40	22.01
10	8	11.20	-1.00	0.42	21.97
10	9	11.78	0.00	0.46	21.91
10	10	11.73	0.00	0.55	21.81
10	11	11.05	0.00	0.61	21.63
10	12	9.78	0.00	0.67	21.40
10	13	8.00	0.00	0.72	21.14
10	14	5.77	0.00	0.80	20.88
10	15	3.16	1.00	0.91	20.66
10	16	0.22	1.00	1.00	20.43

... Continue Table 1

10	17	-2.96	1.00	1.09	20.17
10	18	-6.31	1.00	1.12	19.85
10	19	-9.72	1.00	1.11	19.44
10	20	-13.11	1.00	1.00	18.91
10	21	-16.40	1.00	0.75	18.20
10	22	-19.54	1.00	0.23	17.31
10	23	-22.52	1.00	-0.39	16.31
10	24	-25.36	1.00	-0.98	15.34
10	25	-28.06	-1.00	-1.47	14.48
10	26	-30.68	-1.00	-1.83	13.76
10	27	-33.23	-1.00	-2.06	13.17
10	28	-35.74	-1.00	-2.19	12.68
10	29	-38.22	-1.00	-2.23	12.26
11	1	-7.05	1.00	0.16	22.03
11	2	-4.37	1.00	0.13	21.91
11	3	-1.76	-1.00	0.13	21.80
11	4	0.71	-1.00	0.16	21.72
11	5	2.99	-1.00	0.20	21.66
11	6	5.01	-1.00	0.23	21.62
11	7	6.68	-1.00	0.25	21.60
11	8	7.92	-1.00	0.26	21.58
11	9	8.67	-1.00	0.32	21.55
11	10	8.90	0.00	0.43	21.47
11	11	8.62	0.00	0.53	21.33
11	12	7.86	0.00	0.62	21.14
11	13	6.66	0.00	0.71	20.92
11	14	5.06	1.00	0.81	20.71
11	15	3.09	1.00	0.92	20.52
11	16	0.80	1.00	1.02	20.31
11	17	-1.78	1.00	1.08	20.04
11	18	-4.56	1.00	1.12	19.73
11	19	-7.49	1.00	1.13	19.34
11	20	-10.50	1.00	1.06	18.86
11	21	-13.53	1.00	0.86	18.21
11	22	-16.53	1.00	0.38	17.38
11	23	-19.49	1.00	-0.19	16.44
11	24	-22.40	1.00	-0.75	15.50
11	25	-25.24	-1.00	-1.24	14.64
11	26	-28.04	-1.00	-1.61	13.92
11	27	-30.80	-1.00	-1.87	13.31
11	28	-33.52	-1.00	-2.01	12.81
11	29	-36.21	-1.00	-2.06	12.39
12	1	-10.14	1.00	-0.08	21.50
12	2	-7.65	-1.00	-0.11	21.38
12	3	-5.24	-1.00	-0.11	21.28
12	4	-2.96	-1.00	-0.09	21.20
12	5	-0.85	-1.00	-0.04	21.16
12	6	1.04	-1.00	0.00	21.14
12	7	2.65	-1.00	0.03	21.15
12	8	3.92	-1.00	0.06	21.16
12	9	4.81	-1.00	0.14	21.15
12	10	5.31	-1.00	0.29	21.11
12	11	5.43	0.00	0.43	21.02
12	12	5.17	0.00	0.57	20.89
12	13	4.56	1.00	0.69	20.73
12	14	3.62	1.00	0.83	20.57
12	15	2.33	1.00	0.94	20.40
12	16	0.73	1.00	1.02	20.19
12	17	-1.18	1.00	1.07	19.[illegible]
12	18	-3.36	1.00	1.11	19.60
12	19	-5.75	1.00	1.13	19.24
12	20	-8.33	1.00	1.08	18.79
12	21	-11.04	1.00	0.92	18.19
12	22	-13.86	1.00	0.49	17.42
12	23	-16.76	1.00	-0.02	16.55
12	24	-19.70	1.00	-0.54	15.66
12	25	-22.67	-1.00	-0.99	14.85
12	26	-25.63	-1.00	-1.34	14.15
12	27	-28.57	-1.00	-1.61	13.54
12	28	-31.49	-1.00	-1.76	13.03
12	29	-34.37	-1.00	-1.84	12.59
13	1	-13.59	-1.00	-0.29	20.99

... Continue Table 1

13	2	-11.33	-1.00	-0.35	20.86
13	3	-9.15	-1.00	-0.37	20.75
13	4	-7.09	-1.00	-0.35	20.68
13	5	-5.18	-1.00	-0.31	20.65
13	6	-3.45	-1.00	-0.26	20.66
13	7	-1.94	-1.00	-0.21	20.69
13	8	-0.68	-1.00	-0.14	20.72
13	9	0.32	-1.00	-0.03	20.75
13	10	1.05	-1.00	0.15	20.75
13	11	1.53	-1.00	0.33	20.71
13	12	1.75	0.00	0.51	20.64
13	13	1.71	1.00	0.68	20.54
13	14	1.41	1.00	0.83	20.42
13	15	0.82	1.00	0.94	20.25
13	16	-0.08	1.00	1.00	20.03
13	17	-1.29	1.00	1.03	19.75
13	18	-2.82	1.00	1.05	19.43
13	19	-4.63	1.00	1.07	19.08
13	20	-6.73	1.00	1.05	18.66
13	21	-9.09	1.00	0.91	18.10
13	22	-11.68	1.00	0.54	17.40
13	23	-14.47	1.00	0.09	16.60
13	24	-17.42	1.00	-0.35	15.80
13	25	-20.46	1.00	-0.75	15.06
13	26	-23.54	-1.00	-1.08	14.39
13	27	-26.64	-1.00	-1.32	13.81
13	28	-29.73	-1.00	-1.48	13.30
13	29	-32.78	-1.00	-1.57	12.85
14	1	-17.34	-1.00	-0.47	20.52
14	2	-15.32	-1.00	-0.56	20.37
14	3	-13.40	-1.00	-0.60	20.25
14	4	-11.59	-1.00	-0.60	20.18
14	5	-9.91	-1.00	-0.56	20.16
14	6	-8.37	-1.00	-0.50	20.19
14	7	-6.99	-1.00	-0.41	20.25
14	8	-5.77	-1.00	-0.31	20.31
14	9	-4.71	-1.00	-0.18	20.36
14	10	-3.79	-1.00	0.02	20.39
14	11	-3.01	-1.00	0.23	20.39
14	12	-2.36	-1.00	0.44	20.37
14	13	-1.87	-1.00	0.64	20.32
14	14	-1.55	-1.00	0.82	20.24
14	15	-1.47	1.00	0.93	20.08
14	16	-1.67	1.00	0.98	19.85
14	17	-2.18	1.00	0.99	19.56
14	18	-3.03	1.00	0.99	19.24
14	19	-4.24	1.00	0.99	18.89
14	20	-5.82	1.00	0.96	18.48
14	21	-7.79	1.00	0.85	17.95
14	22	-10.12	1.00	0.52	17.30
14	23	-12.77	1.00	0.14	16.58
14	24	-15.66	1.00	-0.23	15.87
14	25	-18.73	1.00	-0.56	15.21
14	26	-21.90	-1.00	-0.83	14.61
14	27	-25.11	-1.00	-1.04	14.07
14	28	-28.32	-1.00	-1.20	13.58
14	29	-31.51	-1.00	-1.30	13.12
15	1	-21.31	-1.00	-0.64	20.07
15	2	-19.56	-1.00	-0.74	19.91
15	3	-17.90	-1.00	-0.80	19.78
15	4	-16.36	-1.00	-0.81	19.71
15	5	-14.92	-1.00	-0.78	19.69
15	6	-13.60	-1.00	-0.70	19.74
15	7	-12.37	-1.00	-0.57	19.84
15	8	-11.24	-1.00	-0.43	19.94
15	9	-10.16	-1.00	-0.27	20.02
15	10	-9.11	-1.00	-0.07	20.07
15	11	-8.08	-1.00	0.14	20.09
15	12	-7.07	1.00	0.37	20.09
15	13	-6.10	1.00	0.60	20.08
15	14	-5.22	1.00	0.78	20.01
15	15	-4.51	1.00	0.90	19.87

... Continue Table 1

15	16	-4.04	1.00	0.94	19.64
15	17	-3.86	1.00	0.94	19.36
15	18	-4.05	1.00	0.91	19.03
15	19	-4.65	1.00	0.89	18.68
15	20	-5.71	1.00	0.86	18.27
15	21	-7.26	1.00	0.74	17.75
15	22	-9.29	1.00	0.45	17.15
15	23	-11.75	1.00	0.12	16.49
15	24	-14.55	1.00	-0.18	15.86
15	25	-17.60	1.00	-0.44	15.28
15	26	-20.79	-1.00	-0.66	14.75
15	27	-24.06	-1.00	-0.83	14.27
15	28	-27.35	-1.00	-0.96	13.81
15	29	-30.62	-1.00	-1.06	13.36
16	1	-25.43	-1.00	-0.75	19.68
16	2	-23.94	-1.00	-0.88	19.50
16	3	-22.56	-1.00	-0.96	19.36
16	4	-21.29	-1.00	-0.99	19.27
16	5	-20.11	-1.00	-0.96	19.25
16	6	-19.01	-1.00	-0.85	19.33
16	7	-17.98	-1.00	-0.68	19.48
16	8	-16.96	-1.00	-0.49	19.64
16	9	-15.91	-1.00	-0.30	19.76
16	10	-14.79	0.00	-0.10	19.81
16	11	-13.57	1.00	0.10	19.83
16	12	-12.25	1.00	0.32	19.83
16	13	-10.87	1.00	0.53	19.81
16	14	-9.49	1.00	0.72	19.75
16	15	-8.21	1.00	0.84	19.63
16	16	-7.12	1.00	0.88	19.42
16	17	-6.32	1.00	0.89	19.16
16	18	-5.88	1.00	0.84	18.83
16	19	-5.90	1.00	0.79	18.46
16	20	-6.45	1.00	0.73	18.04
16	21	-7.58	1.00	0.63	17.54
16	22	-9.29	1.00	0.35	16.96
16	23	-11.52	1.00	0.07	16.36
16	24	-14.17	1.00	-0.19	15.79
16	25	-17.13	1.00	-0.40	15.27
16	26	-20.28	-1.00	-0.56	14.81
16	27	-23.55	-1.00	-0.69	14.38
16	28	-26.85	-1.00	-0.79	13.96
16	29	-30.15	-1.00	-0.88	13.54
17	1	-29.62	-1.00	-0.83	19.34
17	2	-28.40	-1.00	-0.97	19.15
17	3	-27.29	-1.00	-1.07	18.99
17	4	-26.28	-1.00	-1.13	18.87
17	5	-25.36	-1.00	-1.10	18.85
17	6	-24.51	-1.00	-0.97	18.96
17	7	-23.67	-1.00	-0.73	19.19
17	8	-22.80	-1.00	-0.45	19.45
17	9	-21.82	-1.00	-0.24	19.60
17	10	-20.67	1.00	-0.05	19.65
17	11	-19.32	1.00	0.12	19.64
17	12	-17.77	1.00	0.31	19.61
17	13	-16.04	1.00	0.49	19.57
17	14	-14.24	1.00	0.66	19.50
17	15	-12.46	1.00	0.77	19.39
17	16	-10.83	1.00	0.81	19.20
17	17	-9.47	1.00	0.81	18.95
17	18	-8.49	1.00	0.77	18.63
17	19	-7.99	1.00	0.70	18.25
17	20	-8.07	1.00	0.61	17.81
17	21	-8.79	1.00	0.49	17.31
17	22	-10.15	1.00	0.24	16.77
17	23	-12.11	1.00	-0.01	16.21
17	24	-14.56	1.00	-0.21	15.70
17	25	-17.37	1.00	-0.39	15.23
17	26	-20.41	-1.00	-0.52	14.81
17	27	-23.60	-1.00	-0.62	14.41
17	28	-26.86	-1.00	-0.70	14.03
17	29	-30.13	-1.00	-0.77	13.63

... Continue Table 1

18	1	-33.83	-1.00	-0.90	19.06
18	2	-32.85	-1.00	-1.04	18.86
18	3	-31.99	-1.00	-1.16	18.68
18	4	-31.24	-1.00	-1.22	18.55
18	5	-30.57	-1.00	-1.21	18.51
18	6	-29.95	-1.00	-1.06	18.65
18	7	-29.32	-1.00	-0.72	19.00
18	8	-28.61	-1.00	-0.35	19.38
18	9	-27.73	-1.00	-0.10	19.58
18	10	-26.60	1.00	0.06	19.60
18	11	-25.17	1.00	0.19	19.54
18	12	-23.44	1.00	0.32	19.46
18	13	-21.44	1.00	0.47	19.38
18	14	-19.28	1.00	0.60	19.29
18	15	-17.10	1.00	0.67	19.17
18	16	-15.03	1.00	0.71	19.00
18	17	-13.20	1.00	0.69	18.75
18	18	-11.76	1.00	0.65	18.44
18	19	-10.83	1.00	0.58	18.05
18	20	-10.50	1.00	0.47	17.60
18	21	-10.84	1.00	0.36	17.11
18	22	-11.87	1.00	0.12	16.59
18	23	-13.53	1.00	-0.09	16.08
18	24	-15.72	1.00	-0.27	15.60
18	25	-18.31	1.00	-0.42	15.17
18	26	-21.18	-1.00	-0.52	14.78
18	27	-24.23	-1.00	-0.61	14.40
18	28	-27.38	-1.00	-0.68	14.03
18	29	-30.57	-1.00	-0.75	13.65
19	1	-37.98	-1.00	-0.92	18.84
19	2	-37.23	-1.00	-1.06	18.65
19	3	-36.59	-1.00	-1.16	18.47
19	4	-36.07	-1.00	-1.24	18.33
19	5	-35.63	-1.00	-1.23	18.29
19	6	-35.22	-1.00	-1.04	18.48
19	7	-34.79	-1.00	-0.60	18.96
19	8	-34.23	-1.00	-0.12	19.46
19	9	-33.47	1.00	0.12	19.66
19	10	-32.39	1.00	0.22	19.62
19	11	-30.92	1.00	0.29	19.49
19	12	-29.06	1.00	0.37	19.36
19	13	-26.86	1.00	0.46	19.24
19	14	-24.44	1.00	0.55	19.13
19	15	-21.94	1.00	0.59	19.00
19	16	-19.53	1.00	0.59	18.82
19	17	-17.36	1.00	0.58	18.58
19	18	-15.57	1.00	0.55	18.28
19	19	-14.29	1.00	0.46	17.87
19	20	-13.62	1.00	0.35	17.42
19	21	-13.63	1.00	0.24	16.94
19	22	-14.33	1.00	0.02	16.45
19	23	-15.68	1.00	-0.18	15.97
19	24	-17.58	1.00	-0.34	15.52
19	25	-19.91	1.00	-0.46	15.12
19	26	-22.55	-1.00	-0.56	14.74
19	27	-25.41	-1.00	-0.63	14.37
19	28	-28.39	-1.00	-0.70	14.01
19	29	-31.46	-1.00	-0.76	13.64
20	1	-42.03	-1.00	-0.90	18.68
20	2	-41.46	-1.00	-1.01	18.51
20	3	-41.03	-1.00	-1.09	18.36
20	4	-40.69	-1.00	-1.13	18.26
20	5	-40.44	-1.00	-1.09	18.27
20	6	-40.21	-1.00	-0.84	18.53
20	7	-39.94	-1.00	-0.34	19.08
20	8	-39.53	1.00	0.13	19.58
20	9	-38.87	1.00	0.33	19.73
20	10	-37.84	1.00	0.37	19.63
20	11	-36.37	1.00	0.39	19.46
20	12	-34.44	1.00	0.42	19.29
20	13	-32.11	1.00	0.46	19.14
20	14	-29.52	1.00	0.51	19.01

... Continue Table 1

20	15	-26.82	1.00	0.51	18.86
20	16	-24.19	1.00	0.50	18.68
20	17	-21.78	1.00	0.50	18.45
20	18	-19.74	1.00	0.46	18.14
20	19	-18.21	1.00	0.37	17.73
20	20	-17.27	1.00	0.26	17.28
20	21	-17.00	1.00	0.14	16.81
20	22	-17.40	1.00	-0.07	16.34
20	23	-18.44	1.00	-0.25	15.89
20	24	-20.03	1.00	-0.39	15.47
20	25	-22.07	-1.00	-0.51	15.07
20	26	-24.45	-1.00	-0.61	14.69
20	27	-27.07	-1.00	-0.68	14.33
20	28	-29.86	-1.00	-0.74	13.98
20	29	-32.75	-1.00	-0.81	13.61
21	1	-45.92	-1.00	-0.82	18.58
21	2	-45.52	-1.00	-0.91	18.44
21	3	-45.23	-1.00	-0.95	18.34
21	4	-45.05	-1.00	-0.95	18.29
21	5	-44.94	-1.00	-0.85	18.38
21	6	-44.85	-1.00	-0.56	18.69
21	7	-44.69	-1.00	-0.11	19.18
21	8	-44.38	1.00	0.27	19.58
21	9	-43.79	1.00	0.41	19.67
21	10	-42.81	1.00	0.44	19.56
21	11	-41.36	1.00	0.44	19.39
21	12	-39.41	1.00	0.45	19.21
21	13	-37.03	1.00	0.46	19.05
21	14	-34.36	1.00	0.47	18.90
21	15	-31.56	1.00	0.46	18.74
21	16	-28.82	1.00	0.45	18.56
21	17	-26.28	1.00	0.44	18.33
21	18	-24.10	1.00	0.41	18.02
21	19	-22.40	1.00	0.31	17.62
21	20	-21.27	1.00	0.18	17.16
21	21	-20.77	1.00	0.08	16.71
21	22	-20.91	1.00	-0.12	16.26
21	23	-21.66	1.00	-0.29	15.83
21	24	-22.95	1.00	-0.44	15.42
21	25	-24.69	-1.00	-0.56	15.03
21	26	-26.79	-1.00	-0.66	14.66
21	27	-29.16	-1.00	-0.73	14.30
21	28	-31.72	-1.00	-0.80	13.94
21	29	-34.41	-1.00	-0.87	13.57
22	1	-49.63	-1.00	-0.73	18.50
22	2	-49.35	-1.00	-0.77	18.41
22	3	-49.18	-1.00	-0.78	18.35
22	4	-49.10	-1.00	-0.73	18.37
22	5	-49.08	-1.00	-0.59	18.51
22	6	-49.06	-1.00	-0.33	18.79
22	7	-48.98	1.00	0.00	19.16
22	8	-48.71	1.00	0.28	19.44
22	9	-48.17	1.00	0.40	19.51
22	10	-47.22	1.00	0.45	19.43
22	11	-45.79	1.00	0.45	19.27
22	12	-43.87	1.00	0.46	19.11
22	13	-41.51	1.00	0.46	18.95
22	14	-38.85	1.00	0.45	18.79
22	15	-36.06	1.00	0.44	18.63
22	16	-33.30	1.00	0.44	18.46
22	17	-30.73	1.00	0.43	18.23
22	18	-28.50	1.00	0.39	17.93
22	19	-26.71	1.00	0.28	17.53
22	20	-25.45	1.00	0.15	17.08
22	21	-24.77	1.00	0.04	16.63
22	22	-24.69	1.00	-0.15	16.20
22	23	-25.18	1.00	-0.32	15.78
22	24	-26.20	1.00	-0.47	15.38
22	25	-27.65	-1.00	-0.59	15.00
22	26	-29.47	-1.00	-0.71	14.62
22	27	-31.58	-1.00	-0.79	14.26
22	28	-33.91	-1.00	-0.86	13.90

... Continue Table 1

22	29	-36.39	-1.00	-0.93	13.53
23	1	-53.15	-1.00	-0.61	18.45
23	2	-52.94	-1.00	-0.63	18.39
23	3	-52.84	-1.00	-0.61	18.38
23	4	-52.82	-1.00	-0.54	18.43
23	5	-52.85	-1.00	-0.40	18.57
23	6	-52.86	-1.00	-0.19	18.80
23	7	-52.78	1.00	0.05	19.06
23	8	-52.53	1.00	0.24	19.25
23	9	-51.98	1.00	0.35	19.31
23	10	-51.05	1.00	0.41	19.25
23	11	-49.65	1.00	0.43	19.13
23	12	-47.79	1.00	0.44	18.98
23	13	-45.51	1.00	0.44	18.83
23	14	-42.95	1.00	0.44	18.68
23	15	-40.24	1.00	0.44	18.53
23	16	-37.55	1.00	0.43	18.35
23	17	-35.03	1.00	0.43	18.14
23	18	-32.81	1.00	0.39	17.85
23	19	-31.00	1.00	0.29	17.47
23	20	-29.67	1.00	0.16	17.02
23	21	-28.87	1.00	0.04	16.58
23	22	-28.61	1.00	-0.16	16.15
23	23	-28.89	1.00	-0.33	15.74
23	24	-29.66	1.00	-0.48	15.35
23	25	-30.86	-1.00	-0.63	14.96
23	26	-32.42	-1.00	-0.74	14.59
23	27	-34.27	-1.00	-0.84	14.22
23	28	-36.36	-1.00	-0.92	13.86
23	29	-38.62	-1.00	-0.98	13.50
24	1	-56.46	-1.00	-0.52	18.40
24	2	-56.30	-1.00	-0.51	18.37
24	3	-56.23	-1.00	-0.47	18.38
24	4	-56.23	-1.00	-0.39	18.44
24	5	-56.25	-1.00	-0.26	18.57
24	6	-56.25	1.00	-0.10	18.75
24	7	-56.15	1.00	0.06	18.93
24	8	-55.86	1.00	0.19	19.06
24	9	-55.30	1.00	0.28	19.10
24	10	-54.36	1.00	0.35	19.06
24	11	-53.01	1.00	0.38	18.96
24	12	-51.23	1.00	0.42	18.84
24	13	-49.07	1.00	0.43	18.70
24	14	-46.65	1.00	0.43	18.56
24	15	-44.08	1.00	0.43	18.41
24	16	-41.53	1.00	0.43	18.25
24	17	-39.12	1.00	0.42	18.04
24	18	-36.97	1.00	0.39	17.77
24	19	-35.19	1.00	0.30	17.41
24	20	-33.83	1.00	0.18	16.98
24	21	-32.96	1.00	0.07	16.54
24	22	-32.58	1.00	-0.14	16.11
24	23	-32.68	1.00	-0.32	15.71
24	24	-33.24	1.00	-0.48	15.32
24	25	-34.21	-1.00	-0.62	14.94
24	26	-35.53	-1.00	-0.76	14.56
24	27	-37.15	-1.00	-0.86	14.19
24	28	-39.02	-1.00	-0.95	13.83
24	29	-41.07	-1.00	-1.03	13.46
25	1	-59.57	-1.00	-0.44	18.35
25	2	-59.43	-1.00	-0.43	18.33
25	3	-59.36	-1.00	-0.37	18.36
25	4	-59.35	-1.00	-0.28	18.42
25	5	-59.34	-1.00	-0.17	18.53
25	6	-59.29	1.00	-0.06	18.66
25	7	-59.13	1.00	0.05	18.79
25	8	-58.79	1.00	0.13	18.88
25	9	-58.19	1.00	0.19	18.90
25	10	-57.26	1.00	0.27	18.87
25	11	-55.95	1.00	0.32	18.79
25	12	-54.27	1.00	0.37	18.68
25	13	-52.25	1.00	0.41	18.57

... Continue Table 1

25	14	-50.00	1.00	0.42	18.44
25	15	-47.62	1.00	0.43	18.30
25	16	-45.24	1.00	0.42	18.14
25	17	-42.97	1.00	0.41	17.94
25	18	-40.94	1.00	0.39	17.69
25	19	-39.22	1.00	0.32	17.35
25	20	-37.88	1.00	0.21	16.94
25	21	-36.97	1.00	0.10	16.51
25	22	-36.50	1.00	-0.10	16.09
25	23	-36.48	1.00	-0.29	15.68
25	24	-36.87	1.00	-0.46	15.29
25	25	-37.64	-1.00	-0.62	14.91
25	26	-38.76	-1.00	-0.76	14.53
25	27	-40.17	-1.00	-0.87	14.16
25	28	-41.82	-1.00	-0.97	13.79
25	29	-43.67	-1.00	-1.04	13.43

CONCLUSIONS

Before forming conclusions, it is necessary to remark that in this paper we used data which have been collected up to date. All relevant geophysical, geological and geodetic data have been made for different purposes, not for investigation of recent crustal movement.

In that case, it is important to organize further measuring compaignes which will provide more necessary data. However, the correlation coefficients derived from existing gravimetric and levelling values, show that between these parameters a natural connection exists. This conclusion proved some earlier reports from this area (Joo, 1990).

A weak correlation between tectonic and levelling data, shows that there was not enough relevant geophysical and geological data.

On the base of new measuring data, we expect that the investigated correlation between different geological, geophysical and geodetic data will be proved.

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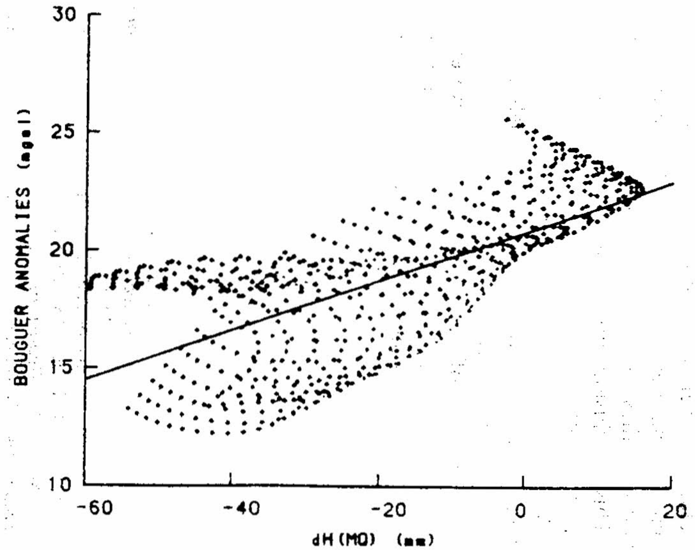

Fig. 6. Regression of bouguer anomalies on dH (MQ)

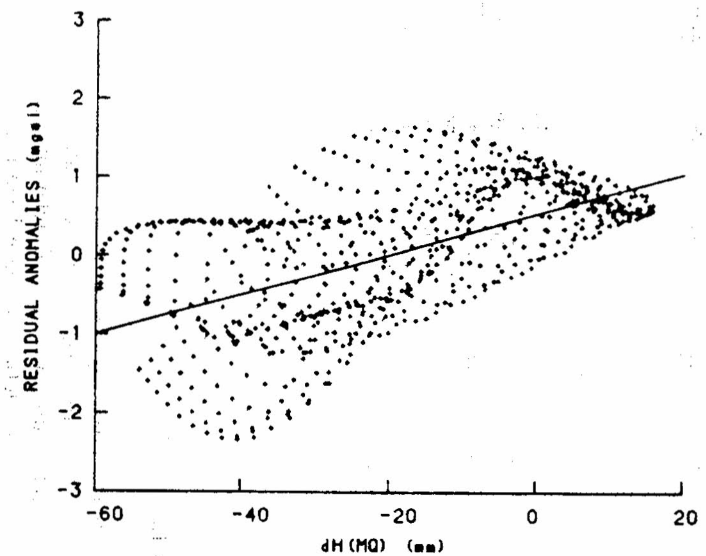

Fig. 7. Regression of residual anomalies on dH (MQ)

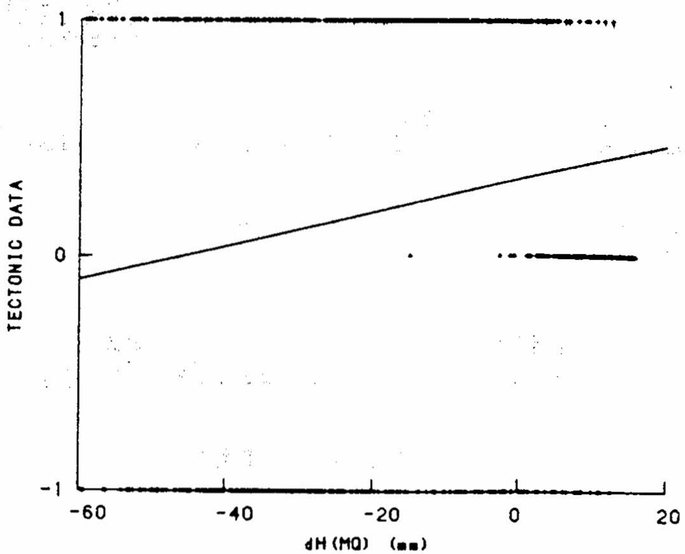

Fig. 8. Regression of tectonic data on dH (MQ)

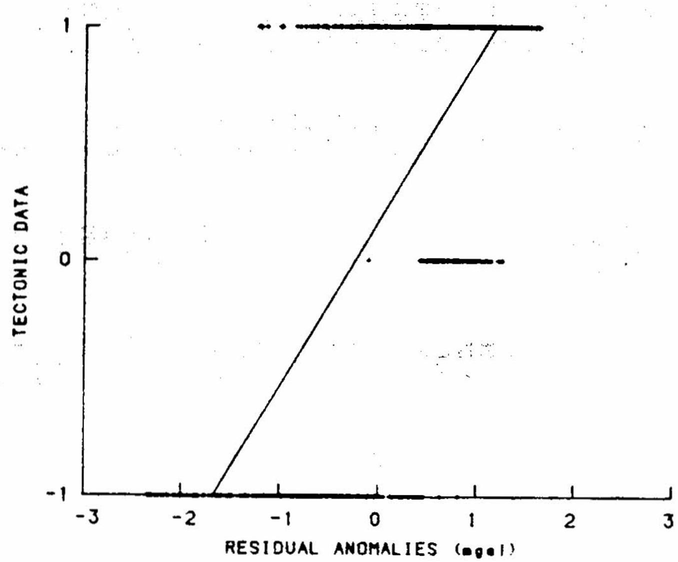

Fig. 9. Regression of tectonic data on residual anomalies

КОРЕЛАЦИЈА ИЗМЕЂУ ВЕРТИКАЛНОГ КРЕТАЊА И ГЕОЛОШКИХ ОБЛИКА НА БЕОГРАДСКОМ ПОДРУЧЈУ

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УДК 528.45
Претходно саопштење

У раду је разматрана међусобна зависност геолошких, геофизичких и геодетских параметара са аспекта праћења вертикалног померања Земљине коре на подручју Београда.

На испитиваном простору нису извођена наведена испитивања специјално за праћење померања Земљине коре. И поред веома оскудног мерног материјала, потврђена је међусобна зависност појединих параметара, изражена кроз њихове корелационе коефицијенте.

Bull. Obs. Astron. Belgrade N^o 144 (1991), 113–119.

UDC 528.422
Preliminary report

DETERMINATION OF THE BENCHMARK HEIGHT CHANGES IN LEVELLING NETWORK BELGRADE DURING THE PERIOD 1930–1959.

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SUMMARY: The paper shows some preliminary results of the investigations of the benchmark height changes in the Belgrade levelling network. The results of the reobserved levelling network are compared, analysed and included into the adjustment. A graphycal presentation is obtained and three main locations with significant sinking relative to the center of the network are outlined. In order to help the understanding of the processes which take part in the Belgrade area, the trend of benchmark movements resulted from multiquadric analysis is presented. In our opinion it is possible to compare these data with other geophysical informations.

1. INTRODUCTION

The rapid development of the urban areas continously introduces new requirements for geodetic networks, methods and procedures. A very good solution, concerning surveying and increased engineering demands was developed during the sixties (Jovanović, 1963; Činklović, 1968; Bratuljević and Mrkić, 1984) through the concept of city networks with high network density in the core of the city area, decreasing outwards. Resurveying of these networks was a good oportunity not only for the points positions control, but also for obtaining the results which, under certain assumptions, can serve as a source for a geodynamical investigation of the area under consideration.

There were two major levelling campaigns in Belgrade during the last century. The assumption on benchmarks height changes is based on the urban development as well as on the morphological and geological properties of this location. Many engineering objects which were built in this century, but also a hard damage during the last war, have certainly influenced the vertical position of the benchmarks. Two rivers in the vicinity, as well as many little fault lines show that the surface of the Belgrade location was influenced by artificial and natural geodynamical processes. Accordingly, investigation of the height changes can contribute to the recent crustal movements studies of this area.

This paper shows some preliminary results of the investigations of benchmarks movements, in order to help recognizing of the processes which take part in the area of Belgrade. These results were partly included in the project named „Multidisciplinary investigation of the mean Belgrade latitude changes" which was carried out in cooperation with the Astronomical Observatory in Belgrade and a number of geo-scientists.

2. LEVELLING CAMPAIGNS IN BELGRADE

The first levelling campaign in the northern part of Belgrade was carried out in the begining of this century by surveyers of Austria–Hungary. Those works were prepared in order to connect some parts of the Austria–Hungary levelling network across the river of Danube. After World War I, a levelling network was established in Belgrade by monumentating 1680 benchmarks mostly in buildings. The measurements were carried out from 1929 to 1932. Old levelling instruments Otto Fennel were used, as well as wooden rods with graduation on both sides. The network was divided into the first and the second order and consisted of levelling lines forming closed loops. In total 1771 height differences were measured forward and backward. The average lenght of the levelled segments was 278 m. Unfortunately, a part of the documentation was destroyed during the war, so there is no original scheme of the network. The configuration of this network was reconstructed by the aid of the benchmark's numbers common to the latter campaign. During the investigation we have joined epoch 1930 to this network.

After the last war, the damaged network was partly reconstructed and enlarged. Preserved benchmarks from epoch 1930 were used in designing the new levelling network. Measurements were carried out from 1957 to 1960, by using instruments provided by planparalel plates and invar strip rods with double graduation. Compared to the measurements carried out in 1930, the station procedure was somewhat different, but every height difference was also measured forward and backward. The new levelling network had 2594 benchmarks and 2708 height differences on the average lenght of 244 m. We decided to join epoch 1959 to this network. After this campaign, the network was allways enlarged in order to provide a basis for surveying and planning, but a complete reobservation of the entire network was not carried out.

The levelling concepts and obtained data for the Belgrade area were very heterogeneous in the past 70 years. Different instruments, methods and procedures were used. Gravimetric measurements which are necessary to account nonparalelism of the equipotential surfaces did not take place in the levelling campaigns. However, the accuracy achieved is almost comparable with modern surveying demands.

3. DETERMINATION OF THE BENCHMARK HEIGHT CHANGES FROM 1930 TO 1959

3.1. Data

The basic quantities for this kind of investigation are the height differences common for both epochs. Before they were included in mathematical models, analysis and accuracy estimation had been carried out.

The levelling discrepances ρ from double levelling were tested in each epoch. It was found out that there was no significant constant systematic error in the measurements. Due to the fact that random errors prevail in measurements, it was decided to homogenize the differences ρ by use of the formula:

$$z_i = \rho_i / \sqrt{R_i}$$

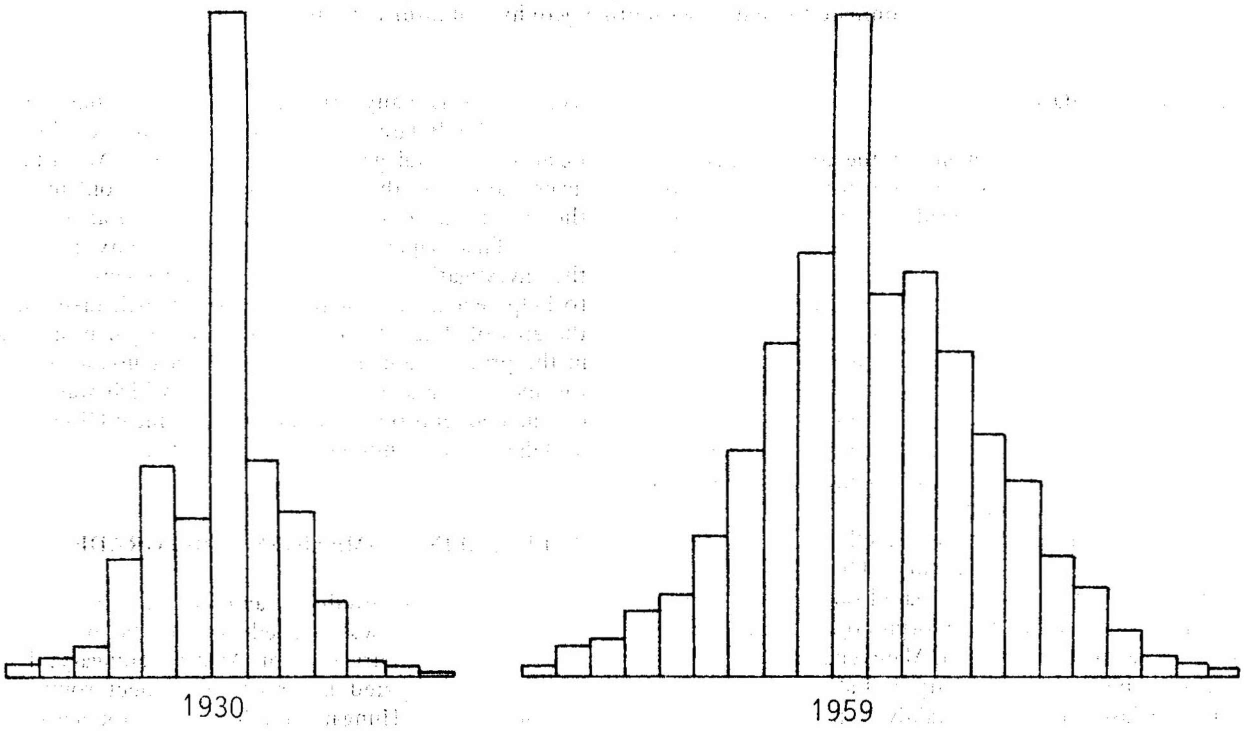

Figure 1. Frequency histogram of z

where ρ_i is in [mm], R_i are corresponding lenghts in [km]. Figure 1. shows the frequency histogram of quantities z in both epochs.

It can be seen that there is a great number of small values of z in both epochs. It is well known that levelling errors do not obey the normal distribution because of various systematic influences. Rejecting the hypothesis which assumes normality, was an expected result (Table 1.).

Table 1.

Epoch	Chi–square	f	Rejected
1930	486.8	9	yes
1959	96.7	18	yes

Rejecting the outliers and applying the formulae:

$$\hat{\sigma}_0 = \sqrt{\frac{1}{4n} \sum_1^n \frac{\rho_i^2}{R_i}}$$

the accuracy of 1 km double levelling was obtained for both epochs:

$$\hat{\sigma}_0 (1930) = 1.60 \text{ mm}/\sqrt{\text{km}}$$

$$\hat{\sigma}_0 (1959) = 0.79 \text{ mm}/\sqrt{\text{km}}$$

These estimations have more than 1000 degrees of freedom, so they can be considered as very reliable. Further, on the basis of the loop misclosures (10 for epoch 1930, and 20 for epoch 1959) by the aid of formulae:

$$\hat{\sigma}_0 = \sqrt{\frac{1}{n} \sum_1^n \frac{\varphi_i^2}{F_i}}$$

where φ_i is the misclosure in [mm], and F_i perimeter in [km] we obtained:

$$\hat{\sigma}_0 (1930) = 1.38 \text{ mm}/\sqrt{\text{km}}$$

$$\hat{\sigma}_0 (1959) = 0.80 \text{ mm}/\sqrt{\text{km}}$$

referring to the measurements which belong to the first order part of the network. It can be seen that the accuracy in both epochs can not be compared to each other. To justify the application of mathematical models, the differences between the common height differences and the coresponding variances were calculated:

$$dh_i = \Delta h_i (1959) - \Delta h_i (1930)$$

$$\hat{\sigma}_i^2 = [\hat{\sigma}_0^2 (1930) + \hat{\sigma}_0^2 (1959)] R_i = 3.2 R_i$$

The significance was accepted for all differences dh_i which have fullfilled the condition:

$$dh_i > 1.96 \hat{\sigma}_i$$

Since there was 88% of significent differences dh we concluded that height changes of benchmarks have to be determined.

3.2. Models

The usual way for determination of benchmark height changes is adjustment of levelling networks for both epochs and comparing the obtained heights. In order to prepare such an adjustment, we had to form both networks from available scattered levelling segments. Generalized configuration of both networks as well as common levelling lines can be seen on Figure 2. The adjustment of each epoch was carried out by the aid of functional and stochastical model which, in the case of real measurements, take form:

$$\vartheta = A\hat{x} - 1$$

$$K_l = \hat{\sigma}_0^2 P^{-1}$$

where ϑ is the vector of corrections, A is the design matrix of known coefficients, $\hat{x}$ is the vector of unknown heights, 1 is the vector of measured height differences, σ_0 is the variance factor, P is the weight diagonal matrix with reciprocal of the segment lenghts and K_l is the variance-covariance matrix. Applying the minimum norm condition, following results can be obtained:

$$\hat{x} = (A^T PA)^{-1} A^T Pl$$

$$\hat{\sigma}_0^2 = \vartheta^T P \vartheta / f$$

$$K_x = \hat{\sigma}_0^2 (A^T PA)^{-1}$$

where f is the degree of freedom (redundance), and K_x is the variance covariance matrix whose elements represent the variances of obtained heights. The adjustment procedure have involved nodal benchmarks only. The heights for the rest were obtained trought the condition adjustment between nodal points. Some results are shown in Table 2.

Table 2.

Epoch	u	n	$\hat{\sigma}_0$	f
1930	166	235	1.88mm/km	70
1959	155	245	1.20mm/km	91

u – the number of benchmarks
n – the number of measurements

During the adjustment procedure, the height of the benchmark R–302 was held fixed in order to avoid singularity. The largest height variance relative to the point R–302 placed in the central part of the network,

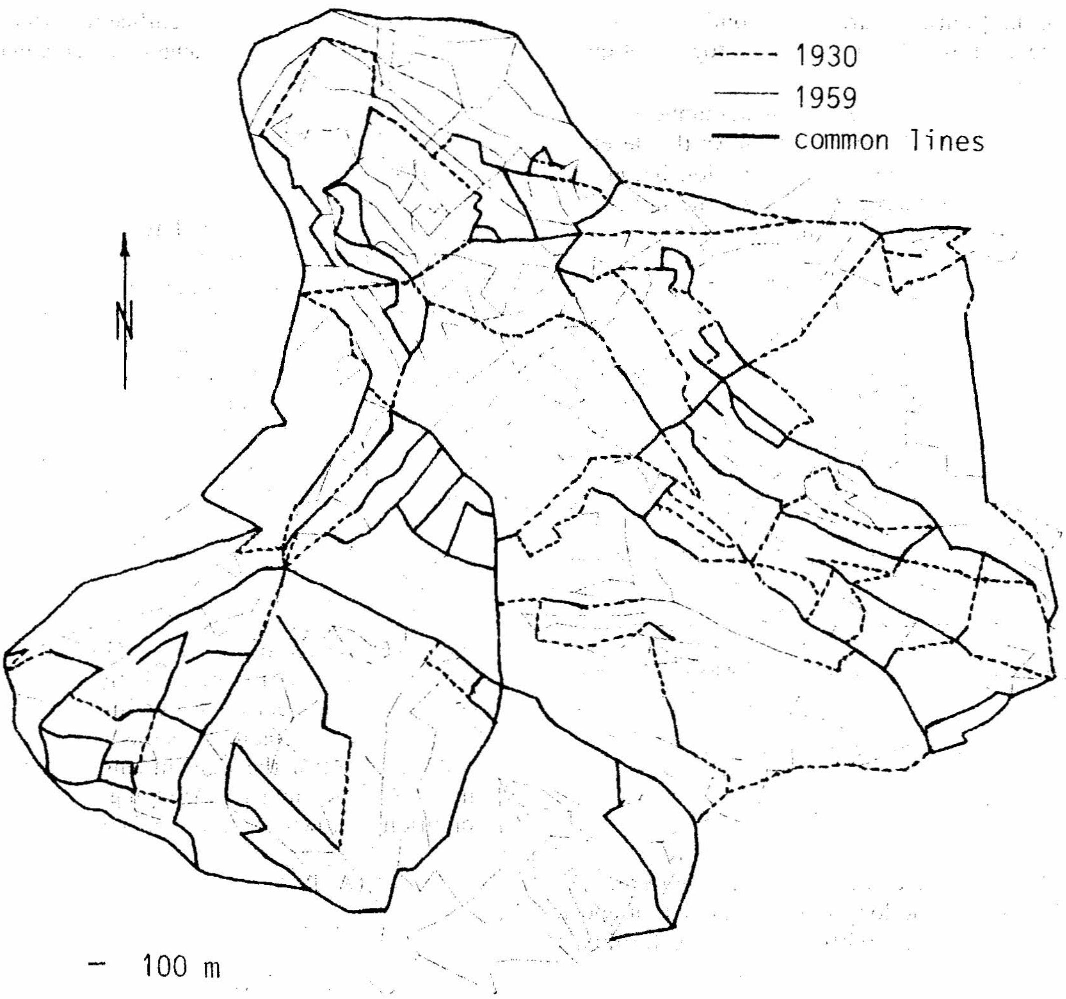

Figure 2. Configuration of networks

was 3.4mm for the epoch 1930 and 2.4mm for the epoch 1959. Differences and variances:

$$\Delta_i = H_i\,(1959) - H_i(1930)$$

$$\hat{\sigma}_i^2 = \hat{\sigma}_H^2\,(1959) + \hat{\sigma}_H^2\,(1930)$$

were used to represent graphically the movement of benchmarks and movement variances in the form of isolines (Figure 3.)

In order to employ over 700 scattered height differences common for both epochs, we decided to apply another model. According to Holdahl and Hardy (1970), the vertical movement of the benchmarks can be considered as a function of position and therefore modelled as:

$$dH_i(x,y) = \sum_{j=1}^{m} c_j\,[(x_i - x_j)^2 + (y_i - y_j)^2 + D^2]^{0.5}$$

where x_i, y_i represent the plane coordinates in a suitable coordinate system, x_j, y_j are the known coordinates of so-called MQ nodal points, D is the the geometrical parameter which controls the shape of the hyperboloid used, and C_j are the unknown parameters. MQ nodal points have to be placed in points where the most height informations are available. Regarding the differences between the height differences measured in both epochs as horizontal gradients of dH the unknown parameters C_j can be determined by means of the least-squares method. Results of such determinations are listed in Table 3.

During this procedure the height change of the point R–302 was assumed to be zero. The accuracy estimation was carried out by the aid of the law of error propagation. Using again the isolines similar to those in Figure 3. the obtained results and the graphical presentation are shown in Figure 4.

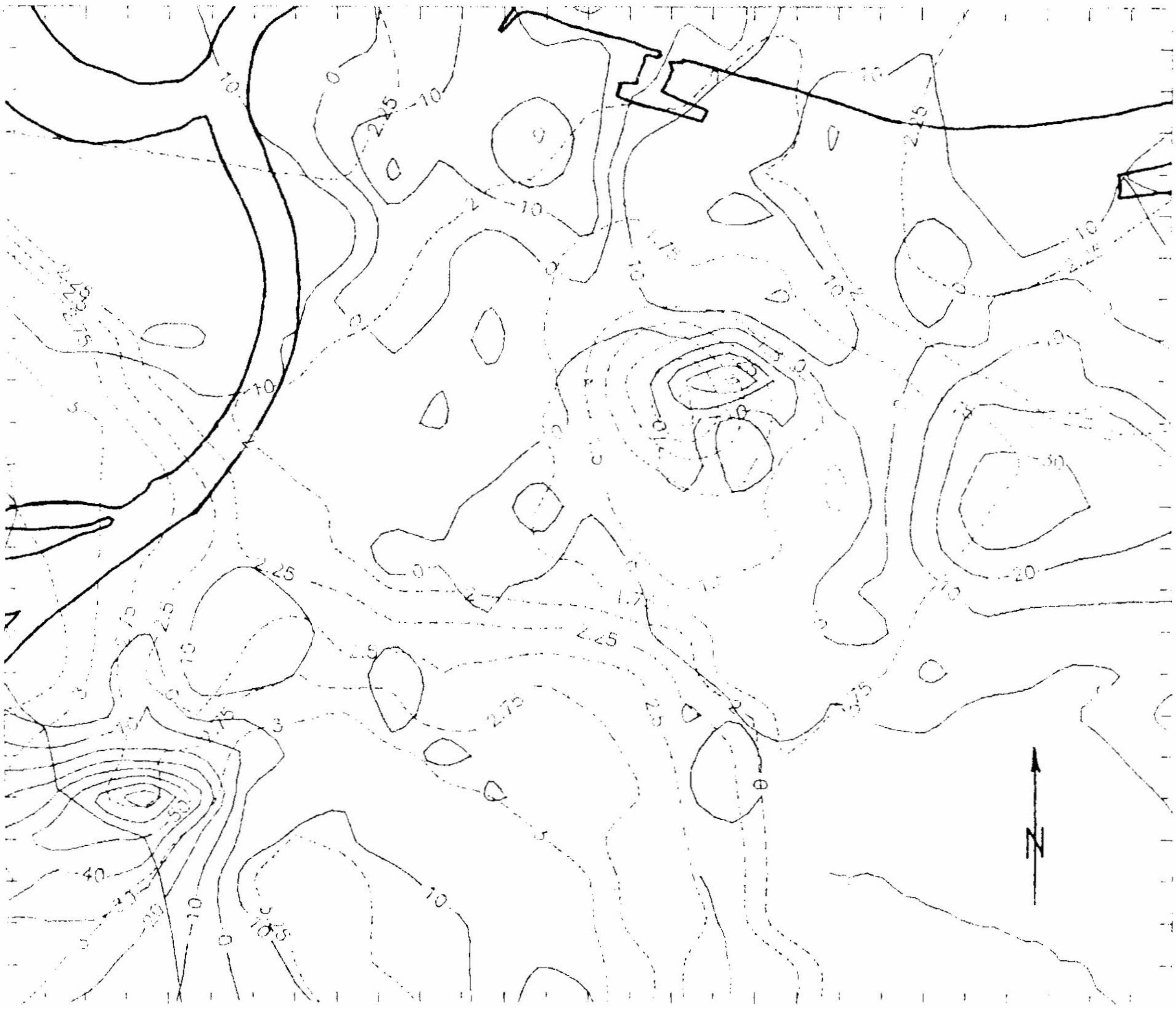

Figure 3. Isolines of benchmark movements (solid lines) and variances (dashed lines). Dimensions in [mm]

Table 3.

j	$\hat{C}_j$	$\hat{\sigma}_j$	$\hat{C}_j/\hat{\sigma}_j$
1	+24.92	10.14	2.46
2	−10.36	15.13	0.68
3	+23.26	11.71	1.99
4	−24.82	13.41	1.85
5	−22.32	17.94	1.24

3.3. Discussion

Regarding Figure 3. it can be seen that there are significant benchmark movements in the range from +10mm to − 50mm relative to the benchmark R−302 placed at the center of the network. Three locations with evident sinking can be outlined. The area of Kalemegdan and partly that of Stari Grad have changed their heights for the amount of −10mm to −20mm. On the location of Vracar, the benchmarks have changed their heights for about −30mm. The most significant sinking was recorded on Topcidersko Brdo and reaches some −50mm. The rest of the network did not move vertically. Some parts slightly raised for +10mm.

On the other side, there is a certain degree of agreement between Figures 3. and 4. In our opinion, the trend shown in Figure 4. is more appropriate for the investigations of the correlation with other geophysical data.

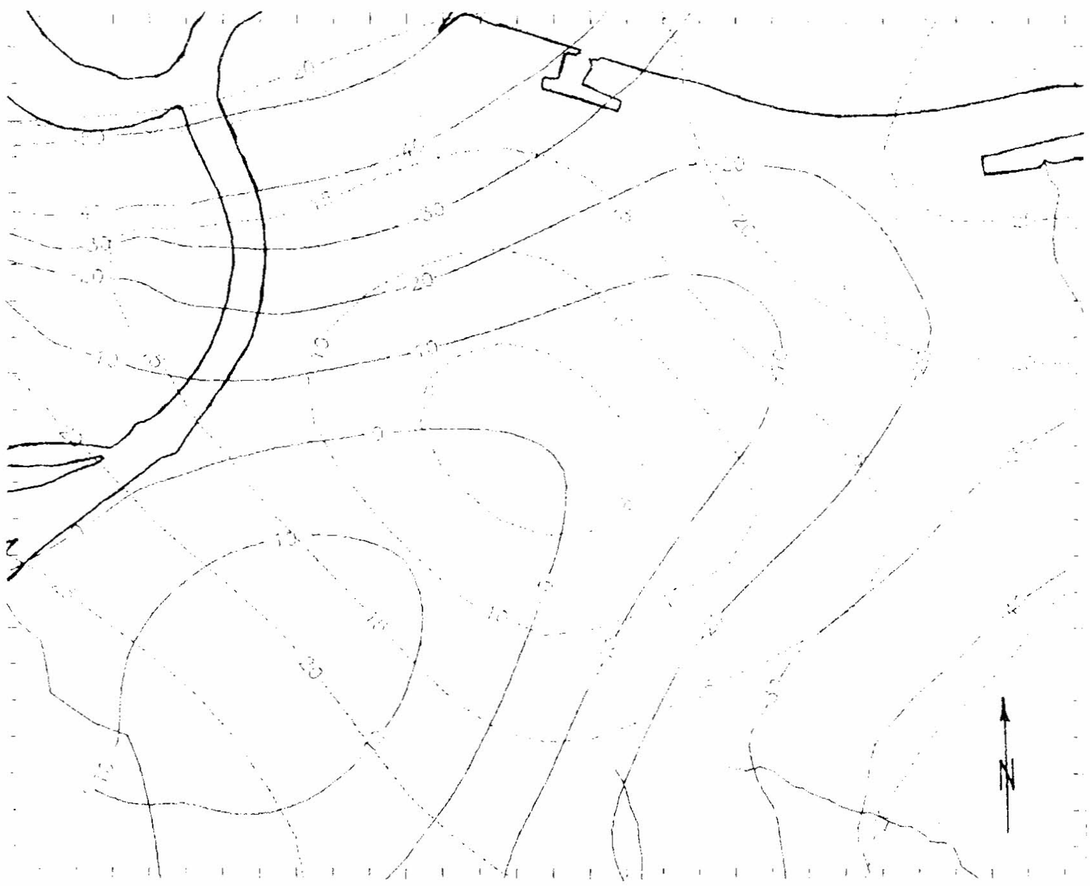

Figure 4. Isolines of benchmark movements (solid lines) and variances (dashed lines). Dimensions in [mm]

4. CONCLUSIONS

There was a significant change in the benchmark heights of the Belgrade levelling network during the period from 1930 to 1959. Assuming linear movements it can be said that the velocity of the benchmarks varied between +0.3mm per year and −1.7mm per year relative to the center of the network. However these velocities can not be refered to the crust because of many nontectonical influences. A general tendency of the Belgrade location is sinking relative to the central part of the area.

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DETERMINATION OF THE BENCHMARK HEIGHT CHANGES IN LEVELLING NETWORK BELGRADE DURING THE PERIOD 1930–1959.

ОДРЕЂИВАЊЕ ПРОМЕНА ВИСИНА РЕПЕРА У НИВЕЛМАНСКОЈ МРЕЖИ БЕОГРАДА ЗА ПЕРИОД 1930–1959 ГОДИНЕ

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УДК. 528.422

Претходно саопштење

Рад приказује прелиминарне резултате истраживања промена висина репера у градској нивелманској мрежи Београда. Резултати поновно нивелане мреже су упоређени, анализирани и укључени у изравнање. Дата је графичка представа и издвојене три главне локације са значајним слегањем у односу на средиште мреже. У циљу бољег разумевања процеса који се одигравају на подручју Београда, представљен је и тренд померања репера добијен тзв. мултиквадратном анализом. По нашем мишљењу, ове је податке могуће упоређивати са осталим геофизичким резултатима.

Bull. Obs. Astron. Belgrade N^{O} 144 (1991), 121–124

UDC 528.232.21
Preliminary report

ENGINEERING GEOLOGICAL ASPECTS OF CHANGES IN BELGRADE MEAN LATITUDES

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(Received: April 4, 1991)

SUMMARY: Engineering geological investigations were carried out under the „Multidisciplinary Study of Changes in Belgrade Mean Latitudes". The departing point for engineering geological investigation was the principal assumption that changes in latitudes result from the recent geological processes. To corroborate the assumption, relevant investigations were carried out, and available data analysed. The establishment of and observation network in landslides was the main work.

1. INTRODUCTION

The engineering geological investigations under the above study have been planned and carried out for elucidation of the part of all engineering geological conditions in changes of the relief, and consequently in mean latitudes.

The investigations consisted of the following:

- compilation and interpretation of available data;
- engineering geological reconnaissance and survey in field;
- observation of process development in selected typical landforms, and
- consideration and synthesis of data.

This paper is a summary of the past engineering geological investigation results.

2. BASIC APPROACH TO INVESTIGATIONS

The investigation area was the township of Belgrade and its general area. The reported engineering geological investigations covered the following:

– recognition of recent geological processes and occurrences, especially landslides, responsible for changes in the relief and reflected on changes in latitude;

– establishing causal relationship of all influential factors on changes in the relief, particularly between exogenic and endogenic processes and phenomena;

– establishing the effects of sheet and linear erosion processes on the formation of microrelief forms; and

– establishing the landslide processes by observation of the amounts and rates of their progress.

The engineering geological investigations of the earlier stages were based on compiling data, selecting occurrences for observation, and partly monitoring the sliding rates at selected occurrences.

Zones of observation were selected where the geotectonic interpretation indicated major dislocations involving landslides. In some of the zones, the engineering geological survey was parallelled with hydrogeological investigation, for a better study of the area.

Besides observations in the newly set network of observation points in selected landslides, for interpretation the use was made of earlier records on landslides: in Duboko, on the Sava slope, in Kotež Neimar,

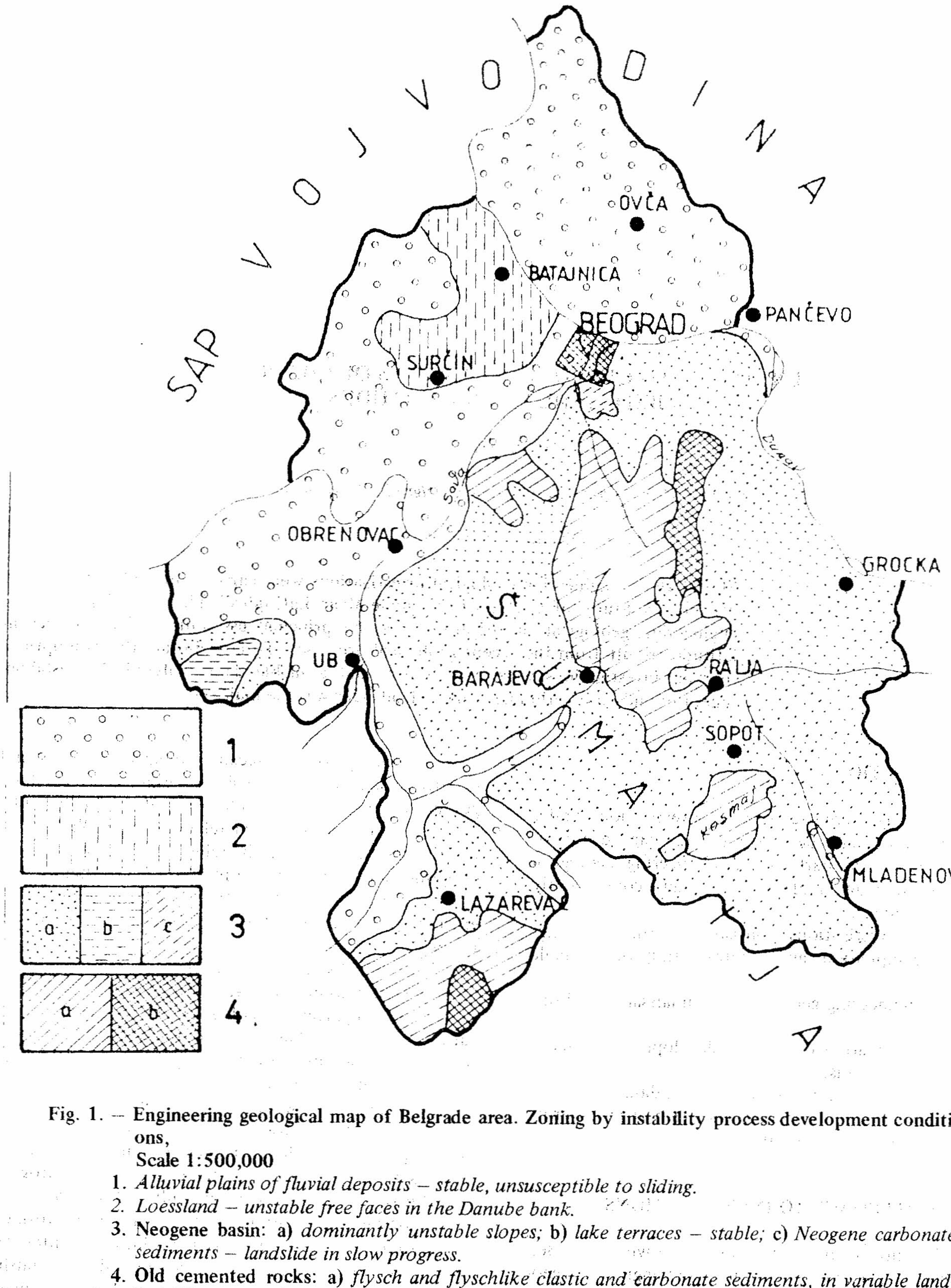

Fig. 1. – **Engineering geological map of Belgrade area. Zoning by instability process development conditions,**
Scale 1:500,000

1. *Alluvial plains of fluvial deposits – stable, unsusceptible to sliding.*
2. *Loessland – unstable free faces in the Danube bank.*
3. **Neogene basin:** **a)** *dominantly unstable slopes;* **b)** *lake terraces – stable;* **c)** *Neogene carbonate sediments – landslide in slow progress.*
4. **Old cemented rocks:** **a)** *flysch and flyschlike clastic and carbonate sediments, in variable landsliding process;* **b)** *magmatic rocks and serpentinite – small rockslide and debris slide.*

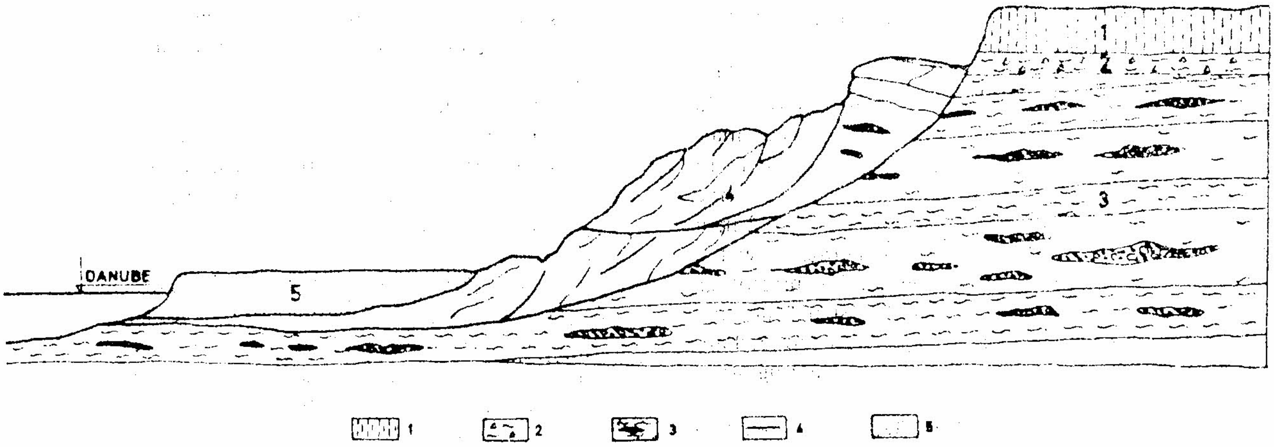

Figure 2. **Landslide at Čortanovci (schematic section according to M.T. Luković)** 1 – *loess;* 2 – *deluvial crumpling clay;* 3 – *Plioceneous sandy clay and clayey sand with fine sand lenses;* 4 – *sliding body;* 5 – *alluvial mud-sand terrace.*

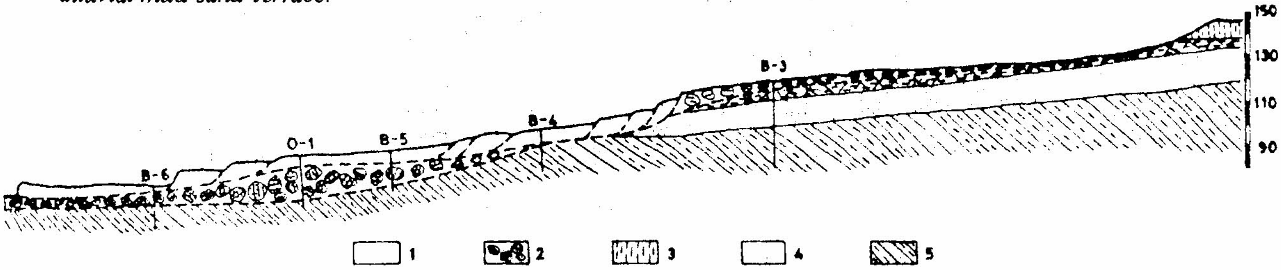

Figure 3. **Vinča landslide:** 1 – *the main scarf;* 2 – *loess;* 3 – *Plioceneous sand;* 4 – *Miocenous shale;* 5 – *exploration boreholes;* 6 – *exploration shaft.*

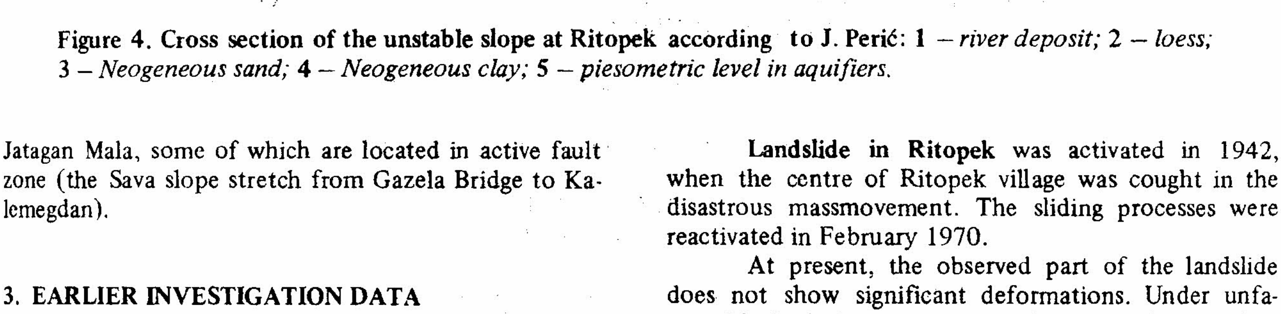

Figure 4. **Cross section of the unstable slope at Ritopek according to J. Perić:** 1 – *river deposit;* 2 – *loess;* 3 – *Neogeneous sand;* 4 – *Neogeneous clay;* 5 – *piesometric level in aquifiers.*

Jatagan Mala, some of which are located in active fault zone (the Sava slope stretch from Gazela Bridge to Kalemegdan).

3. EARLIER INVESTIGATION DATA

Consideration of the available data was supported by additional observations of landslide processes in selected landforms: Ritopek, Umka, Barič, and Mislodin.

Landslide in Ritopek was activated in 1942, when the centre of Ritopek village was cought in the disastrous massmovement. The sliding processes were reactivated in February 1970.

At present, the observed part of the landslide does not show significant deformations. Under unfavourable hydrologic conditions, however, the landslide is likely to be reactivated in some zones. Significant landslides are a cyclic event, every 28–30 years. Massmovement land forms and processes involving the downslope transport, like those in Ritopek, are developed alongside the right Danube bank, in village areas of Vinča, Višnjica, and Karaburma.

Landslides in Umka cover the landforms of the immediate right Sava slope, in the sloping part of the Umka town. The landform developed in altered marl-clay complex, 5 to 20 m deep, resulting in many secondary deformations. Along the Sava bank, large fractures showed exceeding 800 m in length and 1–2 m in level difference. The deformation can launch new massmovements during the next unfavourable hydrologic cycles and variations in the Sava level. Significant landslides are also expected in the upper slope zone. Land deformations are daily, noted on the engineering structures.

Landslides in Barič and Mislođin were reactivated in 1976, after the Bucarest earthquake, and during the extremely wet period and spring floods of 1981. Massmovement processes are recurring, resulting in new fractures and various microrelief landforms. Future deformations in the slopes of high intensity are expected in new landforms: notable massmovement down the slope and delevelling in the least stable sections, such as Golo Brdo slope overlooking Barič collony and directly over the Kolubara river.

4. DISCUSSION

The described observations on landslides, which directly involve changes in the landforms, are based on our observations and available records. However, because the records are not uniform in distribution and cover a short period of observation, the data are not reliable.

Field investigations were used to study the geology of the area, as an important factor of deformation processes. For a complete geodynamic study, more records are required of external and internal force effects on all components of the geologic structure for a sufficiently long period.

Future investigations will follow the adopted scheme, and the planned methods will be used.

Results of complete engineering geological investigation will provide *the engineering geological data base* for consideration of all factors responsible for relief modification, primarily those leading to land erosion and sliding.

The observation of landslide processes is planned to be extended to a larger area to cover different environments and natural conditions contribution to the deformation processes.

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ИНЖЕЊЕРСКОГЕОЛОШКИ АСПЕКТИ ПРОМЕНА СРЕДЊИХ ГЕОГРАФСКИХ ШИРИНА У ПОДРУЧЈУ БЕОГРАДА

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УДК 528.232.21

Претходно саопштење

Инжењерскогеолошка истраживања изведена су у оквиру студије „Мултидисциплинарна изучавања промена средњих географских ширина на подручју Београда". При инжењерскогеолошком изучавању пошло се од основне поставке да су промене географских ширина последица деловања и савремених геолошких процеса. У циљу потврђивања ове поставке изведена су одговарајућа истраживања, уз анализу података из постојеће документације. Успостављање осматрачке мреже на клизиштима представља основну врсту посла за решавање наведеног проблема.

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UDC 528.475
Preliminary report

HYDROGEOLOGIC BASE FOR THE STUDY OF CHANGES IN BELGRADE MEAN LATITUDES

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SUMMARY: The present development stage of the complex geodynamic investigations and predictions of earthquakes, as particularly notable phenomena of movement mechanisms within the Earth's crust, is characterized, among others, by the acceptance of the hydrogeoseismological method and its ample use in many seismic active regions of the globe. The feasible devlelopment of a hydrogeological data base for the study of the geodynamics, or the changes in Belgrade mean latitudes is considered.

1. INTRODUCTION

The geodynamic investigations and prediction of earthquakes, very important for an objective interpretation of changes in the mean latitudes of a territory, has long dwelled only on monitoring the Earth's crust movements and seismic activities, before acquiring in the last thirty years a multidisciplinary approach. The neotectonic geodynamics is based at present on all relevant data: seismological and engineering geological characteristics, geophysical parameters, repeated levelling results, astronomical control of terrestrial movements, modifications in chemical and gaseous compositions of ground water, etc. The modern development stage of complex geodynamic investigations and predictions of earthquakes, as particularly notable phenomena among the Earth's crust movement mechanisms, is characterized, inter alia, by the acceptance of the *hydrogeo-seismic method* and its ample use in many seismically active regions of the world.

The work under the „Multidisciplinary Study of the Changes in Belgrade Mean Latitudes" Project, during 1989 and 1990, has shown an abundance of hydrogeological information, of interest for the Project, but also the lack of many important data, such as, for instance, data on deep water horizons. While dealing with the principal tasks of the given research project, the consideration in hydrogeology was given to the ground water geology of the area, the genesis and movement of thermomineral waters, chemical composition and gas regimen in deep boreholes of the general town environs, and potential indices of tectonic block displacements.

2. HYDROGEOSEISMOLOGICAL APPROACH TO THE GEODYNAMIC STUDIES

Isolated published reports on changes in the water temperature and the level in wells and springs, disturbances in the activity of geyzers, and disappearance of springs before earthquakes, have become common in this century. However, only the results of long systematic studies of a number of instructive localities all over the globe have cast the light on the feasibility of hydrogeoseismological prediction of earthquakes, to mention only *Tashkent and Fergana geodynamic sites* in the Soviet Union, sites in the United States, Japan, China, and other countries, established in the last quarter of the century. Thus the hydrogeological method was developed, based on the studies of hydrodynamic regimen, chemical, gaseous, and isotopic compositions of ground water in association with the occurrence of seismic activity under certain geotectonic conditions, and a proved feasibility of the time of an earthquake event prediction. It has also been established, that each given area, relative to its geology and hydrogeology, requires a specific scientific approach and selection of a particular hydrogeologic element of reference.

In their efforts to predict earthquakes, Japanese, American, Soviet, Chinese and scientists of other countries concentrated the attention on the rapid changes in well water levels, spring discharges, temperature, chemical and gaseous composition of water. This included also sudden depletion or turbidity of water wells before earthquakes (Wakita, 1982; Mogi, 1985; Mavlyanov, 1983; Ulamov, 1966; Yoshioka, 1978; Deng, 1975). Records are given in the literature of successful observations of numerous water wells and artesian springs in China, Soviet Union, Japan, and other countries. For example, significant fluctuations in ground water level and composition were registered in a large area prior to 1975 *Haicheng earthquake* (China). Soviet seismologists, who monitored changes in *Tashkent Geodynamic Site*, came to the conclusion that observation data for gaseous, chemical, and isotopic compositions of water could be used in earthquake predictions (Mavlyanov et al., 1983). Thus, the known *Tashkent earthquake* was predicted in 1966 on the basis of the monitored radon concentration variations (Fig. 1).

The geological Survey of Japan made a numerosity of ground water observations in many boreholes. Among other findings, a decline of 7.0 m (Fig. 2) was registered in *Funabari well* (central Idzu peninsula) during the 1987 earthquake, and the earlier stable temperature in the nearby *Siraiva* locality suddenly dropped a month before the earthquake and continued to decline. Variations in ground water levels were registered on the entire American continent, even at distances of five thousand kilometres from the epicentre, associated with the disastrous earthquakes (March 1969) on Alaska.

3. MAIN HYDROGEOLOGIC FEATURES OF BELGRADE REGION

The territory of Belgrade township is characterized by a complex geology and hydrogeological

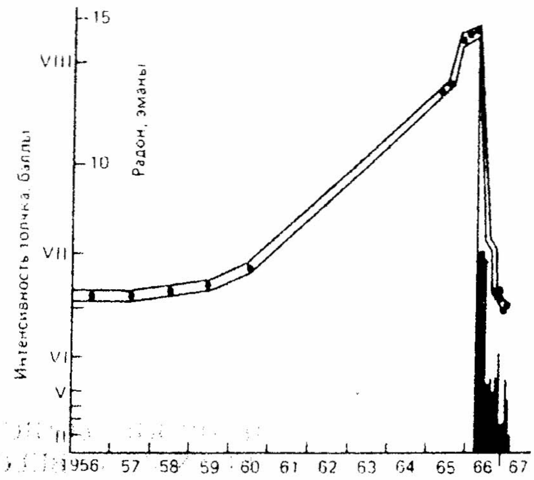

Fig. 1. – ***Radon concentrations*** **(dots) in deep boreholes versus** ***time*** **(Tashkent, Central Asia). Black vertical lines: 1966** ***earthquake intensities.***

conditions. Four types of *aquifers* are recognized on this territory: (1) river alluviums; (2) calcareous rock masses; (3) incoherent Neogene sediments; and (4) Paleozoic-Mesozoic base to Neogene sediments. Among these environments, somewhat lower in hydrogeological significance is the complex of dominantly permeable rocks of Paleozoic and Mesozoic ages.

Alluviums of the Sava and the Danube Rivers are distinguished by high permeabilities and large reserves of fresh ground water. They vary in thickness from 15 to 25, even to 40 metres. The water-bearing sand-gravel beds have good communication with the rivers.

Calcareous water-bearing rocks, together with other hard rocks of the *,Shumadian Mesozoic Ridge'*, generally extend in north-south direction, from the Danube (at Kalemegdan) toward Kosmaj. Notable in the group of strata are Sarmation limestones, which have a significant subsurface extent, but dip westward and eastward from the 'Shumadian Ridge' centre. The water from this aquifer is used for domestic supply at Sopot, Barajevo, Guncate, and Vranić.

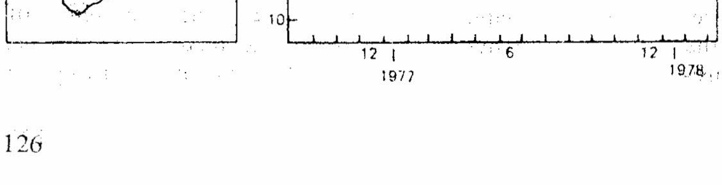

Fig. 2. – **Change in** ***water level*** **in a deep borehole at** ***Fundabora*****, central Idzu peninsula, Japan.**

Neogene incoherent sediments extend east and west from the 'Shumadian Ridge'. Sandy and gravelly sediments vary in thickness, within the group of incoherent rock beds (of dominantly argillaceous rocks), from ten to two hundred meters. The Pannonian and Pontian sands and gravels are of particular interest, because they are a source of water supply to Mladenovac, Grocka, Vrčin, and some other built up areas.

The rock masses of the *Palaeozoic complex* are covered with thicker or thinner rocks of Cretaceous or Tertiary age. Marbled limestones, marbles and quartzites, and contact zones of Palaeozoic rocks and magmatic intrusions, can be bearers of geothermal fluids of practical interest.

The territory is marked by occurrences of *mineral, thermal, and thermomineral waters.* The known springs and wells are, for example, those in Višnjica, Ritopek, Leštani, Boleč, Vrčin (Fig. 3), Ovča, Omoljica, Obrenovac, Vranić, „Braća Jerković" borough (Fig. 4). Most of these occurrences are associated with the zone of Tertiary sediments or the underlying Cretaceous sediments, and mark the existence of artesian water horizons.

The warmest water (51°C) in the general Belgrade area is found at Kupinovo. According to hydrogeologic data, the Belgrade area is abounding in hydrogeothermal resources: thermal water of 62°C was found by drilling at the depth of 789–1137 m in *Selters* at Mladenovac, and of 67°C at 817–862 m in Jugovo near Smederevo. Like in Jugovo, highly mineralized warm water has been found in its general area. The dry residue of this water is up to 19 g/1, and its significant constituents are fluor, ammonia, iron, etc. Water of this kind, classified as mineral water of chloride-sodium type of high mineralization rate: about 16 g/1 and high Cr, Cl, J, CH_4 concentrations, is found by drilling at Ovča.

4. HYDROGEOLOGICAL DATA BASE

The Belgrade area has been the site of voluminous and different geological and hydrogeological investigations. Some of the collected information is instructive for geodynamic studies and interpretation of changes in mean latitudes of the area. This primarily refers to deep drilling data and occurrences of thermomineral water. The occurrences of particular interest for this purpose are those in the Shumadian zone of the Inner Dinarides at the large Avala–Mladenovac–Kragujevac dislocation, or the border zone with the *Serbian–Macedonian Massif.*

For the formation of a reliable modern hydrogeological data base to serve the given task, the available volumionous documentation (primarily the cadastar of exploratory boreholes in the township and its environs, and the complex geological map of the area at 1:10,000) will be used in accurate locating and establishing the hydrogeological role of all significant water horizons and faults, essential in elucidating the geodynamic activity and proper location of observation points. The selection of observation points will, in this case, follow upon the correlations with other disciplines (*neotectonics, seismology, geophysics, engineering geology, geochemistry, geodesy, astronomy*), provided the following conditions: (1) the observation facility is located in a neotectonically active zone; (2) a deep aquifer is tapped, isolated from influences of shallower aquifer, surface water or precipitations; (3) the observation facility is adequately equipped; (4) regimen of the observed water horizon is not disturbed by artificial factors, primarily by pumping. Each of the selected facilities will be observed for variations in piezometric level, water temperature, and radon (and possibly some more chemical constituents in water) concentration.

The purpose *hydrogeological data base* should include the following:

(a) hydrogeological properties of rocks in the area;
(b) spatial position, parameters and place of all significant aquifers and faults;
(c) formation, flow, and discharge of ground water;

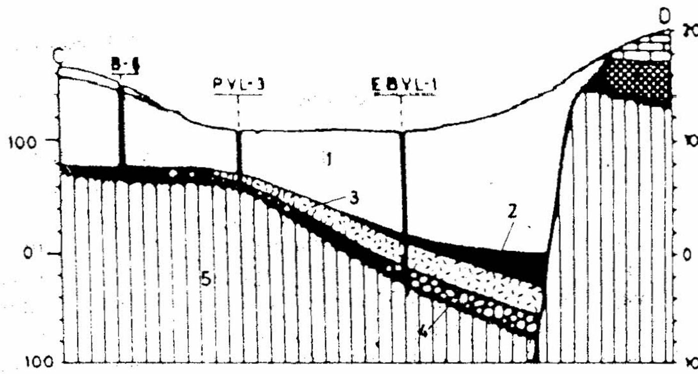

Fig. 3. – **Geological section in the** *Zavojnička River valley.* **1)** *Pannonian marl and clay;* **2)** *pannonian sandstone;* **3)** *Sarmatian limestone;* **4)** *Basal conglomerates;* **5)** *Serpentinite.*

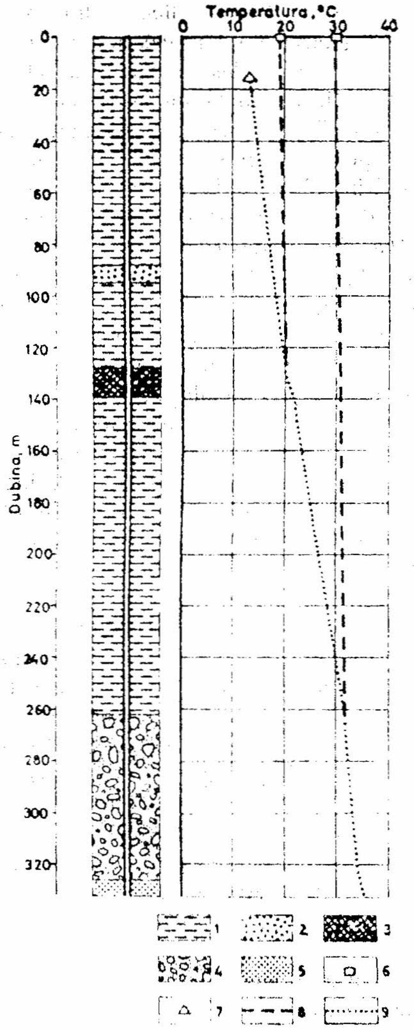

Fig. 4. – **Prediction thermograph for a borehole in „*Braća Jerković*" borough. 1)** *Clay and marl;* **2)** *Gravel;* **3)** *Marl;* **4)** *Conglomerate;* **5)** *Sandstone;* **6)** *Measured water temperature;* 7) *Depth of „neutral zone";* 8) *Water temperature curve for borehole;* 9) *Prediction temperature curve in situ.*

(d) physical and chemical properties of ground water;

(e) variation in gaseous composition and gas emanation intensity;

(f) ground water regimen (variations in level, temperature, chemical and gaseous compositions in time);

(g) relation of geodynamic effects in the Earth's crust surface to the hydrogeological situation.

The data base will be one of important references for geodynamical investigations in Belgrade area and useful in selecting indices of tectonic block displacements for a more reliable prediction of earthquakes.

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ХИДРОГЕОЛОШКА ОСНОВА ЗА ИЗУЧАВАЊЕ ПРОМЕНА СРЕДЊИХ ГЕОГРАФСКИХ ШИРИНА БЕОГРАДА

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Претходно саопштење

Савремена етапа развоја комплексних геодинамичких истраживања и прогнозе земљотреса, као посебно маркантних феномена у склопу механизма кретања земљине коре, карактерише се, између осталог, прихватањем хидрогеосеизмолошке методе и њеним широким коришћењем у многим сеизмичким активним рејонима света. Предмет рада је могућност стварања хидрогеолошке основе за изучавање геодинамике односно промена средњих географских ширина Београда.

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CONTENTS