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ETUDES DE STATISTIQUE STELLAIRE - MIŠKOVIĆ'S PhD THESIS

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Abstract. The PhD thesis of Vojislav V. Mišković (1892-1976), who was the founder and first director of the new Astronomical Observatory in Belgrade, situated at Laudonov Šanac, is presented.

1. INTRODUCTION

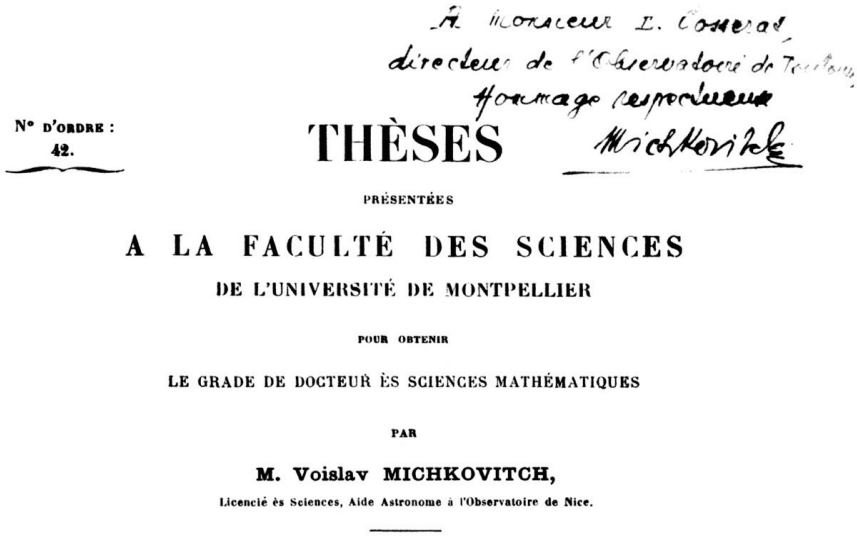
Vojislav Mišković is an important name in Serbian science. He started his university education in Budapest, but because of his keen interest in astronomy he soon left this city, to continue his studies in Goettingen and Vienna where astronomy departments existed. Due to the First World War, wherein Mišković took part, there was a break in his studies. Only after its end Mišković could recommence his studies of astronomy which he did in France. Already in 1919 he took his degree at the University of Marseille and joined the staff of the Marseille Observatory. In 1922 he moved to the Nice Observatory. The Nice period of Mišković's life was namely the period when he obtained his PhD degree. This occured in 1924 at the University of Montpellier.

Mišković's thesis is the subject of the present contribution. In what follows a brief description of the thesis is presented. The present contribution does not contain many data on Mišković's biography. The reason is that there are other papers which deal with his activity, first of all in this proceedings, so there is no need to repeat the facts. Besides, there exists an article (Indjić 1996) which can serve as a very good data source for all who want to study Mišković's life and career.

2. BASIC DATA ON THE THESIS

The University, as said in Introduction, is that of Montpellier. The thesis was approved by the Dean of the Faculty on March 21, 1924, on the very next day, March 22, the University Rector gave the printing permission. The examination took place on July 12, 1924 before the following Comission: Humbert (chairperson), Cabannes and Soula (examinators). The official degree of the thesis is PhD in mathematics (grade de docteur ès sciences mathématiques). The front page of the thesis is presented in Fig. 1.

The text is, of course, written in French. The number of pages is 137. there are many formulae, but they have no numbers, as is the case with the tables. Therefore,


A Monsieur L. Cosserat
directeur de l'Observatoire de Toulouse
Hommage respectueux
Michkovitch

N° D'ORDRE :
42.

THÈSES

PRÉSENTÉES

A LA FACULTÉ DES SCIENCES

DE L'UNIVERSITÉ DE MONTPELLIER

POUR OBTENIR

LE GRADE DE DOCTEUR ÈS SCIENCES MATHÉMATIQUES

PAR

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Figure 1: The front page of Mišković's thesis.

it may be noted that the thesis contains several tables. Figures have numbers, the last one is Figure 16. The citations are given in the form of footnotes, as it was usual at that time. However, in the end there is a rich list of references. The references also have no numbers. The title of the list - "Liste des travaux de statistique stellaire" - indicates that this is rather a general (informative) list of the literature on stellar statistics, than a list comprising only the references necessary to the work itself. The references do not contain the year of publishing. For this reason it becomes difficult to establish the period covered by their publishing. The mentioned title is followed by a footnote wherein the author says that for the purpose of making this list he had at his disposal the libraries of the Observatories at Nice and Marseille.

The thesis text is organised as follows: preface, introduction and three essential parts - Part I: Mathematical Statistics, 36 pages, Part II: Stellar Statistics, 49 pages, Part III: Study of Algol Type Variable Stars, 34 pages.

3. UNIVERSITY OF MONTPELLIER

Montpellier is a city in southern France, situated very near the Mediterranean coast. It is the third largest city in the Mediterranean part of France, after Marseille and Nice (population about 250,000). The University of Montpellier was founded in 1289, but during its history it ceased to exist twice, in 1793 and in 1970. Both times it was renewed, in 1896 and in 2015. Thus Mišković's thesis belongs to the second period (1896-1970). The faculty at which the thesis was defended is Faculty of Sciences (Faculté des sciences). A more specific information about the faculty can be obtained from the list of teaching staff (Fig. 2). In this figure we can see, not only the particular position, but also the profession of every staff member. It is seen that a

FACULTÉ DES SCIENCES DE L'UNIVERSITÉ DE MONTPELLIER

	MM.	
Doyen	GODECHOT, Professeur de Chimie.	
Doyen honoraire	DAUTHEVILLE.	
Professeurs honoraires	FABRY, DUBOSCQ.	
Professeurs	FLAHAULT	Botanique.
	de FORCRAND	Chimie.
	CURIE	Minéralogie.
	BEAULARD de LENAIZAN	Physique.
	BLAYAC	Géologie.
	TURRIÈRE	Mécanique rationnelle.
	HUMBERT	Mathématiques pures.
	BATAILLON	Zoologie et Anatomie comparée.
	SOULIER	Zoologie.
	PAVILLARD	Cryptogamie et Cytologie végétale.
	GAY	Chimie.
	CABANNES	Physique.
Maîtres de Conférences.	SOULA	Mathématiques.
	BEGHIN	—
	CARRIÈRE	Chimie.
Secrétaire	DUBOIS.	

Figure 2: Faculty of Sciences in Montpellier in 1924 - teaching staff.

wide class of sciences was present, mathematics, physics, chemistry, but also geology, mineralogy, zoology as well. Astronomy is not mentioned, the members of Mišković's commission were mathematicians (Humbert, Professor, and Soula, Lecturer) and a physicist (Cabannes, Professor). The French names for the university levels are here translated as Professor (professeur) and Lecturer (maître de conférences). From Fig. 2 we see the family name of the then faculty dean - Godechot, a chemist, who signed the approval, as mentioned above. The Rector's name, who also gave the corresponding approval (Jules Coulet), we do not see from Fig. 1, which leads to a conclusion that he was from another faculty. The importance of the Commission chairman, Humbert, to Mišković is seen from the fact that he is one of the two persons to whom the thesis was dedicated, the other one is Mišković's father.

3. 1. STELLAR STATISTICS I

The Preface begins with the necessary explanations, for instance, what is stellar statistics, the observational data and methods used in it. The data comprise spatial distribution of celestial bodies ("distribution des astres dans l'espace"), their distances and heliocentric displacements. In addition Mišković mentions the physical properties, in particular brightness, colour, spectrum, density, mass, size, temperature. This, according to Mišković, forms the field of stellar astronomy. Further, he says that "this branch, still a new one, but which has already proved to be sufficiently fertile in its results, recommends itself in studying the laws governing these diverse elements and realtions which can unify them, aimed at establishing a general theory concerning the structure and evolution of the stellar universe". Here it should be pointed out that in the time of this thesis (1924) the question of whether the Milky Way appears as the whole Universe or is only a constituent of its was still unresolved.

In the further text Mišković says that the data treatment is relied on mathematical statistics, where the contributions of Bernouli, Laplace, Lexis and Pearson are mentioned. However, as for its application to astronomy, Mišković points out the contribution of Charlier[1] and his pupils as "a completely remarcable set of important achievements" (un ensemble tout à fait remarquable de recherches importantes).

This is not a mere note. As the objective of his work Mišković says: 1. giving a general idea of the employed statistical methods and the results obtained by Charlier and his coworkers; 2. furnishing a presentation detailed enough which permits young astronomers full of desire to carry out successful applications of these methods without being obliged to consult the numerous articles published in "Meddelande från Lunds Astronomiska Observatorium".

In the last paragraph of Preface there is an acknowledgement which concerns Prof. Humbert (valuable information and advices) and G. Fayet, the then Director of the Nice Observatory (unselfish aid in composing the manuscript).

Following what he had written in the Preface in the Introduction Mišković presented a short description of mathematical statistics and probability theory where one finds notions such as: theory of errors, frequency curve, moment, correlation coefficient and homograde and heterograde statistics, given as subtitles at the beginning of a paragraph. At the very end of Introduction Mišković points out that "due to the complexity of the data it was necessary to create a new theory based on some hypotheses on one hand and on the other hand on the procedures and theorems known from mathematical analysis, instead of some elementary theorems of probability theory". In the next sentence (final in Introduction) he says that "this is exactly the development of this second set of statistical methods, which is his subject and appears as a constituent of the important contribution of Charlier's school".

3. 2. STELLAR STATISTICS II

As said above, Part I is written on 36 pages. It concerns mathematical statistics. It contains many formulae, also followed by explanations and derivations. The material is organised in a similar way as in Introduction, but the subjects are treated in more detail. There are numerical examples presented by use of tables. For instance Tables II and III contain results of Mišković's own calculations, as he says a scheme which he adopted from a paper of Charlier published in "Meddelande från Lunds Astronomiska Observatorium", but with some modifications believed by Mišković to be useful.

In the second part in view of the intensive application of mathematical statistics stellar kinematics is also included in stellar statistics. Taking into account our modern terminology the subject in this part is in fact statistics of the Milky Way and the kinematics in the solar neighbourhood.

In the time of Mišković's thesis both the global structure of the Milky Way and the interstellar extinction were unknown. The stress was done on the distribution of stars in apparent magnitude, the number of stars brighter than the value corresponding to a given apparent magnitude and the mean distance of the stars with the same apparent magnitudes. Since the first two quantities are obtainable by treating the observations, it is possible to study the distribution of stars in absolute magnitude and their spatial distribution (number density as function of distance). The equations used in this procedure are rather complicated, therefore some hypotheses actual at

[1] Carl Charlier (1862-1934), a Swedish astronomer from the Observatory at Lund.

that time are discussed, the results following from them are compared to the results for the two star numbers obtained from observations. The agreement was found to be satisfactory.

Then there is a part dealing with heliocentric distances of stars. In 1924 the trigonometric method was, practically, the only one in determining the distances, whereas sufficiently reliable parallaxes were available for a small number of stars. For this reason statistical relations between parallaxes and apparent magnitudes and between parallaxes and proper motions were very welcome and it is quite understandable why this subject finds its place in the thesis.

In the last lines of the second-part text the kimenatical problems are considered. Correlations with physical characteristics are also analysed. For this reason apparent magnitudes and spectral types are added to the proper motions appearing as the basic observational material. It is pointed out that the discussion concerning stellar motions should be based not on the angular displacements, but on the velocities of celestial bodies. The velocity is estimated by applying to the observed proper motions a numerical parameter. Though, at first glance, such an approach seems rather different from that used today, the results indicate a distinction among spectral types; the used parameter shows a wavy behaviour between O and G, to show an increase afterwards, but the author draws attention that the determination for M type is very uncertain because of a small fraction of such stars in the treated sample.

Of a special interest may be the position concerning the comparison of the hypotheses of two streams and ellipsoidal one. Based on the earlier studies Mišković infers that "all seems to indicate that the two stream hypothesis is not sufficient to reflect in a satisfactory way the facts concerning the observed stellar motions" (tout semble donc indiquer que l'hypothèse des deux courants stellaires n'est pas suffisante pour représenter, d'une manière satisfaisante, les faits relatifs aux mouvements stellaires observés).

At the end of the second part one finds a list of papers referred to as "studies on stellar statistics" published in "Meddelanden från Lunds Astronomiska Observatorium". These papers are divided into theoretical ones and applications in stellar astronomy.

3. 3. VARIABLE STARS

As said above (Subsection Basic data on the text), the third and last part is devoted to variable stars of Algol type. In the title, except Algol type, there is also short period. Thus it can be inferred that Algol type and short period are the two main caharacteristics, which should unify the kinds of stars under study. Due to the short period Mišković also includes the types of β Lyrae and δ Cephei. He further says that "these three categories are most likely (fort probablement) nothing else but the three principal stages in the evolution of binary systems". This standpoint should be viewed as something obsolete, probably as a consequence of the then (in 1924) state of the art. The relationship with stellar statistics is found in the author's objective to "apply the method of stellar statistics to the study of binaries". In addition Mišković says that here he had to "limit himself to the Algol type variables".

Mišković examined the data concerning the Algol type stars and formed a list containing 152 such stars (all of them known till the end of 1923). At the disposal he had the following data: period, eclipse duration and the extremal values of the apparent

magnitude. The quality of data were not always satisfactory, this is especially true for the case of the eclipse duration. Mišković carried out a statistical analysis which included the correlation study.

At the time of Mišković's thesis moving groups were already known. Therefore, another question was if the Algol type stars formed a moving group. Mišković performed a kinematical analysis, though the proper motions were available for 17 stars only. On the other hand, in the case of 86 stars the spectral type was known, it was largely B or A. Combining the spectral types and proper motions Mišković was able to estimate the distances. He gave a final table including all 152 stars. This table has 17 columns. In addition to the ordinal number, star designation, the four quantities mentioned above (period, eclipse duration, ...) there are also right ascension, declination, the estimated distances, the quantities derived from them and spectral types (where available). The quantities derived from the distances (also from angular coordinates) are the rectangular coordinates and parallaxes. All of this was a basis for a statistical analysis focused on, first of all, studying the spatial distribution of the Algol type stars. Mišković found a distribution practically symmetric with respect to the Milky Way plane. As distance unit Mišković used siriometer. This, now almost completely forgotten unit, is equal to 10^6 astronomical units. Its name is due to the fact that Sirius is about half siriometer away from the Sun. It is also curious to note that Mišković uses the word "grandeur" for magnitude (brightness measure). Such a word seems to have been characteristic for that time. For instance in the titles of some references in Mišković's thesis written in German one finds "Groesse" which completely corresponds to "grandeur" in French. However, in both modern French and German other terms are used, in particular "magnitude" and "Helligkeit", respectively.

4. CONCLUSION

Mišković's PhD thesis is, undoubtedly, a serious work. Mišković treated much of that which is now known as stellar astronomy, more precisely Galactic astronomy. The time when the thesis was prepared was on the eve of the important discoveries concerning the structure and dynamics of the Milky Way. In the numerous references cited in Mišković's thesis one cannot find, for instance, the names of the two classics in Galactic astronomy, B. Lindblad and J. H. Oort. Unfortunately, for the well known reasons Mišković could not continue his work in that field.

Acknowledgment

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