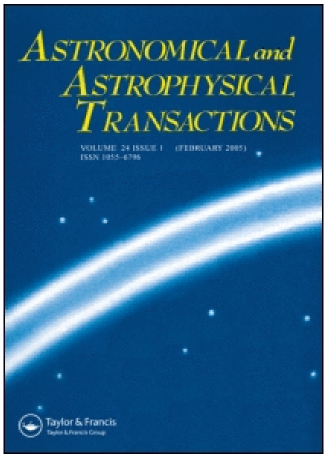

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ON ONE PARTICULAR PARAGRAPH FROM THE HANDBOOK BY D. Ya. MARTYNOV

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The article draws the reader's attention to the small section "Determination of the diameters of stars by lunar occultations" of one particular paragraph from the *Handbook of Practical Astrophysics*, by Prof. D. Ya. MARTYNOV, and stresses its considerable importance for astronomers in general and, for students studying astrophysics in particular. A brief history of the evolution of investigations in the field mentioned of contemporary observational astrophysics all over the world and, in Russia (the former Soviet Union) in particular, is given. One particular result of photoelectric observation of the lunar occultation of the star 54 λ Gem which has been carried out in Moscow, at the 70-cm telescope AZT-2 of the Sternberg Astronomical Institute, is presented.

KEY WORDS History of science, astronomical education, photoelectric observations, lunar occultations of stars, stellar angular sizes, fundamental characteristics of stars, close binary systems

As is widely known, Dmitrij Yakovlevich Martynov was a scientist and professor of wide and deep learning. He was well aware of the crucial role which observations play in the progress of astronomical science, and astrophysics, in particular. His *Handbook of Practical Astrophysics*, republished several times, and so very familiar to all astronomers, contains valuable and well-expounded knowledge on practically all the branchs of observational astrophysics of his day, necessary for everyone wishing to work professionally in this field of astronomy. If we perhaps do not take into account the contemporary achievements of observational technology (first of all, the CCD cameras widely used in recent years, and corresponding methods of computer data processing are referred to), the material that the handbook contains hardly needs any updating. In the present article I'd like to turn the reader's attention to a certain section of one particular paragraph that must have been inserted into the handbook, probably, in 1960s (in the 1977 edition it was Chapter III, §25, pp. 465–469). I have in mind the section "Determination of the diameters of stars by lunar occultations."

Being engaged in this very field of contemporary observational astrophysics, I have discussed this topic with many astronomers, both specialists from scientific institutions, and students. Very often people, though not unaware of the method's existence, proved to have but a vague notion of its principles. In some cases a superficial acquaintance with the method was acquired while looking through scientific journals. It seemed strange to me at the time, because the general ideas as well as the physical principles of the method are wonderfully explained in Martynov's handbook. This situation may probably be accounted for if we consider the fact that during many years in our country observations of lunar occultations were carried out with only the aim of timing these events with maximal accuracy and thus obtaining valuable data for celestial mechanics (the building of exact models of the Moon's motion), astrometry (determination and refinement of stellar coordinates), geodesy (determination of coordinates, in particular, of altitudes, of various sites on the Earth's surface), and the detailed study of the relief of the lunar edge and the figure of the Moon (selenodesy). We may suppose that during a large interval of time at a great majority of astronomical subfaculties of universities and institutes teachers did not attract the students' attention to the possibility of gathering valuable astrophysical information by observing lunar occultations of stars.

Meanwhile, D. Ya. Martynov has given in the very short section of his handbook a brief but quite clear description of how, by analysing the diffraction curve recorded in the observation of the lunar occultation of a star one can determine the star's angular diameter. A brief history of the problem is also given, beginning with the birth of the initial idea based on the concepts of geometrical optics (Mc Mahon, 1908) and finishing by the results of direct measurements of angular diameters of a number of stars obtained from the analysis of photoelectric observations. The author stressed the fundamental role of such measurements since they allow us to determine, without additional indirect assumptions, the most important characteristics of stars such as the linear radii and effective temperatures, and sometimes, when relatively near-by giants and supergiants are considered, to discover and study circumstellar envelopes, to recover the brightness distribution over the disk of the occulted star. He also points out the possibility of discovering, with the help of observations of lunar occultations, previously unknown close double stars and measuring the angular distances between the components of such systems of the order of hundredths of an arc second.

In the 1930s a few astronomers from different countries had come to the conclusion that the diffraction occultation pattern must include information about the star's angular diameter. D. Ya. Martynov, in his handbook, names one of them, S. G. Natanson, our compatriot, who, in 1936, had analysed, independently of Western colleagues, the effect of the finite size of a stellar disk upon the intensity behaviour in the diffraction pattern and showed that accurate photoelectric photometry allows us to distinguish between the diffraction curve obtained in the observation of the occultation of a star having a finite angular diameter and an analogous one recorded while observing the occultation of a point-like source (Natanson, 1937). These theoretical results were confirmed observationally in the same 1930s. Western publications on the topic do not mention Natanson's work, so Martynov's handbook helps to recuperate the names of all the astronomers who have made a considerable contribution to the development of the principles of the method we are discussing.

Since the 1950s photoelectric observations of lunar occultations of stars have been conducted in many observatories all over the world. Up to the present the angular diameters of about 150 stars or slightly more have been measured by this method; typical values of the diameters are as small as a few milliarcseconds; the minimal reliably determined ones approach the value of $0\overset{''}{.}001$. Moreover, numerous close binary stars with the lower limits of angular distances between the components ranging from $\sim 0\overset{''}{.}5$ down to $\sim 0\overset{''}{.}002$ have been discovered. In the overwhelming majority of cases the measuring of angular diameters of such small values with the use of other presently existing methods is impossible; spectral, photometric and interferometric observations permit us to resolve such close binary or multiple systems and to determine their physical parameters in a strictly limited number of cases; in particular, it is hard to detect in most cases the faint secondary component and to measure reliably a luminosity ratio of the components. Meantime, an analysis of high-accuracy photoelectric curves of lunar occultations gives us the possibility of obtaining by a direct independent method valuable information on the orbits of close binary systems, to determine the luminosity and mass ratios of their components and, in the best cases, the angular and linear diameters of one or both components, to obtain independent estimates of distance to some of these systems.

In the late 1970s the high-speed photometry system based on the direct input of the photoelectric data into the computer main memory has been designed at the High-Mountain Tien-Shan Observatory of the Sternberg Astronomical Institute first within the Institute (Kornilov, 1978). The system permitted us to realize photoelectric recording of the lunar occultation curves of stars with a time resolution of 1 ms. The first successful series of such observations was performed in winter 1981–82. I well remember the vivid interest which had been shown by Dmitrij Yakovlevich, who was then the holder of the chair of our subfaculty of astrophysics and stellar astronomy, while contemplating the pictures of the occultation diffraction curves obtained during those observations that I had brought from Alma-Ata. His attitude to the results of that work had revealed that he considered it important to extend the investigations in this direction. The first domestic paper on the determination of the angular diameter of the star by analysis of the photoelectric curve of its lunar occultation was submitted to *Astronomicheskij Zhurnal* in 1983 (Kornilov *et al.*, 1984).

In winter–spring, 1995, the author, jointly with V. G. Kornilov, carried out for the first time in Moscow, at the 70-cm telescope AZT-2 of the Sternberg Astronomical Institute, a series of photoelectric observations of the lunar occultations of stars with a time resolution of 1 ms, and obtained diffraction curves of sufficiently high quality. In particular the diffraction curve of the lunar occultation of the star 54 λ Geminorum has been recorded. The curve is shown in the Figure 1. The dots represent the data of the flux measurements (the photometer counts in the accumulation interval of 1 ms), the solid line is the optimal model curve for the occultation of a single star of negligible angular diameter (practically of a point source), which has been fitted taking into account the presence of atmospheric scintillation (flux variations before the occultation due to this cause are clearly seen on the curve). In the lower part of the figure, deviations of the recorded counts from the optimal

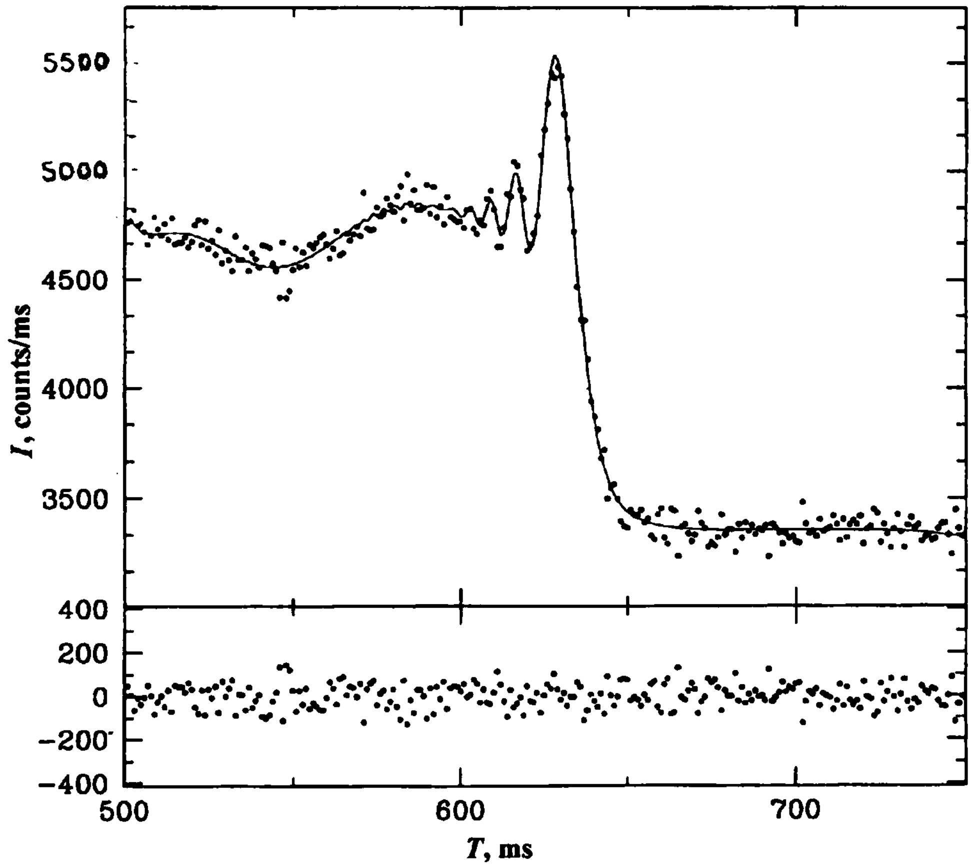

Figure 1 Occultation diffraction curve of 54 λ Gem. March 11, 1995, Moscow, Sternberg Astronomical Institute, 70-cm reflector AZT-2. Observers: E. Trunkovsky *et al.* Horizontal axis: time, ms (conventional values); vertical axis: counts in 1 ms; second vertical axis: deviation, of the counts recorded from the best model diffraction curve which has been fitted (counts in 1 ms).

model curve are shown. 54 λ Geminorum has been known as a close binary system (in reality, as a multiple one, but the third component is quite faint and considerably distant from the two main components), with the angular distance between the components of about 0.″04. However, the processing of our data, performed together with A. Richichi (Arcetri Astrophysical Observatory, Florence, Italy), did not reveal the secondary component whose presence could be expected according to the data of past observations. Such a result probably could be explained by orbital motion of the components of the binary system (the secondary component had been discovered by observation of the star's occultation almost 20 years ago; probably, it has moved considerably during this interval of time). A paper including the result of our observation described here was published in *Astronomy and Astrophysics* in 1996 (Richichi *et al.*, 1996).

References

Kornilov, V. G. (1978) *Astron. Tsirk.* (AS USSR), No. 1005, 1–3.
Kornilov, V. G., Mironov, A. V., Trunkovskij, E. M., Khaliullin, Kh. F., and Cherepashchuk, A. M. (1984) *Astron. Zh.* **61**, 739–749.
Mc Mahon, P. A. (1908) *Month. Not. Roy. Astron. Soc.* **69**, 2, 126–127.
Natanson, S. G. (1937) *Astron. Zh.* **14**, 1, 57–63.
Richichi, A., Calamai, G., Leinert, Ch., Stecklum, B., and Trunkovsky, E. M. (1996) *Astron. Astroph.* **309**, 163–170.