

ON G.P. KUIPER'S WORK ON THE STARS OF LARGE PROPER MOTION

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ABSTRACT

The writer is preparing for publication a complete listing of the late G.P. Kuiper's spectral classifications of stars of large proper motion north of $\delta = -50^\circ$. This work, resulting from his observations made at the Yerkes and McDonald Observatories some 35 years ago, has been only partially published; it is estimated that useful unpublished classifications exist for the order of 1000 stars. This paper discusses the background of his program and the procedures to be followed in making these data generally available.

Kuiper's spectral classification program on the stars of large proper motion, which eventually comprised some 3500 objects observed during 1938-1944 at Yerkes and McDonald, represented a natural outgrowth of his earlier determination with the Lick Crossley reflector of the colors of all known stars of large parallax north of $\delta = -20^\circ$ for which no spectral class nor color index was known. On reporting its completion, Kuiper (1935) states: "Next in importance to the stars of (known) large parallax, in a statistical study of the near-by stars, are the stars with large proper motions (but without known parallax). Annual proper motions of $0''.50$ and larger invariably indicate interesting stars; they are either in the immediate neighborhood of the Sun, or possess very high space velocities. The lower limit $0''.50$ has been adopted in the present color program, but in future work the limit may well be taken as low as $0''.4$ or $0''.3$."

When Kuiper became a staff member at the Yerkes Observatory

in 1936 the feasibility of a systematic spectroscopic examination of a very large number of faint proper-motion stars was greatly enhanced by three factors: (1) he there had access to the extensive plate material used by Ross in his then largely completed proper-motion survey, which facilitated the preparation of finding charts for these stars; (2) he soon oversaw the modification of an old prismatic Brashear spectrograph into an instrument which gave the very low dispersion of 340 Å/mm at H γ , enabling very faint stars to be observed; and (3) he decided, following the lead of W.W. Morgan who had just shown that M dwarfs could be very accurately classified in the visual spectral region (at considerably higher dispersion), to make extensive use of this region for the classification of the redder proper-motion stars. The new so-called "K" spectrograph utilized panchromatic film, bent to the proper focus over the entire spectral region recorded. Customarily two exposures of different densities were taken of each star, and the redder stars were classified in the visual region, the bluer ones in the photographic. With this efficient instrument he began, first with the 40-inch and then in many observing sessions with the McDonald 82-inch, including the first use of that telescope, his very important spectroscopic work on the stars with proper motions larger than approximately three-tenths of a second of arc.

The progress of his program is well recorded in Struve's several Yerkes Annual Reports of that period, as well as in Kuiper's own series of six papers dealing with his work (Kuiper 1938, 1939, 1940a, 1940b, 1942, 1943). Progress was rapid: the annual report for 1939-40 (Struve 1940) states that "Kuiper's program of stars of large proper motion is nearing completion. The spectra of more than 1500 stars have been determined.... The complete publication of the results is planned for the fall of 1940." But in the report for the next year (Struve 1941), we read that "Kuiper, in collaboration with Dr. W.J. Luyten of Minnesota, undertook an extensive program of observations of all new proper-motion stars within reach of the 82-inch, which had been discovered by the latter in his Bruce survey.... The total number of proper-motion stars for which Kuiper has determined spectral types since 1938 is about 2000." Finally, in the report for 1942-43 (Struve 1943) we learn that "Kuiper completed at McDonald the program, started at Yerkes in 1938, of determining accurate spectral types of stars with large proper motion, north of -50° in declination. A total of about 9000 spectra of 3200 stars was obtained during the six years. The spectra of some 300 stars for which Luyten provided the positions were also obtained by Kuiper. The results of this collaborative program will be published in the near future by Luyten and Kuiper." But alas, in the following years' report (Struve 1944) little is said of Kuiper's stellar work - instead the report notes his wartime discovery of an atmosphere on Saturn's largest moon, Titan. When we recall Kuiper's

many other enormously important contributions to stellar astronomy in addition to the work discussed here, we can only regretfully conclude that an era of remarkable personal achievement in that field had come to an end.

Unfortunately the promised comprehensive and collaborative catalogues containing the results of Kuiper's spectroscopic observations never eventuated. Though Kuiper provided magnitudes and spectral types for a great many of the entries in The General Catalogue of Trigonometric Stellar Parallaxes (Jenkins 1952), a substantial part of this work has never seen the light of day.

Some time after Kuiper's death and as a result of renewed interest in the characteristics of the stars of large proper motion aroused by the systematic Lowell Observatory survey (see Bidelman and Lee, 1975), the writer inquired of Dr. E.A. Whitaker of the Lunar and Planetary Laboratory of the University of Arizona as to whether any of Kuiper's unpublished proper-motion star material could be unearthed among his effects. When I learned that several notebooks that appeared to contain useful data had been found, I asked to have copies of this material sent to me, which, through the good offices of Drs. E. Roemer and H.A. Abt, eventually happened. What I finally obtained were copies of five large notebooks which were evidently themselves copies of Kuiper's original observing logs on which he had written his determination of the spectral type of every star observed. In many cases, several different films had been taken of the same star, with differing resultant classifications. Thus it was necessary to make up a card file containing each star (or pair, as many binaries were included) and to enter the individual classifications. Since Kuiper, being economical of clerical time, had only indicated the stars by name and right ascension (declinations not being given), finding the exact stars observed was at times a bit difficult. It is important to emphasize that I have not attempted to reclassify (or even inspect) Kuiper's original spectrograms; I think it very doubtful that any useful purpose would be served by doing this. However, I hope to cross-check my card file with one that he presumably also must have made up, if such can be found. In some cases it may be desirable to check his observing cards to determine which star was actually observed; these have also not yet been located.

The question of what to publish is a rather difficult one. In cases where Kuiper has determined more than one type an average will have to be taken (unless he has already done so). Further it is well known that Kuiper's classification scheme was not identical to that in general use today; thus I plan to provide a short table that will permit one to transform his spectral types to others scaled to the MK system for the K stars or to the new system recently established for the M dwarfs by Dr. P. Boeshaar.

Many of his stars have already, of course, been assigned objective-prism spectral types of varying quality, but Kuiper's types are undoubtedly better than most of these. Also, not surprisingly, slit-spectrograph types are available for a great many of Kuiper's stars, and there may seem little point in publishing his types if better ones are available. However, at times it is rather difficult to tell which types are better. My present inclination is to publish all of Kuiper's types, noting cases where they have been clearly or presumably superseded. A similar difficulty arises in the matter of magnitudes. It is not entirely clear where the magnitudes that Kuiper gives in his notebooks come from. Many were no doubt determined by the late Carl Seyfert, some may have been photometric determinations by Kuiper himself, but the majority are probably eye-estimates at the telescope. My thought is to give the V magnitude if it is available, and otherwise to use Kuiper's values.

In conclusion it should be pointed out that, though very extensive, the stars included in Kuiper's program do not represent a complete sample of proper-motion stars to any given limit in motion or magnitude. Later discovery lists such as those of Luyten or Giclas are far better in that respect.

Nonetheless, it is estimated that there must be contained in Kuiper's unpublished material of the order of 1000 stars for which his spectral types are better than those available anywhere else, and it thus seems certain that this somewhat belated contribution to our knowledge of the distribution of the stars in the HR diagram will prove a most valuable one. The writer is happy to have had a part in it.

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