A SURVEY FOR O-B STARS IN THE PUPPIS WINDOW

David J. Westpfahl, Jr.
Physics Department, Montana State University,
Bozeman, MT 59717 U.S.A.

(visiting astronomer, CTIO, supported by NSF under contract AST 78-27879)

I. INTRODUCTION

In the 1950's Haro (Haro and Luyten 1962) developed a survey method in which three images, roughly corresponding to U,B, and V, are exposed on one plate. The images are separated by several arc seconds by moving the telescope between exposures. Exposure times are chosen so an unreddened star of spectral type A0 to A5 shows three images roughly equal in size and density. The plates are examined by eye to find stars by their colors. A red star shows a strong central image flanked by two weaker images, while a blue star shows a weak central image flanked by two stronger ones. This method allows surveys for stars and galaxies with very red or very blue colors to be carried out with any telescope, and in particular with the Schmidt telescopes at Tonantzintla and at Palomar which were not equipped with objective prisms.

II. THE SURVEY METHOD

This method has several advantages over the standard objective prism technique. 1. The method is useful over the range $12<V<18$ on one plate (Haro and Luyten 1962), or about two magnitudes wider than objective prism surveys. 2. Crowding is less of a problem in dense Galactic fields because the three images cover less area on the plate than even an unwidened spectrum. 3. The method remains useful even during poor seeing when objective prism images lose their detail. 4. It works equally well for stars and extended objects, such as galaxies and gaseous nebulae.

There are also some disadvantages to the method. 1. It gives incomplete spectral information, so cannot be used to identify objects with emission lines. 2. It is selective on the basis of color only, so a reddened B5 star may have the same appearance as an unreddened A0 star. This means that desirable stars may be missed in a blue-star survey, but also assures that the survey will be over-selective, missing some late B-type stars, instead of being under-selective and including undesirable A and F-type stars. 3. The method is not sensitive to small

M. Capaccioli (ed.), Astronomy with Schmidt-Type Telescopes, 265--268.

differences in color near spectral type A0 because the colors of the stars combined with the effects of interstellar reddening give small changes in the relative appearances of U,B, and V images.

In 1981 the author decided to undertake a survey for faint blue stars in the Puppis window, where absorption in the plane of the Milky Way is low enough that it should be possible to see stars at the edge of the Galaxy's disk (Westpfahl and Christian 1979). A survey method was needed which could be used in crowded fields near the Galactic plane and which could allow identification of stars as faint as eighteenth magnitude in V to assure that the edge of the galactic disk could be observed. Following the suggestions of Chromey (1981) it was decided to use an updated version of Haro's method with a new choice of emulsion and filters in order to increase the discrimination of the method near spectral type A0 and allow for better plate resolution. To get better discrimination, ultraviolet, blue, and red images (U,B,R) were chosen instead of U,B,V, because the B-R color changes faster than the B-V color near spectral type A0. This required an emulsion with extended red sensitivity. IIIa-F plates were chosen for the spectral sensitivity of the F-Class emulsion and the finer grain of IIIa emulsions.

The determination of required exposure times and the survey for blue stars in the Puppis window were undertaken with the Curtis-Schmidt telescope at Cerro Tololo Inter-American Observatory during 19-27 December, 1981. Exposure times were calibrated using the spectral types and magnitudes of the standard stars in Selected Area 98 from Landolt (1973) and using the spectral types and colors of two clusters in the Puppis window, NGC 2362 (Johnson 1950, Johnson and Morgan 1953) and NGC 2483 (FitzGerald and Moffat 1975). The final exposures on IIIa-F plates were 50 minutes through a UG-1 filter for the ultraviolet image, 20 minutes through an RG-610 filter for the red image, and 25 minutes through a Wratten 47A filter for the blue image. The images were displaced twenty arc seconds from each other using the micrometer eyepiece of the guiding telescope. This resulted in three uniformly-spaced images of roughly equal size and density for stars of spectral type A0-A2. Following each three-image plate a conventional single-image plate was taken of the same field to provide finding charts and help eliminate confusion from crowding.

III. THE SURVEY AND PRELIMINARY RESULTS

The survey covers 13 fields corresponding to $235<l<245$, $-17.5<b<17.5$. These fields were chosen to give coverage of the window of low absorption near $l=240$, $b=0$ to study the extent and rotation of the Galactic disk, and to cover nearby fields out of the plane to look for possible warping of thickening of the disk. This will also allow comparison of the nature of blue objects at low latitude $|b|<5$, with those at intermediate latitude, $10<|b|<20$.

Each plate has been examined by eye to search for blue stars, which show a faint central red image flanked by brighter blue and ultraviolet

images. The blue stars have been divided into three natural groups, blue, very blue, and extremely blue, according to the relative sizes of the three images. Two of the fields overlap fields observed in detail by FitzGerald and Moffat (1975) and Nordstrom (1975). Comparison of the blue stars in those surveys with stars in the present survey has allowed rough determinations of the spectral types falling in each natural group. Stars classified as blue have all three images roughly equal, and are unreddened A2-B7 stars or reddened B8-B4 stars. Those classified as very blue have the U and B images roughly equal and both larger than the R image. They are unreddened B7-B4 stars and reddened B5-09 stars. Those classified as extremely blue have the U image larger than the B image, which is larger than the R image. All are B3 or earlier. Altogether 2035 blue stars have been found, of which 416 are very blue or extremely blue. These 416 stars are distributed about equally for $|b|<5$, but for $5<|b|<10$ there are more stars below the plane than above, and for $10<|b|<17.5$ there are more stars above the plane than below. Any conclusion about warping or thickening of the plane should be postponed until after the photometry and spectroscopy are complete. It is interesting to note that it has long been suspected that blue stars were more common below the plane than above in this region. The large number of stars with $|b|>10$ is, however, a surprise.

Photometry of the very blue and extremely blue stars was started in January, 1983, using the 1.5m and 0.9m telescopes at CTIO. All of the 50 stars observed have B-V colors of slightly reddened O-B stars, and all fall in the magnitude range $13.0<V<18.6$. This confirms that the stars are within the desired range of colors and magnitudes for galactic structure studies. The UBV photometric observations will be continued and slit spectroscopy started in January, 1984.

REFERENCES

Chromey, F.R., 1981, private communication
FitzGerald, M.P., and Moffat, A.F.J., 1975, Astron. Astrophys. Supp.20, 289.
Haro, G., and Luyten, W.J., 1962, Bol. Obs. Tonantzintla Tacubaya 22, 37.
Johnson, H.L., 1950 Astrophys. J. 112, 240.
Johnson, H.L., and Morgan, W.W., 1953, Astrophys. J. 117, 313.
Landolt, A.U., 1973, Astron. J. 78, 959.
Nordstrom, B., 1975, Astron. Astrophys. Suppl. 21, 193.
Westpfahl, D.J., and Christian, C.A., 1979, Bull. Am. Astron. Soc. 11, 415.

https://doi.org/10.1017/S0252921100106700 Published online by Cambridge University Press

DISCUSSION

M.SANTANGELO: Have you searched for systematic errors due to the variations of the atmospheric conditions during the long exposures? Have you also searched for an abnormal extinction law in this region?

D.WESTPHAL: I have searched the regions where neighbouring plates overlap and find very good agreement, suggesting that such systematic errors are not present. I have not searched for abnormal extinction, but extensive observing in the Puppis window by FitzGerald and coworkers shows only normal extinction.

https://doi.org/10.1017/S0252921100106700 Published online by Cambridge University Press