SPECTRAL CLASSIFICATION OF M STARS BY PHOTO-ELECTRIC TECHNIQUES

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In pursuit of a program (Jones 1976, 1977) to establish the mass function of stars in the solar neighborhood it has been necessary to establish whether many faint red stars are dwarfs or not. If they prove to be dwarfs then their luminosities are needed to derive their photometric parallaxes. The first approach (Jones 1973) used interference filters with the following wavelengths (in Å): 6076 Window; 6830 CaH; 7100 TiO; 7460 Window. The band passes are all roughly 30 Å. The magnitude difference m(6076) - m(7460) is comparatively free from blanketing by atomic lines and molecular bands and so provides an estimate of color temperature. As shown in the top panel of Fig. 1., the CaH; TiO ratio m(6830) - m(7100) is a powerful discriminant in separating M dwarfs from M giants and supergiants. The color m(7100) - m(7460) measures spectral type; the types so derived prove to be in good accord with those of Morgan and Keenan (1973), Wing (1973, 1978) and Wing et al. (1976). The three lower panels of Fig. 1 show the application of this technique to three objective prism surveys of faint red stars. MBT refers to McCarthy, Bertiau and Treanor (1964) who made a near infrared survey covering 165 square degrees in the South Galactic Cap. The dwarfs can be easily separated when they are redder than m(6067) - m(7460) = -1. The frequency of giants and dwarfs as a function of m(7460) is shown to the right. U refers to Upgren (1960) who made a blue survey covering 400 square degrees in the North Galactic Cap. In contrast to the near infrared, the blue region of the spectrum allows luminosity discrimination. Upgren's luminosities are in good accord with those derived here. However, working to a fixed blue magnitude limit introduces a bias against the reddest dwarfs which emerges when U is compared with MBT. The lowest panel is based on the square degree area discussed by Murray and Sanduleak (1972) which was based in turn on the near infrared survey by Sanduleak (1964). Most of the interference filter observations were made with the 2.5m

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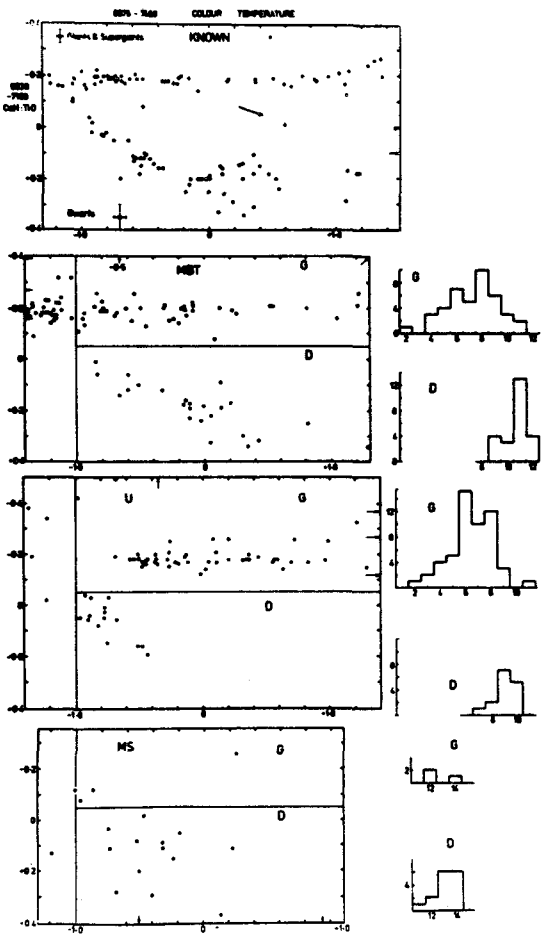

Fig. 1. Two color plots of m(6830) - m(7100) against m(6076) - m(7460) for four samples of stars. Stars of known luminosity are shown in the top panel where crosses represent supergiants, open circles giants and filled circles dwarfs. The arrow indicates the effect of reddening corresponding to an absorption of one magnitude. Typical error bars for dwarfs and giants are shown. The three lower panels illustrate the three objective prism surveys discussed in the text. The zones G and D have been delineated to separate the dwarfs from the giants in the top panel. To the right of each sample the frequency of giants and dwarfs redder than m(6076) - m(7460) = -1 is shown as a function of m(7460).

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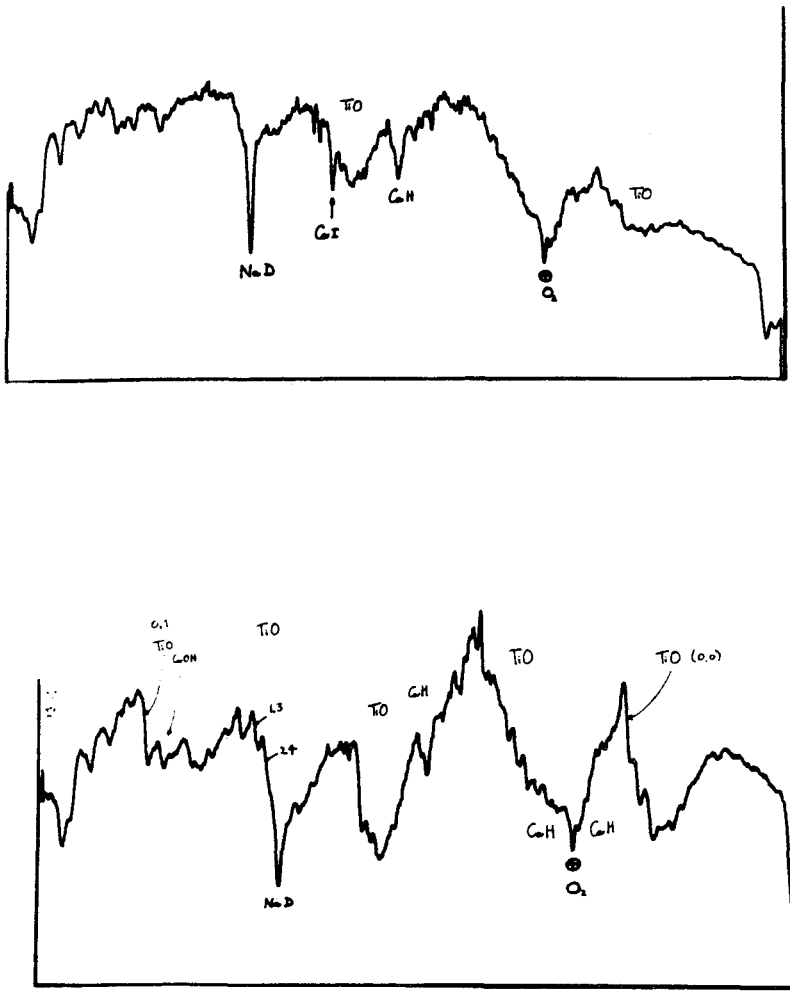

Fig. 2. Representative spectra of two red dwarfs observed with the Robinson-Wampler scanner 5100 - 7600 Å. Above is Kapteyn's star, sdM0 and below -8° 4352, dM3.5e.

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Isaac Newton Telescope but, as can be seen, photon statistics have degraded the accuracy. Nevertheless it is clear that the great majority are dwarfs, unlike the previous two samples. As might be expected the proportion of dwarfs to giants rises rapidly with apparent magnitude at the Galactic poles.

Although single channel interference filter photometry has proved a powerful technique it is being superseded by digital panoramic detectors which are becoming increasingly available. A sample of faint red stars discovered by Thé and Staller (1974) in the South Galactic Cap have been observed with the Robinson-Wampler scanner on the Anglo-Australian Telescope. The near infrared spectra of two typical red dwarfs observed with this equipment are shown in Fig. 2. The Na D lines and CaH prove to be luminosity dependent, in accordance with earlier work. Pesch's (1972) 5560 A band of CaOH is found to be an excellent luminosity indicator for stars later than M2 (Bailey, Jones and Mould 1979).

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