Horizontal Branch Stars, and Galactic and Magellanic Cloud Globular Clusters

Klaas S. de Boer

Washburn Observatory
University of Wisconsin, Madison WI 53706

Seven blue horizontal branch stars in the field have been observed, and a few HB stars have been isolated in globular clusters. Energy distributions are compared to assess possible differences, also in comparison with model atmospheres. Observed energy distributions of HB stars in NGC 6397 are used to estimate the total number of HB stars which produced the integrated fluxes as observed by ANS. Preliminary results are given for colors of globular clusters observed in the Magellanic Clouds and for their extent, based on the Washburn IUE extraction.

Since the observations of galactic globular clusters by the OAO-2 (Welch and Code 1980) and by the ANS (van Albada, de Boer and Dickens 1979, 1980) there is need for basic data on those constituents of globular clusters which provide most of the ultraviolet light. Neither of the two satellites had observed blue horizontal branch (BHB) stars in the field for their own sake, except for HD 109995 by OAO-2 (see Koornneef et al. 1980) and a few possible BHB stars by ANS (de Boer and Wesselius 1980).

IUE provided the opportunity to fill this gap. In addition, with its high spatial resolution it seemed to be possible to isolate BHB stars in galactic globular clusters, while an extension of the data base to Magellanic Cloud globular clusters is of general interest (Freeman 1979).

Blue Horizontal Branch Stars in the Field of the Galaxy

Seven BHB stars have been observed at low dispersion in the wavelength range 1150-3200Å. Most of the stars have an energy distribution in the UV which drops rapidly to <10% of the 1500-2000Å flux near 1330Å and none of the stars shows detectable flux shortward of Lα. In Fig. 1 the spectrum is shown for HD 86986. The fluxes are from the Washburn extraction which was adapted to correct the ITF error (see de Boer, Koornneef and Meade 1980, henceforth

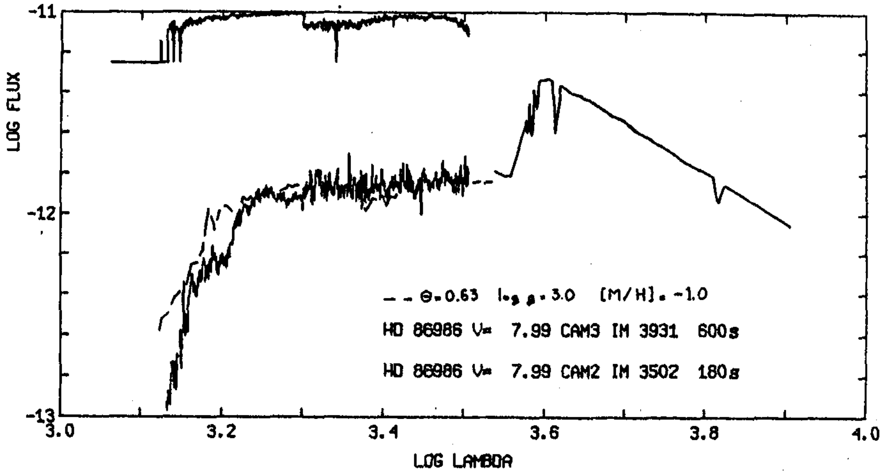

Fig. 1: Absolute flux of a field blue horizontal branch star. The uncertainty of the flux is plotted at the top in the same units as the spectrum (based on the Washburn extraction routine, see de Boer, Koornneef, and Meade 1980). Visual data are from Christensen (1978). Dashed lines near the UV spectrum are from a Kurucz model as labelled. Since the star has spectroscopically [M/H] ≈ -1.5, a better fit would be obtained with T ≈ 7800 K.

BKM). The large and small aperture spectra have been combined with weighting according to the error found in the Washburn extraction (BKM). The absolute calibration used is the one given by Bohlin et al. (1980) and the connection between SWP and LWR spectrum is made at 1992Å. From stromgren photometry and spectrum scans one obtains that HD 86986 has $T_{eff} \approx 8000$ K, log g ≈ 3.05, [M/H] ≈ -1.5 (Kodaira, Greenstein and Oke 1969; Hayes and Philip 1979). The UV, at λλ < 1600, is very sensitive for temperature effects. Comparison with the Kurucz (1979) models indicates that a fair fit is obtained with a model with T_{eff} one or two hundred degrees below 8000 K. Models at 8000 K also give a lower UV flux for metallicities more near solar, but then strong lines near 2400Å are indicated, while these are very weak in the observed stellar spectrum.

BHB Stars in Globular Clusters

NGC 6397 is a relatively open cluster, and is bright in the UV in spite of E(B-V) ≈ 0.2. Both characteristics make it possible to isolate BHB stars with IUE. Up to now 3 stars have been observed, star no. 56 and 210 (Graham and Doremus 1968) and a star very near the nucleus of the cluster. The BHB stars in NGC 6397 are much bluer than the known field HB stars. GD 56 has T_{eff} = 12000 K and log g = 3.15 (Newell, Rodgers and Searle 1969).

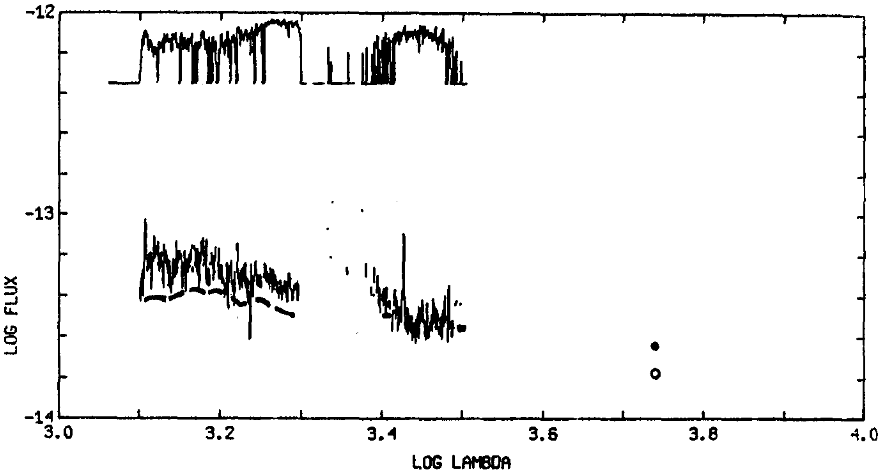

Fig. 2: Absolute reddening corrected flux for the BHB stars 56 with m_V = 13.95 (full spectrum and error plotted as in Fig. 1) and 210 with m_V = 13.63 (dashed line and filled circle at V) in NGC 6397.

The absolute flux at 1550Å of GD 56, log F_{1550} = -14.0, can be used in relation with the photometric flux from ANS log F_{1550} = -12.97 erg $cm^{-2}s^{-1}$ A^{-1} (van Albada, de Boer, Dickens 1980). Hence, in the ANS field of view of 2'.5 x 2'.5, 10 BHB stars have been sampled. Together with visual photometry this allows the determination of the total number of BHB stars in NGC 6397.

Globular Clusters in the Magellanic Clouds

The earlier UV photometric satellites OAO-2 and ANS had insufficient spatial resolution and sensitivity to isolate and measure globular clusters outside our galaxy. With IUE long integration times are possible and a few

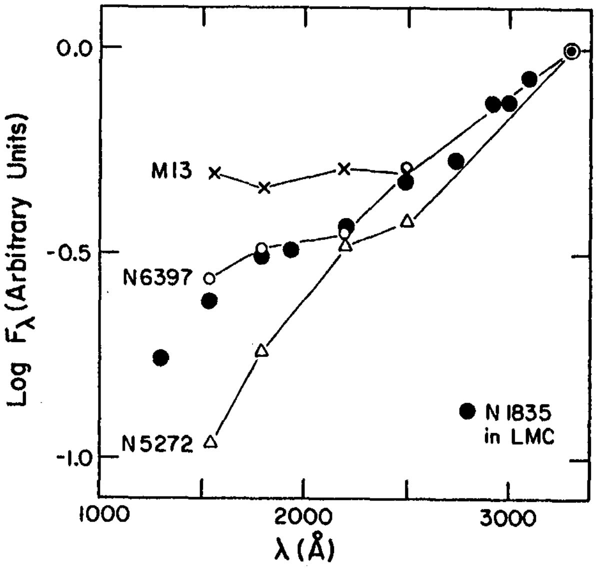

Fig. 3: UV energy distribution of the globular cluster NGC 1835 in the LMC, and for comparison 3 galactic globular clusters observed by ANS (van Albada, de Boer, Dickens 1980) adjusted to the IUE calibration following Bohlin et al. (1980). Fluxes with arbitrary relative shift.

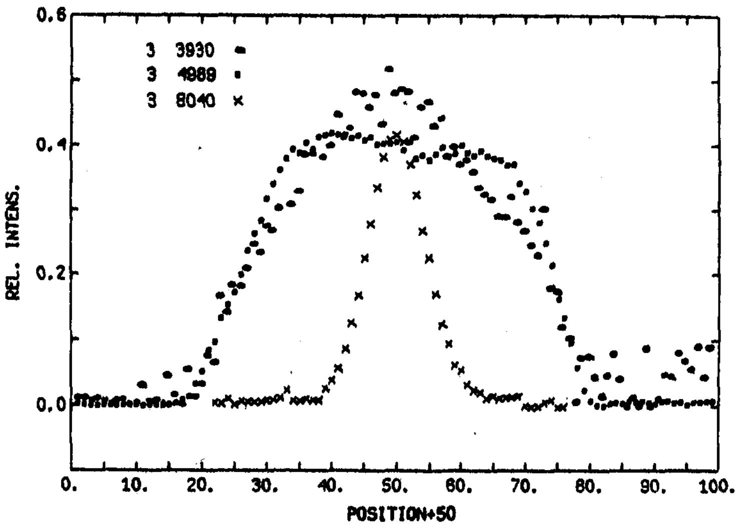

Fig. 4: Response of the large aperture in SWP (positionally adjusted coadded fits of 350 diagonals between 1580 and 2000Å; see BKM) for three different objects. Image 3-8040: star 56 in NGC 6397; image 3-2989: even illumination from diffuse light near the Trapezium; image 3-3930: NGC 1835 in the LMC. Further analysis of such responses can yield information on the spatial structure of LMC globular clusters.

clusters in the Magellanic Clouds have been observed. This program is still in progress and only preliminary results are given.

In Fig. 3 we show the UV energy distribution for NGC 1835, in comparison with three galactic globular clusters. The latter three have been selected from (van Albada, de Boer and Dickens 1980) group EB: M13, with extremely blue HB; group B: NGC 6397, with blue HB; group I: NGC 5272 with only moderately populated horizontal branch. NGC 1835 seems to have a UV brightness like a normal blue HB globular cluster.

The Washburn Extraction Routine (see BKM) can also be used to infer spatial information from the large aperture data. Fig. 4 shows as an example the spatial intensity distribution for a few different objects. Several of the globular clusters in the LMC are still so extended that two displaced large aperture IUE observations are required to get proper spatial information.

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