THE COMPOSITION OF WARM GIANTS IN M 71 AND M 5

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In 1979 a disturbing controversy arose in the field of globular cluster research when Cohen (1980) and Pilachowski, Canterna, and Wallerstein (1980) announced the results of the first high dispersion studies of the composition of giants in the globular clusters M 71 and 47 Tucanae. In contrast to earlier studies, which found metallicities of typically -0.3 and -0.5 dex, these investigators obtained values of -1.3 and -1.1. Since then, many have attempted to redetermine the abundances of M 71 and 47 Tuc to explain the discrepant results. These efforts have all suffered from the absence of high signal-to-noise, high resolution spectra of stars with temperatures above 4300 K.

Improvements to the 4m echelle spectrograph in the last 5 years have allowed us to get better spectra than previously possible. These improvements include a new, fast focal length camera, new coatings, better gratings, and CCD detectors. Furthermore, Cudworth (1985) has also provided a proper motion membership survey of stars in M71, so that members can be selected unambiguously.

New CCD spectra of two warm giants in M 71 and 3 giants in M 5 were obtained in May, 1986, with the Kitt Peak National Observatory 4m Telescope and echelle spectrograph equipped with the new UV Fast Camera and a TI CCD detector. The spectra have a resolution of 28,000, and a signal-to-noise of 50 or greater for the M 71 stars and 30 or greater for the M 5 stars, and are complete from 5000 to 7000 Å. Spectra of Arcturus and of the K0 III star ϵ Cygni were obtained as standards.

Model atmosphere effective temperatures were established based on

*Operated by the Association of Universities for Research in Astronomy, Inc., under contract with the National Science Foundation.

J. E. Grindlay and A. G. Davis Philip (eds.),
The Harlow-Shapley Symposium on Globular Cluster Systems in Galaxies, 497–498.

the Ridgway et al. (1981) calibration of (V-K) for the M 71 giants and the Böhm-Vitense (1981) calibration of (B-V) for the M 5 giants. The (V-K) colors for the two M 71 giants were kindly provided by M. Sitko. Surface gravities for the cluster giants were determined from the apparent magnitude, the cluster distance modulus, the temperature, bolometric corrections, and a stellar mass assumed to be 0.8 $M_\odot$. The adopted atmospheric parameters for the stars are given the Table I. The differential model atmosphere analysis followed procedures described by Pilachowski et al. (1983).

TABLE I
Astrophysical Parameters

Star	V	B-V	T(K)	log g	[Fe/H] (Arcturus)	[Fe/H] (eps Cygni)
M 71 - 56	13.25	1.37	4500	1.5	-0.2	-0.7
M 71 - 95	13.39	1.24	4600	1.6	-0.2	-0.7
M 5 - I-71	13.10	1.20	4340	1.2	-0.7	-1.2
M 5 - III-18	13.30	1.00	4580	1.4	-0.6	-1.1
M 5 - IV-34	13.06	1.20	4340	1.2	-0.7	-1.2

For M 71, we used E(B-V) = 0.25 and $(m-M)_v$ = 14.0; the photometry is from Arp and Hartwick (1971). For M 5, we used E(B-V) = 0.03 and $(m-M)_v$ = 14.51; the photometry is from Cudworth (1979).

The abundance of iron in our standard stars is given in Cayrel de Strobel and Bentolila (1983); in Arcturus, [Fe/H] = -0.5, and in ϵ Cygni, [Fe/H] = -0.06. With these values, we conclude that the abundance of iron in M 71 is [Fe/H] = -0.75 ± 0.15; M 5 is more metal poor, at [Fe/H] = -1.2 ± 0.15. In both clusters the abundances [Ca/Fe] and [Si/Fe] are near +0.2. We found no evidence these species are more enhanced in M 71 than in M 5.

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