A SEARCH FOR CATACLYSMIC BINARIES IN THE GLOBULAR CLUSTER M3

M. M. Shara*
Space Telescope Science Institute, Baltimore
A. F. J. Moffat*
Dept. de Physique, Universite de Montreal
D. A. Hanes
Anglo-Australian Observatory

ABSTRACT. Deep Hβ narrowband and broadband images of M3 have been electronically blinked to search for cataclysmic binaries. Tests of the method on a known, faint cataclysmic enable us to set limits on the sensitivity of the technique. No bright (M_B < 6) emission-line (equivalent width > 12 Å) cataclysmic binaries exist in M3 between 4 and 30 core radii from the center. Low luminosity globular X-ray sources could still be weak-lined (E.W. < 12 Å) and bright ($M_B \simeq +5$ like some old novae) or strong-lined (E.W. ≃ 60 Å) and faint (M_B > 7 like dwarf novae).

INTRODUCTION

Binary stars (*except* for cataclysmic variables) seem to be at least 30 times rarer in globular clusters than in the Galactic disk (Webbink 1980, IAU Symp. No. 88). For example, a sensitive radial velocity search has failed to detect a single spectroscopic binary (Gunn and Griffin 1979, A.J. *84*, 752) amongst 111 giants in M3. No W Ursae Majoris stars have been found on deep plates of M55 (Trimble, 1976 BAAS *8*, 443) or NGC 6397 (Budding and Alexander 1978, NATO Globular Cluster Workshop, Cambridge). Not a single ecliping binary of any other type is known to be a definite globular cluster member.

There are tantalizing indications, however, that cataclysmic variable (CV) binaries (which comprise a red dwarf transferring matter via a luminous accretion disk onto a white dwarf companion) are very common in globulars. One possible and two near certain classical novae have been sighted in globular clusters in the last century (and more may have been missed). Novae recur every $\sim 10^{5-6}$ years (Ford, 1978, Ap. J. *219*, 595), thus implying that a) 10 to 100 old novae reside in an average globular cluster (with a few far enough from the cluster core to be resolvable) and b) novae are 10 to 100 times more common in globulars than in the Galactic disk. The recent

*Guest observers, Canada-France-Hawaii telescope.

J. Goodman and P. Hut (eds.), Dynamics of Star Clusters, 103–104.

spectroscopic confirmations of a dwarf nova in M5 (Margon et al. 1981 Ap. J. Lett. *247*, L89) also hint that a systematic deep search for CV binaries in globulars would be rewarded.

Practically all of the ~500 known field cataclysmics have been discovered on the basis of their optical brightening to m $\lesssim$ 13. So few CVs are known in globulars, we believe, because no one has surveyed for them down to faint enough magnitudes or with the right technique. The main objective of this program is to discover CVs in globulars to a limiting magnitude m $\simeq$ 21 systematically using the method described below.

OBSERVATIONAL METHOD

The distinguishing characteristics of CV spectra in quiescence are a blue continuum which is essentially free from absorption lines but dominated by Balmer emission lines. These emission lines make even faint CVs detectable in the following manner.

We have used the Canada-France-Hawaii 3.6 meter telescope +90 m. ITT image tube camera at prime focus to obtain Hβ narrowband (35 Å FWHM) and broadband (350 Å FWHM) plates of i) a 19th magnitude, moderate line-strength cataclysmic binary and ii) a 20' diameter field centered on M3. The plates have been digitized on a Space Telescope Science Institute PDS machine and displayed on a de Anza image display. An empirical density-to-density transformation is derived for each plate pair which nulls stars in the difference image Hβ narrow-Hβ wide. Stars with excess Hβ (i.e. Hβ in emission) then stand out from all others, even in crowded fields.

RESULTS

The cataclysmic binary used to test the observational technique, WY Sge (Nova 1783) is at $M_B \simeq 19$, and has equivalent width (Hβ) $\simeq$ 18 Å. It was immediately and easily re-discovered as the only Hβ-emission object on the Hβ narrow-Hβ wide image. From our experience with WY Sge we estimate that our technique works for stars $\gtrsim$1 magnitude brighter than the plate limit, and with E. W. (Hβ) $\gtrsim$12 Å.

No Hβ emission-line candidates (with $M_B < 6$ and E.W. (Hβ) > 12 Å) were found in M3 between four and thirty core radii from the cluster center.

CONCLUSIONS

Significant numbers of bright, strong emission-line cataclysmic binaries do not exist in M3 (except possibly near the cluster core). Weak-lined novalike objects and dwarf novae would have escaped detection in this first survey.

More rigorous data reduction is underway, as are deeper searches for very faint cataclysmics; both will be reported in detail elsewhere.

https://doi.org/10.1017/S0074180900147321 Published online by Cambridge University Press