Faint Cataclysmic Variables in the globular cluster 47 Tucanae

* Rivera Sandoval L. E. 1; van den Berg, M. 1, 2; Heinke, C. O. 3; Cool, A. 4; Cohn, H. N. 5; Lugger, P. M. 6; Ivanova N. 7; Edmonds P. D. 8; Grindlay J. E. 9; Freire P. C. C. 9; Wijnands, R. 2.

1 Anton Pannekoek Institute, The Netherlands
2 Harvard-Smithsonian Center for Astrophysics, USA
3 Department of Physics of University of Alberta, Canada
4 Department of Physics and Astronomy of San Francisco State University, USA
5 Department of Astronomy of Indiana University, USA
6 Max-Planck-Institut für Radioastronomie, Germany

GOALS OF OUR SURVEY
1. Identify faint CVs in 47 Tuc by looking for counterparts to Chandra X-ray sources in near-ultraviolet (NUV).
2. Obtaining the deepest measurements of the CV luminosity function of 47 Tuc.
3. Comparing the CV luminosity function of 47 Tuc with those measured in the field and in the core collapsed cluster NGC 6397. Based on the spatial distribution and unusually flat (compared to the field) CV optical luminosity function in NGC6397, Cohn et al. (2010) found that the CV population in this cluster is dynamically altered. In this context we want to test whether the CV luminosity function of NGC 6397 is unusually flat or if it is typical for globular cluster CVs.

INTRODUCTION

As very high stellar densities can be reached in GCs (10^4 stars per cubic parsec), interactions and collisions between stars are common. In those conditions, the cores of GCs are rich sites to produce exotic binaries such as cataclysmic variables (CVs), which are systems harboring a white dwarf accreting from low mass companions (figure 1). Studying the CV population helps to understand how dense environments alter the production and destruction of binaries.

The study of binaries in globular clusters (GCs) is important to understand the dynamical evolution of GCs, since binaries can help to prevent core collapse.

The globular cluster 47 Tuc is ideal to study those binaries because it is a nearby, dense, massive and low extinction cluster. Moreover, distance, stellar age and metallicity are well known for this cluster. This allows the study of a large population of interacting binaries on their descendents, such as CVs, millisecond pulsars (MSPs), low mass X-ray binaries (LMXBs), blue stragglers (BSS) and active binaries (ABs).

GOALS OF OUR SURVEY

1. Identify faint CVs in 47 Tuc by looking for counterparts to Chandra X-ray sources in near-ultraviolet (NUV).
2. Obtaining the deepest measurements of the CV luminosity function of 47 Tuc.
3. Comparing the CV luminosity function of 47 Tuc with those measured in the field and in the core collapsed cluster NGC 6397. Based on the spatial distribution and unusually flat (compared to the field) CV optical luminosity function in NGC6397, Cohn et al. (2010) found that the CV population in this cluster is dynamically altered. In this context we want to test whether the CV luminosity function of NGC 6397 is unusually flat or if it is typical for globular cluster CVs.

ANALYSIS AND RESULTS

In our survey we are using near-ultraviolet images of the globular cluster 47 Tuc taken in the wavelengths 280.7 nm and 392.1 nm with the Wide Field Camera 3 on the Hubble Space Telescope (HST).

Combining our data with the catalog of Chandra sources in this cluster (Heinke et al. 2005, completeness limit L_X=10^31 erg/s), we are identifying the NUV counterparts of 241 Chandra sources that are in our FOV, including 116 previously unclassified sources. We have identified 18 new faint CV candidates so far.

Figure 2 shows the position of the new CV candidates in the color magnitude diagram (CMD) of 47 Tuc in NUV. An identification of a CV with blue colors in the 3-sigma error circle of Chandra source is shown in figure 3. In figure 4 we observe that the new identifications have X-ray luminosity an order of magnitude deeper than the previously identified CVs by other authors (Edmonds et al., 2003).

SUMMARY

Using a catalog of X-ray sources and NUV colors, we have found 18 new candidate CVs so far out of 44 unclassified sources investigated.

New faint sources show blue colors and many of them are on the white dwarf sequence.

The new CV candidates have the lowest X-ray luminosities compared with other classes of known X-ray sources in 47 Tuc for which we have found their counterpart in NUV, such as MSPs, QLMXB and previously identified CVs. X-ray values were taken from Heinke et al. (2005).

PLANS FOR THE FUTURE

Identifying more CV candidates using the CMD, X-ray source positions and proper motions to exclude non cluster objects.

Comparing our results with the measured CV luminosity function in the field and in other globular clusters like the core collapsed globular cluster NGC 6397.

REFERENCES


World Map of the hypothetical 47 Tuc in the wavelengths 280.7 nm and 392.1 nm. The sequence on the right is the main sequence of 47 Tuc. X rays (Chandra) and not calibrated yet. The new CV candidates have the lowest X-ray luminosities compared with other classes of known X-ray sources in 47 Tuc for which we have found their counterpart in NUV, such as MSPs, QLMXB and previously identified CVs. X-ray values were taken from Heinke et al. (2005).