Precise *Chandra*/HRC imaging of globular cluster LMXBs: first results on NGC 1851 and Liller 1

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[Contributed talk, 15min.]

Abstract

The nature of the 12 bright ($>10^{36}$ erg s^{-1}) X-ray sources in globular clusters appears distinct from that of low-mass X-ray binaries (LMXBs) in the Galaxy as a whole. They are over-abundant by a factor $\gtrsim$100 indicating the need for different formation mechanisms. All but one have been reported to exhibit type-I bursts, indicating neutron star accretors. Moreover, the limited number of optical counterparts (only 3 or 4) already implies that their period distribution is also remarkably different from that of field LMXBs, with a preponderance of ultra-short period systems. As well as their intrinsic interest, it is now understood that even this small population of binaries may play a crucial role in the dynamical evolution of their host clusters. Clearly, a more complete understanding of the nature of these systems is of great importance, for which IR/optical/UV counterpart identification is the vital next step. However, even given the $3''$(90% confidence limit) *Einstein* X-ray positions, counterpart identifications have proven very difficult, due to the extremely crowded locations. Hence, the vast improvement in positional accuracy/precision afforded by *Chandra* imaging promises to bring the breakthrough we need. Here we present first results on two clusters we have imaged with the HRC.

We obtained exposures of the field of X 0512-401 in the globular cluster NGC1851 with the *Chandra*/HRC-S in X-rays, and also in the far-UV with the *Hubble Space Telescope*. We derive an accurate new X-ray position (within $\sim1''$) for X 0512-401, which enables us to confirm that the *only* plausible candidate for the optical/UV counterpart is the Star A, which we previously identified from WFPC2 imaging. We find no evidence for X-ray or UV flux modulation on the ultra-short ($\lesssim$ 1 hr) expected binary period, which implies a low system inclination. In addition, we have detected and spatially resolved an X-ray burst event, confirming the association of the burster, quiescent X-ray source, and optical object. The very large L_X/L_{opt} of this object implies an extraordinarily compact system, similar to the sources in NGC6624 and NGC6712.

In spite of many X-ray studies of the "Rapid Burster" (MXB1730-335) located in the highly reddened globular cluster Liller 1, to date there has been no known optical/IR counterpart for the object, no precise astrometric solution that correlates X-ray, radio, and optical positions and thus restricts the number of possible candidates, nor even published IR images of the field. We solve a previous radio/X-ray positional discrepancy, presenting the results of our precise *Chandra*/HRC-I X-ray imaging, which definitively show that the radio source is positionally aligned with MXB1730-335. At the same time, we have detected three additional low luminosity ($L_X \sim 10^{34}\,\mathrm{erg\,s^{-1}}$) X-ray sources within two core radii, which are possibly quiescent low-mass X-ray binaries. We present both ground-based and *Hubble Space Telescope* infrared imaging of the field (in quiescent and bursting X-ray states of the RB), together with the necessary astrometric solution to overlay the radio/X-ray source positions. Even at *HST* resolution, the RB field is very complex and there are multiple candidates. No object of unusual color, or of substantial variability in quiescent versus active or burst versus non-burst states, is identified. Further, more sensitive *HST*/NICMOS and/or

ground-based AO observations are needed to confidently identify the proper counterpart.

CATEGORY: Black Hole and Neutron Star Binaries