Discovery of a new X-ray transient in the globular cluster Liller 1

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Publication date
2018
Document Version
Final published version
Published in
The astronomer's telegram

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2 Apr 2019; 10:31 UT

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*on **3 May 2018; 07:32 UT***
Distributed as an Instant Email Notice Transients
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Subjects: X-ray, Request for Observations, Globular Cluster, Transient

Referred to by ATel #: 11646, 11747

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We report on the discovery of a new X-ray transient in the globular cluster Liller 1 with Chandra.

Swift/XRT monitoring observations of the globular cluster Liller 1 in early April 2018 revealed low-level activity (around 0.1 ct/s) in the core of the cluster. Liller 1 harbors the well-known transient neutron star low-mass X-ray binary MXB 1730-335, also known as the Rapid Burster. An archival Chandra HRC-I observation of Liller 1 (Homer et al. 2001, ApJ, 122, 2627) indicates that in addition to the Rapid Burster, at least three other (low-luminosity) X-ray sources are present in the error circle of the Swift X-ray source. Type-II bursts (Lewin et al. 1976, ApJ, 207, L95), which would have identified the Swift source as the Rapid Burster, were not seen in the Swift observations (April 4, 9, 17, 20, 24, and 29) nor in follow-up NICER observations (April 20 and 22). Type-I bursts were not detected either. Prompted by the absence of type-II bursts, we triggered our Chandra program to identify possible new transients in globular clusters.

Chandra observed Liller 1 with ACIS-S in 1/8 subarray mode for ~9 ks, starting on 2018 April 30 at 11:08 UT. Our observation reveals three X-ray sources in the core of Liller 1. The brightest of these sources, the current X-ray transient, does not show type-I or type-II bursts. Comparison with a reprocessed version of the archival Chandra HRC-I observation indicates that two of the sources in our ACIS-S observation can be matched with two of the low-luminosity X-ray sources (C2 and C3) reported by Homer et al. (2001). However, the third source detected in the ACIS-S image does not coincide with the Rapid Burster. As can be seen from the coordinates listed below, the offsets (ACIS-S minus HRC-I) are (delta_ra,delta_dec)=(+0.1",-0.3") for C2 and (+0.1",-0.1") for C3. This is consistent with the absolute pointing accuracy of Chandra (~0.6"). However, the current transient is shifted from the Rapid Burster by an angular distance that is substantially larger (+0.1",-1.3"), indicating that the current transient corresponds to a previously unidentified X-ray source in Liller 1.

ACIS-S R.A. Dec.

Current Transient	17:33:24.60	-33:23:21.5
C2	17:33:24.16	-33:23:22.1
C3	17:33:24.11	-33:23:26.1

HRC-I	**R.A.**	**Dec.**
Rapid Burster	17:33:24.59	-33:23:20.1
C2	17:33:24.15	-33:23:21.8
C3	17:33:24.10	-33:23:26.0

The formal errors on these coordinates (from wavdetect in CIAO 4.9) are less than 0.1" in each direction.

Following Chandra's naming convention, we refer to the new transient as CXOU J173324.6-332321. The 0.5-10 keV spectrum of the source can be well fit with an absorbed power law (when including Chandra's pile-up model). We find NH=3.8(2)e22 cm^-2, a power-law photon index of 1.9(1), and an unabsorbed 0.5-10 keV flux of 6.9(3)e-11 erg/cm^2/s. For a distance of 8.2 kpc (Harris 1996, AJ, 112, 1487), the 0.5-10 keV luminosity is 5.5(3)e35 erg/s. We note that at this luminosity the observed power-law index is consistent with either black hole or neutron star X-ray binaries (Wijnands et al. 2015, MNRAS, 454,1371).

Finally, our results suggest that past low-level activity in Liller 1 (detected with all-sky monitors, or even the Swift/XRT) that was attributed to the Rapid Burster may have come from CXOU J173324.6-332321.

We thank the Chandra staff for their help in executing this observation as soon as possible.

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