Garden variety X-ray binaries in Cen A

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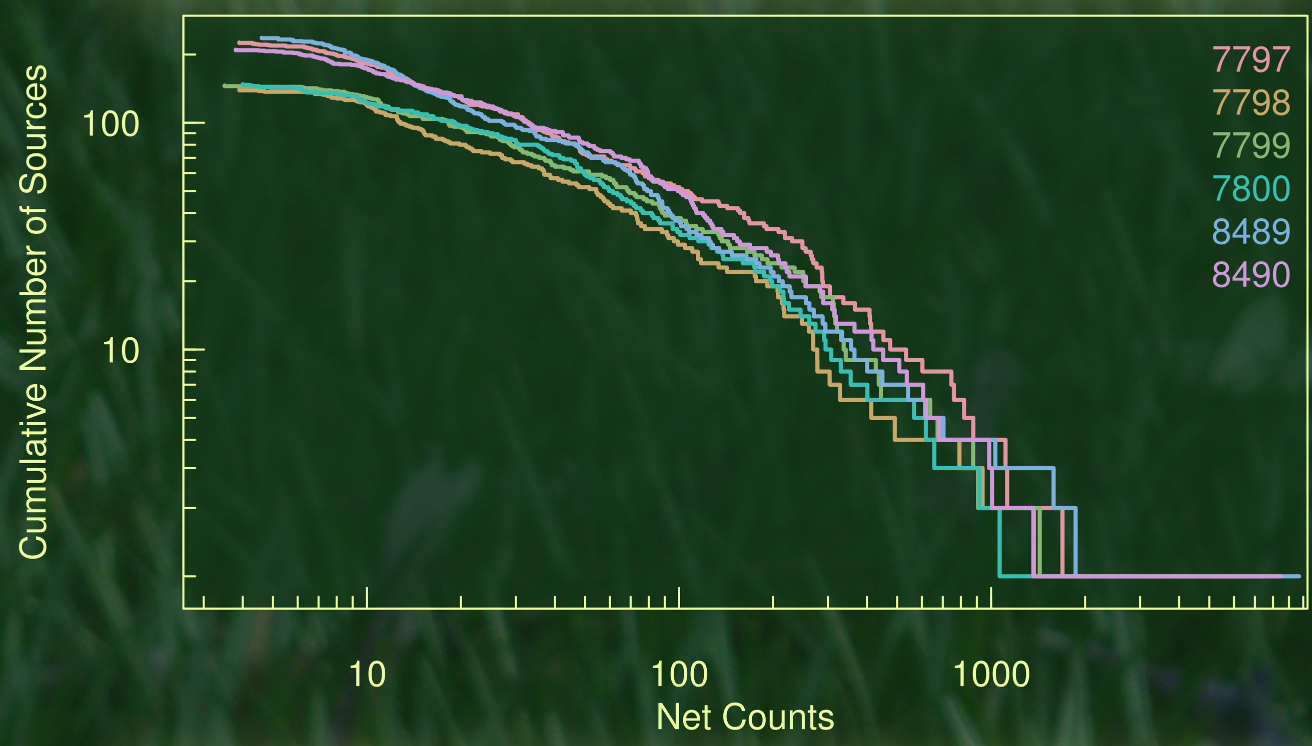
Cen A Very Large Project

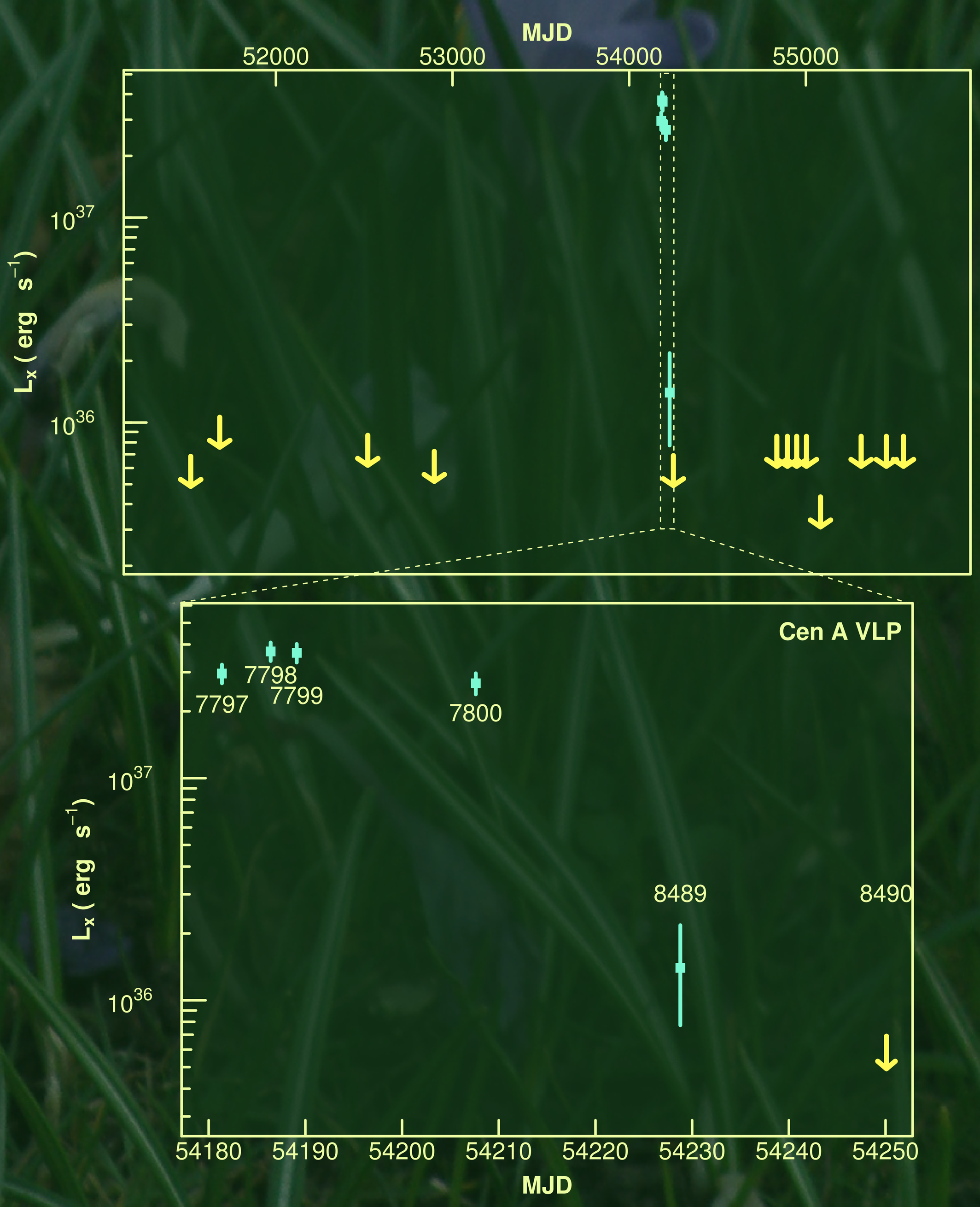
Cen A is a giant early-type galaxy 3.8 Mpc away, outside of the Local Group. Six 100 ks Chandra observations in 2007, led to investigation of the central X-ray jet, hot gas, AGN and the discovery of a new Ultraluminous X-ray Source (ULX) [4,5,7,8]. In terms of detailed spectral analysis, ULXs are the most studied X-ray binaries that reside beyond the Local Group.

Our work involves spectral modelling of the large X-ray binary population. This will give an unprecedented insight into black hole and neutron star X-ray binaries of the 'garden variety', those that are analogues to the majority of Galactic sources. We also hope to test the apparent preference of black hole binaries to exist in redder globular clusters.

Within a 5' radius of the Cen A nucleus we identified 360 X-ray point sources. Of these, there are around 70 sources that have >100 counts in at least one of the six observations, which are cumulatively shown below.



We contrast this with spectral modelling of point sources in galaxies NGC 3379 and NGC 4278 [1,3], also outside the Local Group, from which only 15 non-ULX sources have been bright enough to subject to spectral fitting.

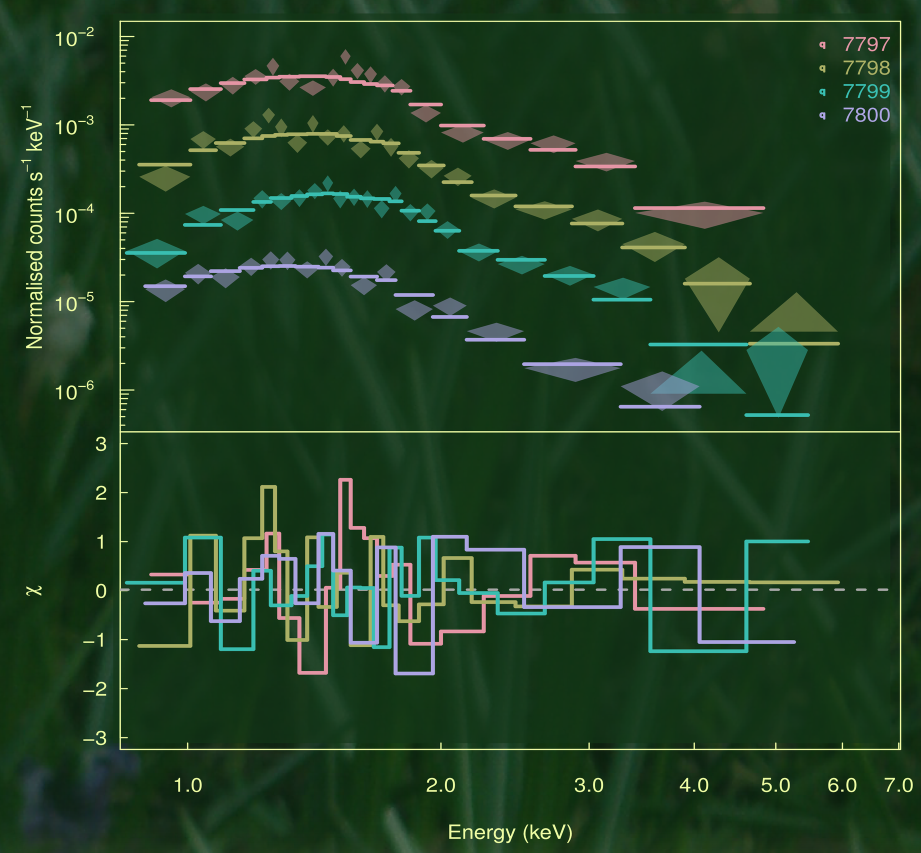


Black Hole Transient Candidate

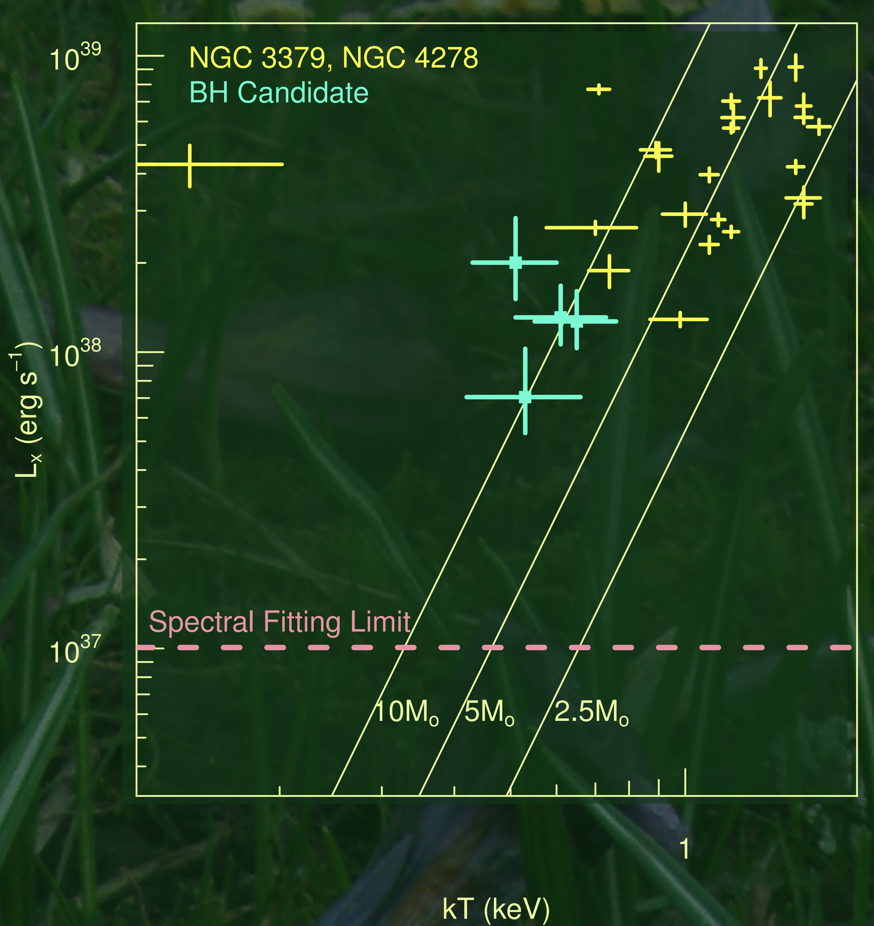
On the left is the 0.5-2.0 keV lightcurve, uncorrected for absorption, of a source detected (light blue) in the VLP data. The yellow arrows represent upper-limits obtained from all other Chandra ACIS observations of Cen A.

The lower-panel shows the VLP observations only. The source experienced an extreme change in luminosity on a timescale of a few weeks, characteristic behaviour of black hole low mass X-ray binary (LMXB).

This conclusion is supported by the spectra from the bright observations (right). Analysis suggests the source was in the thermally dominant spectral state, and is softer than comparable neutron star LMXB spectra.



The above plot shows the four bright spectra fit to an absorbed disc blackbody model (with y-axis offset) with T_{in} = 0.6 keV and a peak L_X = 2x10^{38} erg/s. Absorption was consistent with that of the dust lanes, which are coincident with the source position.



Thermal States

The figure to the left shows the best-fit disc blackbody parameters of the black hole transient candidate in Cen A together with sources from other galaxies situated outside the Local Group [1,3]. Reasonable estimations of black hole mass are overlaid.

Globular Cluster Sources

Of the 50 brightest sources, 10 reside within 2" of a globular cluster. Determining the nature of the compact object in these systems will allow us to further test the hypothesis that the formation of black hole accretors is favoured in redder clusters [6].

We performed single component spectral fits to the brightest source coincident with a cluster. The absorption column tended toward zero for an absorbed disc blackbody fit, while consistent with the Galactic value for an absorbed power law. Comparison with the results of fitting simulated source spectra [1] suggests the source was in a power law dominant hard state with a luminosity of 3.6x10^{38} erg/s. This is suggestive of a black hole, but unsupported by the transient behaviour typical of LMXBs.

References

[1] Brassington et al. 2010, ApJ, 725, 1805
[2] Burke et al. 2012, ApJ, 748 (http://arxiv.org/abs/1202.3149)
[3] Fabbiano et al. 2010, ApJ, 725, 1824
[4] Hardcastle et al. 2007, ApJL, 670, L81
[5] Kraft et al. 2008, ApJL, 677, L97
[6] Maccarone et al. 2011, MNRAS, 410, 1655
[7] Sivakoff et al. 2008, ApJL, 677, L27
[8] Worrall et al. 2008, ApJL, 673, L135

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