**Chandra XVP Observation of Low-mass X-ray Binaries in NGC 3115**

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**Abstract:** We present our study of low-mass X-ray binaries (LMXBs) in NGC 3115 using the Ms Chandra X-ray Visionary Project (XVP) observation. By systematically comparing their spectral dependence on luminosity with those of Galactic X-ray binaries, we show that most bright sources in NGC 3115 are neutron star (NS) LMXBs in the soft state, except ten candidate black hole (BH) LMXBs showing very soft spectra. We construct the X-ray luminosity function (XLF) down to the limit of $10^{36}$ erg/s, and show significant flattening of the overall XLF from $dN/dL \propto L^{-2.2}$ above $6 \times 10^{37}$ erg/s to $dN/dL \propto L^{-1.0}$ below it. The XLF of globular cluster (GC) LMXBs is flatter than that of field LMXBs, indicating their different origins.

### Introduction

Chandra carried out 1 Ms XVP observation of the nearby lenticular galaxy NGC 3115 in 2012. With a limiting $L_X \sim 10^{36}$ erg/s, it is one of the best observed early-type galaxies by Chandra and is ideal for addressing two long-standing problems in understanding LMXBs in nearby galaxies: the source identification and X-ray luminosity function in the low luminosity limit.

Figure 1. Chandra X-ray image of NGC 3115. The image is false-colored (0.5-1.2 keV in red, 1.2-2.0 keV in green, and 2.0-7.0 keV in blue), adaptively smoothed, and exposure-corrected. The D$_2$ eclipse of the galaxy is also shown.

### Source Identification

Figure 2. Incompleteness corrected and cosmic X-ray background (CXB) contribution subtracted XLFs for all LMXBs (left panel), field LMXBs (middle panels) and GC LMXBs (right panel). We plot both the cumulative (upper panels), the red solid line with the shaded area representing the Poissonian uncertainty and differential forms (lower panels). The green lines are our best broken PL fits. The dashed blue lines in the left panels are the fit to the average XLF of 20 early-type galaxies by Zhang et al. (2012), with the normalization decreased by 24%. The black dotted line is the expected CXB distribution.

Our main findings concerning XLFs in NGC 3115 include (Lin et al. 2014b):

- **Dominance of sources in the NS LMXB soft-state track in the $L_X$-$T_{kT}$ plots (gray region in Figure 1):**
  - $L_X \lesssim 10^{37}$ erg/s: harder spectra at higher luminosity, dominated by atolls (the low-$L_1$ class of NS LMXBs) in the soft state, in which the thermal disk and NS emission follow $L \propto T^4$ evolution (Lin et al. 2007, 2009, 2010),
  - $L_X \gtrsim 10^{37}$ erg/s: relatively constant spectral shape ($T_{kT} \sim 1.5$ or $kT_{MCD} \sim 1.5$ keV), dominated by Z sources (the high-$L_1$ class of NS LMXBs), in which the inner disk and NS emission reach local Eddington limit, resulting in relatively constant temperature (Lin et al. 2009, 2012),
  - Ten BH LMXBs with significantly softer spectra than NS LMXBs.

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