Multiwavelength Observations of Gamma-ray Binary Candidates

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Abstract

There are currently only six known high mass X-ray binaries (HMXBs) that also exhibit MeV, GeV, and/or TeV emission ("gamma-ray binaries"). Expanding the sample of gamma-ray binaries and identifying unknown *Fermi* sources are currently of great interest to the community. Based upon their positional coincidence with the unidentified *Fermi* sources 1FGL J1127.7-6244c and 1FGL J1808.5-1954c, the Be stars HD 99771 and HD 165783 have been proposed as gamma-ray binary candidates. During *Fermi* Cycle 4, we have performed multiwavelength observations of these sources using *XMM-Newton* and the CTIO 1.5m telescope. We do not confirm high energy emission from the Be stars. Here we examine other X-ray sources in the field of view that are potential counterparts to the Fermi sources.

Introduction

About 60% of HMXBs are Be/X-ray binaries (BeXRBs) that contain a B-type star with a circumstellar mass-loss disk (a Be star) with a compact companion, usually a neutron star (Liu et al. 2006). Be star systems also comprise 50% of the known gamma-ray binaries: LS I +61 303, PSR B1259−63, and HESS J0632+057. The high energy emission is powered by either wind accretion onto the compact star, or by the collision of stellar and relativistic pulsar winds in a shock region (Dubus 2006). All of these sources present a unique opportunity to study particle acceleration in nearby, Galactic sources.

We have cross-correlated the 1FGL catalog (Abdo et al. 2010) with the Jaschek & Egret (1982) catalog of known Be stars, and we discovered two Be stars within the 95% error ellipse of 1FGL sources. Using *XMM-Newton* images, we find that the Be stars are not significant X-ray sources and are unlikely counterparts of the very high energy emission.

References

Abdo, A. A., Ackermann, M., Ajello, M., et al. 2010, ApJS, 188, 405
Dubus, G. 2006, A&A, 456, 801
Jaschek, M. & Egret, D. 1982, IAUS, 98, 261
Liu, Q. Z., van Paradijs, J., & van den Heuvel, E. P. J. 2006, A&A, 455, 1165
Nolan, P. L., Abdo, A. A., Ackermann, M., et al. 2012, ApJS, 199, 31
Watson, M. G., Schröder, A. C., Fyfe, D., et al. 2009, A&A, 493, 339

1FGL J1808.5−1954c (2FGL 1808.6−1950c)

The GeV source position is known to within 4.7 arcmin (95% confidence) and may be associated with the Be star HD 165783. The optical star has been correlated with a serendipitous *XMM-Newton* source (Watson et al. 2009), but the pipeline images suffer from very high background and the source lies near the chip gaps. Therefore we obtained new XMM-Newton observations of the field on 2012 March 24.

We observed HD 165783 using the CTIO 1.5m telescope and CHIRON spectrograph between 2011 August and 2011 November. The star has a spectral type of B3/5 Ve. It has a high proper motion of 6.4 μas/yr but we are unable to determine its radial velocity, so its runaway nature cannot be determined. No orbital period is known. This star may be a post-supernova runaway system.

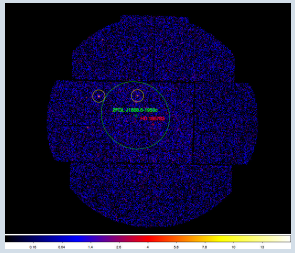

Figure 1: A 1.78 ks *XMM-Newton* MOS1 image of the HD 168783 field of view. The GeV source position and 95% error ellipse are shown in green. The position of the Be star is marked as a red cross, but no keV emission is detected at that position. However, two unidentified keV sources lie within or near the 2FGL error ellipse.

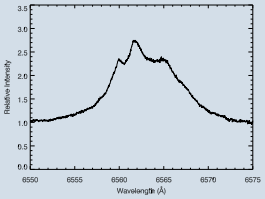

Figure 2: The Hα line profile of the Be star HD 168783 reveals a complex circum-stellar disk structure that makes it difficult to determine the star's radial velocity.

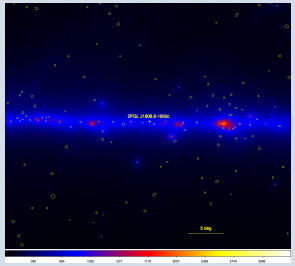

Figure 3: The source 1FGL J1808.5−1954c (2FGL 1808.6−1950c) lies in the crowded Galactic plane region. Since the time our *Fermi* Cycle 4 proposal was written, the GeV source has been associated with a globular cluster.

1FGL J1127.7−6244c

The second correlation between the 1FGL and the Jaschek & Egret catalog is the star HD 99771. Little is known about the Be star other than its spectral type (B7 Vne), and no previously known X-ray sources lie within the *Fermi* 95% error ellipse (7.5 arcmin). We observed the field with XMM-Newton on 2012 February 4. Optical observations with the CTIO 1.5m telescope and CHIRON spectrograph are anticipated during Spring 2013. No counterpart to this source was noted in the 2FGL catalog (Nolan et al. 2012).

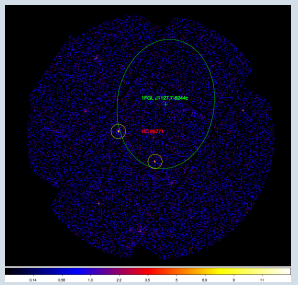

Figure 4: A 1.35 ks *XMM-Newton* MOS2 image of the HD 99771 field of view. The GeV source and Be star positions are marked in the format of Figure 1. Once again, no keV emission is detected at that the Be star's position. Two unidentified keV sources lie within or near the 1FGL error ellipse.

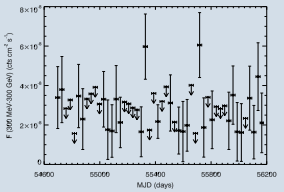

Figure 5: A binned light curve of 1FGL 1127.7−6244c reveals 2 significant flaring episodes since the *Fermi* mission began.

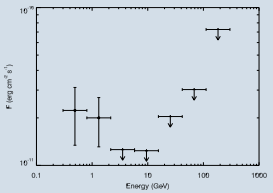

Figure 6: GeV spectrum of 1FGL 1127.7−6244c during the bright flares.

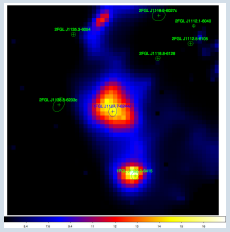

Figure 7: A counts map of 1FGL 1127.7−6244c during the bright flares.

Acknowledgements

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