A multi-wavelength study of the first gamma-ray emitting LMXB XSS J12270-4859

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(Suzaku special issue; arXiv:1105.4717)

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1. Introduction

Fermi detected 1451 $\gamma$-ray sources (Abdo+ 2010). Most are AGN, some are Galactic sources. Half of them are un-Ided.
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Fermi detected 1451 $\gamma$-ray sources (Abdo+ 2010). Most are AGN, some are Galactic sources. Half of them are un-IDed.

There are many un-IDed Galactic sources.

So, there must be new classes of Galactic sources.

Goal of this study: to find $\gamma$-ray emitting LMXBs
1. Introduction

**Approach**

1. **Find LMXBs from the INTEGRAL catalog.**
   - Optical spectroscopy can find CVs and LMXBs. (Masetti+ 2006; Pretorius 2009)
   - X-ray observations distinguish CVs and LMXBs. (Saitou+ 2009)
     - CVs: Fe lines, long-term variability (~hours).
     - LMXBs: no Fe lines, short-term variability (~sec).

2. **Find the Fermi counterpart.**
   - Correlation of $\gamma$-ray and others. (de Martino+ 2010; Hill+ 2011)

3. **Reveal the nature.**
   - Simultaneous X-ray / IR observations. (Saitou+ 2011)
   - Broad-band SED. (Saitou+ 2011)
2. LMXB? - Optical spectroscopy

We observed INTEGRAL sources with Suzaku.

**XSS J12270-4859**
- discovered by RXTE (Revnivtsev+ 2004)
- re-discovered by INTEGRAL (Bird+ 2007)
- a binary system with a low-mass companion by follow-up optical spectroscopy (Masetti+ 2006; Pretorius 2009)
2. LMXB? - Optical spectroscopy

We observed INTEGRAL sources with Suzaku.

**XSS J12270**
- discovered
- re-discovered
- a binary system by follow-up
  (Masetti+ 2006)
We observed INTEGRAL sources with Suzaku.

**XSS J12270**
- discovered
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  (Masetti+ 2006)

**XSS J12270-4859 is a CV or LMXB**
2. LMXB? - X-ray spectroscopy

- Intensity (s\(^{-1}\) keV\(^{-1}\))
- XIS FI
- XIS BI
- HXD PIN

Energy (keV)

- \(10^{-4}\) to \(10^{-1}\)
- \(30\) to \(6.5\) to \(7.0\)

\(\chi\)

Intensity vs. Energy (keV)
2. LMXB? - X-ray spectroscopy

![Graph showing X-ray spectra with labels XIS FI, XIS BI, and HXD PIN.]

- Power-law spectra
- No emission lines
2. LMXB? - X-ray light curve

Flares (~250 s), Dips, and Hardenings

(0.2–12 keV)
2. LMXB? - X-ray light curve

**Flares (~250 s), Dips, and Hardenings**

- **0-20 (ks)**
- **20-40 (ks)**
- **40-60 (ks)**

**Count rate (s⁻¹)**

**Median energy (keV)**

**Elapsed time (ks)**
2. LMXB? - X-ray light curve

Flares (~250 s), Dips, and Hardenings

No emission lines + Short-term variability → LMXB
3. Fermi counterpart? - $\gamma$-ray and radio

$\gamma$-ray

1FGL J1227.9-4852

(de Martino+ 2010)

X-ray

XSS J12270-4859

(de Martino+ 2010)
3. Fermi counterpart? - \( \gamma \)-ray and radio

**XSS J12270-4859** is a Fermi source and a radio source

X-ray (RXTE; 2-10 keV) and NIR (IRSF; J, H, Ks) observations (Pl: Saitou)

Flares (~1500 s)

X-ray and IR emissions have the same origin

(a) XSS J12270-4859

(b) Microquasar

log $F_\nu$ (Jy)

log $\nu$ (GHz)

SUMSS
ATCA
AKARI
2MASS
USNO
XMM-Newton/OM
Suzaku
Fermi

GRS 1915+105
XTE J1118+480
Cygnus X-3

(a) XSS J12270-4859

(b) Microquasar

Broad-band SED + repetitive flares → **microquasar** with synchrotron jet
5. Discussion

1. Find LMXBs from the INTEGRAL catalog. Suzaku revealed the source is a LMXB.

2. Find the Fermi counterpart.
   The source has the Fermi counterpart.

3. Reveal the nature.
   A microquasar with a synchrotron jet.

At 1 kpc, $L_{\text{bol}} \sim 10^{34} \text{ erg/s}, \sim 10^{-4} L_{\text{Edd}}$ for 1 M☉.

**XSS J12270-4859 is**
- the first γ-ray emitting LMXB
- a microquasar at low luminosity state
5. Discussion

XSS J12270-4859 shows characteristic variability
5. Discussion

Are there similar variable sources?

Yes.

Similar variable source IGR J17091-3624 is discovered (Altamirano+ 2011).
5. Discussion

IGR J17091-3624

(http://web.me.com/tbelloni/BlackHoleTransients/IGR17091.html)
Are there similar variable sources?

Yes.
Similar variable source IGR J17091-3624 is discovered (Altamirano+ 2011).

Similar variable $\gamma$-ray sources may be still hidden in the Galaxy.
6. Summary

Lots of un-IDed Galactic sources in the Fermi catalog. There must be new classes of sources.

XSS J12270-4859 is a good example.
- first $\gamma$-ray LMXB at low $L_{\text{bol}}$
- microquasar with a synchrotron jet
- unique X-ray variability

In the future, eROSITA & ASTRO-H are helpful to identify these un-IDed Fermi sources.
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References

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