XSS1227.0-4859: a mysterious LMXRB with Gamma-ray association to 1FGLJ1227.9-485

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XSSJ1227.0-4859

OUTLINE

1) Discovery & tentative identifications
2) Multi-λ follow-ups
3) The FERMI/LAT association
4) The variabilities (X-ray, UV, Optical, nIR)
5) The spectral properties
6) Possible natures

XSSJ12270-4859: a hard X-ray source

Discovery & Tentative Identification

- Detected in RXTE Slew Survey (Sazonov & Revnivtsev 2004)
- Detected INTEGRAL /IBIS Surveys (Bird et al. 2007)
- Detected in SWIFT /BAT Survey (Tueller et al. 2010)
- CV-like optical spectrum possibly magnetic (Masetti et al.2006)
- mCV claimed from putative P∼860swith RXTE (Butters et al.2008)
- No period in optical photometry discards a mCV (Pretorius 2009)

Controversial nature

Multi-λ follow-ups

(de Martino et al. 2010, A&A)

- XMM-Newton (EPIC, OM/UV-U): Jan.2009 (30ks)
- INAF-REM (ESO) V,J-bands: Mar.2009 (3nights)
- RXTE archival data: Nov.2007 (48.8ks)
- INTEGRAL archival: March 2003- Oct. 2007 (750ks)

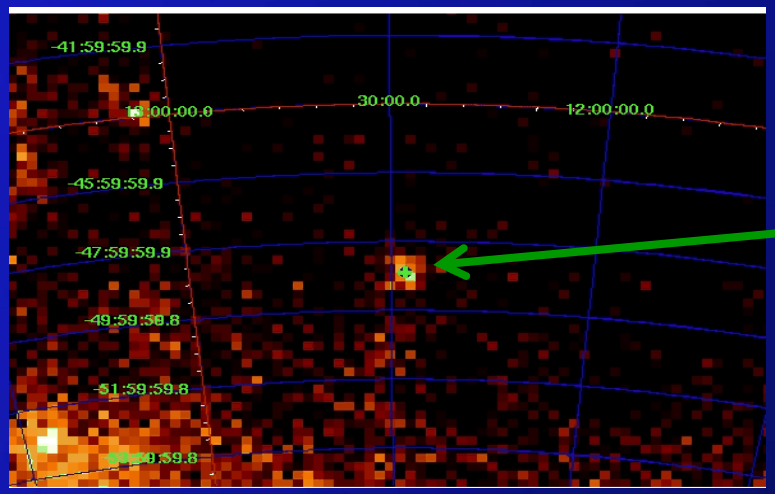
(de Martino et al. in prep)

- XMM-Newton (EPIC,OM/U): Jan. 2011 (30ks)
- RXTE monitoring: Jan-Apr. 2011 (60ks - 3ks x week)
- Swift monitoring: Aug.2010-Mar.2011 (12ks)
- AGILE/GRID: Oct.2007-May 2011
- FERMI/LAT: Aug. 2008 – May 2011

The FERMI/LAT Association with 1FGL J12279-4859

(Abdo et al. 2010)

- Unidentified source in 1^{rst} Fermi/LAT catalogue
- Detected from 100MeV up to 10GeV (16.9 σ)
- Flux $_{(100MeV-100GeV)}$ = 4x10^{-11} erg/cm2/s Γ=2.45$\pm$0.07



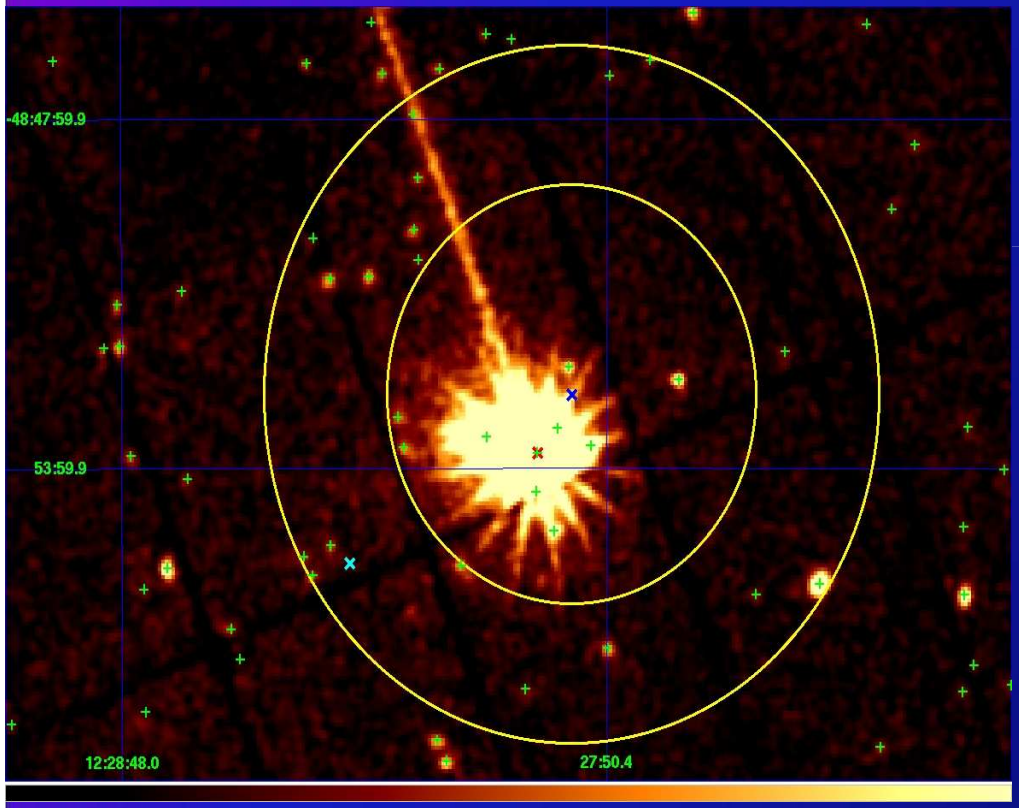
12degx12deg count map in 100MeV – 300GeV range

- No other source within radius 2.5deg (de Martino et al. 2010)

The FERMI/LAT Association with 1FGL J12279-4859

(de Martino et al. 2010)

- Located at 1.2arcmin from XSSJ12270-4859



Combined EPIC PN/MOS

68% err. circl. (3.6')

95% err. circl. (6.0')

- XSS J12270-4859 brightest
- SUMSSJ122820-4855 radio source at 5.2' from 1FGLJ

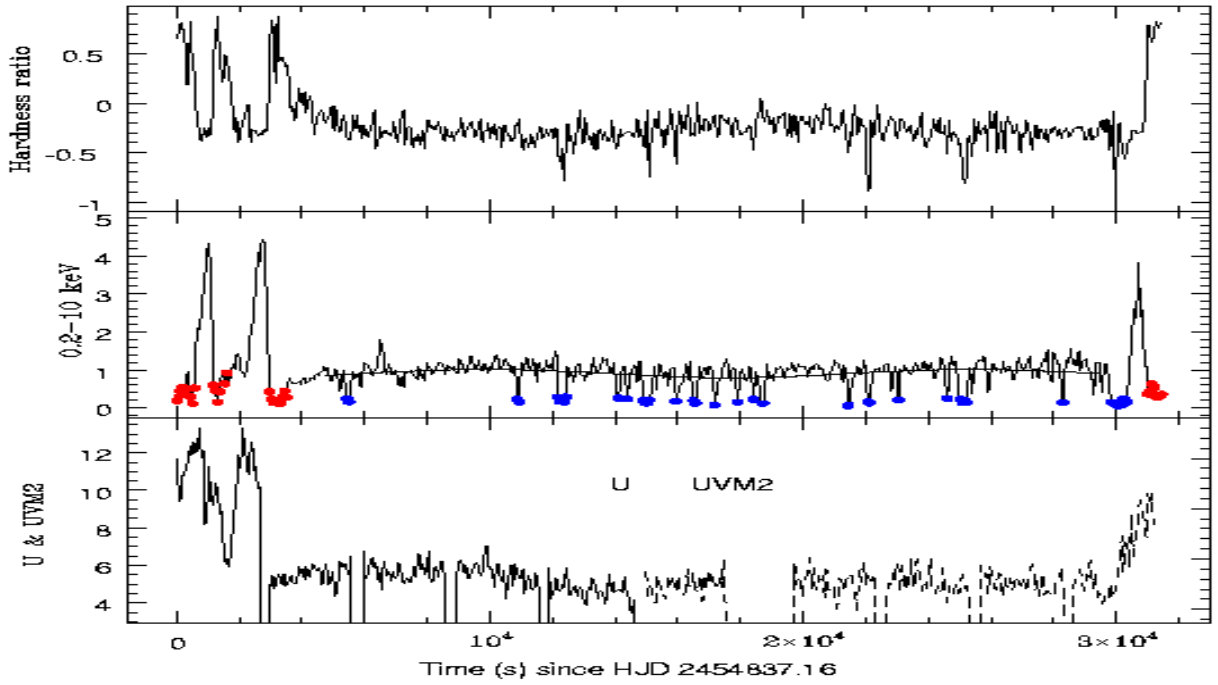
82.2mJy @843MHz

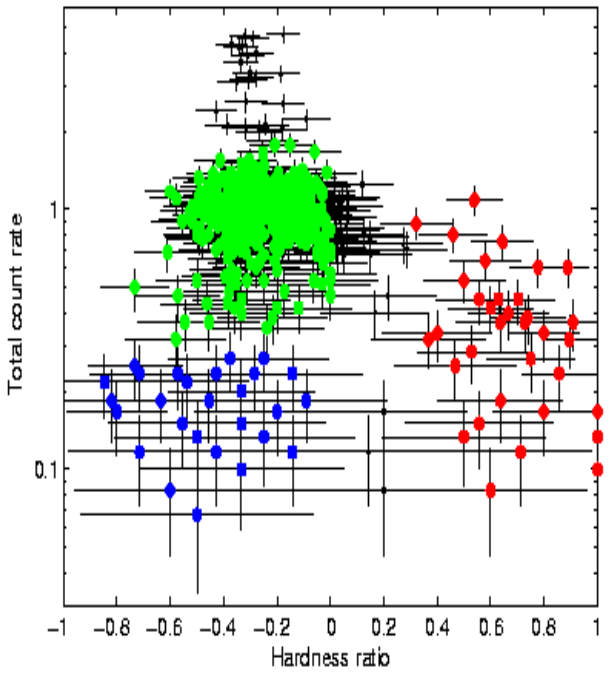
unlike association also confirmed by Hill (et al. 2011)

The X-ray Variability

(de Martino et al. 2010)

- EPIC-pn & MOS light curves atypical for mCV (flares & dips)
- No 860s periodicity found
- X-ray flares: $\Delta T \sim 9\text{-}12$min; $F_{peak} \sim 5 \times F_{quiesc.}$
- Post-Flare Dips are hard.
- Reminiscent of type II bursts like GRO1744-28 or Rapid Burster

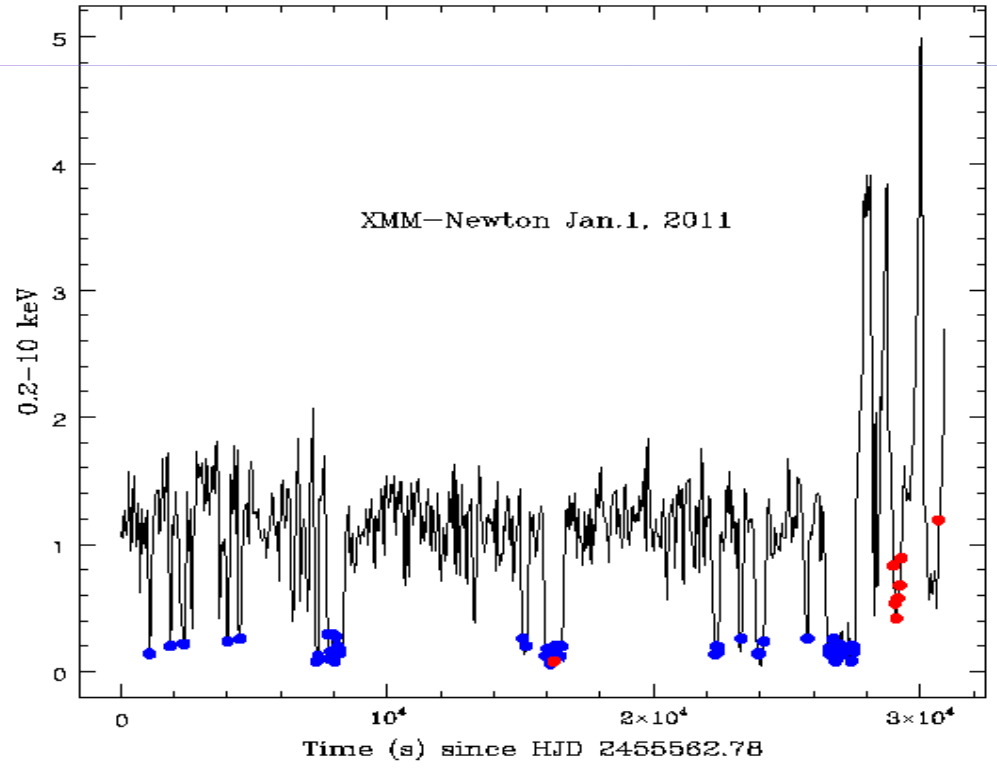


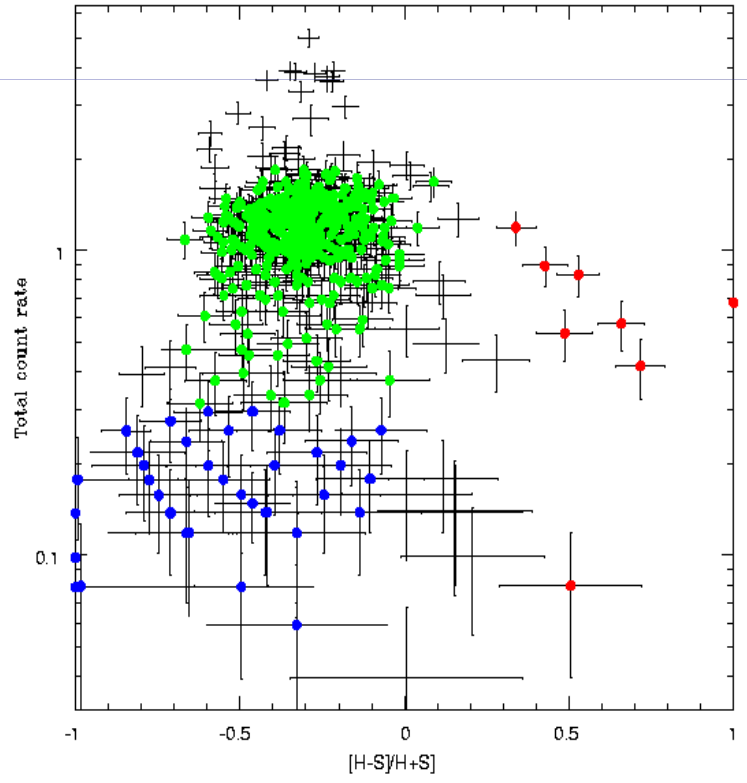


The X-ray Variability

(de Martino et al. in prep)

- Flares & Dips : persistent characteristics at all epochs seen by XMM-Newton, RXTE and Swift.

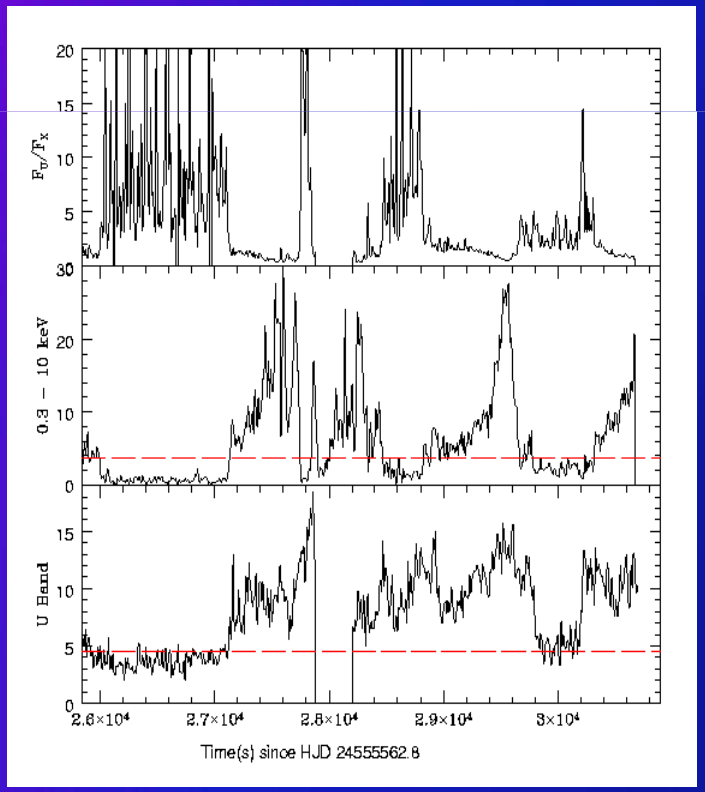




The UV Variability

(de Martino et al. 2010; 2011 in prep)

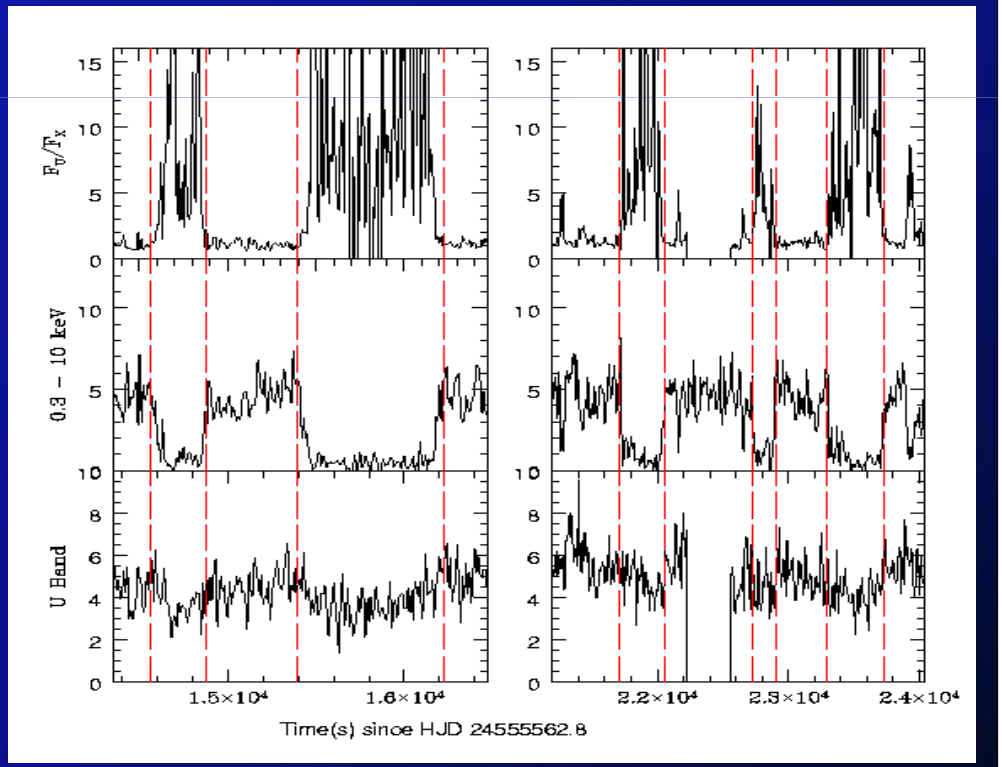
- UV Flares longer than in X-rays
- Dips occur in UV but shallower



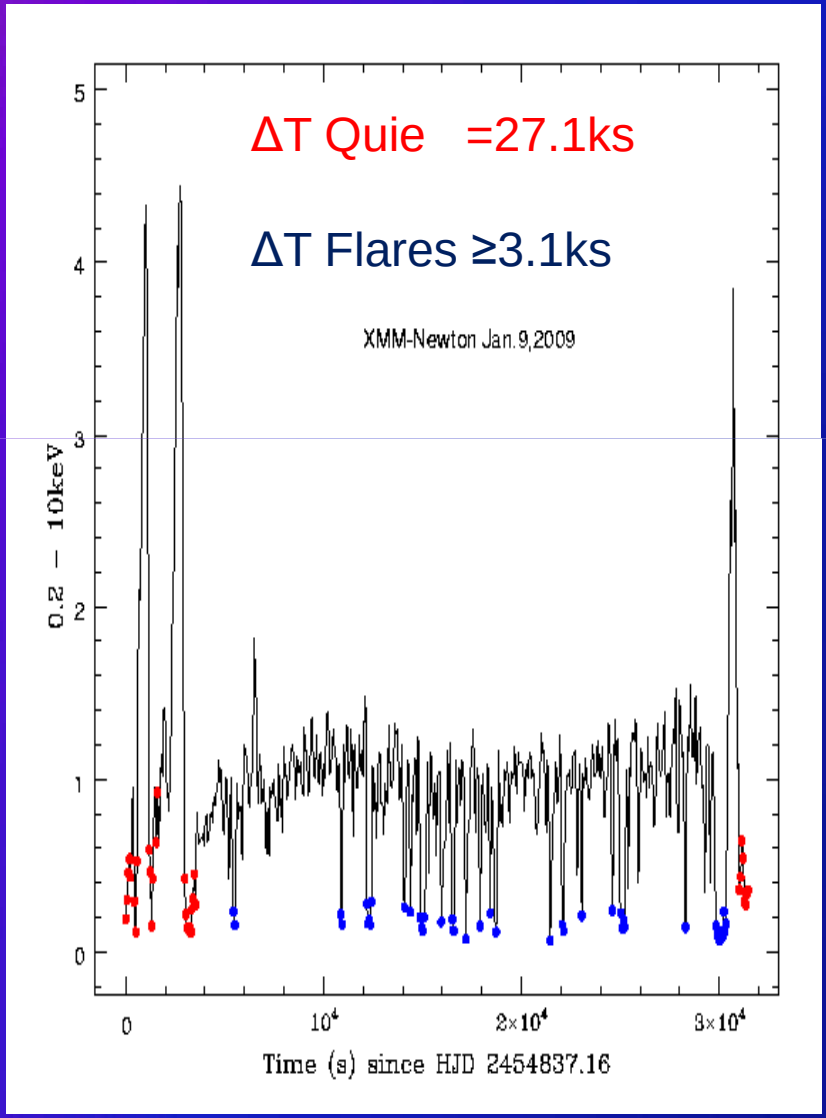
F_u/F_x

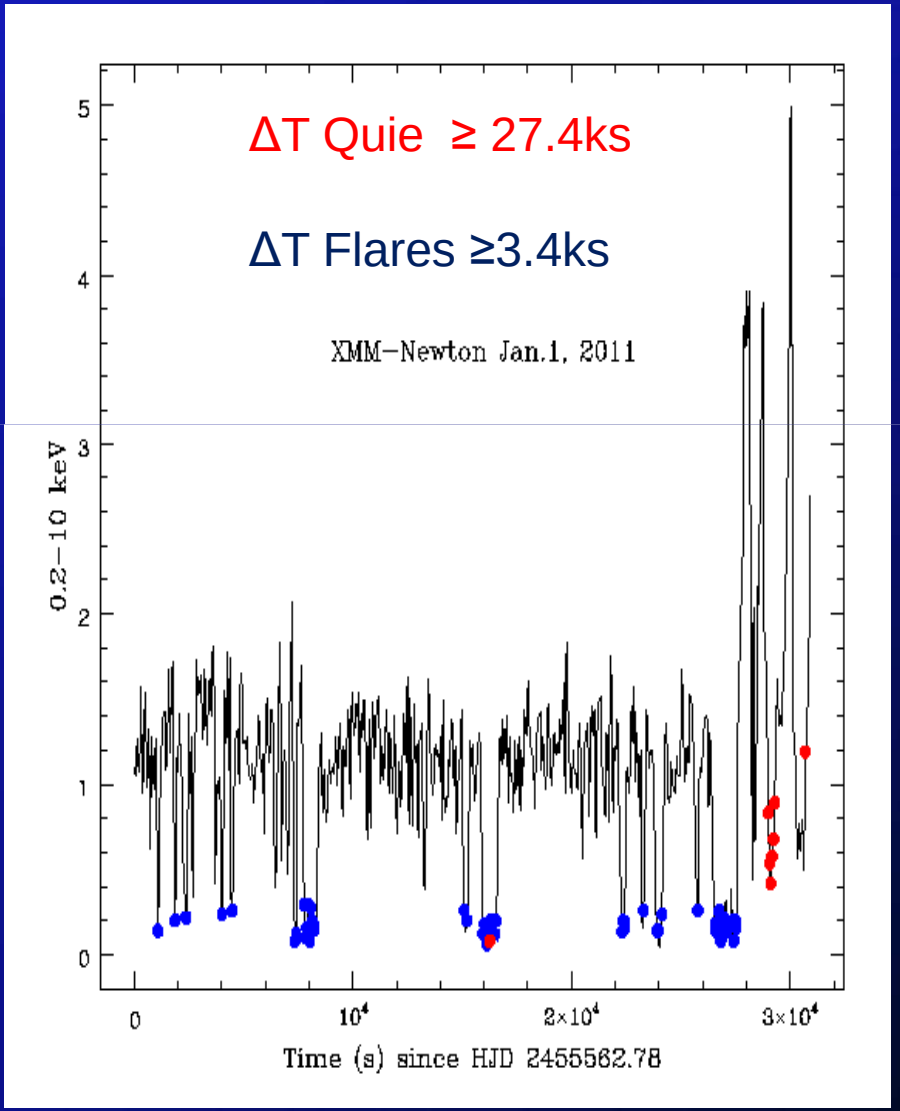
X-ray

U band



Flare Occurrence?

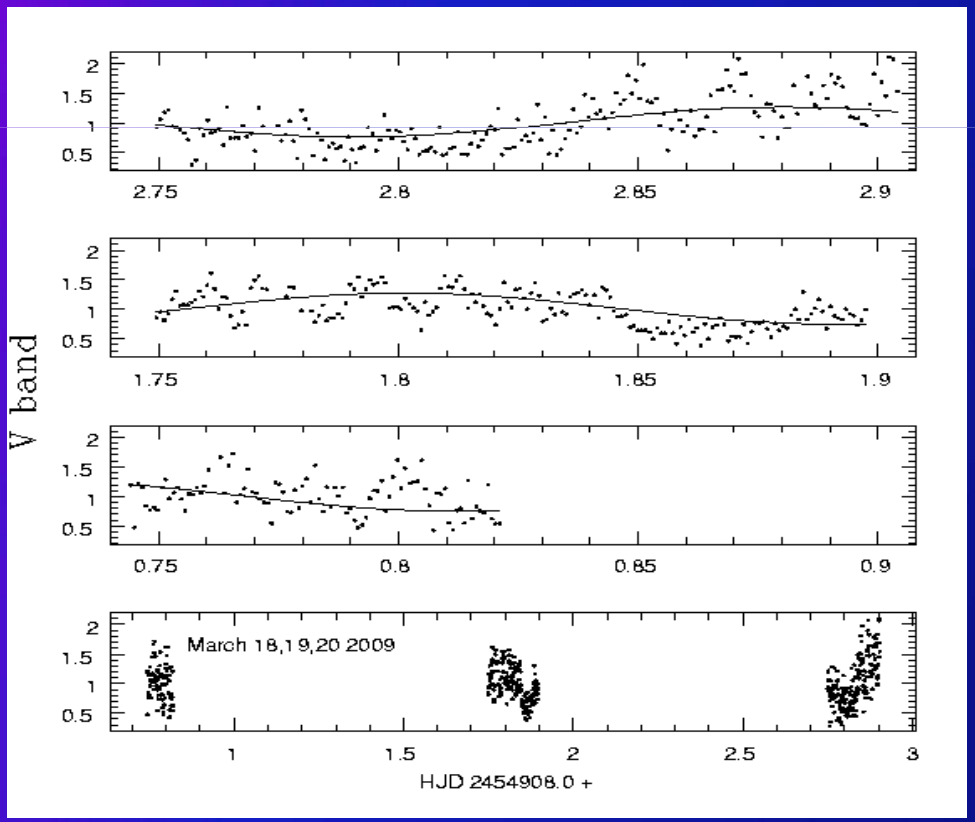


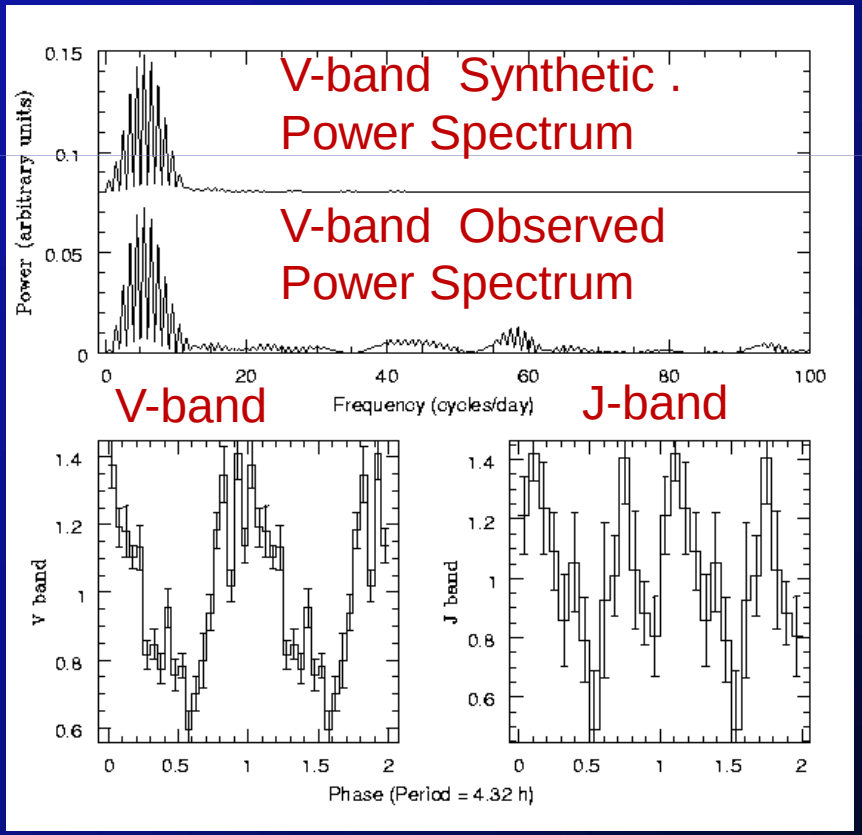


The optical nIR variability

(de Martino et al. 2010)

- V-band photometry: Large amplitude (~1mag) variability
- Period=4.32hr → Porbital
- nIR amplitudetoo large for ellipsoidal – Flare contamination?

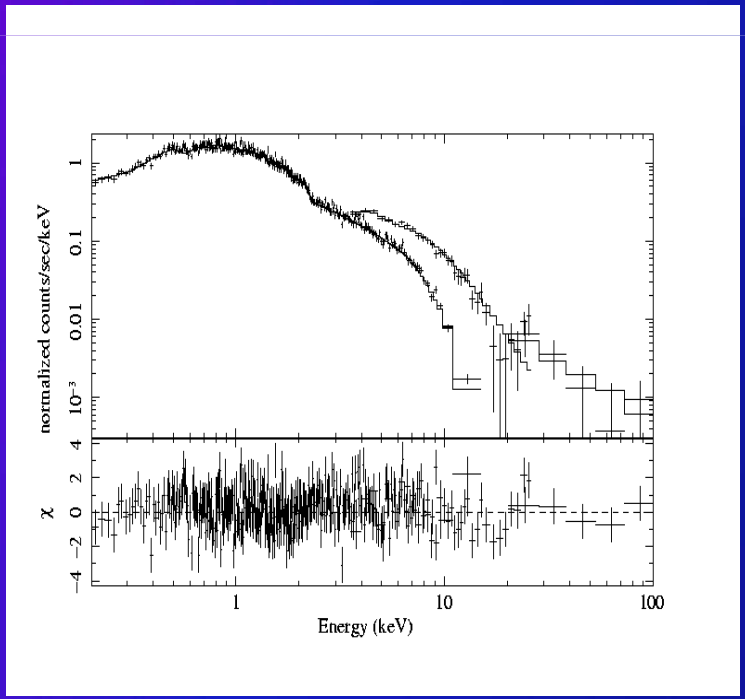




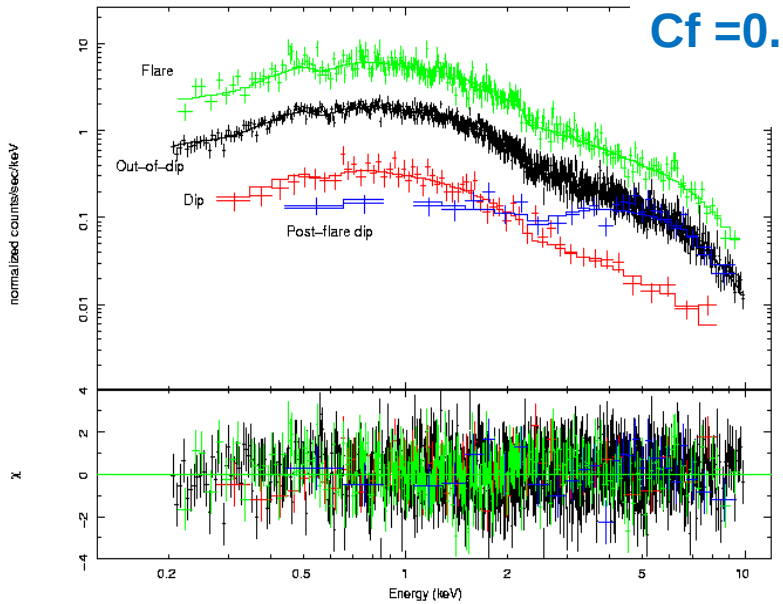
The X-ray spectrum

(de Martino et al. 2010; 2011 in prep)

- X-ray (EPIC/PCA/ISGRI) spectrum featureless: no Fe complex
- Power law : Γ =1.7 $\pm$ 0.02 invariant with intensity
- Post-flare Dip spectrum requires (quasi-total) absorber



NH=6.1x10^{22}cm-2
Cf =0.86

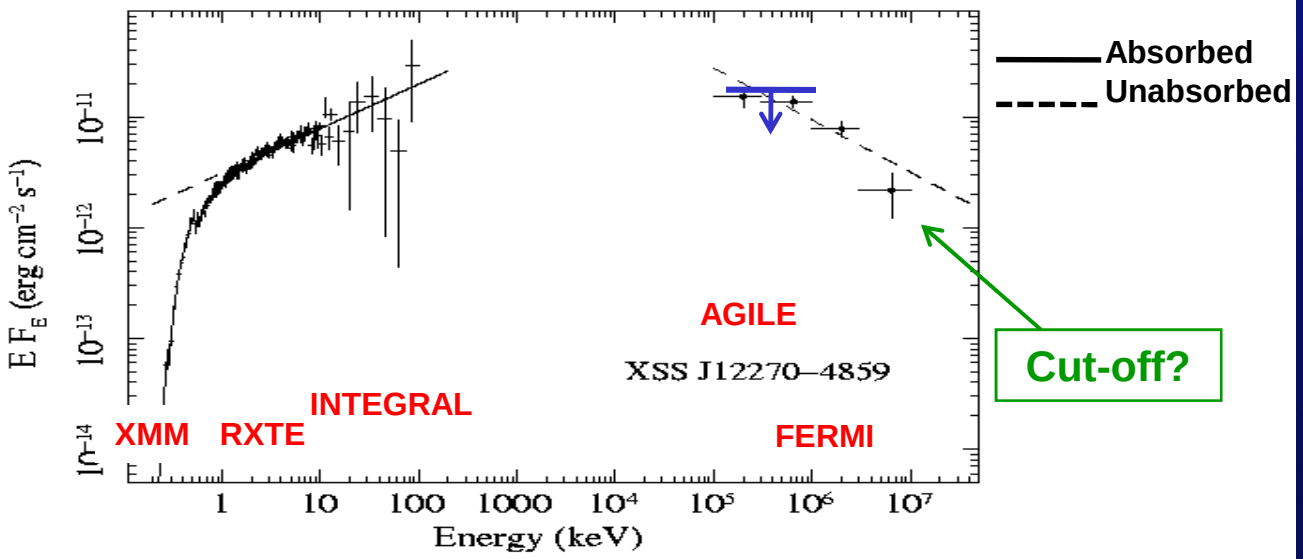


The X-ray to γ-ray spectrum

(de Martino et al. 2010; 2011 in prep)

- XMM/EPIC, INTEGRAL/ISGRI, RXTE/PCA , AGILE/GRID; FERMI/LAT
- Power laws : Γ_x=1.74 & Γ_γ = 2.45 – possible cut-off @ 4GeV
- Peak @ 1-100MeV

F(0.1-100GeV)/F0.2-100keV)~0.8 !!!



Possible Nature:
A LMXRB with NS?

• Type II bursts (GRO1744, Rapid Burster, SMC X-1) similarities but differences:

- Low Lx ≥ 10^{33} $(d/1.1kpc)^2$ erg/s and energetics
- Bursts and Dips: timescales and energy dependence
- Type II bursts different morphologies
- Type II bursts harbour NS (either pulsars or type I bursts)
- No type I burst

→XSSJ12270-4859 could be a type II low-level bursting source

Possible Nature:
A LMXRB with NS?

- One FERMI γ-ray LMXRB FIRSTJ102347+0038 (Tam et al. 2010)

- MSEC (1.96ms) radio pulsar -- P_{orb}=4.75hr (Archibald et al. 2009)
- Wrongly identified as a CV (Thorstensen &Armstrong 2005)

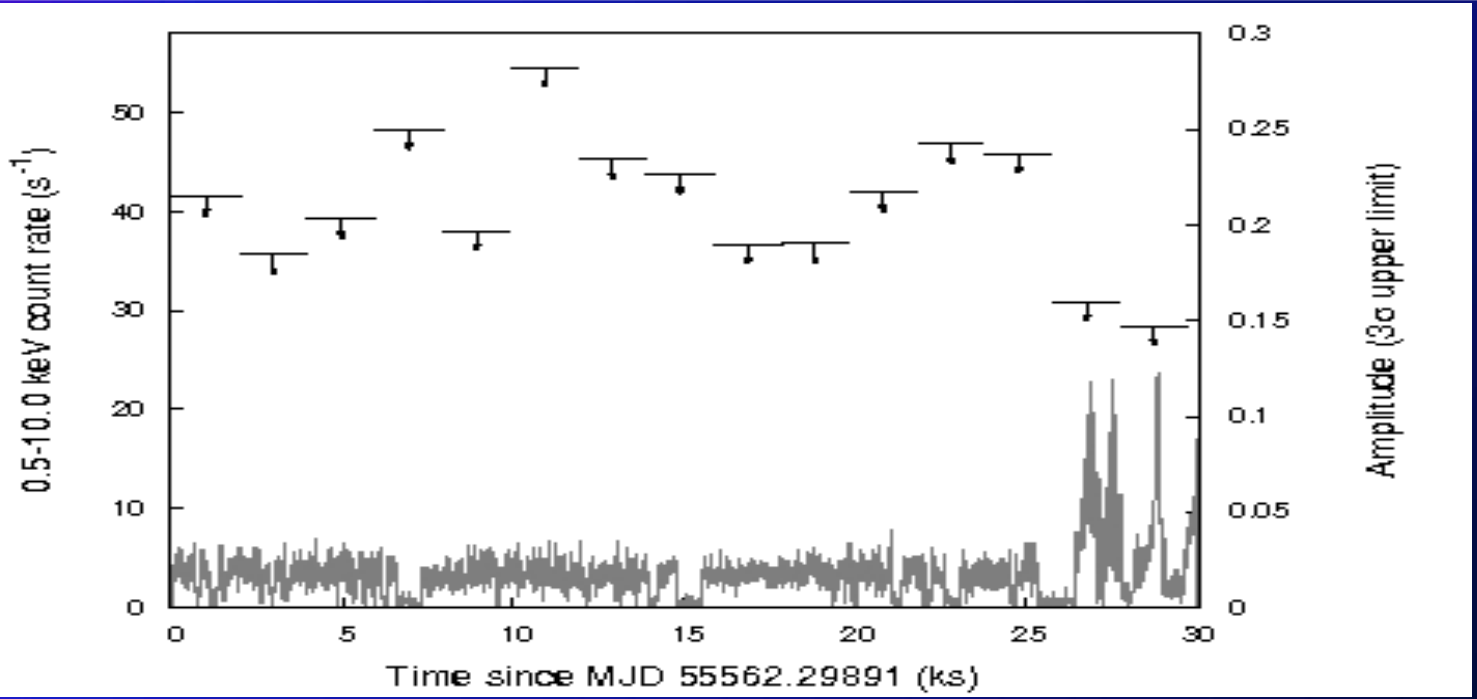
- X-ray spin pulses detected in quiescence (Archibald et al. 2010)
- PL Γ_x = 1.26 or BPL 1.75/1.07 E_B=1.8keV & Γ_γ = 2.9
- PSRJ1023 radio active when accretion off
- New born MSEC: missing link of Rot.Power MSPs from LMXRB
- Msec Pulsar have Γ_γ ~1.9-2.0 but a few Γ_γ > 2.2 E_{cut}<5GeV (Kong et al. 2010; Abdo et al. 2009)

Search for X-ray msec pulses

JAN 2011 XMM-Newton/EPIC-pn timing mode

- Quadratic Coherence Recovery Techniques (QCRT; Wood et al. 1991)
- 3σ upper limits: $A_{\_UL} = 0.15 – 0.25$

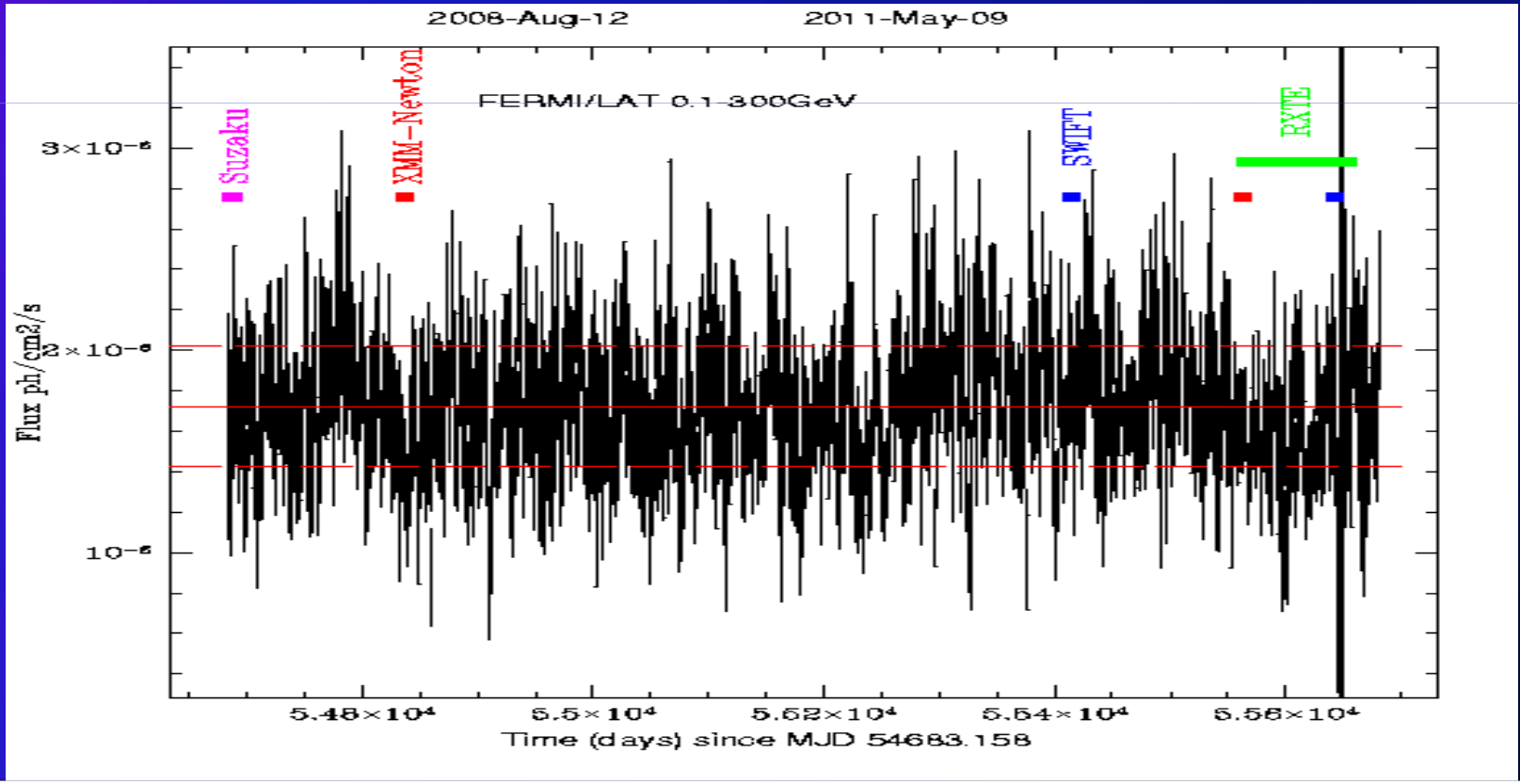
→Lower amplitude (few %) pulses cannot be excluded



Persistency of X-ray and γ-ray emissions

- Persistent X-ray source since 2004
- Average $F_{2\text{-}10keV} \sim 1.4 \times 10^{-11}$ erg/cm^2/s in all obs.
- Fermi/LAT (0.1-300GeV) persistent emission on $\Delta T > 1$day

→ XSSJ12270-4859 is active in both X-ray and γ-ray



Possible Natures:
A micro-quasar?

- Flares are observed in BH galactic Binaries but differences:
  - Different luminosity states
  - Different timescales of active phases (Belloni et al. 1997; 2000)
  - Spectral changes in flares
  - Hardening after flares (GRS1915+105) not due to Absorption
  - Micro-quasars not detected by Fermi except Cyg X-3 (flare)

(Abdo et al. 2009; Tavani et al. 2009)

  - Expected PL $E_{cut\text{-}off} \sim 400$ MeV

→ XSSJ12270-4859 could be a micro-quasar in low/hard state but rather unlikely

SUMMARY

- Multi-λ observations reveal variability and spectral properties:
  - X-ray variability shares similarities with Type II bursts
  - XSSJ12270-4859 is active both in X-rays and γ-rays
  - γ-ray emission is substantial fraction of energy budget
  - A MSEC pulsar cannot be excluded with present data
  - A Micro-Quasar is unlikely

- Future work:
  - Porb =4.3hr to be confirmed with allocated optical spectroscopy
  - γ-ray emission to be explored on short timescale; quie.vs.flare