The redback nature of XSSJ12270-4859

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"Neutron stars at the crossroads" – EWASS 2015 - June 25-26, 2016

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➢ The orbital variability & spectral properties

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Discovery and Tentative identification

XSSJ12270-4859: a hard X-ray source

- RXTE Slew Survey (Sazonov & Revnivtsev 2004)
- INTEGRAL/IBIS Survey (Bird et al. 2007)
- Swift/BAT Survey (Tueller et al. 2010)
- Claim of a magnetic CV from RXTE follow-up (Butters et al. 2008)

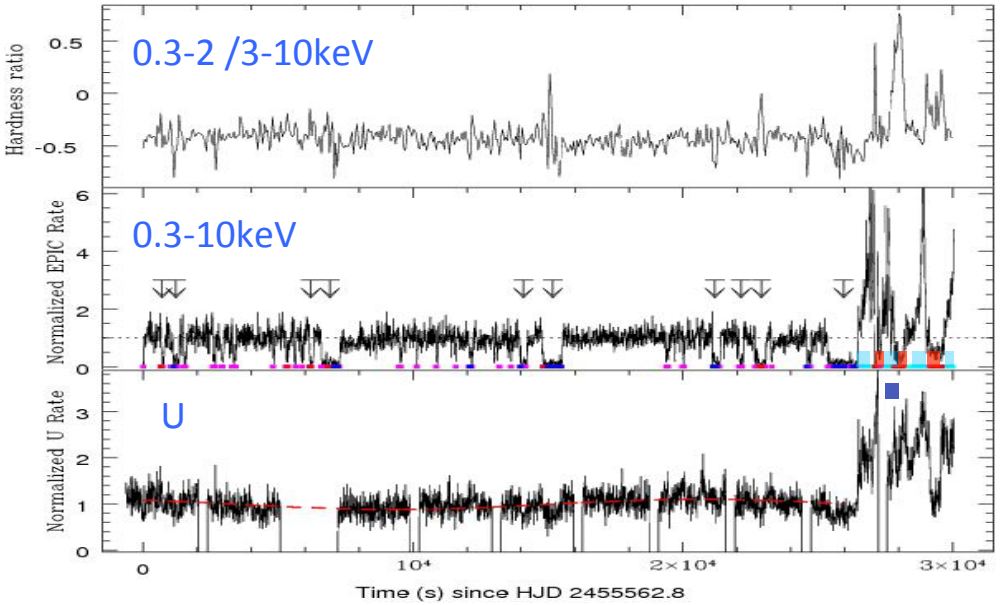
The Optical Counterpart

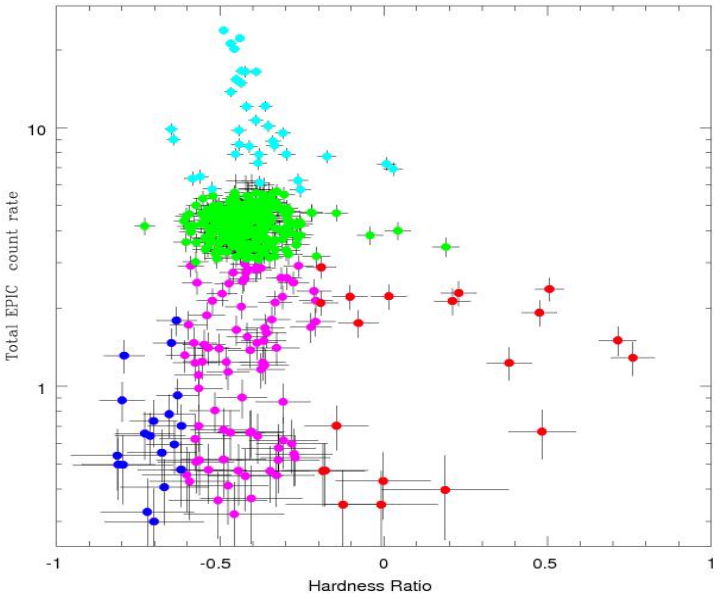
- CV-like spectrum: blue continuum + Balmer & He emission lines (Masetti et al. 2006)
- Erratic optical photometric variability (Pretorius 2009)
- No 860s periodicity in optical light (Pretorius 2009)

Follow-ups and LMXB nature

X-ray variability

- Erratic variability in XMM-Newton, RXTE and Swift light curves
- Flares : $\Delta T \approx$ 10-15min; $F_{flare} \approx 6\ F_{quie}$ Flare-dip pairs
- Dips: $\Delta T \approx$ 10-1200s $F_{dip} \approx$ 3-6 F_{quie}
- Simultaneous UV Flares & weak dips (≤40% decrease)
- Weak UV modulation at ≈ 6.4h (de Martino et al. 2010, 2013)





The X-ray spectrum

- Average Spectrum is Featureless → Power Law: Γ = 1.70(2)
- Time-resolved EPIC-pn spectra:

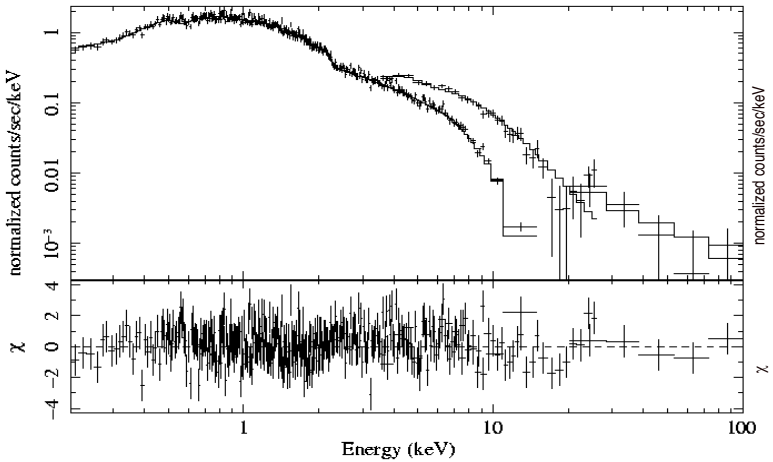
  Γ = 1.64(1) Quiescence

  Γ = 1.65(3) Flares

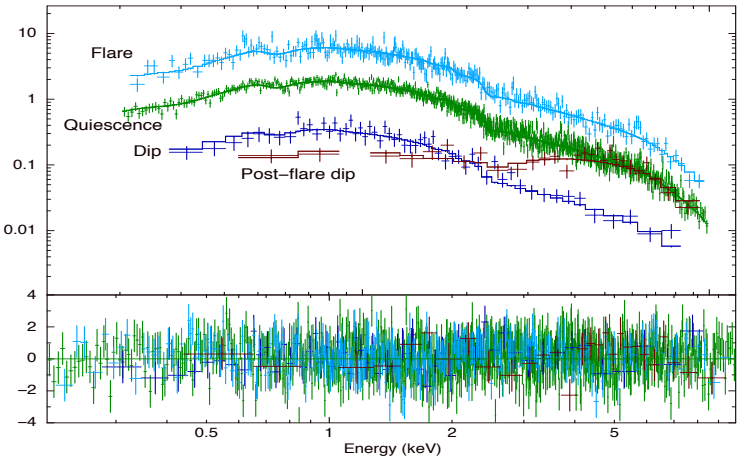
  Γ = 1.71(4) Quiescent dips

  Γ = 0.74(8) + PC [Nh ≈ 4×10^{21} cm^{-2} CF ≈ 0.60] Post-flare dips

  Lx ≈ 6×10^{33} d_{1kpc}^{2} erg/s (de Martino et al. 2010,2013)



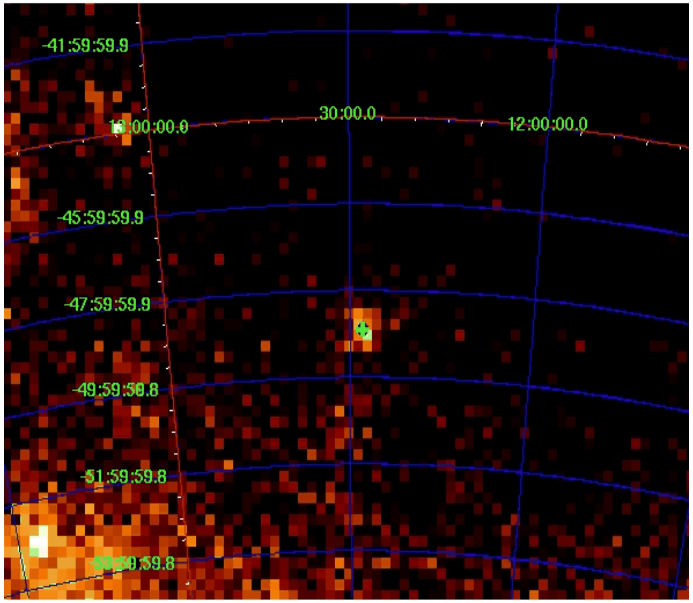
Average
XMM-Newton/RXTE/INTEGRAL



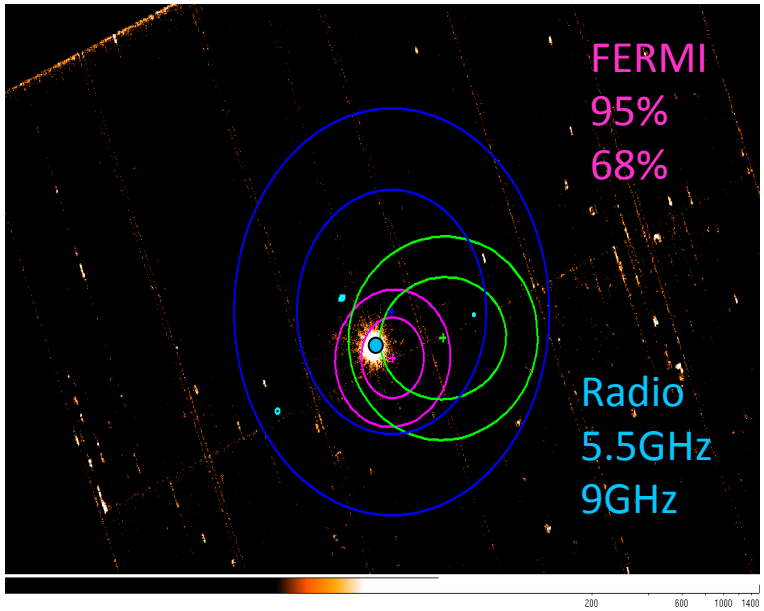
EPIC-pn Time Resolved

The Fermi-LAT association

- Unidentified source **1FGLJ1227.9-4852** (de Martino et al. 2010)
- Later as **2FGLJ12277-4853** and **3FGLJ1227.9-4854**
- No other γ-ray source within radius 1deg
- XSSJ12270-4850 is the brightest X-ray source
- New radio source @ XSSJ12270-4859 (Hill et al. 2011)



12°x12° count map
[100MeV – 300GeV]

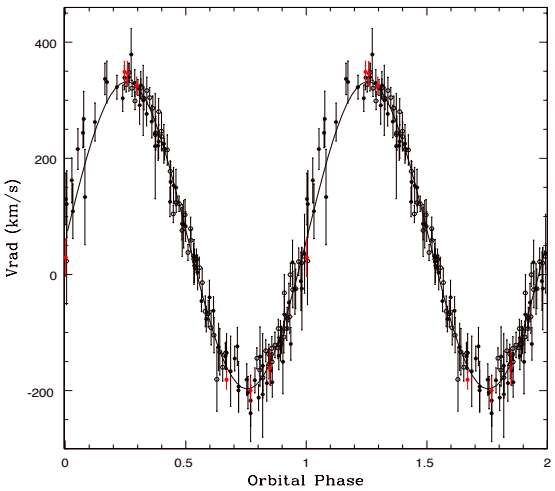


EPIC PN/MOS combined

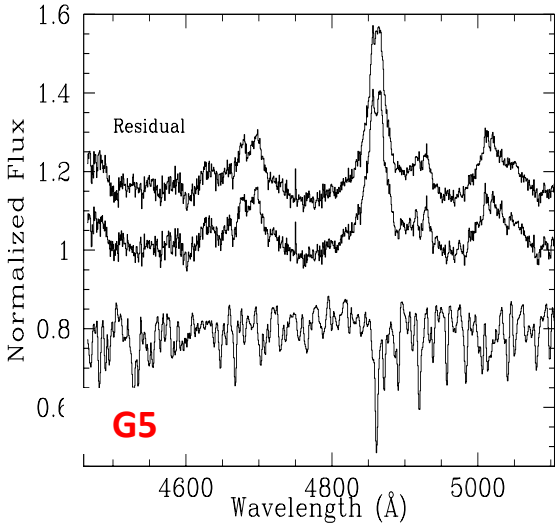
The optical variability in the LMXB state

- Optical NTT/SALT spectroscopy and SAAO photometry in spring 2012
- Emission lines of Balmer & He I, HeII (disc) + Absorption features (donor)
- Donor Vrad curve gives Porb = **6.91**hr
- Spectral changes G5 → F5 between inferior and superior conjunction donor

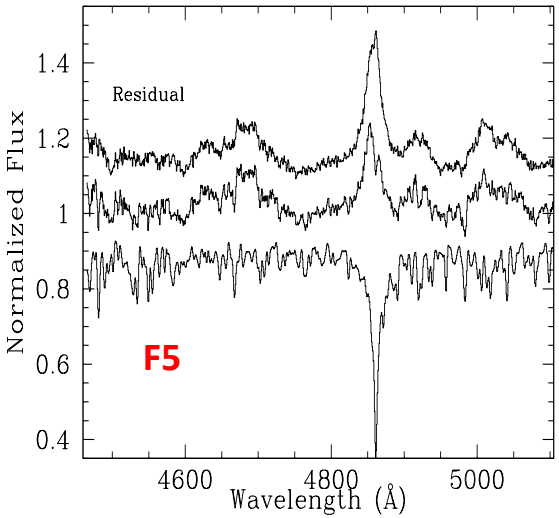
(de Martino et al. 2014)



Porb = 6.91 hr



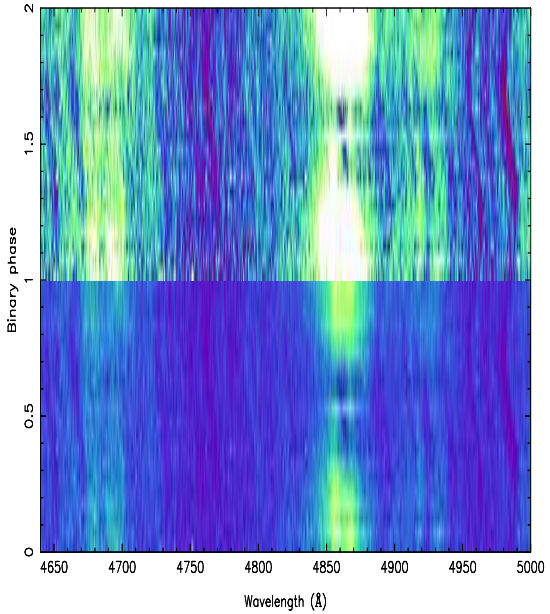
Phase ≈ 0.0



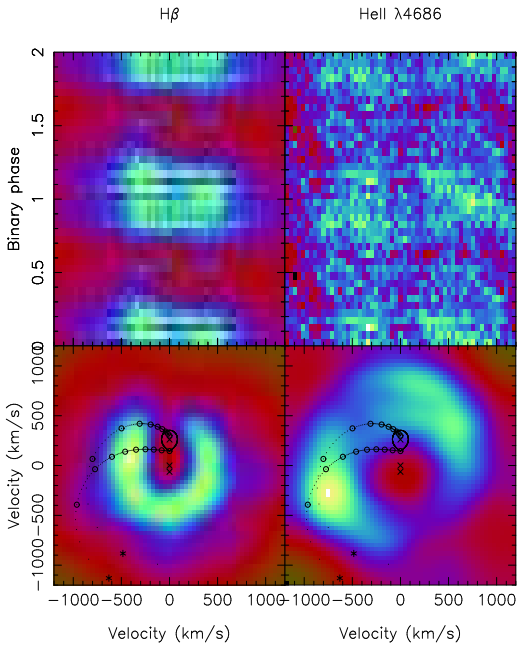
Phase ≈ 0.5

The optical variability

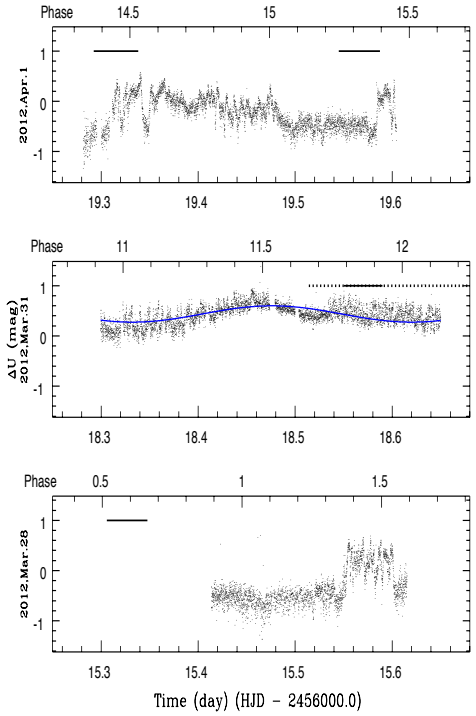
- Vrad emission lines antiphased with donor → disc around compact star
- Emission lines tend to vanish @ superior conjunction of donor and @ Dips



He II Hbeta



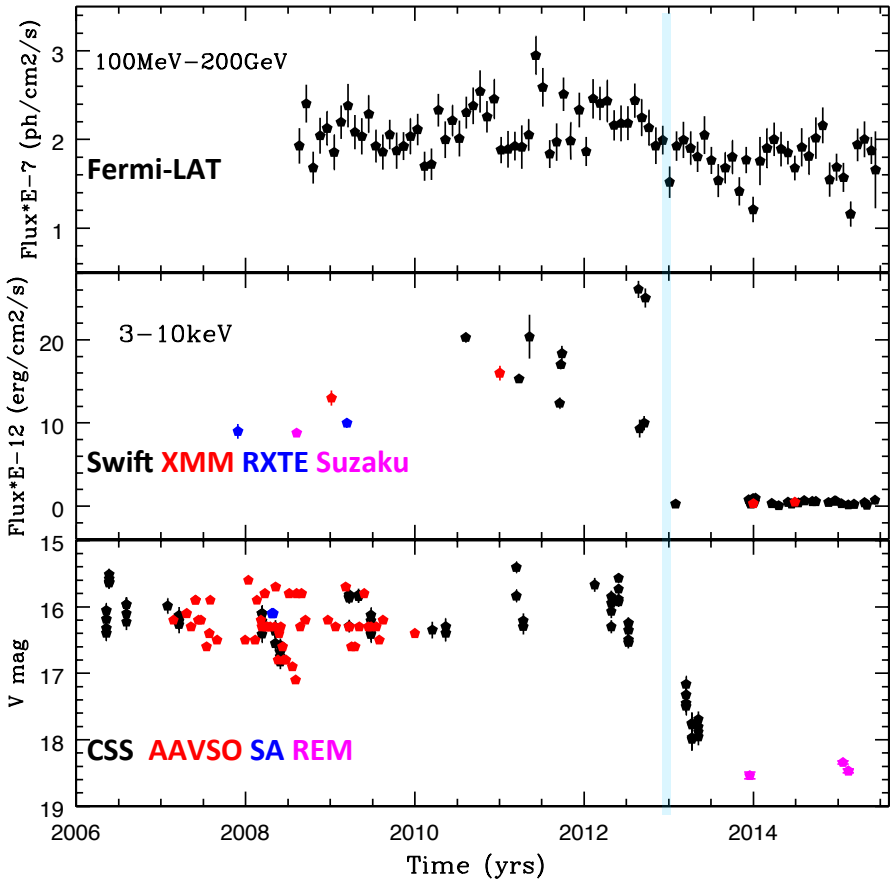
Hbeta & He II Spots

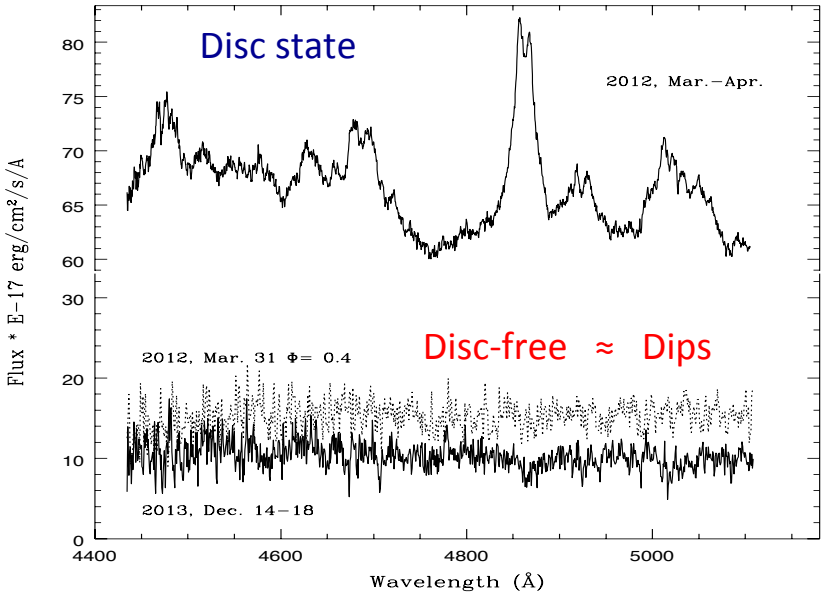


Simultaneous spectra

The state change

- Optical & X-ray emission decline between Nov. – Dec. 2012 (Bassa et al. 2013)
- Absence of emission lines in Dec. 2013 (Bassa et al. 2014, de Martino et al. 2014)
- **Radio discovery** of a fast spinning (1.67ms) pulsar (Roy et al. 2015)

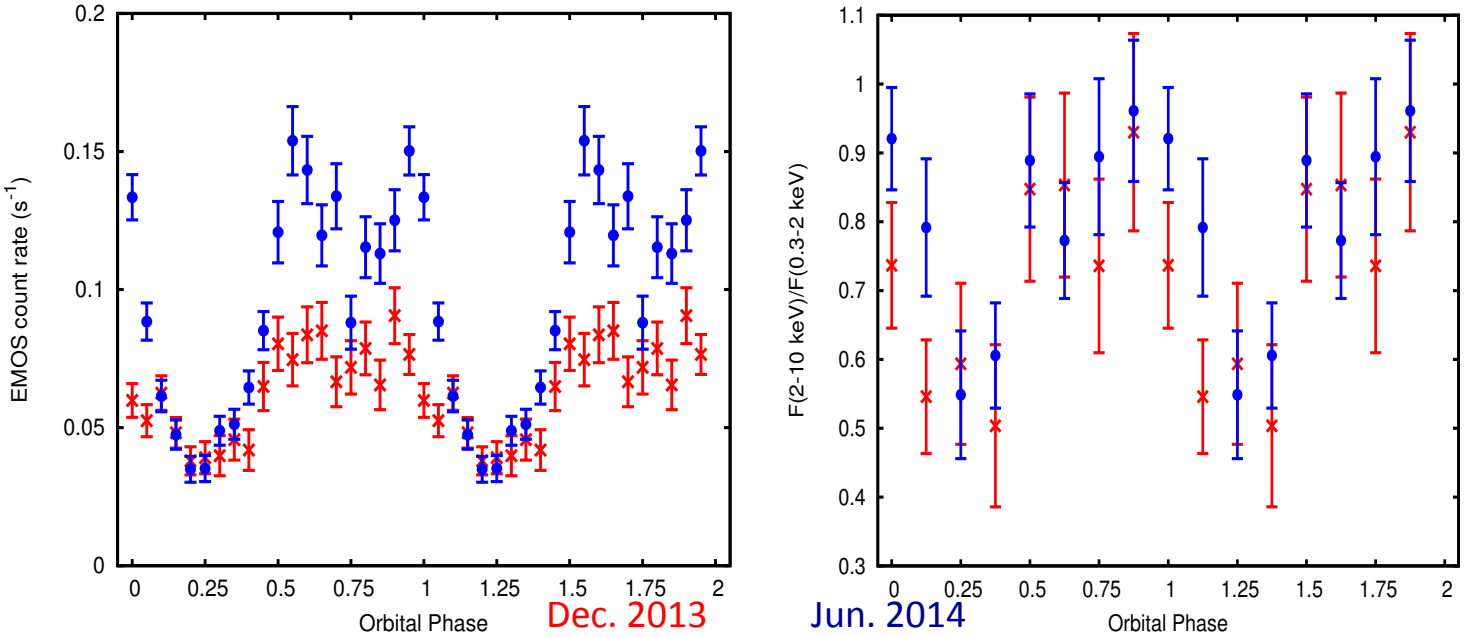




The disc-free state

Two XMM-Newton exposures in **2013** (Bogdanov et al. 2014) and **2014**:

- X-ray orbital modulation and hardening at inferior conjunction of NS
- Average Spectrum harder $\Gamma = 1.02(8)$ than in disc state
- X-rays originate in Intrabinary shock $L_X \approx 1\text{-}1.7 \times 10^{32}$ erg/s
- Amplitude & shape variable with time de Martino et al. 2015

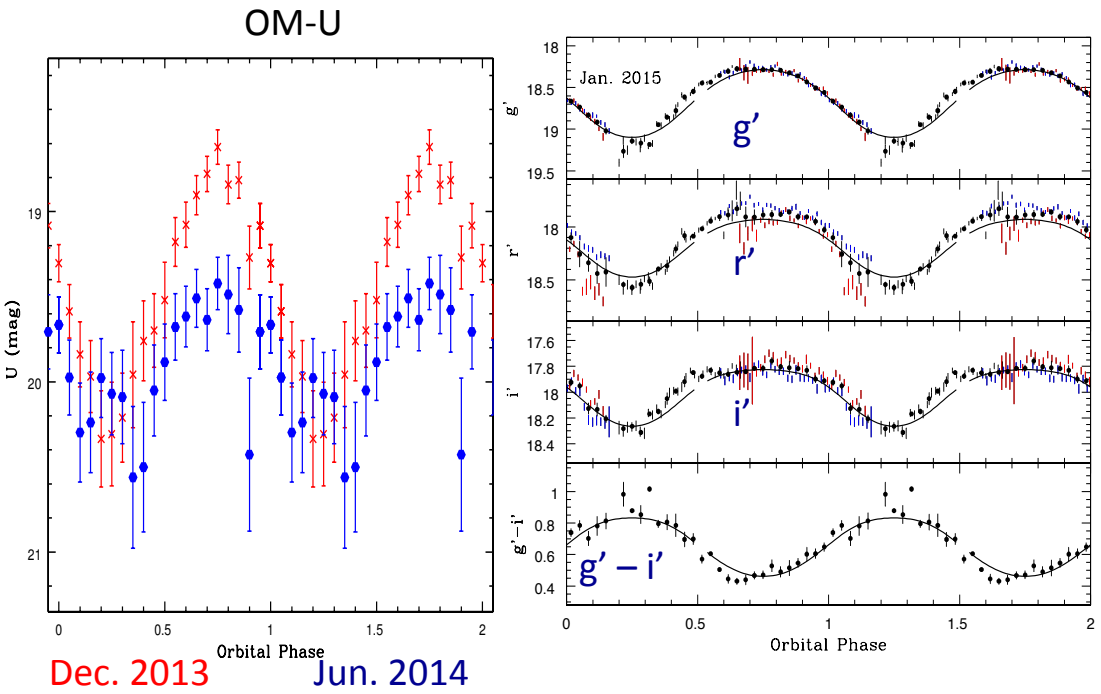


The disc-free state

OM-UV (**2013** and **2014**) and optical-REM (2014, 2015) observations:

- UV/optical orbital modulation in phase with X-rays
- Reddening at inferior conjunction of donor → irradiated secondary
- Amplitude changes antiphased with X-rays →changes in dayside face of donor

(de Martino et al. 2015)



Dec. 2013 Jun. 2014

Light curve modelling gives:

$0.11 \leq q \leq 0.26$

$46^{o} \leq i \leq 65^{o}$

$T \approx 5500 \rightarrow 6500$

For NS=1.4 $M_{\odot}$:

$0.15 \leq M_d \leq 0.36 M_{\odot}$

Redback

Summary

- XSSJ12270-4859 is a **redback** transited from disc to disc-free state

- **Disc state**: erractic activity with three levels (flares, quiescence,dips)
  - The NS in propellering and partly accreting → listen Papitto's talk
  - Dips of different nature (post-flare/quiescence): Mdot changes inner disc radius
  - Donor star irradiated by high energy emission

- **Disc-free state**: dominated by orbital variability
  - Intrabinary shock produces X-rays
  - Donor irradiated from the pulsar wind
  - Changes in Mdot → changes shock size → variable modulation at Porb

Two States – Two SEDs

- Several but different components in both states
- Disc state: X-ray, Gamma-ray, radio → partial accretion & propeller (Papitto et al 2014)
  UV/optical/nIR → disc + donor star (de Martino et al. 2014)
- Disc-free state: X-ray → intrabinary shock (Bogdanov et al 2014; de Martino et al 2015)
  Gamma-ray, radio → Pulsar wind
  UV/Optical/nIR → donor star