Shanghai Astronomical Observatory, Chinese Academy of Sciences

GAMMA-RAY VARIABILITY OF A CANDIDATE PULSAR BINARY

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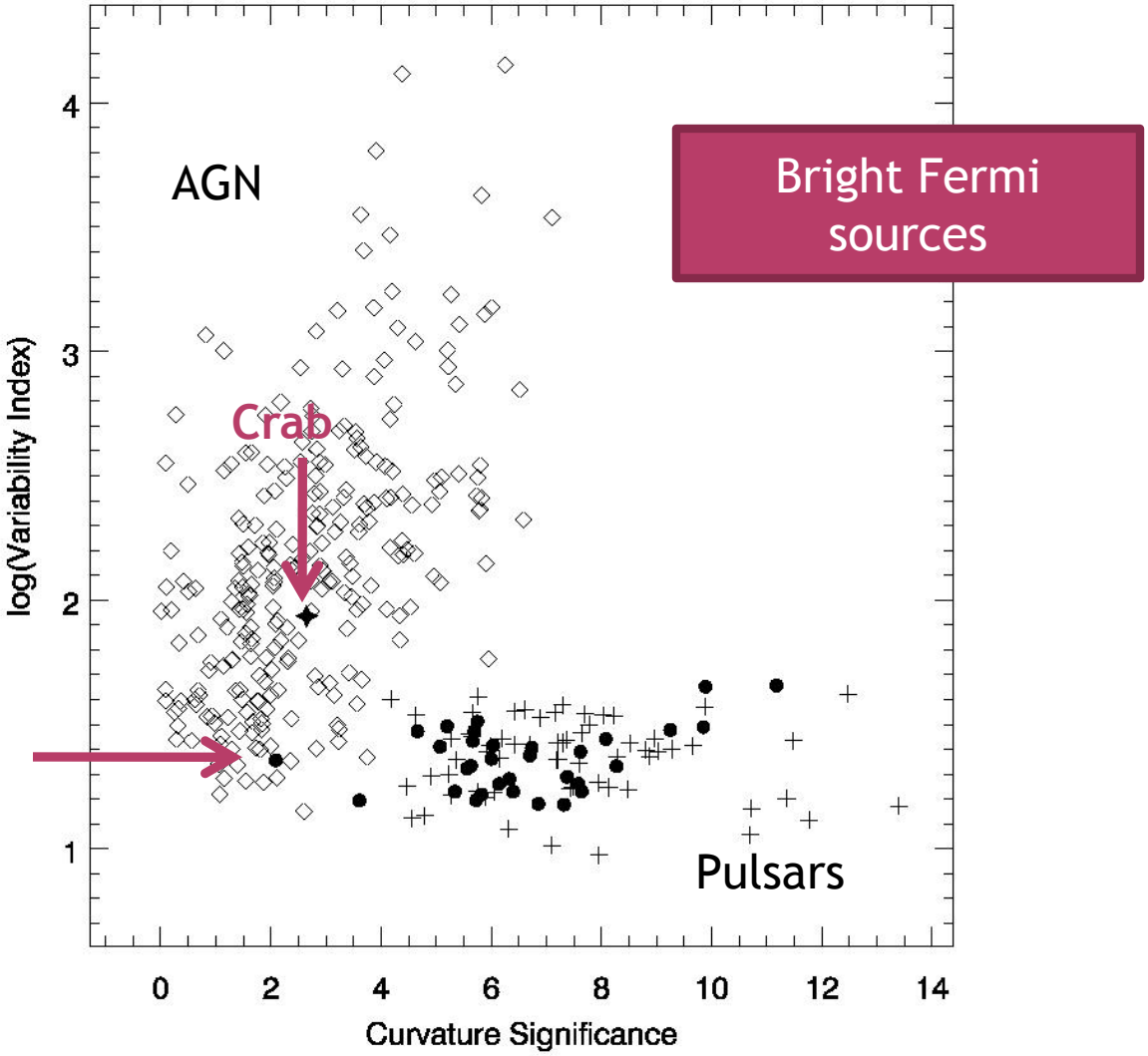
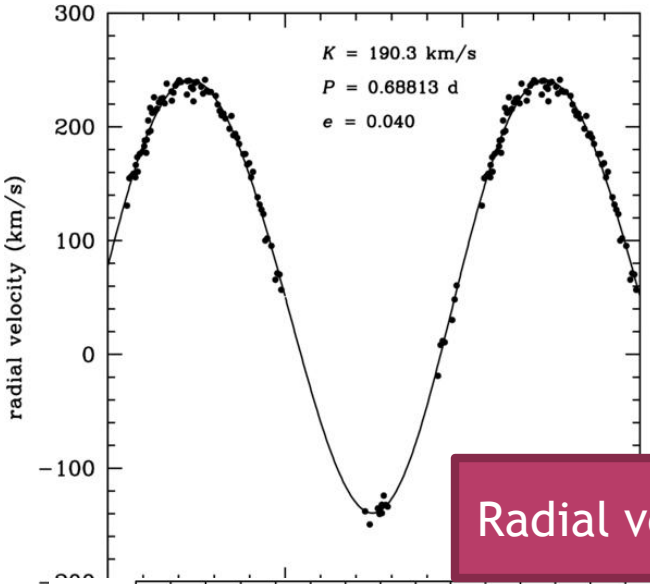
2FGL J0523.3-2530

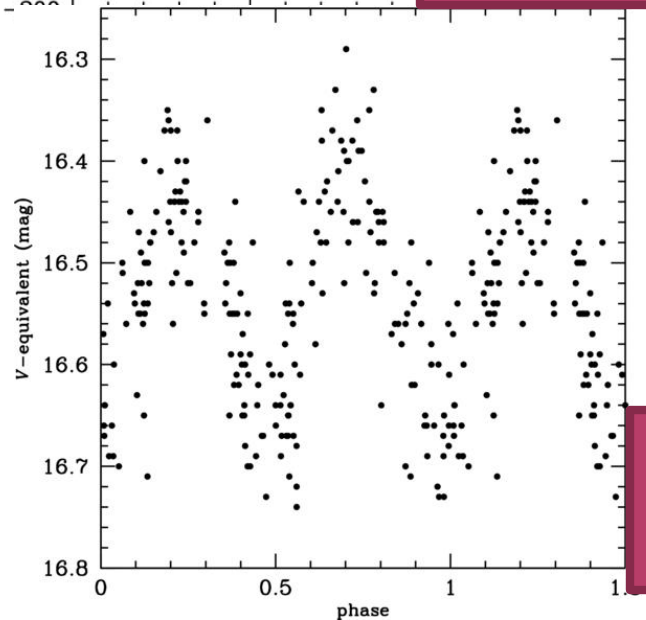


Bright Fermi sources

OBSERVED PROPERTIES OF 2FGL J0523.3-2530



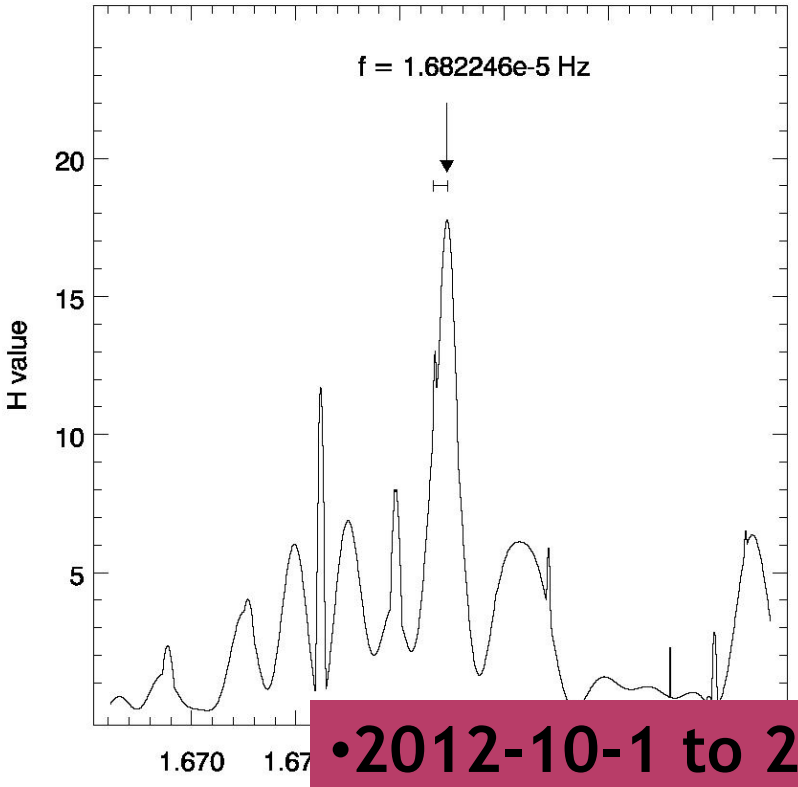
Radial velocity

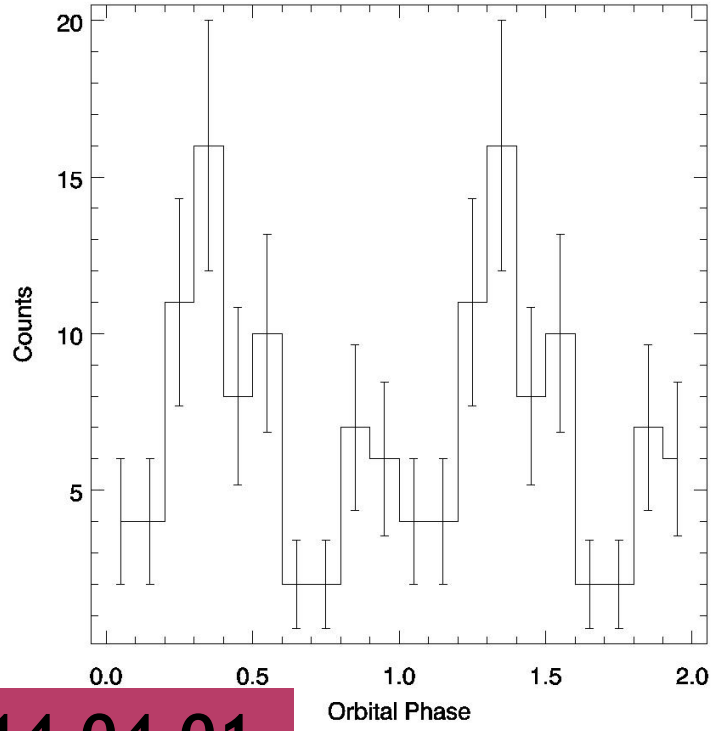


Optical light curve

- Optical spectroscopy and photometry has found it is a binary with **orbital period 16.5 hrs (Strader et al. 2014)**
- **0.8 Msun optical star**
- **High Galactic latitude** Gb=-30 deg
- **Lγ = 3x10^33 erg/s (1 kpc)**
- Given these, likely a MSP binary, or even a redback because no radio pulsations have been detected

ORBITAL MODULATION

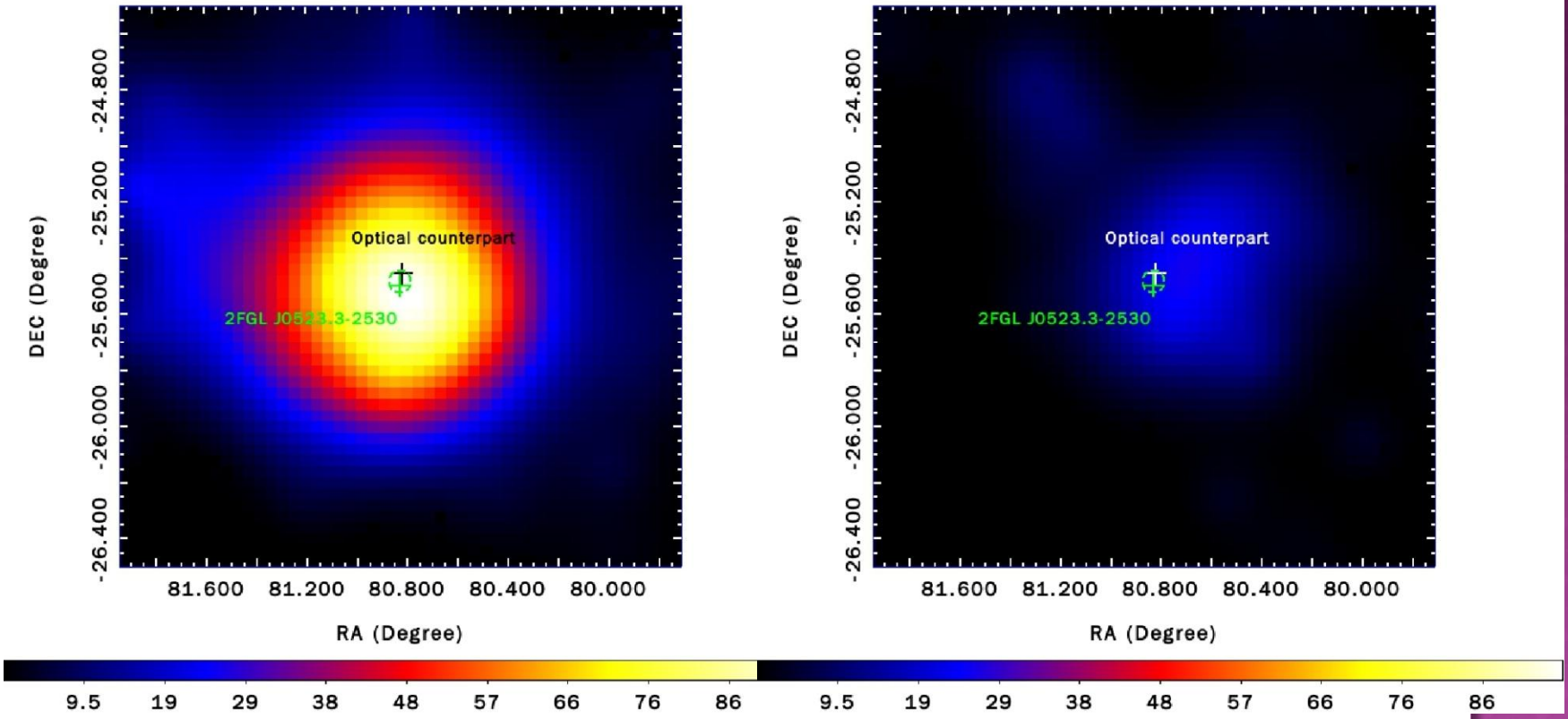




- 2012-10-1 to 2014-04-01
- >2 GeV energy range

- We certainly see orbital modulation, but the signal is not very strong
- No significant differences between the on-peak and off-peak spectra (due to limited photon counts)

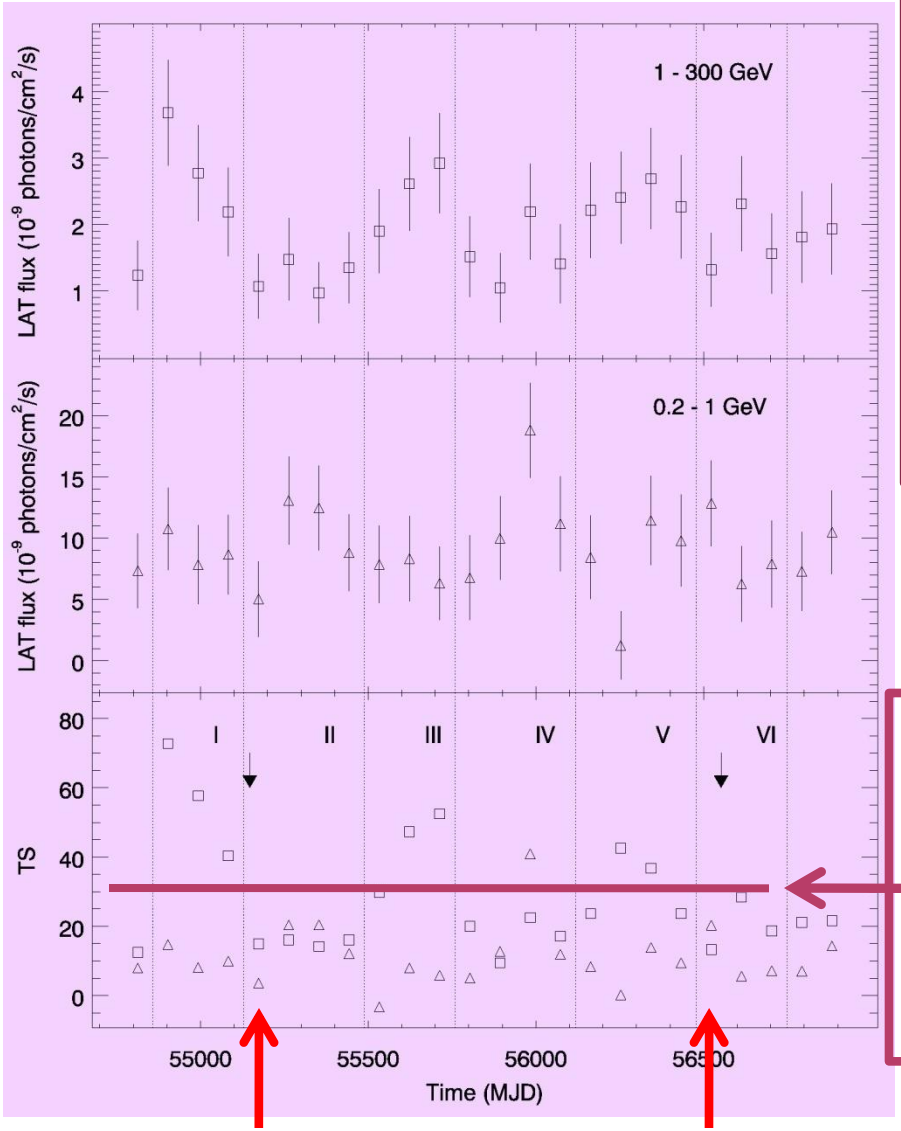
ORBITAL MODULATION



TS=90
(when the primary is behind the secondary)

TS=20
(when the secondary is behind the primary)

LONG TERM VARIATIONS

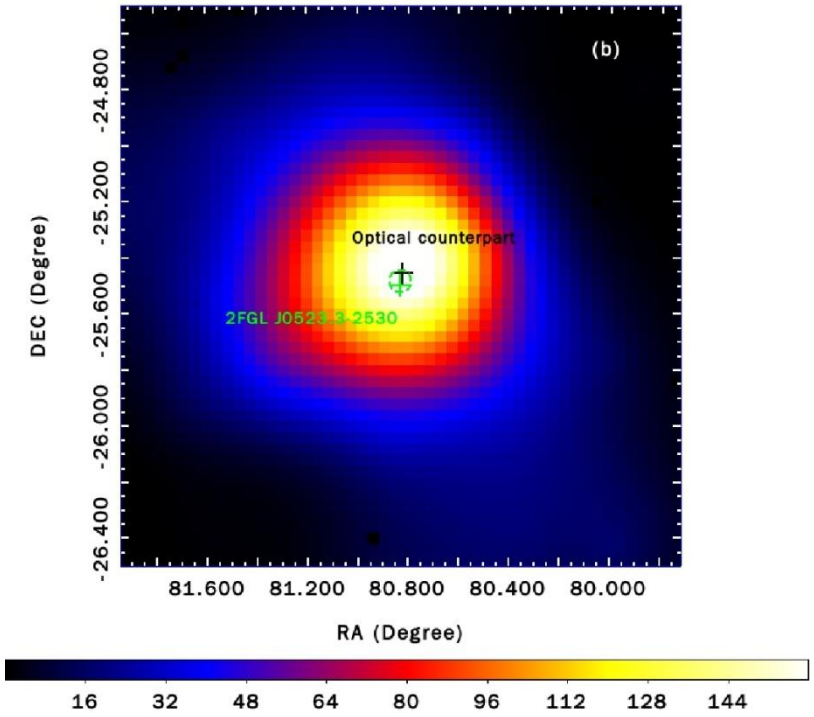


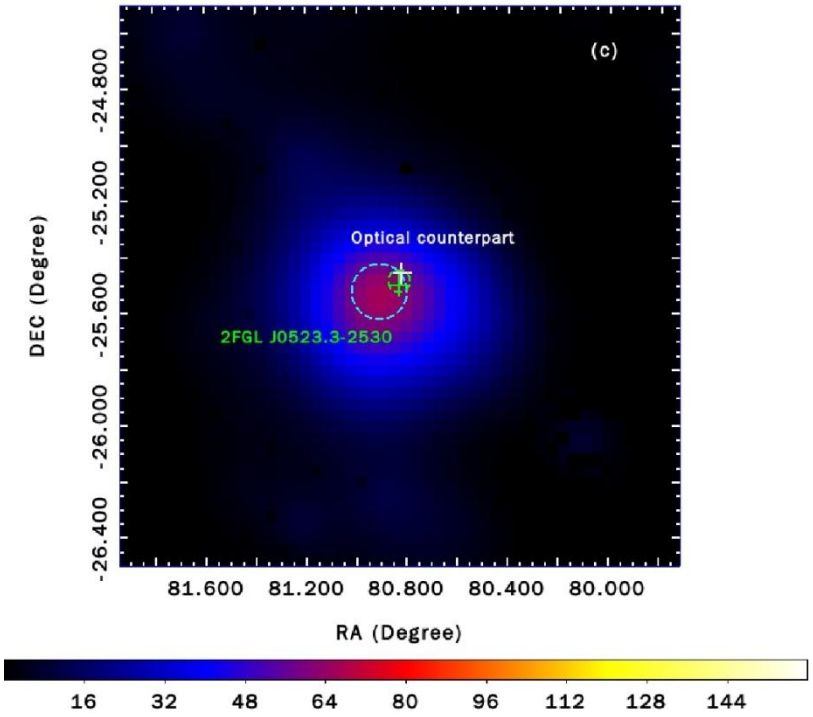
- We find significant flux variations for the >1 GeV energy range
- The time scale is roughly a year
- Two X-ray fluxes obtained are low and consistent, both measured during the low states

TS=30 as the line to define high and low states

Two Swift X-ray observations: power-law emission, with properties consistent with that of intrabinary shock emission

TS MAPS DURING HIGH AND LOW STATES

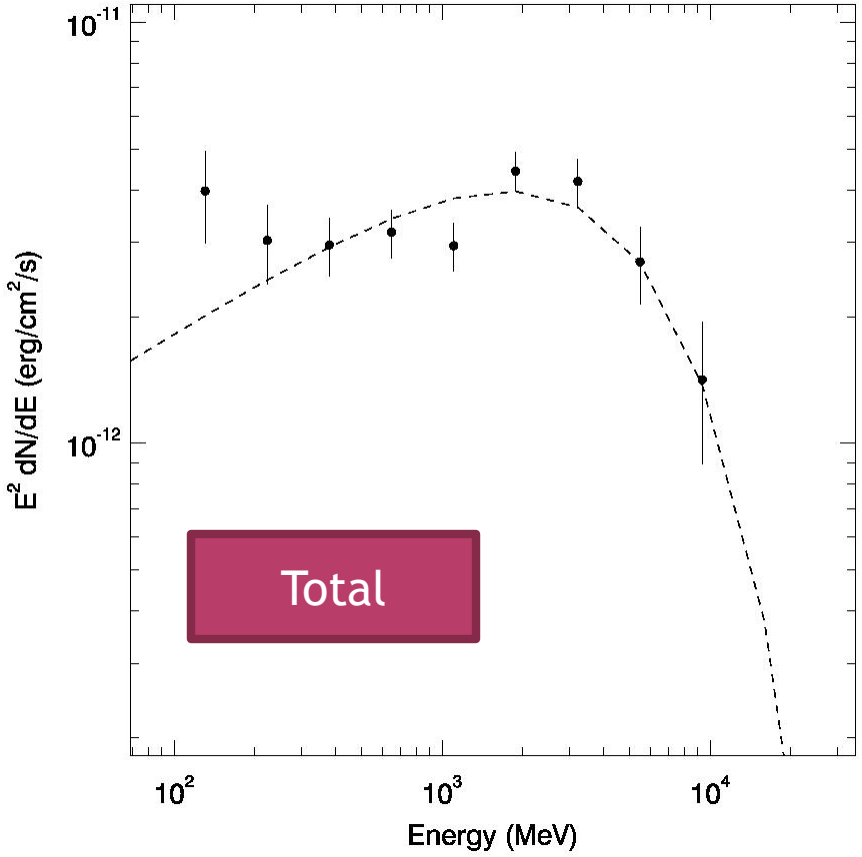




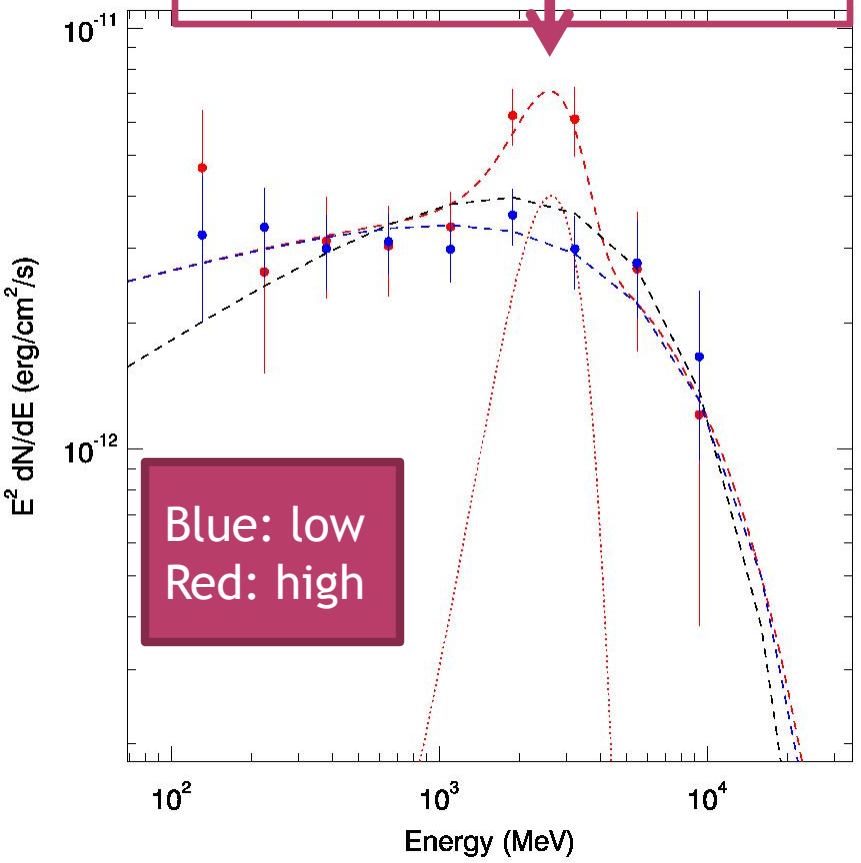
TS=170 at the source (Time interval I)

TS=60 at the source (Time interval II)

SPECTRA

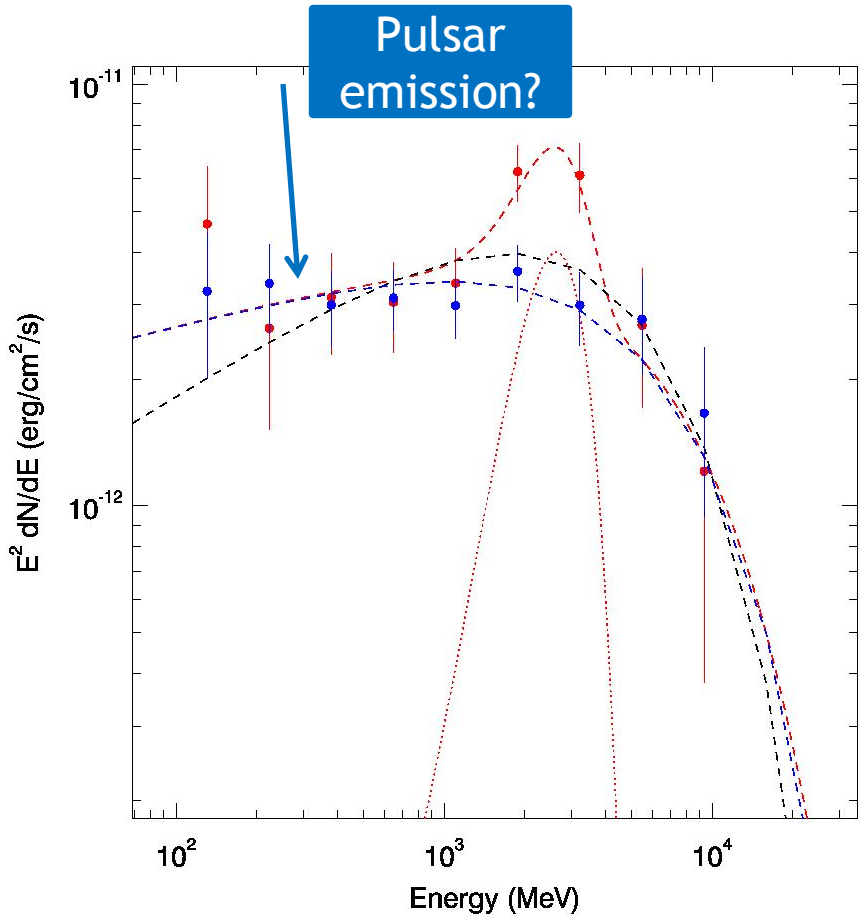


Extra component at 2-3 GeV in the high state



- We use exponentially cutoff power law
- For the total data, Ec=4.4 GeV, but does not describe well the low-energy data points
- For the low state, much better, Ec=6.2 GeV
- For the high state, the same, but with an extra component at 2-3 GeV

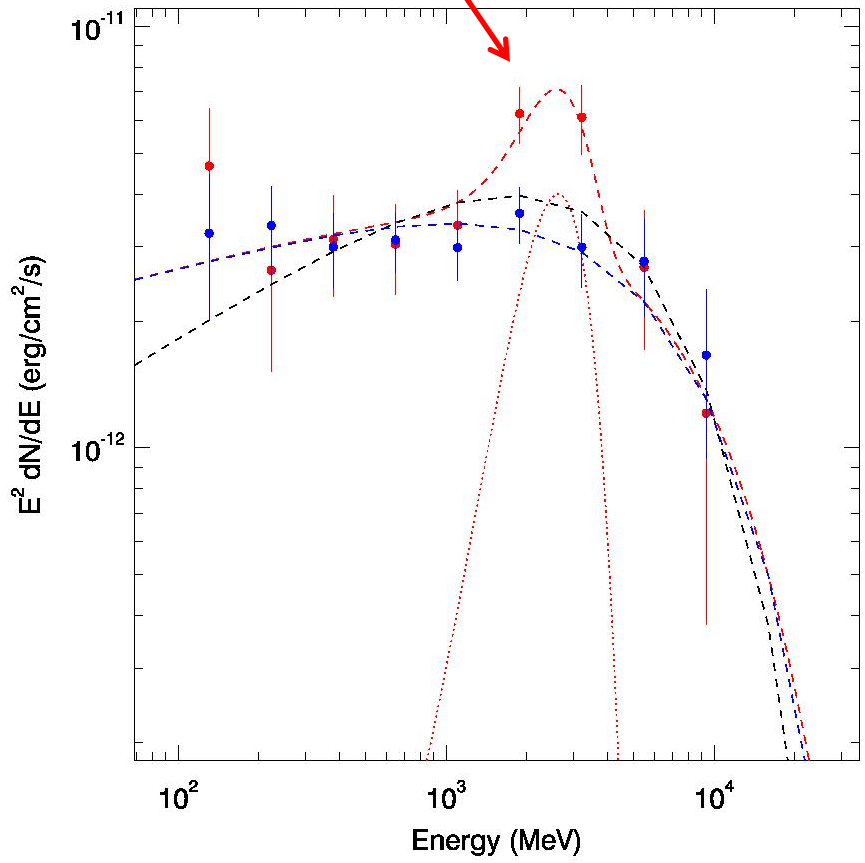
HOW TO UNDERSTAND? 1) ORBITAL MODULATION



- The low state spectrum is well described by an exponentially cutoff power law -> pulsar emission?
- How to explain **the orbital modulation?** Because the source was mostly in the low state
- Comparing to the black widow pulsar binary B1957+20 (Wu et al. 2012), there could be an extra component at >2 GeV and this explains the high Ec value (Ec=6.2 GeV)

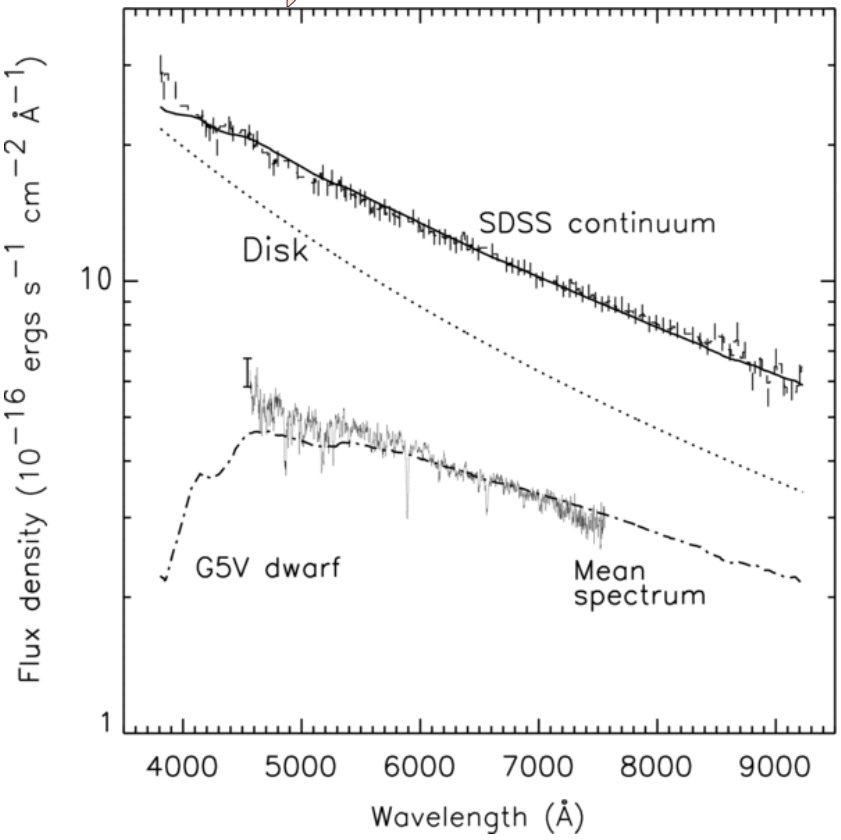
HOW TO UNDERSTAND?
2) LONG-TERM VARIABILITY

Intrabinary shock?



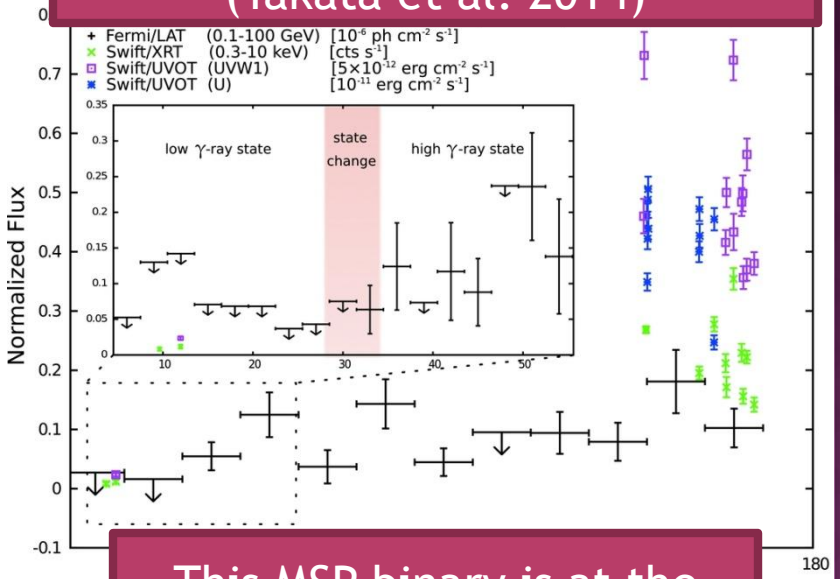
- Comparing to J1023+0038, the variability due to state switching?
- However, NO irradiation of the companion has been seen and no extra emission was seen in the optical light curve
- The high state has an extra component, similar to that seen in the black widow B1957+20. So would the component arise from the intra-binary shock?
- If this is the case, we would detect stronger orbital modulation during the high state? From our analysis, we actually see marginal orbital signals only in the low-state time intervals.

MSP BINARY J1023+0038 (DISCOVERED BY ARCHIBALD ET AL. 2009)



2001 optical spectrum (Wang et al. 2009)

2013 late June its flux increased by an order of magnitude (Takata et al. 2014)



This MSP binary is at the end of its LMXB evolution, and can repeatedly have an accretion disk once a while

Another MSP binary XSS J12270-4859 was recently found that its disk disappeared in 2012 Nov-Dec (Bassa et al. 2014)

FOLLOW-UP OBSERVATIONS

- **We have asked *XMM-Newton* X-ray observations of the binary,** aiming to determine the X-ray properties, detect orbital modulation (verifying the intrabinary-shock origin), and search for pulsed emission
- **We are monitoring the source at optical bands,** searching for any correlated changes in its optical orbital modulation when it enters the high state
- Radio searches for spin period signals during the low state, since the interaction of the pulsar wind with the companion is weak and the system is clean?

Thank you for your attention!