Discovery of a 26.2 day period in the long-term X-ray light curve of the Be/X-ray pulsar SXP1323

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The X-ray Universe

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Artist view of SXP 214, Gabriel Pérez (SMM-IAC)

Be/X-ray binaries (BeXBs)

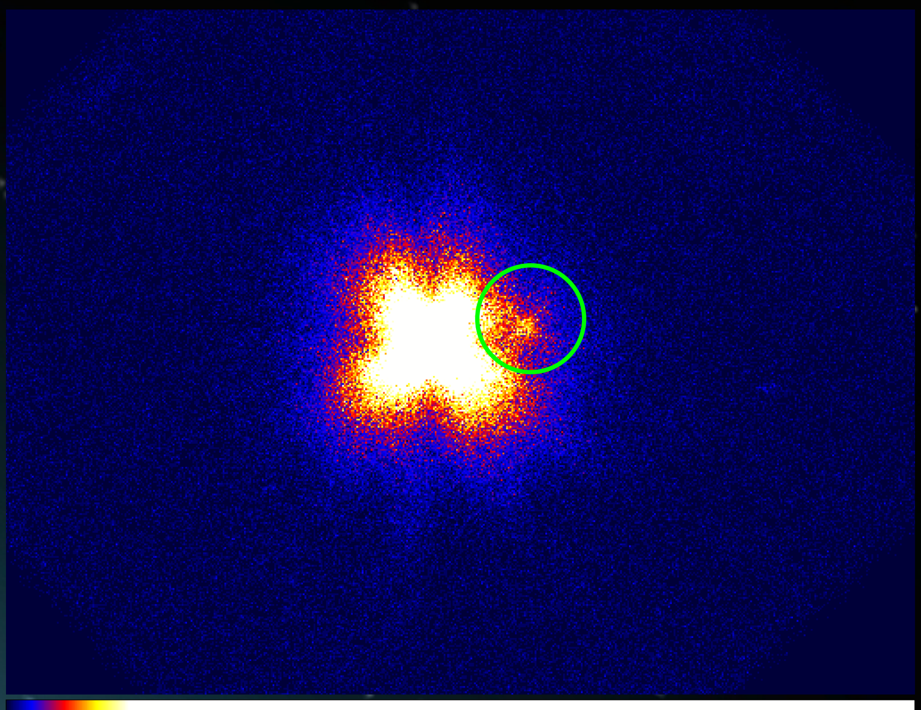
- Be/X-ray binaries belong to the class of High-Mass X-ray binaries
- Are composed of a Be star and a compact object (generally neutron star)
- Mass transfer occurs from the equatorial decretion disc surrounding the Be star onto compact object, either via accretion disk or wind capture
- For many BeXBs, the pulse period is well correlated with the orbital period

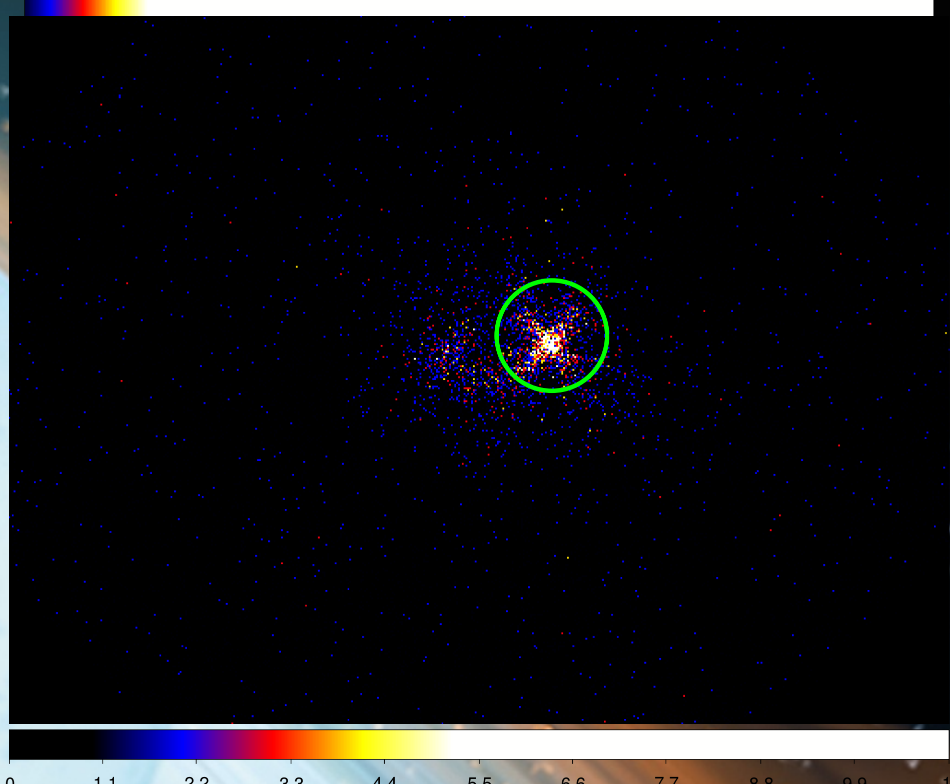
RX J0103.6-7201 alias SXP1323

- SXP1323, discovered by Haberl & Pietsch (2005), is one of the longest-period pulsars known in SMC
- Analysing optical OGLE data, Schmidtke & Cowley (2006a,b) discovered several periodic signals, one being at 26.16d
- SXP1323 is very close to the bright SNR 1E 0102-72.3 which is often observed for calibration purpose

X-ray observations of SXP1323

1. Suzaku observations





- 1E 0102-72.3 has been observed 75 times with Suzaku between August 2005 and April 2015 with the XIS instrument.
- Period search performed on 70 XIS datasets having a total exposure time>15ks
- In the full energy band the light of the SNR and pulsar are confused, but at energies>2.5kev the contribution of the SNR is negligible.

2. XMM-Newton observations

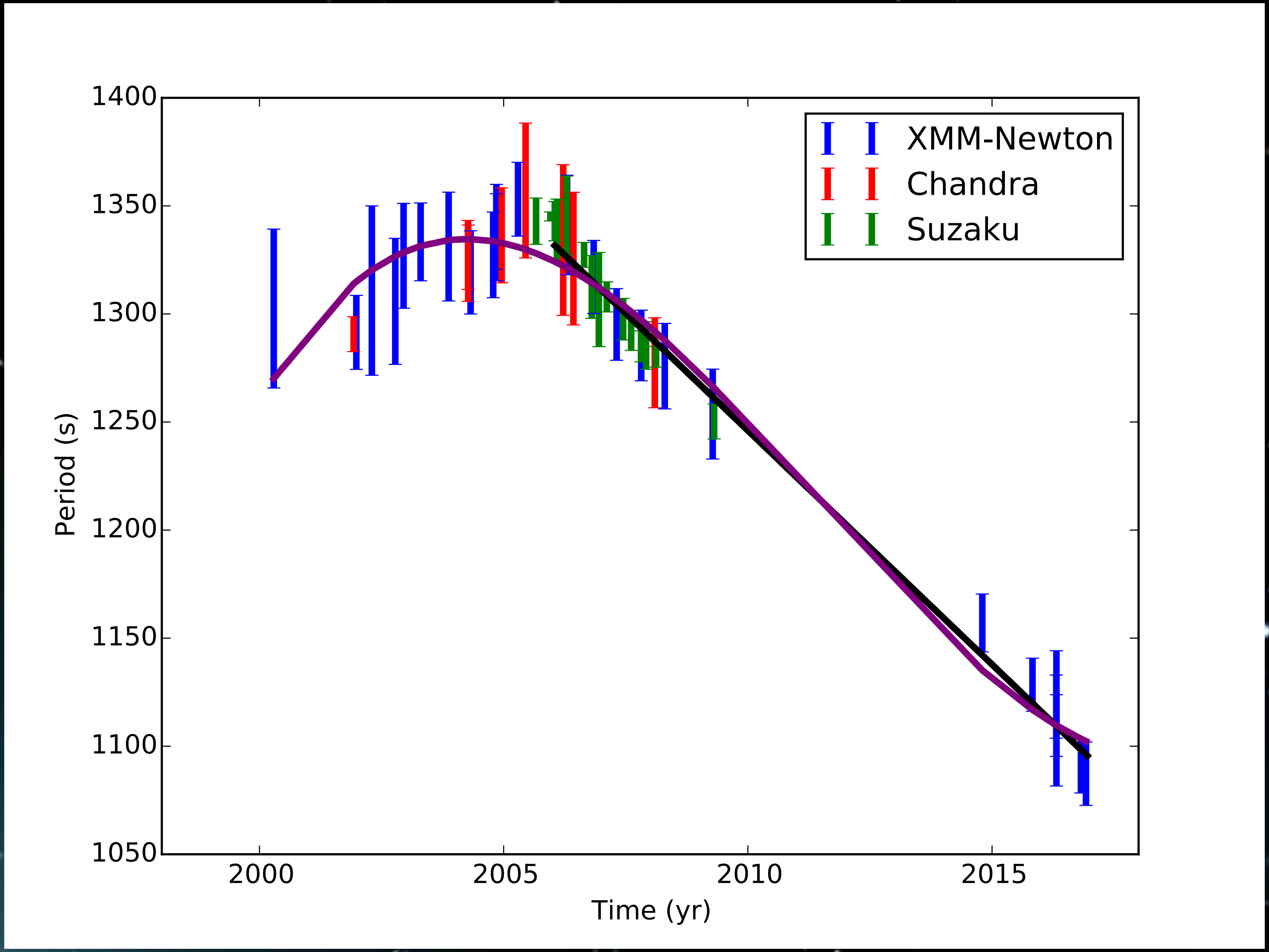
46 XMM-Newton EPIC observations are available for SNR 1E 0102-72.3, performed between April 2000 and December 2016

3. Chandra observations

- The pulsar is visible in 201 observations performed with ACIS instrument, between August 1999 to March 2016.
- Events from observations performed on the same day or on two consecutive days are merged together leaving 66 independent datasets
- From 2008 the source is not in the FOV for most observations.

Pulse period search

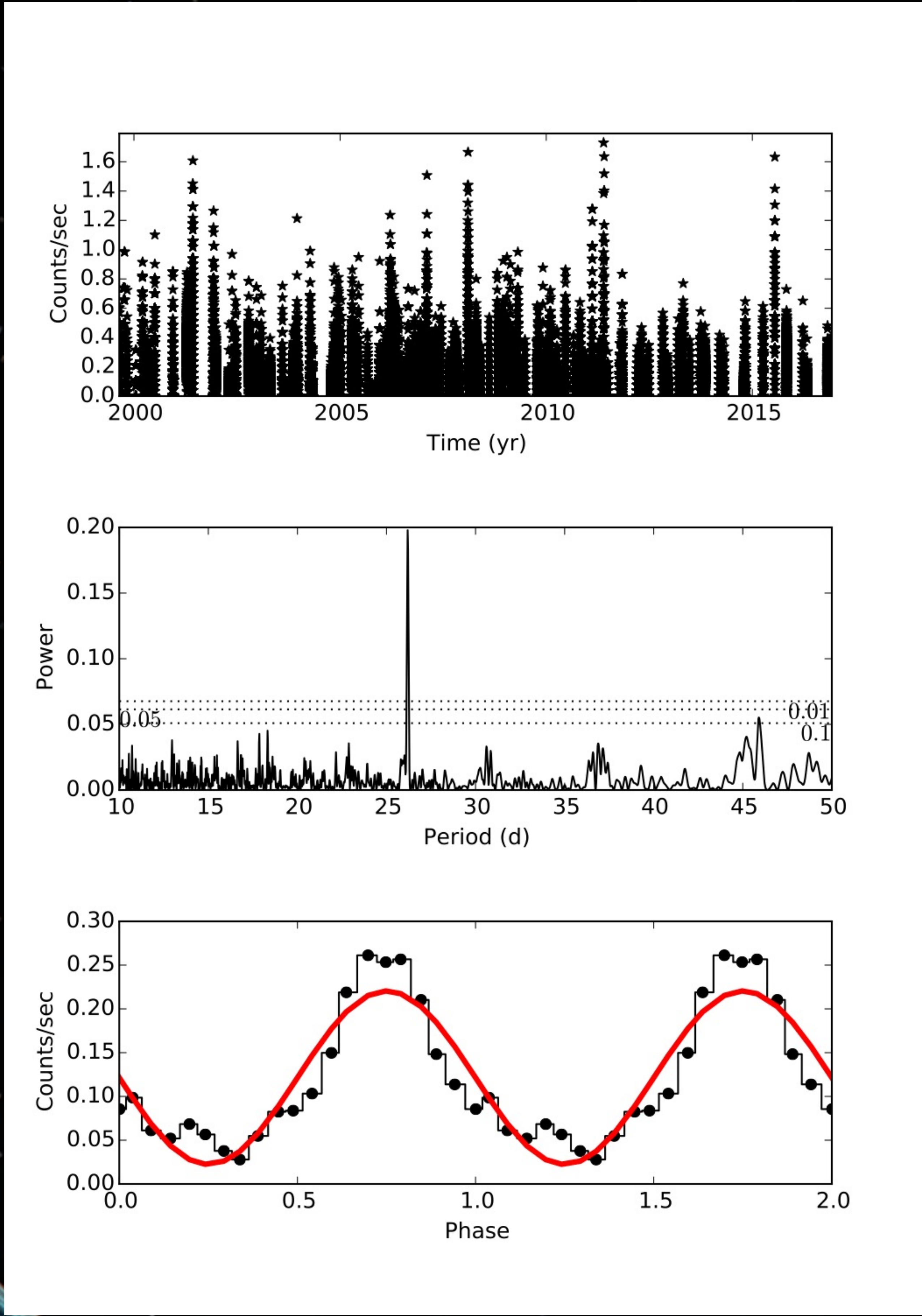
- Pulse period search is performed using Lomb-Scargle periodogram analysis, in the energy band 2.5-10 keV, and in period range 900-1600 s.
- Light curves are barycenter-corrected, background-subtracted and binned to 50s.
- Events recorded by different instruments (pn and MOS for XMM-Newton, and XIS0→XIS3 for Suzaku) are merged together. When a instrument is not operating in some time interval a corrective factor is applied to avoid discontinuities in light curves.
- Uncertainty on periods are measured by fitting a Gaussian function on periodograms; error bars correspond to the 1σ standard deviation.



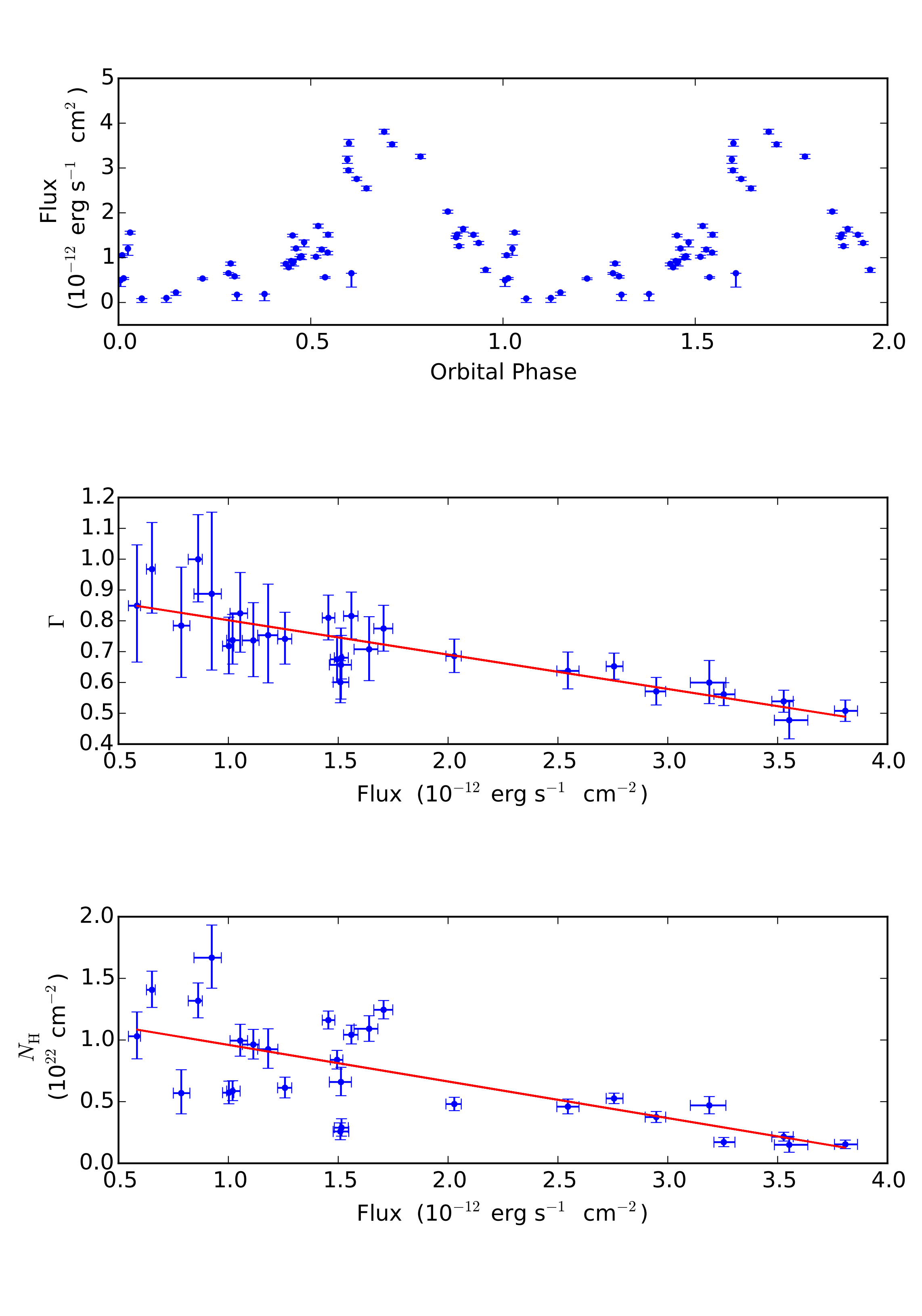
- From 2006 to end 2016, the source is spinning up at a rate of $\dot{P}$=-21.65 s/yr!
- From 2010 to end 2014 the pulse period is occasionally detected but at a lower confidence level

Orbital period search

- Orbital period search was made using all observations from Suzaku, XMM-Newton and Chandra
- Differences in the sensitivity of the various instruments and vignetting issues were taken into account
- A clear peak is found at 26.188d with a 1σ uncertainty of 0.045d.



Spectral change with orbital period



- Spectral analysis performed on XMM-Newton data, because of its higher sensitivity
- Spectra are fitted in the 0.3-10 keV with XSPEC using the model: phabs*vphabs*power
- The first absorption component has a fixed Galactic N_H=5.36x10^{20} cm^{-2}, and the second N_H is left free, while the abundances fixed to SMC values.
- Flux variation follows orbital modulation
- Anti-correlation between power-law index and flux (source harder at high flux), and between absorption and flux (less absorption at high flux).

Conclusions

- SXP1323 is a very atypical BeXB for many reasons:
    1. it has long pulse period.
    2. from 2006, it is spinning up much more rapidly than any other SMC BeXBs
    3. from 2010 to end 2014 the pulse period is not clearly detected anymore (also observed in other systems). Since the spectrum and flux haven't changed in that period, this could be explained by a change in the system geometry.
    4. The orbital period (found in X-rays and optical band) is short with respect to the long pulse period. Hence it doesn't follow the spin-orbit period relationship: a pulse period of 1323s would lead to an orbital period of 364d.
- The folded X-ray and optical light curves have sinusoidal shapes → the system likely does not undergo regular outbursts, but neutron star would accrete continuously during its orbit