

## Phase-dependent absorption features in X-ray spectra of XDINSs

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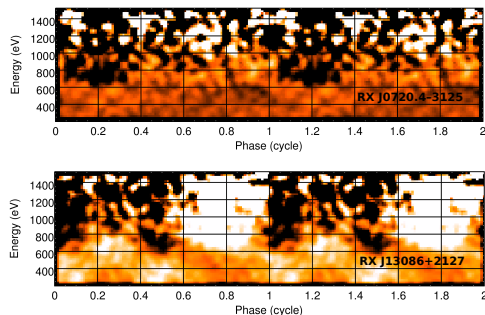


Figure 1: Normalized energy versus phase images of RX J0720.4-3125 (top panel) and RX J1308.6+2127 (bottom panel) obtained by binning the EPIC-pn source counts into 100 phase bins and 25-eV-wide energy channels.

A possible candidate was found in the X-ray spectrum of RX J1308.6+2127 [2]. This absorption feature shows the same phase dependency and energy as the first one, revealing the presence of a high-B structure close to the stellar surface.

In both cases we performed Monte Carlo simulations to verify the significance of these discoveries and the outcome has confirmed the detection of the phase-variable absorption feature in both sources. This result provides evidence for deviations from a pure dipole magnetic field on small scales for highly magnetized neutron stars and supports the proposed scenario of XDINSs being aged magnetars, having still a strong non-dipolar crustal B-field component.

## References

- [1] A. Borghese et al., 2015 *ApJ*, 807, L20
- [2] A. Borghese et al., 2017, *MNRAS*, submitted

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A detailed pulse phase spectroscopy using all the available XMM-Newton observations of X-ray dim isolated neutron stars (XDINSs) have revealed the presence of narrow and strongly phase-dependent absorption X-ray features. The first discovered was in the X-ray spectrum of the nearby XDINS RX J0720.4-3125 [1]. The line seems to be stable in time over a timespan of 12 years and is present in 20% of the pulsar rotation. Because of its narrow width and its strong dependency on the rotational phase, the spectral line is probably due to proton cyclotron absorption in a  $\sim 10^{14}$  G confined magnetic structure (with a field strength about 7 times the dipolar field of this pulsar). Performing the same analysis to all archival XDINS data, a new