Discovery of a keV-X-ray Excess of RX J1856.5-3754

Tomokage YONEYAMA, Kiyoshi HAYASHIDA, Hiroshi NAKAJIMA,
Shota INOUE and Hiroshi TSUNEMI (Osaka University)

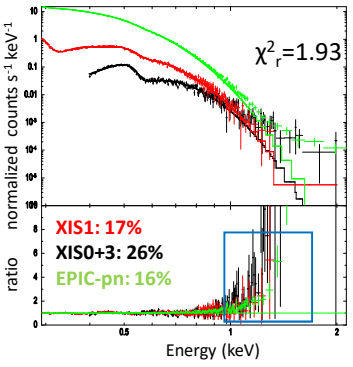
大阪大学 OSAKA UNIVERSITY

Abstract

RX J1856.5-3754 is the brightest thermally emitting isolated neutron star, whose spectrum is well-fitted with a two-temperature (kT = 32 and 63 eV) blackbody model. Fitting 10-years data from Suzaku XIS1, XIS0, XIS3 and XMM-Newton EPIC-pn with the two-blackbody models, we discover an excess emission above 0.8 keV. We examine possible causes of this ***keV-X-ray excess***; uncertainty of the background, pile up of the low energy photons and confusion of other sources. None of them succeeds in explaining the keV-X-ray excess observed with different instruments. We thus consider the keV-X-ray excess is most likely originated in RX J1856.5-3754. However, it is difficult to constrain the spectral shape of the keV-X-ray excess. We also analyze the periodicity of 0.8-1.2keV data, but only the upper limit of pulse fraction < 3 % is obtained. We shortly discuss about a relation between the keV excess and hard power law component in magnetars. Errors in this poster is 90 % confidence level.

1. Discovery of a "keV excess"

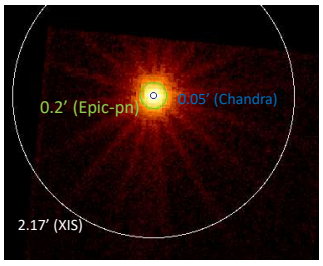
Fitting the 10-years data of XIS and EPIC-pn of RX J1856 with known two-temperature blackbody model[1][2][3] (kT = 63 & 32 eV), we find all the data exceed the model by 16~26 % of excess fraction in 0.8-1.2 keV band. We call this keV-X-ray excess or shortly "keV excess".



2. Possible causes of the excess

We examine the keV excess considering possible causes, from which we calculate the fraction to two-BB model to compare with the observed excess; **fluctuation in background**, **Pile up** of low energy photons.

Cause	Fraction to 2BB model [%]		
	XIS1	XIS0+3	EPIC-pn
Observed Excess	17±8	26±7	16±2
Fluctuation in BGD	±6.6	±6.7	±0.44
Pile up	0.07	0.003	2.5

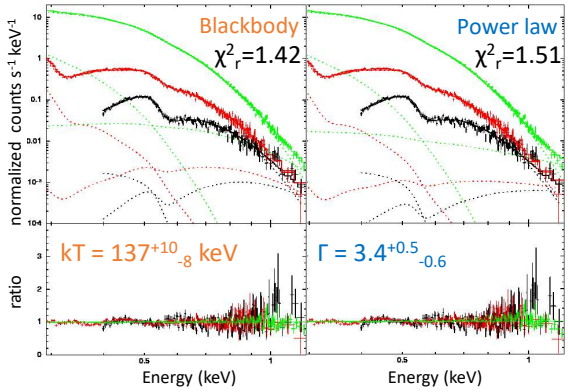


EPIC-pn image

We use 2.17' and 0.2' radius circle as extraction regions of XIS and EPIC-pn, respectively. We thus employ EPIC-MOS and Chandra data to calculate the flux of **confusion sources**. We obtain the fraction to two-BB model of **4.0±3.0 %** (EPIC-MOS; 0,2'-2.17') and **-3.3±5.7 %** (Chandra; 0.05'-0.2'), respectively.
Comparing the observed value, none of them can explain the keV excess. We thus consider it is most likely intrinsic to RX J1856.

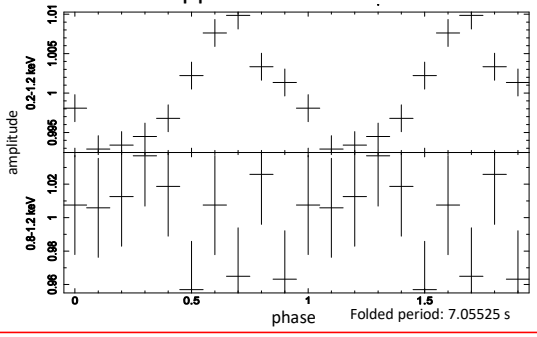
3. Spectral fitting for the keV excess

We then fit the keV excess spectra with blackbody or power law model as an additional component by making the parametres of the baseline two-BB model fixed. The best fit parameter is kT = 137^{+10}_{-8} eV for blackbody and Γ = $3.4^{+0.5}_{-0.6}$ for power law.



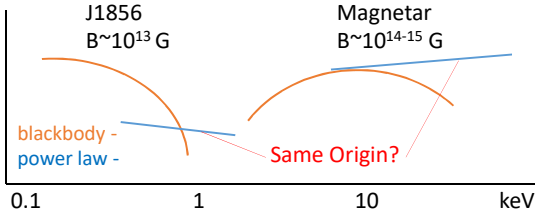
4. Search for Pulsation

We coherently analyze the 10-years data of EPIC-pn and obtain 7.05525 s pulsation in 0.2-1.2 keV, consistent with 1.5 % pulsation in previous studies[4][5]. However, we cannot find any significant periods in 0.8-1.2 keV. We thus fold the light curve with 7.05525 s and fit with a sinusoid to derive the pulsed fraction. We obtain the pulsed fraction of 1.13 ± 1.93 % and upper limit of **3.06 %**.



5. Discussion

We note an interesting analogy between the keV excess in RX J1856 and the hard X-ray (>10 keV) component of the magnetars[6] which have B~10^{14}-10^{15} G, while RX J1856 has 10^{13} G[5]. Considering the difference of the magnetic field magnitude, the keV excess component might be a weak version of the hard power law component in magnetars. We need further observations of the keV excess to approach its origin.



Reference

[1] Pons et al. 2002, ApJ, 564, 981
[2] Burwitz et al. 2003, A&A, 399, 1109
[3] Beruermann et al. 2006, A&A, 458, 541
[4] Tiengo & Mereghetti 2007, ApJ, 657, L101
[5] Karkwijk & Kaplan 2008, ApJ, 673, L163
[6] Enoto et al. 2010 ApJ, 722, 162