Suzaku spectroscopy of a magnetar 1E 1841-045 and search for NIR pulsation of a magnetar 4U 0142+61

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Abstract

Magnetars are strongly magnetized neutron stars ($\sim 10^{14} - -10^{15}$ G) (Thompson & Duncan 1995). The energy spectra in soft/hard X-ray and IR/optical are known to be peculiar (Woods & Thompson 2006). The emissions are thought to be generated by release of magnetic energy, however the energy release mechanism is still open question. Here, we present observations for two magnetars 1E 1841−045 and 4U 0142+61 by Suzaku and Subaru, respectively.

Key words: stars: neutron — stars: pulsars: individual (1E 1841−045, 4U 0142+61)

1. Suzaku spectroscopy of a magnetar 1E 1841−045

The soft X-ray emission (< 10 keV) characterized by a two-temperature blackbodies is related with radiative processes in magnetosphere. The hard X-ray emission (> 10 keV) with very hard photon indices (gamma ~ 1) may be related with an activity of magnetic field (Kuiper, Hermsen, & Mendez 2004). Here, we present the result of Suzaku observation of a magnetar 1E 1841−045. The two-blackbody (BBs) and BB + PL (power-law) model is confirmed in all pulse phase, suggesting that the emission is intrinsically of such a shape rather than produced from two hot spots in the surface. The combination BB + PL + PL can best represent the phase-averaged spectrum (Fig. 1, 2). We found that the temperatures and radii of the two-blackbody components showed significant correlations in phase-resolved spectra (Fig. 3). This fact and the same correlations among phase-averaged spectra of various magnetars (Nakagawa et al. 2009) suggest that a self-similar function can approximate an intrinsic energy spectra of magnetars below 10 keV (Morii et al. 2009).

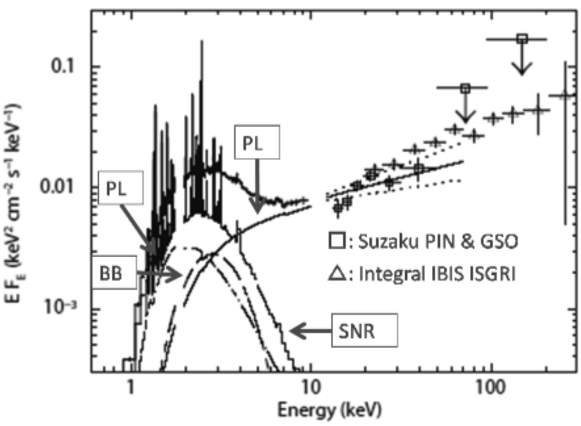

Fig. 1. Phase-averaged spectrum (νF_ν), compared with that of Integral (taken from Morii et al. 2009).

2. NIR Pulse search for 4U 0142+61

About half of magnetars have IR/optical counterparts, and they are bright in IR (Woods & Thompson 2006). This property is different from that of young rotation-powered pulsars. The IR emission mechanism is thought to be either pulsed non-thermal emission owing to an effect of strong magnetic field or un-pulsed thermal emission from a debris disk around magnetars (Wang, Chakrabarty, & Kaplan 2006). The NIR pulsation is a key to determine the emission mechanism. Here, we present the result of a search for pulsation of a magnetar 4U 0142+61 using IRCS at the Subaru 8.2-m telescope (Fig. 4). Although we found no significant signal at the pulse frequency expected by the X-ray observation, we obtained a best upper limit of 17% (90% C.L.) for the root-mean square pulse fraction in the K' band. Combined with i' band pulsation (Dhillon et al. 2005), the slope of the pulsed component can be constrained (Fig. 5). It will help to constrain the IR/optical emission mechanism (Morii et al. 2009).

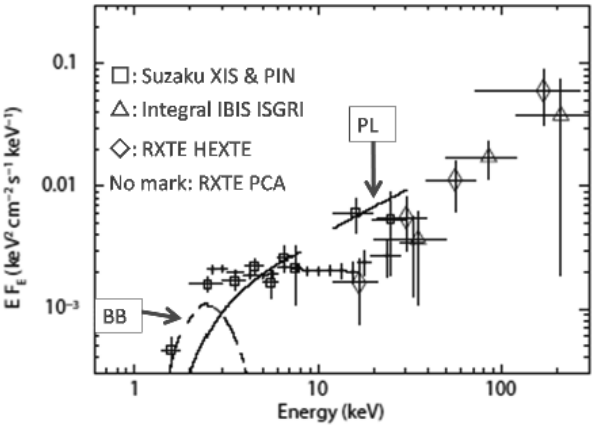

Fig. 2. Pulsed-component spectrum (νF_ν), compared with those of Integral and RXTE (taken from Morii et al. 2009).

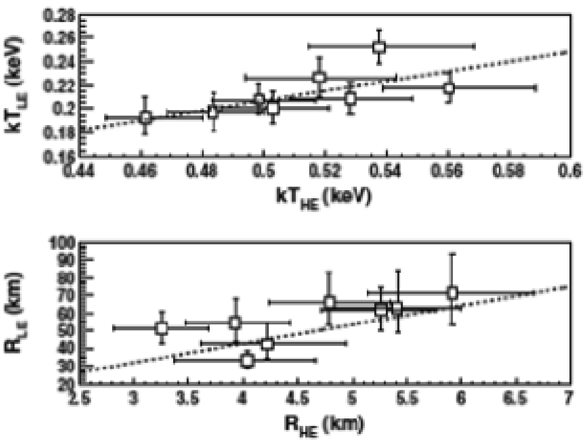

Fig. 3. Correlation in phase-resolved spectra: correlation between temperatures (kT) and radii (R) for the blackbody components with the lower (LT) and higher (HT) temperatures, when the phase-resolved spectra were fitted with a BB + BB + PL model (taken from Morii et al. 2009).

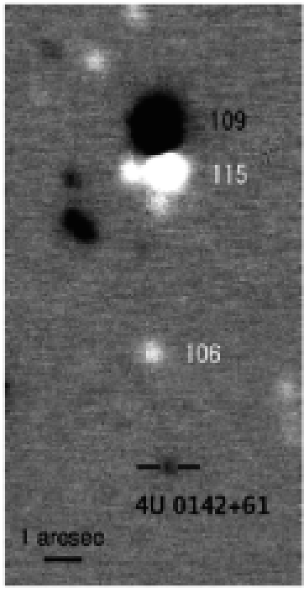

Fig. 4. Combined image of all pulse phases taken by IRCS.

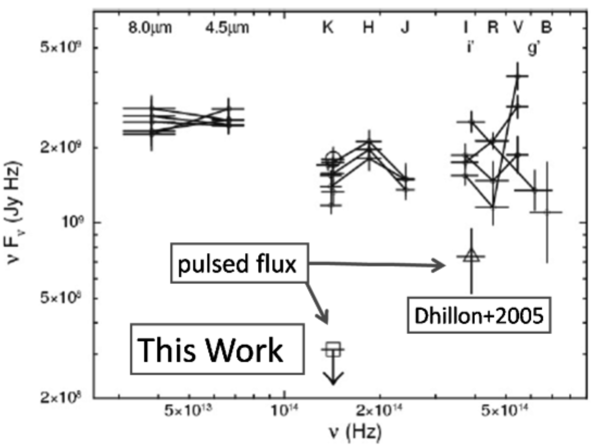

Fig. 5. SED of 4U 0142+61 for total and pulsed components.

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