Discovery of keV excess emission in the isolated neutron star RX J1856.5–3754

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Abstract

RX J1856.5–3754 is the brightest and nearest (∼120 pc) thermally emitting isolated neutron star, a prototype of X-ray dim neutron stars (XDINS). After its discovery with ROSAT, the source was observed many times with various X-ray satellites. Observations with XMM-Newton and Chandra satellites indicate that the X-ray spectrum is well reproduced with a combination of blackbody models, one with $kT \sim 32$ eV and the other with $kT \sim 63$ eV. In addition, the X-ray spectrum and intensity are found to be fairly stable over the time. Therefore, the source was employed as a calibration target of the soft X-ray detectors, which are sensitive to contamination of material onto detectors or filters inside the satellites. Suzaku observed this source 10 times during its lifetime primarily for the calibration purpose. The X-ray spectra below 0.8 keV are well fitted with the two blackbody model determined with XMM-Newton and Chandra. Nevertheless, we notice systematic excess of the observed spectra over the two blackbody model. The excess is about 20% in the integrated counts in 0.8–1.2 keV band, and is found both in the spectra of BI-CCD (XIS1) and FI-CCD(XIS0+XIS3). We further analyze the XMM-Newton EPIC-PN spectra of this source and find similar excess. We call this keV excess, discovered 1st time for this source and for the XDINS class. We examine possible causes of this excess, including uncertainty in background subtraction, pileup of photons below 0.8 keV, and contamination of other sources. We show qualitative difficulties in explaining the keV excess with these causes. We then conclude the keV excess is originated in the source RX J1856.5–3754, or its neighbor within the radius of 0.2 arcmin. The keV excess component is fitted either with a blackbody model ($kT \sim 140$ eV) or a power law model ($\Gamma \sim 4.5$), though it is hard to constrain considering the systematic uncertainty. We shortly discuss possible origin of this keV excess.