A joint *NICER* + *XMM* view of the Magnificient XINS RX J1605.3+3249

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Overview

Thermally emitting X-ray isolated neutron stars represent excellent targets for testing cooling surface emission&atmosphere models, which are used to infer physical parameters of the neutron star. Among the 7 known members of this class, RX J1605.3+3249 is the only one that still lacks confirmation of its spin period. Here we analyze NICER+XMM observations of J1605. We put stringent upper limits on the pulsed fraction and fit the X-ray spectrum with a double-blackbody model or with an atmospheric model. The predictions of the best-fit X-ray models extended to IR, optical and UV bands are compared with archival data. Our results are interpreted in the framework of a fallback disk scenario.

Main results

Contrary to a previous tentative detection, but in line with the recently published work from Pires et al. (2019), we find no significant pulsation with pulsed fraction higher than 1.3% and 2.6% (3σ) for periods above 150ms and 2ms, respectively, despite searches in different energy bands. The source's X-ray spectrum can be fit by both a double-blackbody model or by a single-temperature magnetized atmosphere model, both modified by a Gaussian absorption line at ~0.44 keV (see Table 1). Comparison of the best-fit X-ray models with archival data hint to emission from a fallback disk that peaks in the optical band.

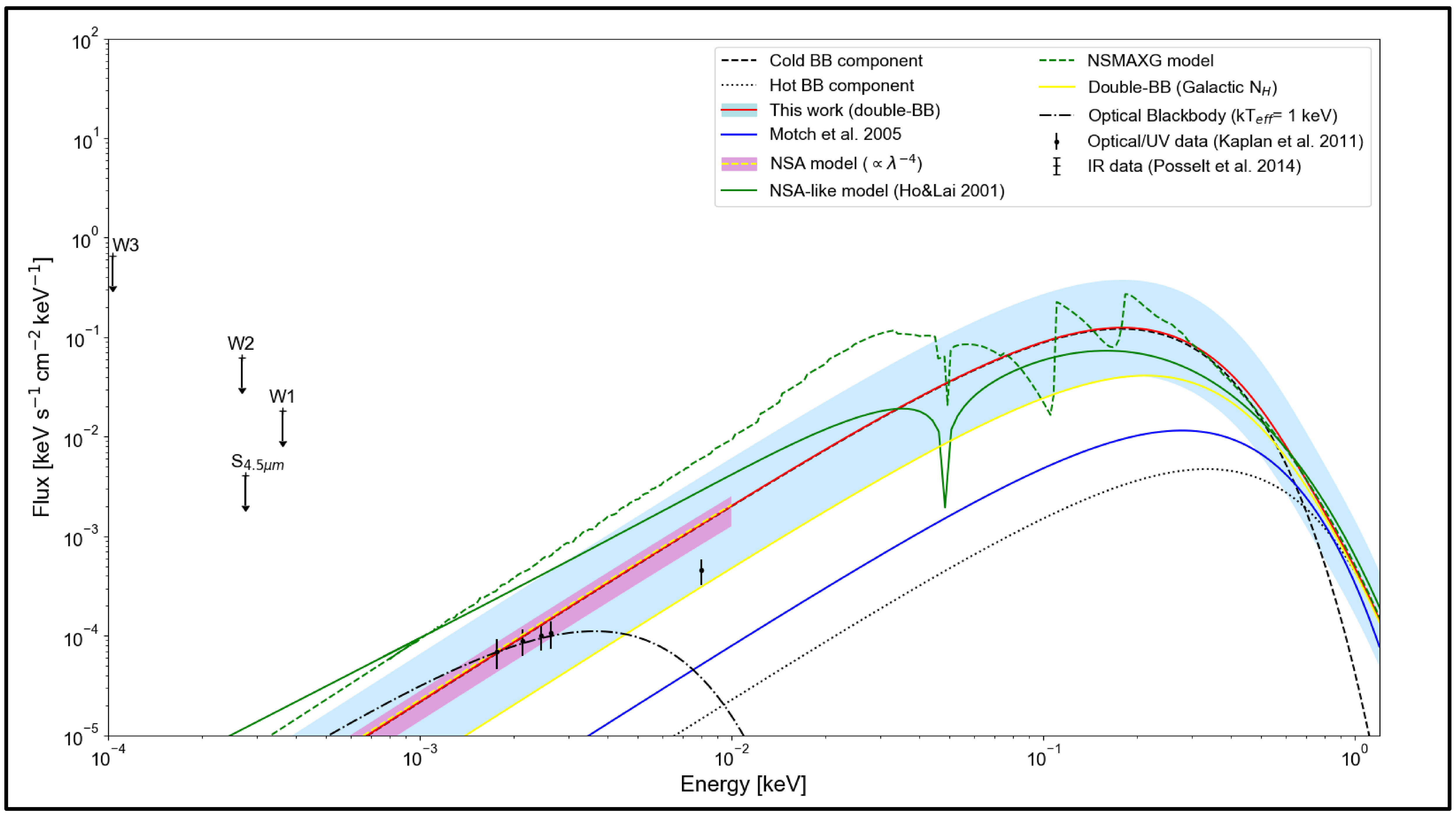

Fig. 1: Broadband spectral energy distribution of J1605. Black dotted and dashed lines are the hot and cold (unabsorbed) blackbody components, respectively, obtained from the fit of X-ray data (see Table). The red continuous line represents the sum of the two blackbody components (uncertainty at 90% c.l. shown as the cyan shaded region). The yellow solid line represents the best-fit double-blackbody model obtained with N_H fixed to the Galactic value to the source. For comparison, the best-fit single-blackbody model obtained by Motch+2005 is also shown (continuous blue line). IR upper limits are shown as black arrows. Optical/UV data are shown as black points with error bars,while the black dash-dotted line represents blackbody emission at kT_eff= 1keV (see text and Ertan+2017). The best-fit NSA-like model (Ho&Lai 2001) and NSMAXG model are also reported for comparison (continuous and dashed green lines, respectively). The low-energy tail predicted by the NSA model corrected for a color factor of 2.5 is shown (yellow dashed line), including propagated uncertainty (plum shaded region) in the relevant energy band.

Table 1: Best-fit parameters for models with N_H free. Reported errors are at 90% c.l.

	T_{hot} [eV]	T_{cold} [eV]	T_{eff} [eV]	E_{cyc} [eV]
Double-BB	119^{+6}_{-4}	63^{+7}_{-6}	–	435^{+13}_{-6}
NSA	–	–	47^{+1}_{-1}	452^{+3}_{-3}
NSMAXG	–	–	46^{+2}_{-2}	445^{+3}_{-3}

Conclusions

We do not detect X-ray pulsations from J1605. The best-fit double-blackbody model seems puzzling due to the non-detected pulsation, but the contrast can be mitigated if there is an unfavorable geometry and by accounting for light-bending effects. An absorption feature at ~0.44 keV is clearly detected in the energy spectrum. Differently from previous works, we do not find harmonic features (in line with Pires+2019). Our analysis favors a proton cyclotron line interpretation, thus reflecting a magnetic field strength of ~9x10^{13} G. The best-fit, N_H free, double-blackbody model is consistent with optical data from Kaplan+2011, but overpredicts UV flux, while the opposite holds for the best-fit double-BB model with Galactic N_H. The predicted UV excess might be due to absorption from a dusty environment surrounding the compact object, but IR data do not support this scenario. If the best-fit double-blackbody model with Galactic N_His considered, UV data are also well fitted, while optical data can be accounted as blackbody emission at kT_eff= 1keV from a fallback disk.The best-fit single-temperature atmospheric models are tempting to solve the non pulsation puzzle, but are not consistent with optical/UV data. A measurement of the distance to J1605 would greatly aid in the resolution of these questions.

References

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