The Neutron Star in the Supernova Remnant PKS 1209–52

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We analyzed soft X-ray data collected with the *ROSAT* and *ASCA* observatories on 1E 1207.4–5209 which is a candidate young neutron star (NS; age $\sim 10^4$ K) near the center of the supernova remnant PKS 1209–52. We fitted the observed spectra with NS atmosphere models. The models take into account realistic radiative opacities in the plasma of surface NS layers which make atmosphere spectra to differ significantly from blackbody emission (e. g., Zavlin et al. 1996). The hydrogen atmosphere fit yields more plausible parameters of the NS and the intervening hydrogen column than the traditional blackbody approach. In particular, for a NS of mass $M = 1.4\ M_\odot$ and radius $R = 10$ km, we obtained a surface temperature $T = (1.4 - 1.9) \times 10^6$ K and distance $d = 1.6 - 3.3$ kpc versus $T = (4.2 - 4.6) \times 10^6$ K and $d = 11 - 13$ kpc for the blackbody fit. The distance inferred from the atmosphere fit is consistent with the estimation $d \sim 1 - 2$ kpc for the supernova remnant obtained from radio observations. Our fits suggest that the surface magnetic field is either very weak, $< 10^{10}$ G, or it exceeds $\simeq 2 \times 10^{12}$ G. The hydrogen column density given by the atmosphere fits, $(0.8-2.2)\times 10^{21}$ cm^{-2}, agrees fairly well with independent estimates obtained from UV observations of nearby stars (e. g., HD112244, HD115842, HD111822), radio data and *EXOSAT* and *ROSAT* spectra of the shell of the supernova remnant, whereas the blackbody and power-law fits give considerably lower and greater values, respectively. The inferred NS surface temperature is consistent with a number of NS cooling models. As an example, in the figure there are shown a few standard (solid) and fast (dashed) cooling curves (with and without frictional heatings), $T^\infty = \sqrt{1 - 2.95M/(M_\odot R)}\ T$ versus age, for a stiff (PS) equation of state of NS interior matter. The shaded and empty boxes indicate the results yielded by the atmosphere and blackbody fits, respectively.

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