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The direct cooling tail method for X-ray burst analysis to constrain neutron star masses and radii

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Abstract

© 2016 The Authors. Determining neutron star (NS) radii and masses can help to understand the properties of matter at supra-nuclear densities. Thermal emission during thermonuclear X-ray bursts from NSs in low-mass X-ray binaries provides a unique opportunity to study NS parameters, because of the high fluxes, large luminosity variations and the related changes in the spectral properties. The standard cooling tail method uses hot NS atmosphere models to convert the observed spectral evolution during cooling stages of X-ray bursts to the Eddington flux F Edd and the stellar angular size ω. These are then translated to the constraints on the NS massMand radius R. Here we present the improved, direct cooling tail method that generalizes the standard approach. First, we adjust the cooling tail method to account for the bolometric correction to the flux. Then, we fit the observed dependence of the blackbody normalization on flux with a theoretical model directly on theM-R plane by interpolating theoretical dependences to a given gravity, hence ensuring only weakly informative priors for M and R instead of F Edd and ω. The direct cooling method is demonstrated using a photospheric radius expansion burst from SAX J1810.8-2609, which has happened when the system was in the hard state. Comparing to the standard cooling tail method, the confidence regions are shifted by 1σ towards larger radii, giving R = 11.5-13.0 km at M = 1.3-1.8M ⊙ for this NS.

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Keywords

Stars: neutron, X-rays: bursts, X-rays: individual: (SAX J1810.8-2609), X-rays: stars

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