Accretion History of AGNs. II. Constraints on AGN Spectral Parameters Using the Cosmic X-Ray Background

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Abstract

We constrain X-ray spectral shapes for the ensemble of active galactic nuclei (AGNs) based on the shape of the cosmic X-ray background (CXB). Specifically, we rule out regions of X-ray spectral parameter space that do not reproduce the CXB in the energy range 1–100 keV. The key X-ray spectral parameters are the photon index, Γ; the cutoff energy, Ecutoff; and the reflection scaling factor, R. Assuming each parameter follows a Gaussian distribution, we first explore the parameter space using a Bayesian approach and a fixed X-ray luminosity function (XLF). For σE = 36 keV and σR = 0.14, fixed at the observed values from the Swift-BAT 70-month sample, we allow áR E ñá ñ , cutoff and áGñ to vary subject to reproducing the CXB. We report results for σΓ = 0.1–0.5. In an alternative approach, we define the parameter distributions, then forward model to fit the CXB by perturbing the XLF using a neural network. This approach allows us to rule out parameter combinations that cannot reproduce the CXB for any XLF. The marginalized conditional probabilities for the four free parameters are: áRñ = - á ñ= = s + - + G - + 0.99 , 118 , 0.101 0.26 E 0.11 cutoff 23 24 0.001 0.097 and áGñ = - + 1.9 0.09 0.08. We provide an interactive online tool for users to explore any combination ofáEcutoffñ, σE,áGñ, σΓ,áRñ, and σR, including different distributions for each absorption bin, subject to the integral CXB constraint. The distributions observed in many AGN samples can be ruled out by our analysis, meaning these samples cannot be representative of the full AGN population. The few samples that fall within the acceptable parameter space are hard-X-ray-selected, commensurate with their having fewer selection biases.