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The Compton shoulder of the Fe Kalpha fluorescent emission line in active galactic nuclei

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We present new, high signal-to-noise ratio results from a Monte Carlo study of the properties of the Compton shoulder of the Fe Kalpha emission line in the toroidal X-ray reprocessor model of Murphy & Yaqoob (2009, MNRAS, 397, 1549). The model comprehensively covers the Compton-thin to Compton-thick regimes and we find that the variety of Compton shoulder profiles is greater than that for both (centrally-illuminated) spherical and disk geometries. Our Monte Carlo simulations were done with a statistical accuracy that is high enough to reveal, for the case of an edge-on, Compton-thick torus, a new type of Compton shoulder that is not present in the spherical or disk geometries. Such a Compton shoulder is dominated by a narrow back-scattering feature at ~6.24 keV. Our results also reveal a dependence of the shape of the Compton shoulder (and its magnitude relative to the Fe Kalpha line core) on the spectral shape of the incident X-ray continuum. We also show the effects of velocity broadening on the Fe Kalpha line profile and find that if either the velocity width or instrument resolution is greater than a FWHM of ~2000 km/s, the Compton shoulder begins to become blended with the line core and the characteristic features of the Compton shoulder become harder to resolve. In particular, at a FWHM of ~7000 km/s the Compton shoulder is NOT resolved at all, its only signature being a weak asymmetry in the blended line profile. Thus, CCD X-ray detectors cannot unambiguously resolve the Compton shoulder. Our results are freely available in a format that is suitable for direct spectral-fitting of the continuum and line model to real data.

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