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Polarisation due to returning thermal disk radiation in the soft state of black-hole binaries

Reflection of thermal disk emission returning to the disk has recently been claimed to be important in the soft states of black hole binaries. In particular, Steiner et al. (2024) proposed that it could explain the X-ray polarisation measured by IXPE in the soft state of Cyg X-1. This would be an important argument for rapid rotation of black holes in HMXBs, since the effect is only important for the spin values close to the extreme. We have extended the relativistic reflection model reflkerr to include this effect and we find that our results are in full agreement with those of Schnittman & Krolik (2009), who first discussed this effect. However, we find that it is very unlikely to give an observable signal in real accretion systems, since even for extreme spin values it would be completely outweighed by the radiation of the X-ray corona, whose presence is often required by hard X-ray data. For example, for the black hole mass and accretion rate relevant to Cyg X-1, and in the absence of any coronal emission, the polarisation signal due to the returning thermal radiation would indeed be similar to that measured by IXPE. However, the presence of the coronal component measured by NuSTAR reduces the degree of polarisation associated with the returning thermal radiation to less than 1%, making this effect unimportant.

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