

described in §7 and is most convincing when it is applied to BHBs in the thermal state (§4, §5, & §7). Effectively, in this technique, one determines the radius R_{in} of the inner edge of the accretion disk and assumes that this radius corresponds to R_{ISCO} (see §1). Because $R_{\text{ISCO}}/R_{\text{g}}$ is a monotonic function of a_* , a measurement of R_{in} and M directly gives a_* . Provided that (a) i and D are sufficiently well known, (b) the X-ray flux and spectral temperature are measured from well calibrated X-ray data in the thermal state, and (c) the disk radiates as a blackbody, it is clear that R_{in} can be estimated. A major complication is that the disk emission is not a true blackbody but a modified blackbody with a spectral hardening factor f_{col} . Therefore, the observations only give the quantity $R_{\text{in}}/f_{\text{col}}^2$, and one needs an independent estimate of f_{col} in order to estimate a_* (Shimura & Takahara 1995; Davis et al. 2005). A second caveat is that the orbital inclination may differ significantly from the inclination of the BH's spin axis (Maccarone 2002).

Using the new disk models mentioned above, Shafee et al. (2006) fitted **ASCA** and RXTE spectral data on the BHB GRO J1655–40 and found $a_* \sim 0.65 - 0.75$. For 4U 1543–47, they found $a_* \sim 0.75 - 0.85$, although this result is based only on RXTE data. The authors consider it unlikely that either BH has a spin close to the theoretical maximum, $a_* = 1$. On the other hand, in the case of 4U 1543–47, the estimated spin appears too high to be explained by spin up due to accretion, which suggests that their measurements are sensitive to the BH's natal spin.

8.2.3 Fe K line profile

The first broad Fe K α line observed for either a BHB or an AGN was reported in the spectrum of Cyg X–1 based on EXOSAT data (Barr et al. 1985). Since then, the line has been widely studied in the spectra of both BHBs and AGN. The Fe K fluorescence line is thought to be generated through the irradiation of the cold (weakly-ionized) disk by a source of hard X-rays (likely an optically-thin, Comptonizing corona). Relativistic beaming and gravitational redshifts in the inner disk region can serve to create an asymmetric line profile (for a review, see Reynolds & Nowak 2003).

The line has been modeled in the spectra of several BHBs. In some systems the inner disk radius deduced from the line profile is consistent with the $6R_{\text{g}}$ radius of the ISCO of a Schwarzschild BH, suggesting that rapid spin is not required (e.g., GRS 1915+105, Martocchia et al. 2002; V4641 Sgr, Miller et al. 2002a). On the other hand, fits for GX 339–4 indicate that the inner disk likely extends inward to $(2 - 3)R_{\text{g}}$, implying $a_* \geq 0.8 - 0.9$ (Miller et al. 2004). XTE J1650–500 is the most extreme case with the inner edge located at $\approx 2R_{\text{g}}$, which suggests nearly maximal spin (Miller et al. 2002c; Miniutti et al. 2004). Large values of a_* have also been reported for XTE J1655–40 and XTE J1550–564 (Miller et al. 2005). Sources of uncertainty in the method include the placement of the continuum, the model of the fluorescing source, and the ionization state of the disk (Reynolds & Nowak 2003). Also, thus far the analyses have been done using the **LAOR** model in XSPEC, which fixes the spin parameter at $a_* = 0.998$ (Laor 1991). A reanalysis of archival data using new XSPEC models that allow one to fit for a_* may prove useful (KY, Dovčiak et al. 2004; **KD**, Beckwith & Done 2004).