X-RAY SPECTRAL SIGNATURES OF SPINNING BLACK HOLES

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ABSTRACT. The ASCA discovery of a relativistic iron line in the Seyfert 1 galaxy MGC-6-30-15 has prompted a wealth of work in modelling line profiles from both static and spinning black holes under different physical and geometrical assumptions. Not much attention, however, has been paid on the effects on the reflection continuum, which is produced along with the iron line. We present calculations of the relativistic effects on both the reflection continuum and the line profile, obtained with a fully relativistic code in Kerr metric, and discuss the observability of these effects by present and future detectors.

Shortly after the discovery of quasars it was speculated that imprints of a massive central Black Hole [BH] could be observed by study the radiation emitted in their vicinity and propagating to a distant observer. Nowadays researchers are even thinking to possible ways to discriminate between static and spinning BHs through considering the radiation transfer in Kerr metric. Such a path of research can now allow for a more effective testing of the BH hypotheses because of the improvements in X-ray observation techniques. In fact the X-ray radiation emitted from AGNs and BHCs contains the signatures of BH fields both in the continuum and in the line profiles, and great hopes rest on satellites like XMM and ASTRO-E, due to be launched in 1999 and 2000, respectively.

General relativistic effects in emission line profiles have been modelled by many authors (see Martocchia et al., 1998, and references therein), and a relativistic iron line has actually been already detected by ASCA in the Seyfert 1 galaxy MGC-6-30-15 (Tanaka et al. 1995); signatures of a spinning black hole in the same source have also been reported (Iwasawa et al. 1996). Not as much attention, however, has been paid on the effects on the reflection continuum which is produced along with the iron line following illumination of the disc by the primary X-ray source (Matt et al. 1991). We consider particularly important to address this matter, i.e. to self-consistently calculate the shape of iron lines *and* continuum together, because this will impose further constraints on physical properties of the system which will thus be less ambiguous.

For the emitted spectra we modelled the Compton reflection assuming neutral matter and a plane parallel geometry. The overall shape of the continuum results to be spread through, more and more with increasing inclination, as an effect of the Doppler shift. Moreover, both the line and the iron edge are progressively smoothed down. In order to

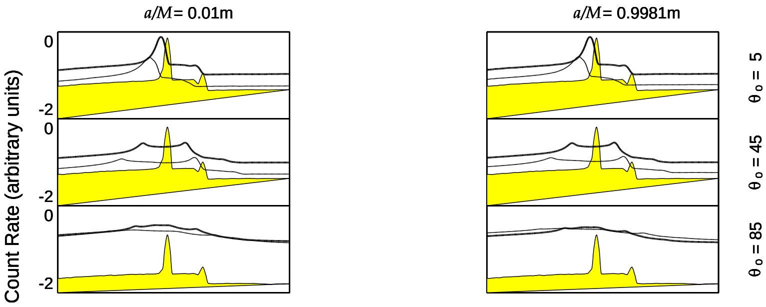

Fig. 1. Continuous thick diagrams correspond to emission coming from the "whole" disc (supposed to extend from the innermost stable orbit up to 100 m); continuous thin diagrams correspond to radiation coming from the innermost area of the disk (obtained through dividing the previous range into three). Those filled are the diagrams obtained in pseudonewtonian approximation [PN], that is neglecting redshift and curvature of spacetime, so that the "emitted" lines and edge can be easily recognized.

show these smearing effects clearly, we considered the energy range E=4-9 keV, which contains the most important iron features (Kα and Kβ lines, edge). The result can be seen in Fig.1. For an observer located pole-on, the iron line is broadened and redshifted because of the high potential well. This effect is more pronounced in the extreme Kerr situation, when the stable (emitting) orbits can extend pretty near the horizon, expecially if a consistent amount of the flux comes from the innermost part of the disc, like in the case of a very anysotropic illumination (e.g. Martocchia & Matt 1996). Although we used a rather flat emissivity law, a difference can be already noticed here expecially for the radiation coming from the innermost orbits (thin diagrams).

References

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