Could the presence of a massive black hole companion impact the shape of the K-alpha emission line at a detectable level ?

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Massive black hole (MBH) binaries are a challenge to identify in electromagnetic observations because of the uncertainties about the uniqueness of their observational signature. Thus simulations are a key step to understand the accretion and ejection processes in their vicinity and thus to build a set of observational clues allowing to infer the presence of a binary system.

Using numerical simulations, with the open-source code AMRVAC, we are studying the gravitational influence of a MBH companion on the accretion disc of a primary MBH in the very first stages of their coalescence, which is made possible by the use of a pseudo-newtonian potential (Paczynski & Wiita 1980). Among other features, we show that the gravitational influence of a second MBH creates a spiral wave in the disc. Moreover, the radius of the outer edge of the disc decreases with the separation of the MBH binary.

The formation of the spiral wave (an over-dense arm that is rotating with the MBH companion) is interesting for high resolution X-ray spectroscopy since it could have an impact on the iron K-alpha line, emitted at 6.4 keV. Following the method proposed by Hartnoll & Blackman (2002), we have computed the shape of the iron K-alpha emission line for an analytical model of the spiral wave in a MBH disc. This work gives a first overview of the detectability of such a spiral pattern.

Regardless of the presence a spiral wave within the disc, we show that the radius of the external edge of the disc also impacts the shape of the iron line. Depending on the inclination of the system with respect to the line of sight, we quantify how the truncation of the primary MBH disc modifies the iron line.