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Effects of Photon Bending on Spectral and Temporal Properties of Two Component Advective Flow

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Abstract. Effects of photon bending are separately investigated for Keplerian and CENBOL components of Two Component Advective Flow (TCAF) model. Red shift, Bolometric Flux, temperature profile and time of arrival of photons are also calculated.

Keywords : black hole physics – gravitational lensing – accretion disk

1. Introduction

Hard X-rays originate from regions very close to black holes (Chakrabarti and Titarchuk, 1995, hereafter CT95). We use equations of 3D photon trajectory following Weinberg (1972) and trace paths of each ray. In CT95, major components are the geometrically thin Keplerian disk in the pre-shock flow and a geometrically thick torus or CENBOL. We produce here images of optically thick and geometrically thin Keplerian disk and both optically and geometrically thick accretion disks (Chakrabarti, 1985) separately to highlight effects. In future, combined results would be shown.

2. Results and Conclusion

For simplicity, we assume that the Keplerian disk matter radiates isotropically while moving in circular orbit. Each ring of matter is assumed to emit exactly the same number of photons at energies obtained from Wiens law from respective radii. We computed effects of Doppler and gravitational shifts. We also studied effects of time delay between low and high energy photons. Effects of inclination angle was studied.

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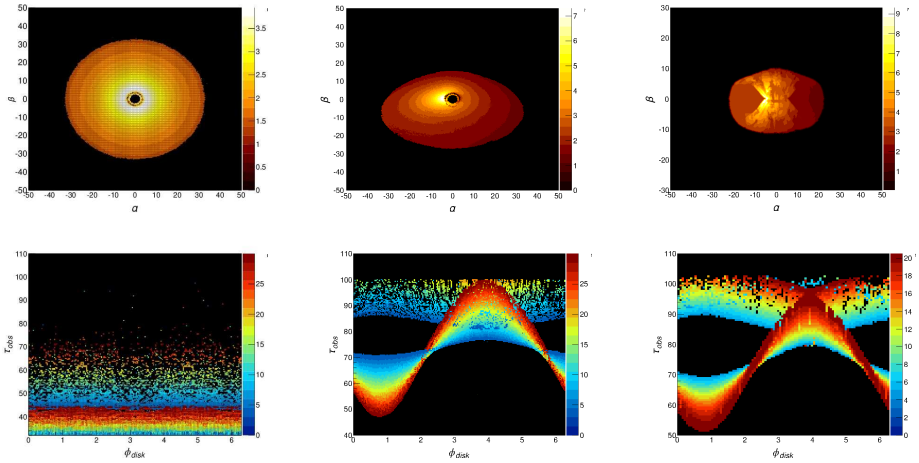

Figure 1. The upper panel shows the image of a Keplerian disk of 3.0 – 30.0 r_g (left, middle) and a thick disk shell of 4.8 – 20.0 r_g (right) where inclination angles are 0.01°, 50° and 82° respectively. The colour-bar represents normalized temperature or flux. Lower panel show corresponding time of arrival of photons to the observer from different azimuthal point. Colour-bar represents radial distance.

We found a significant amount of time delay (∼ 6ms and higher) in higher inclination angle cases. We show a particular case of thick disk shell between 4.8 – 20r_g. The angular momentum distribution of this barotropic disk is taken from Chakrabarti (1985).

In a TCAF this thick disk is surrounded by a Keplerian disk with the black hole at the Centre. However, the photons from the CENBOL are produced self-consistently using Comptonization. This is being pursued and will be reported elsewhere.

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