6th Asia-Pacific Conference on Plasma Physics, 9-14 Oct, 2022, Remote e-conference

Images and Spectra of Black hole Accretion Flows Computed by GRRT Code RAIKOU

Tomohisa Kawashima[1], Ken Ohsuga[2], Hiroyuki R Takahashi[3]
[1] Institute for Cosmic Ray Research, The University of Tokyo
[2] Center for Computational Sciences, University of Tsukuba
[3] Department of Natural Sciences, Faculty of Arts and Sciences, Komazawa University
e-mail (speaker): kawshm@icrr.u-tokyo.ac.jp

Astrophysical black holes are thought to be powered by accretion flows, which are plasma spirally falling onto the central object, via the gravitational energy release. The magnetic fields, which will be amplified in accretion flows by the dynamo effects, play an important role on the gravitational energy release. As a consequence, an enormous amount of radiation will be emitted and powerful outflows (i.e., relativistic jets and mildly relativistic winds) will be also ejected. The computations of general relativistic radiative transfer (GRRT) will be a powerful tool to study the black hole spacetime, physics of accretion flows in the strong gravity field, and the launching mechanism of relativistic jet by via the direct comparison between theoretical models and observed data.

One of the most important observable features of the black holes is their shadows, which the Event Horizon Telescope (EHT) detected the black hole shadow in the elliptical galaxy M87*[1] and our Galaxy center Sgr A*[2]. The EHT observations provided powerful evidence of the presence of supermassive black holes and their black hole masses are strongly constrained. Towards the future EHT and simultaneous multi-wavelength observations from radio to gamma-ray band to reveal the black hole spin and plasma dynamics near the black holes, we developed a multi-wavelength GRRT code RAIKOU[3]. We calculate the images and multi-wavelength spectra of accretion flows and relativistic jets of supermassive black holes to reveal the black hole spacetime and the dynamics of accretion flows and relativistic jets.

We found that the resultant radio black-hole shadow images can constraint the black hole spin of M87* by using a future EHT[4], which will be extended to the space VLBI. We also found that the footprint of the particle accelerations in the vicinity of the black hole can appear in X-ray black-hole shadow images[3], which can be observed by a future X-ray interferometry.

References
[1] Event Horizon Telescope, Astrophysical Journal Letters, vol. 875, L1 (2019)
[2] Event Horizon Telescope, Astrophysical Journal Letters, vol. 930, L13 (2022)
[3] Kawashima, T., et al. submitted to Astrophysical Journal Supplement (arXiv:2108.05131)
[4] Kawashima, T., et al. Astrophysical Journal, vol. 878, 27 (2019)

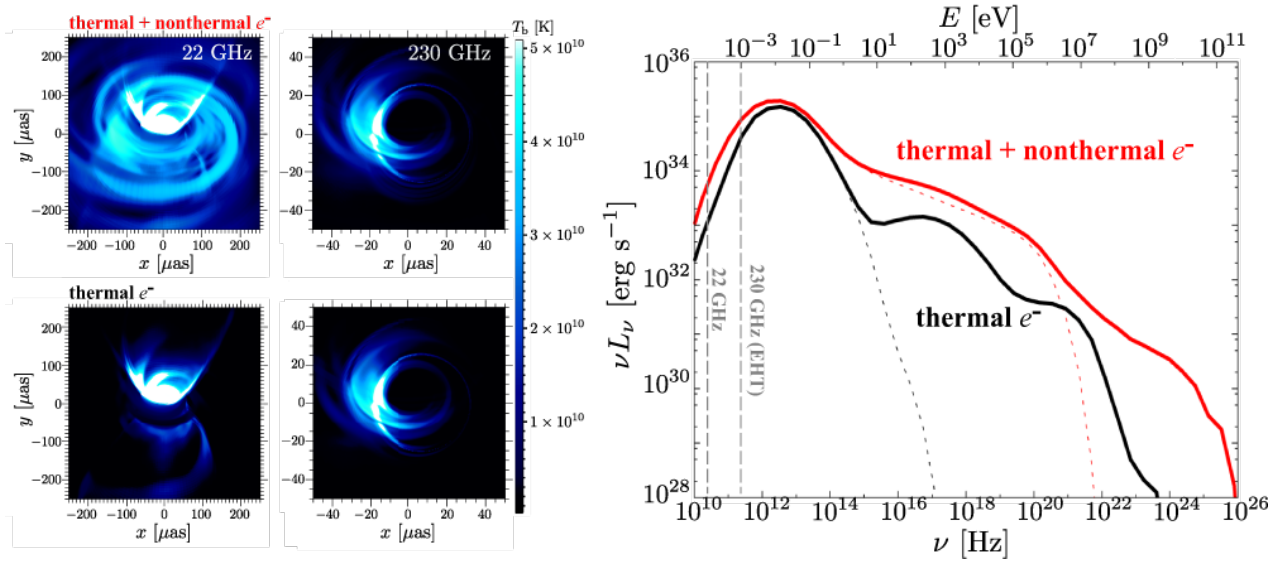

Figure 1 Left: Calculated images of an accretion flow and relativistic jets around a rapidly rotating, supermassive black hole with the 4.1 million solar mass and the dimensionless spin parameter $a_* = 0.9375$. A black hole shadows appear in the images at 230 GHz. Right: Computed photon spectra from radio to very-high-energy gamma-ray energy bands.