Introduction

Goal: Observational proof of the black hole space-time in order to prove the existence of the event horizon and test of general relativity theory

Spacetime is uniquely determined by black hole mass and spin: $\mathcal{M}$, $\alpha$

$\mathcal{M}$: Relatively easily estimated by observing the motions of stars and gas

$\alpha$: NOT easy to measure — Important to consider the relativistic effect near the black hole

Ozel et al. 2010

1. New method for black-hole spin measurement based on flux variation from an infalling gas ring

Moriyama & Mineshige, 2015, PASJ, 67, 106

[Simple model] Key assumptions of gas cloud:

(i) The ring (arc-shaped) cloud is intermittently formed

(ii) The gas cloud has almost Keplerian rotational velocity and slowly falls to the black hole

(iii) Flux variation due to relativistic effects can be distinguished from the emissivity variation

 ISC0 radius

By estimating the flux variation timescale we can measurement value for spin

$r_{in}$: photon circular orbit, $R_s$: GM/$c^2$

2. New method for probing Kerr space-time based on imaging observation of in-falling gas blob

Moriyama & Mineshige, 2016, PASJ, 68, L6

Test the black hole space-time by combining the imaging and flux variation

Image (spatial information)

Flux (temporal information)

Measured spin depends on radial space-time structure

Gas-cloud assumptions are reproduced by more realistic case?→ 3.1-3.3

3.1 Intermittently gas clouds formation

Moriyama, Mineshige, & Takahashi 2017, 850, 56

Arc-shaped (ring) clouds are intermittently formed

3.2 Dynamical properties of arc-shaped gas clouds

Solid (dashed): first (second) gas cloud

gas clouds fall to the black hole

Small radial velocity very close to Keplerian velocity

[→ support the assumption (i)]

gas cloud has nearly the Keplerian orbital velocity and slowly falls to the black hole

3.3 Flux variation of arc-shaped gas cloud

$a=0$, $i=60^\circ$ (viewing angle)

Long time duration (0.08 – 0.10 sec) due to the density variation

Peaks with short time intervals (0.01 s)

← Beaming effect of the non-axisymmetric gas clouds

Future study

- Adopt the constructed method to the observational result from the VLBI observation (∼2.)
- Add Compton scattering process to the GRRMHD simulation (∼3.)