

***** EXAMPLE *****

Question and Discussion in Lecture XX (Jan XX, 20XX)

In the lecture,

Write your questions (at least 1 in each lecture) on google doc with your name & student ID#

In the discussion section (last ~30 min)

- Making a group consisting of 2(3) students.
- Choosing an interesting question in the google doc discussing results in the group (~20min)
- Sharing the discussion results (~10 min)

Write your questions and discussions below

#Questions are in blue, while discussions are in black.

- (Kakuma, 122): How can we regulate the radiative efficiency for SMBH? With simulation or is there any observational support?
 - (Qiu, 384; Kushibiki 125): The radiative efficiency is not a determined number. It changes with the mass and the rotation speed of the BHs. There are lots of data support the results. So It is more likely depended on the observation. (https://www.researchgate.net/publication/274895502_Radiative_efficiency_of_black_holes_in_AGN) In this paper, they have calculated a lot of BHs in AGN and got different results. The efficiency is larger with larger mass and rotation.
 - Radiative efficiency can be constrained in observation (Davis+2010, <https://arxiv.org/pdf/1012.3213.pdf>)

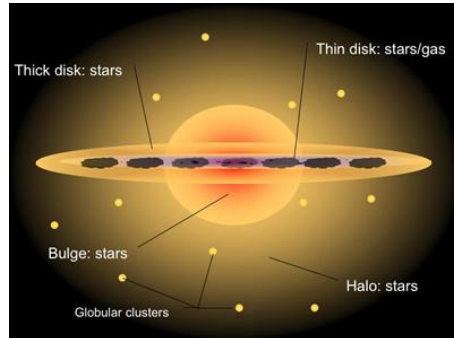
$$\dot{M} = 2.6 M_{\odot} \text{ yr}^{-1} \left(\frac{L_{\text{opt},45}}{\cos i} \right)^{3/2} M_8^{-1};$$

$$M_{\text{BLR}} = 1.5 \times 10^8 M_{\odot} L_{\text{opt},45}^{0.69} v_{3000}^2,$$

$$\eta = \frac{L_{\text{bol}}}{\dot{M} c^2 \cos i}.$$

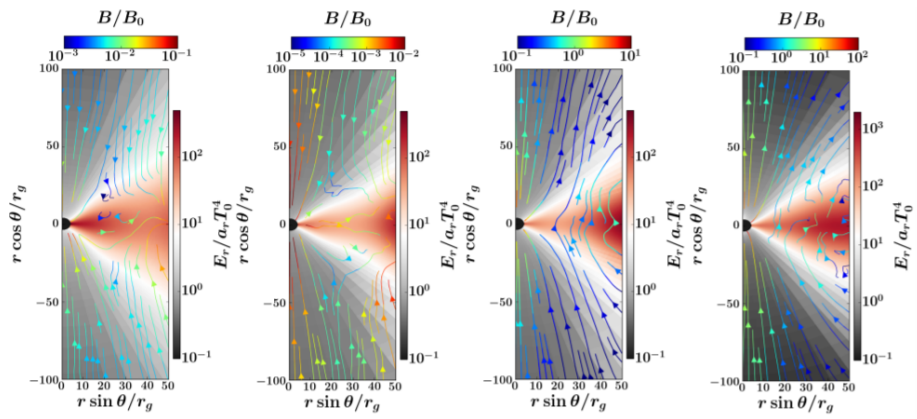
- (Kushibiki, 125): If Radiative efficiency is 10%, what is the rest of gravitational energy released by accretion used for?
- (Jian, 168): How to define bulge from disk and halo?

(Lu, 383; Abe, 610): The bulge is a round structure made primarily of old stars, gas and dust. The halo primarily contains individual old stars and clusters of old stars. The outer parts of bulge is difficult to distinguish from the halo. As we can see from the following figure.



The disk is a flattened region that surrounds the bulge in a spiral galaxy. It contains mostly young stars, gas and dust, which are concentrated in spiral arms.

- (Abe, 610): If the accretion is not isotropic, can the total rate of accretion become bigger than the Eddington accretion rate?
- (Qiu, 384): Will GRB occur when the black holes merge? If not, why is the merger of neutron stars so special?
 - (Jian, 168; Lin 169): Probably no. GRBs are usually thought to be produced in ultra-relativistic jet (inverse-Compton scattering of photons by energetic electrons), while no jet is expected in a BBH merger. However, GRB can occur before or after BBH merger, e.g. from death of a massive companion star (arXiv:1310.4869) or from accretion disk (arXiv:1602.05140).
- (Liang, 955): Why the GRB rate model is shifted compared to the GRB observed data? Different parameters are assumed?
- (Liang, 955): The blue/red-shifted velocity could be either due to outflow/inflow in the near side or the inflow/outflow in the far side, so how to distinguish them?
 - (Kakuma,122; Liang, Soken-0955): We think we can't see the inflow/outflow in the far side of the galaxies because they may be absorbed by the galaxy itself or we can't see them because galaxy (star) is much brighter.
- (Lin, 187): Can we estimate accretion rate directly from observations without the knowledge of radiative efficiency?
- (Tang, 385): How could it be the possible mechanism for the direct collapse of SMBHs? (Compared to the Fe core collapse of the main sequence stars?)
- (Ando, 117): How can we explain the super-Eddington accretion of the SMBH? Is there any widely accepted explanation?
 - (Ando, 117; Tang, 385): Super-Eddington accretion of the SMBH is found to be able to happen in some cases. When we say that the accretion rate is lower than Eddington rate, it is to ensure that the matter can be confined around the black hole, but on the other hand, matter can be emitted by the SMBH in the form of jet, in this paper, they have done a simulation on the energy density and magnetic field of SMBHs under super-Eddington



accretion(<https://arxiv.org/pdf/1709.02845.pdf>)

- (Lu, 383): Why does the perpendicular trace indicate scattering by a central LyA source?