Black hole accretion on 17576 CPUs

Bijia Pang and Ue-Li Pen

Low luminosity of Sgr A*

- ## Supermassive

  Gillessen et al. 2009

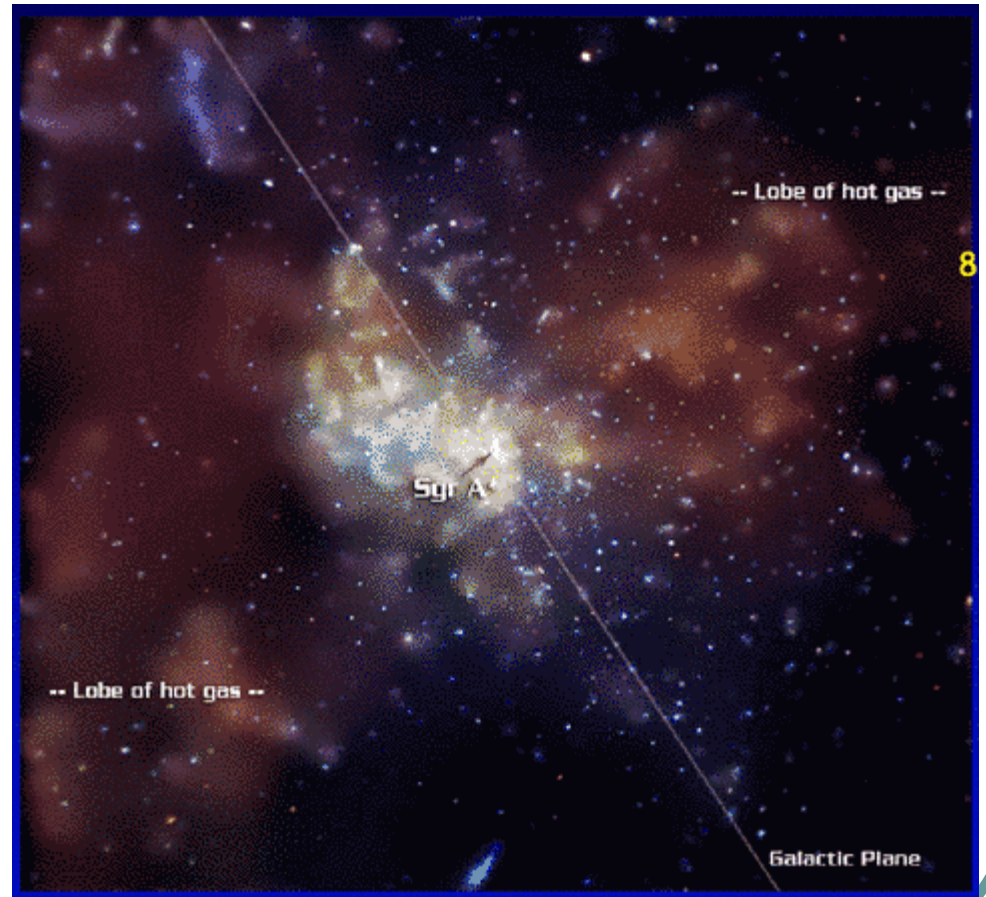 $$M_{BH} = 4.3 \times 10^6 M_\odot$$

- ## Reported luminosity

  Baganoff et al. 2001ab; Genzel et al. 2003; Ghez et al. 2003

  $$2.4 \times 10^{33} \, ergs^{-1}$$

- ## Expected luminosity

  From Bondi solution

  $$10^{39} \, ergs^{-1}$$

-- Lobe of hot gas --

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Sgr A*

-- Lobe of hot gas --

Galactic Plane

Baganoff, et al. 2001

MHD and simulation setup

- Magneto-hydrodynamics (MHD) describes how conducting fluid evolves under a magnetic field.

- MHD code (3D, time-dependent, finite-difference, finite-volume), was written by Prof. Ue-li Pen, then expanded by Phil Arras, ShingKwong Wong, Hugh Merz, Matthias Liebendoerfer, Stephen Green, Bijia Pang.

- Expanding Cartesian grid, denser center, bigger box
- Inner boundary represents black hole
- Outer boundary far away from accretion radius
- Initial static flow
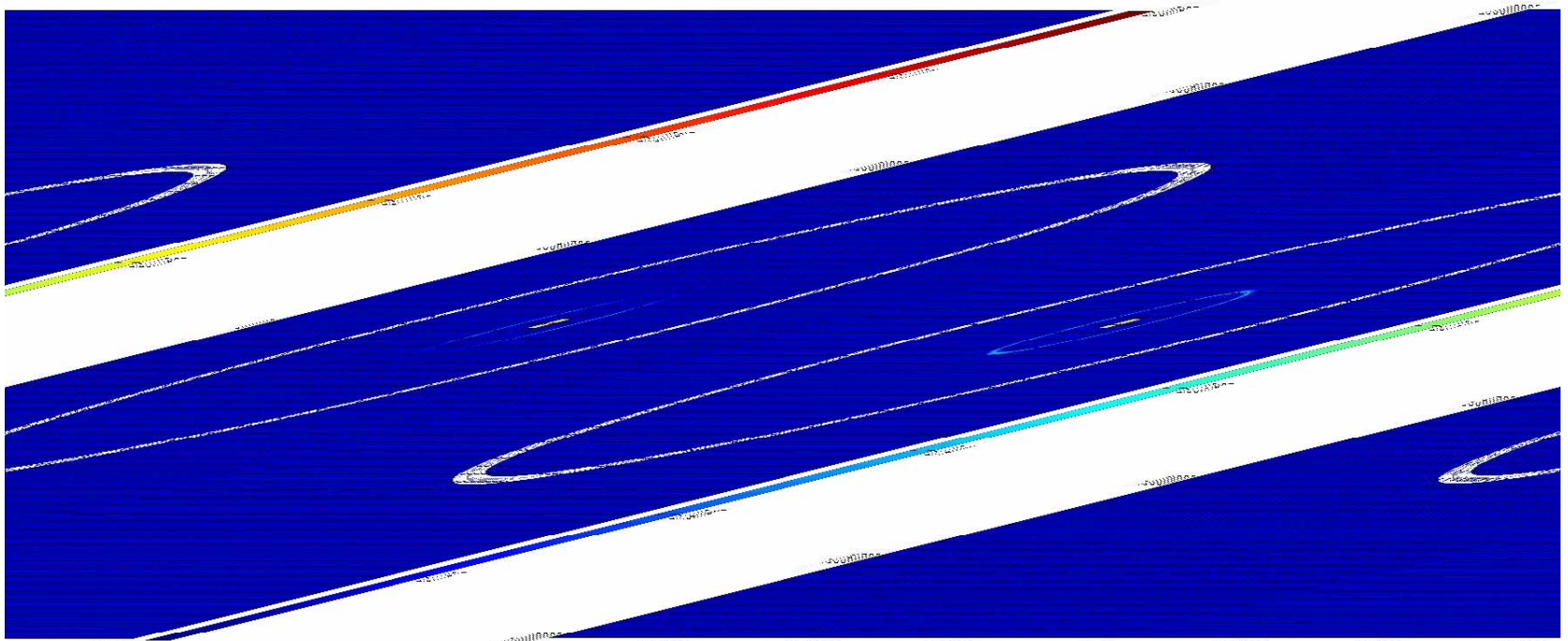- Keplerian rotation and magnetic field are added

From small to large

- **Double interpolation to attain long term results**

- Fixed box size: 8000^3 unit

- 600^3 on 125 nodes (120^3 per node):
    528800 time steps, 20 CT, dx=1

- 585^3 on 125 nodes (117^3 per node):
    30700 time steps, 21.06 CT, dx=1

- 1170^3 on 125 nodes (234^3 per node):
    7600 time steps, 21.14 CT, dx=0.5

- 2340^3 on 729 nodes (260^3 per node):
    3600 time steps, 21.1459 CT, dx=0.25

- 4680^3 on 2197 nodes (360^3 per node):
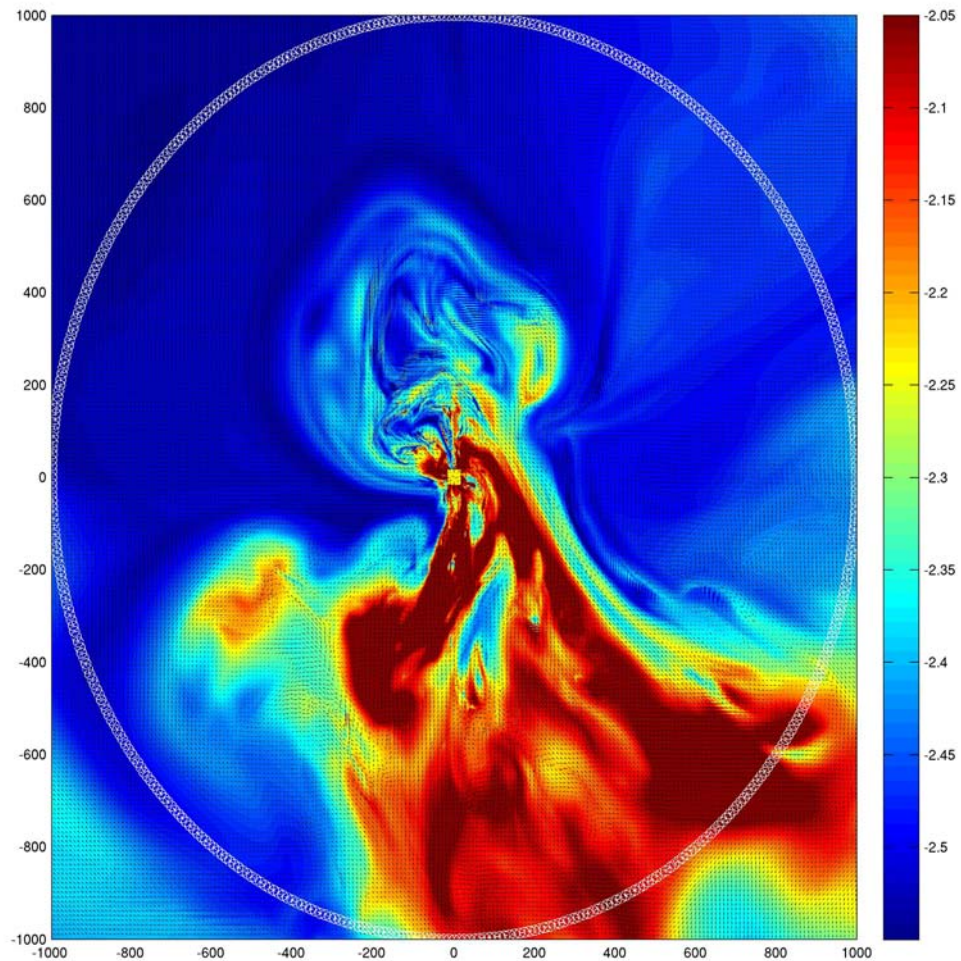   2964 time steps, 21.1465 CT, dx=0.125

Problems for higher resolution

- CFL time constraint

- Expensive inner boundary subroutine

- 5 layers for loop

- Update inner every 8 time steps in the highest resolution (results proved to be correct)

Small run movie (600^3)

Final 4680^3 plot

Thank you!