

A General Relativistic Magnetohydrodynamic Model for the Emission Structure of the M87 Jet

Taiki Ogihara
(Astronomical Institute)

19/05/08, GPPU Progress Report

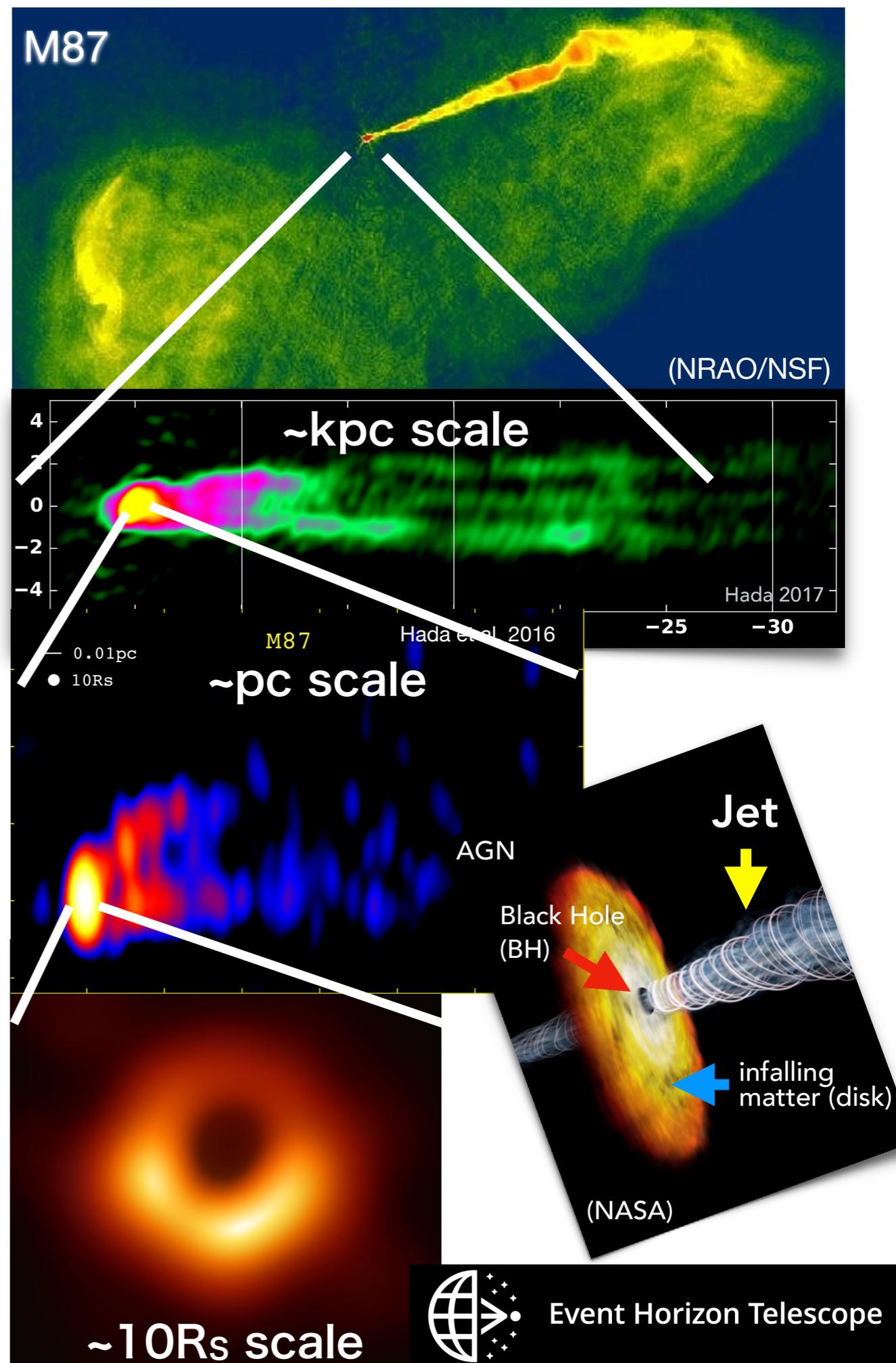


AGN jet

- **Active Galactic Nucleus (AGN) Jet:**
 - relativistic outflow of plasma ($v \sim c$)
 - extends over the galaxy
 - synchrotron radiation
 - electromagnetically driven

- **Where the jetted matter come from?**

(Of course, not from the black hole!!)

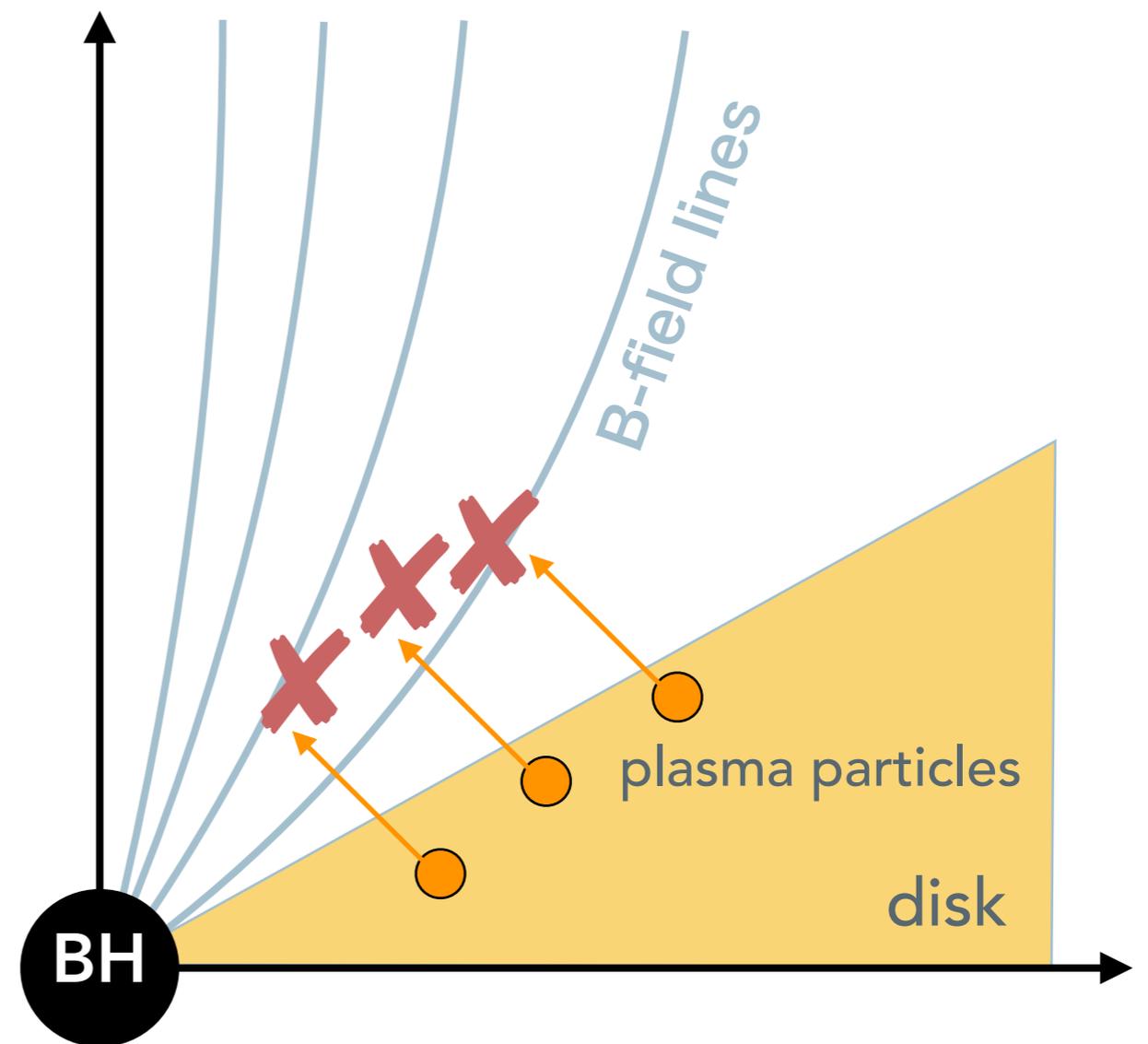


Jet Origin

論文イントロを参考に

density distribution in jet = unclear

- relativistic jet:
electromagnetically driven
- surrounding plasma:
unable to dissipate into the jet
launching region due to the strong
magnetic field
→ **the origin of jetted particles is
still unclear**



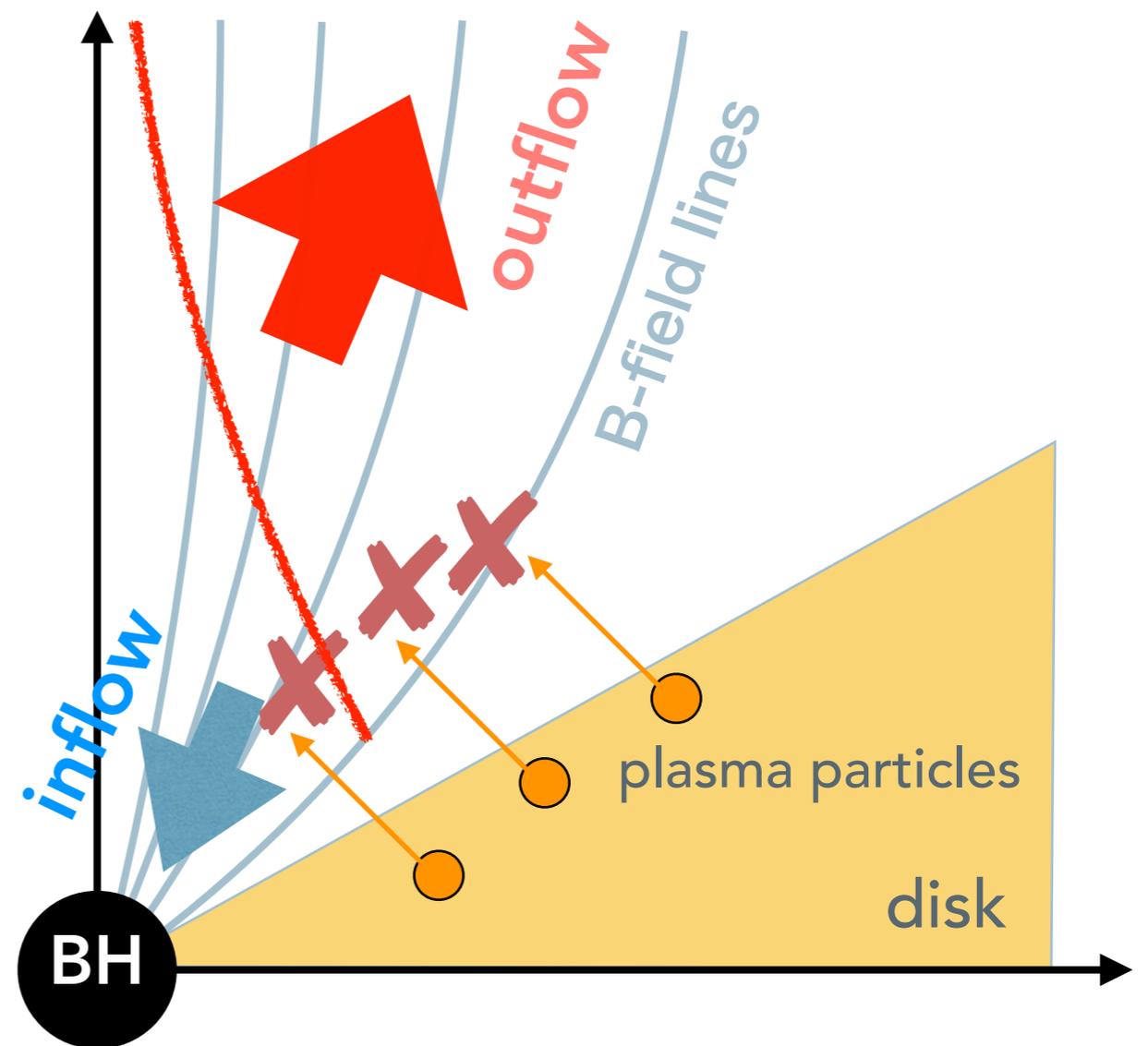
ラーマー半径見積もり

Jet Origin

論文イントロを参考に

density distribution in jet = unclear

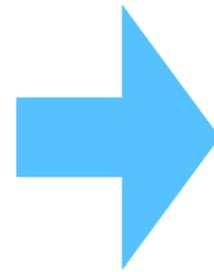
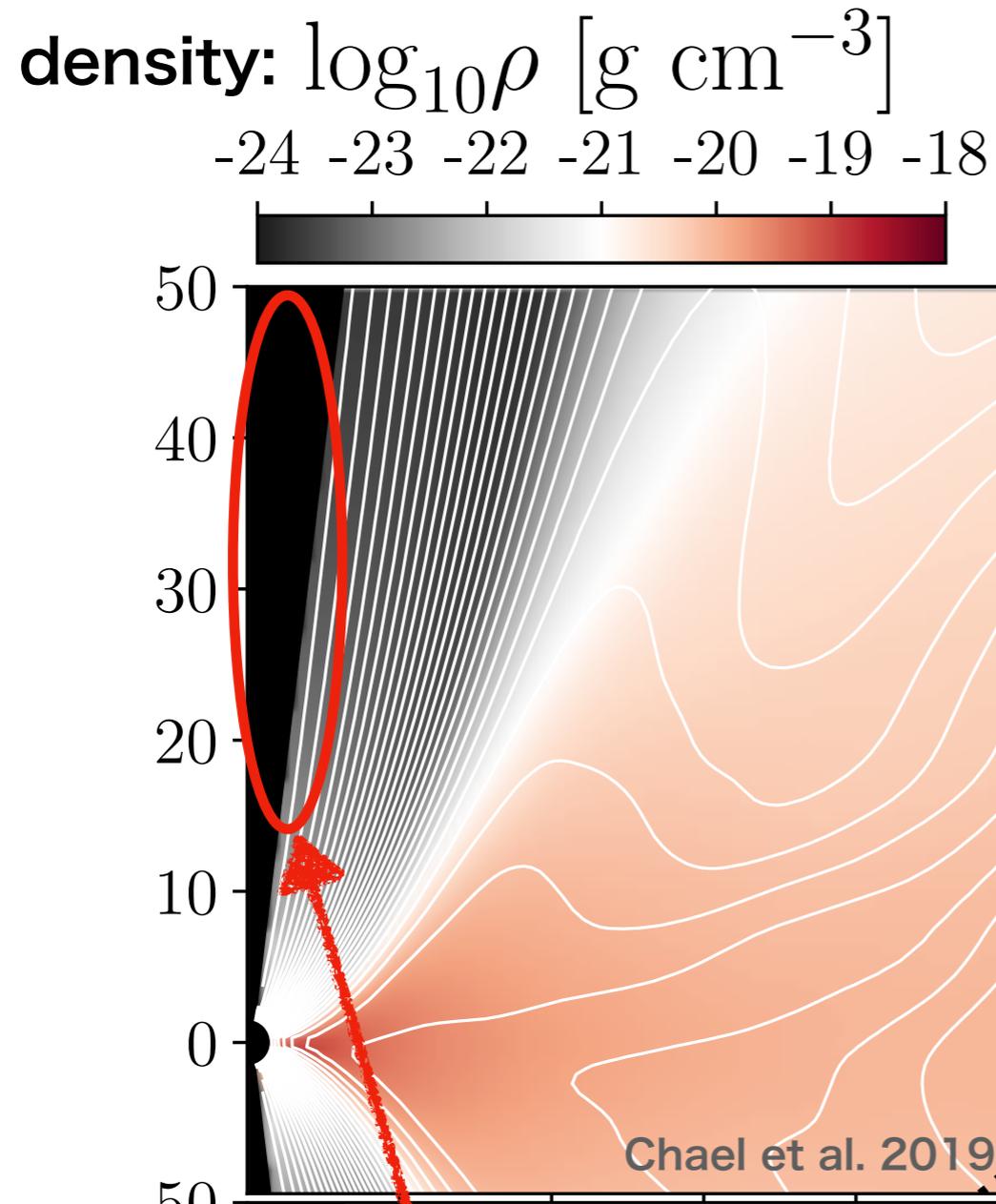
- relativistic jet:
electromagnetically driven
- surrounding plasma:
unable to dissipate into the jet
launching region due to the strong
magnetic field
→ **the origin of jetted particles is
still unclear**
- **separation surface
(gravity = centrifugal force)**
~ jet launching point



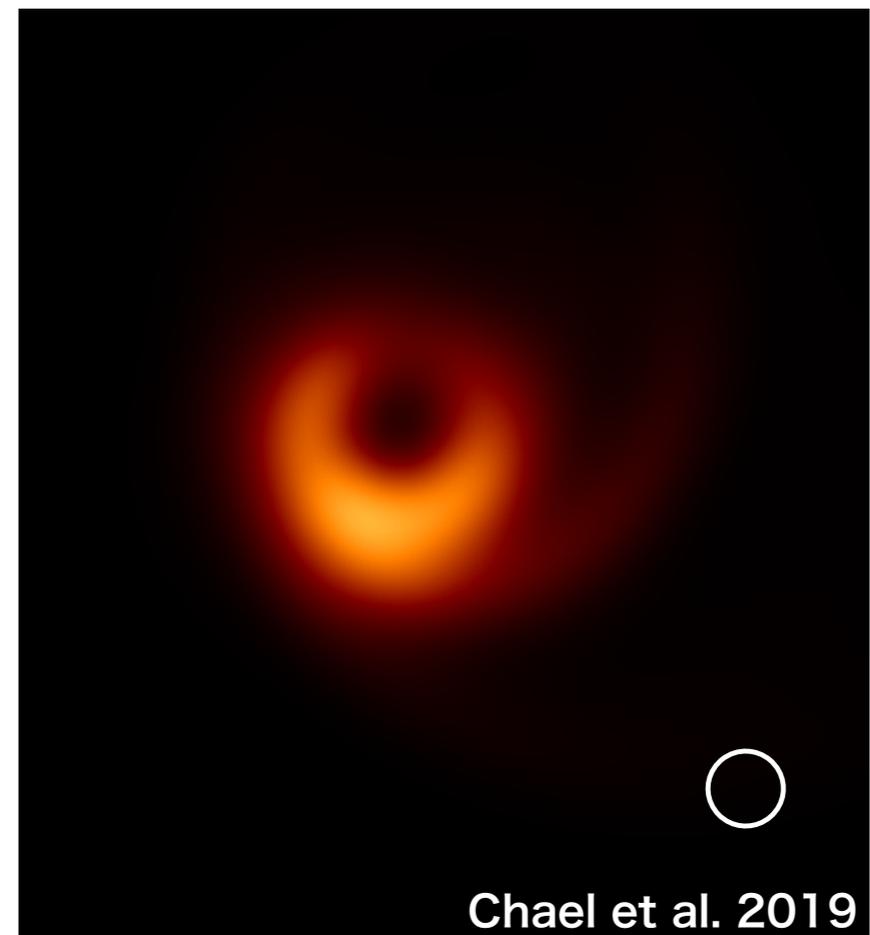
↑ Event Horizon Telescope scale ($\sim 10r_g$)

ラーマー半径見積り

Simulations for EHT



computed image



Jet launching region is not considered

due to the numerical reason
→ no constraint for jet origin

observed image



Our Study

reproduce jet image
& constrain density distribution in jet

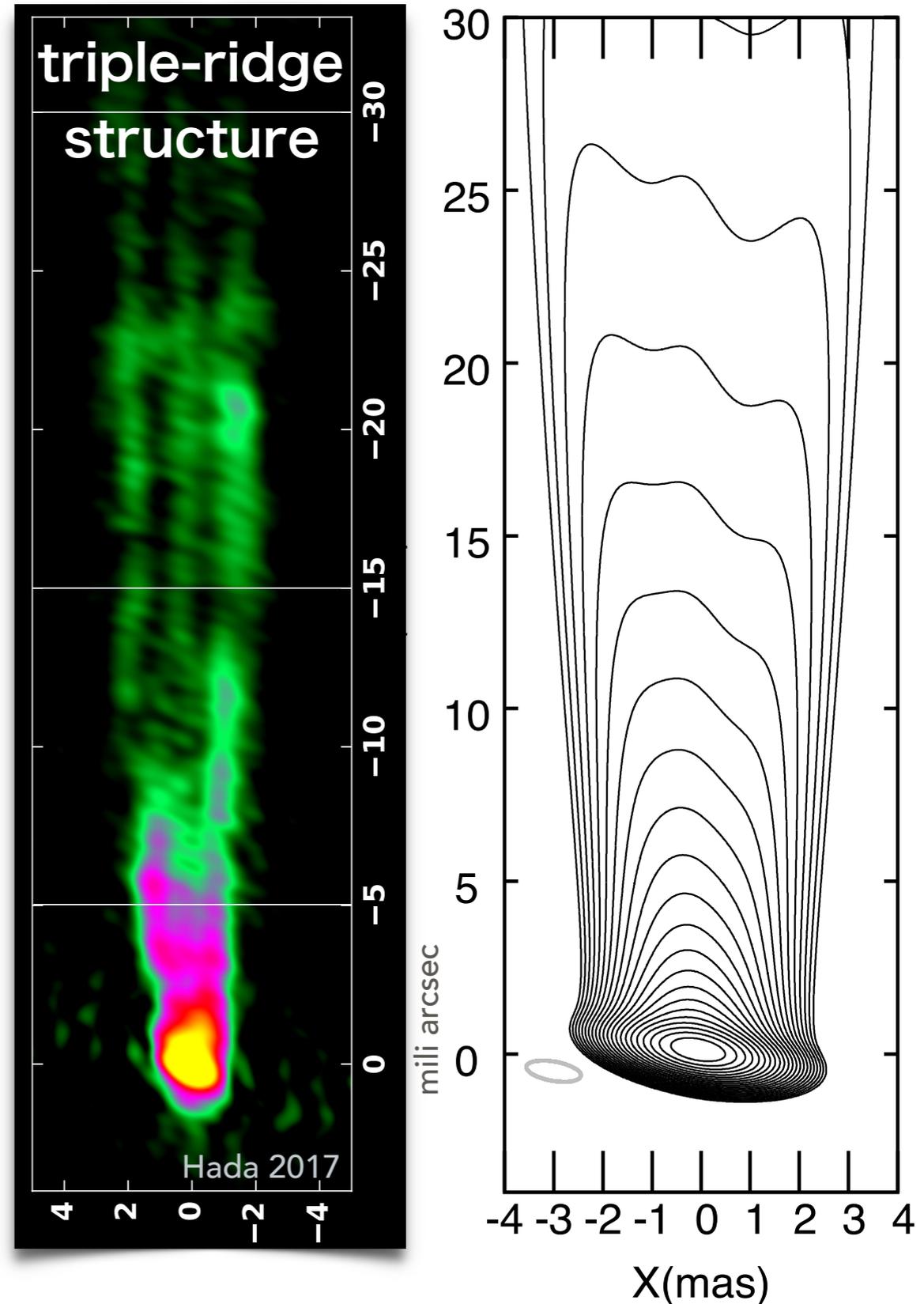
- Ogihara et al. 2019
 - reproduced “triple-ridge” structure
 - special relativistic jet model
 - computed image depends strongly on the density distribution at the jet base

Triple-Ridge Structure of Relativistic Jet Synchrotron Images

TAIKI OGIHARA,¹ KAZUYA TAKAHASHI,² AND KENJI TOMA^{3,1}

accepted by the *Astrophysical Journal*

arXiv:1904.07243



Our Study

reproduce jet image
& constrain density distribution in jet

- **present jet model**

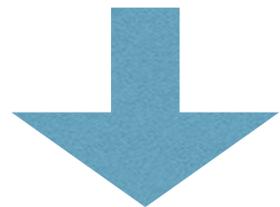
force-free approximation: energy density of EM \gg kinetic one
no feedback from plasma kinematics to electromagnetic (EM) field

Our Study

reproduce jet image
& constrain density distribution in jet

- **present jet model**

force-free approximation: energy density of EM \gg kinetic one
no feedback from plasma kinematics to electromagnetic (EM) field



REMOVE THE APPROXIMATION

to treat fluid velocity consistently
&

INCLUDE GENERAL RELATIVITY

for detailed analyses at the jet base

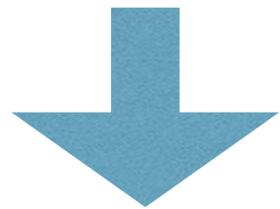
- **approaching
the mass injection physics**

Our Study

reproduce jet image
& constrain density distribution in jet

- present jet model

force-free approximation: energy density of EM \gg kinetic one
no feedback from plasma kinematics to electromagnetic (EM) field



REMOVE THE APPROXIMATION

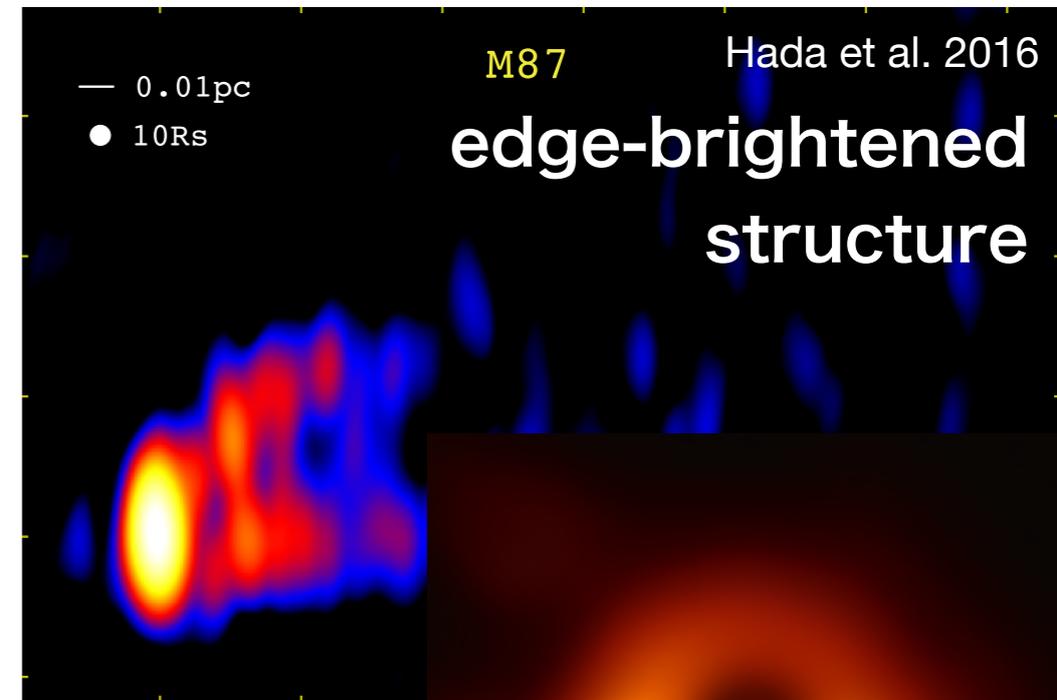
to treat fluid velocity consistently
&

INCLUDE GENERAL RELATIVITY

for detailed analyses at the jet base

- approaching
the mass injection physics

1. construct general relativistic (GR) jet model ← Now
2. include GR radiative transfer
3. contribute to the theoretical analyses of EHT image



GPPU Points

- GSP: 18
- GASP: 2
- Oversea Stays:
 - 1 month in Waterloo University, Canada
 - ↑ visit Dr. Hung-Yi Pu,
expert of GRMHD jet physics
 - 10 days conference in Barcelona, Spain