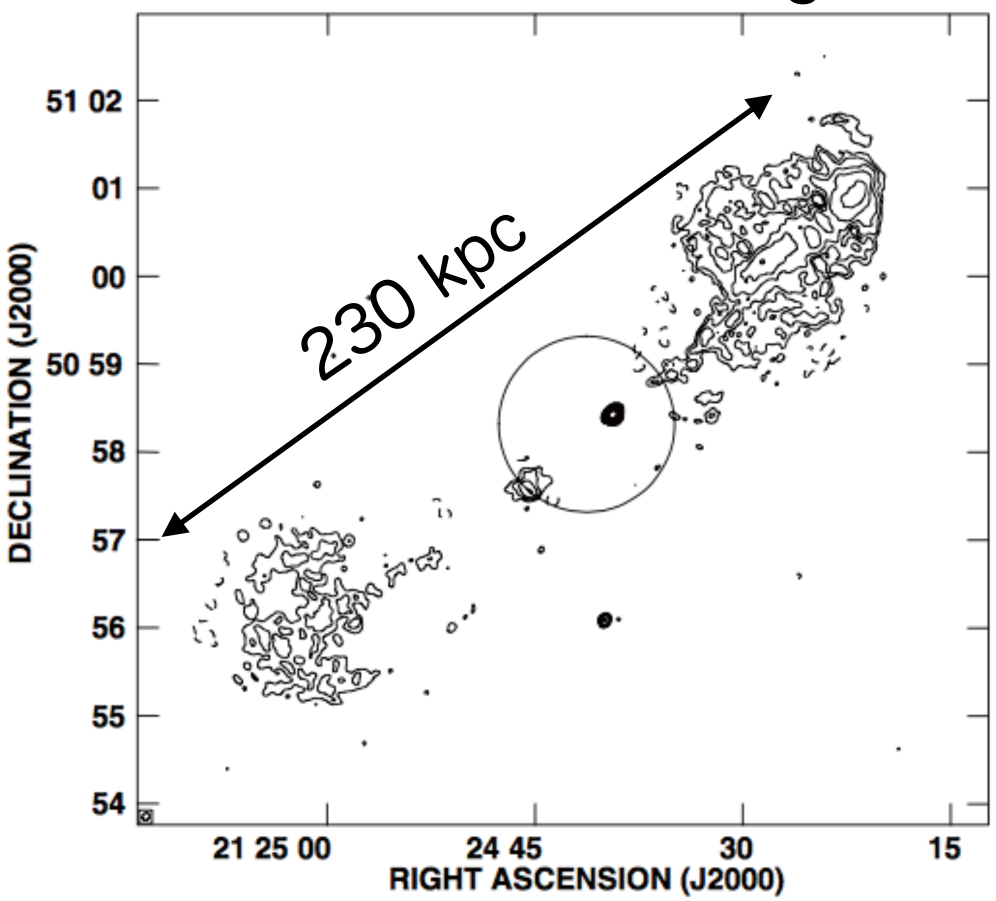
First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

VLA 1.4 GHz image



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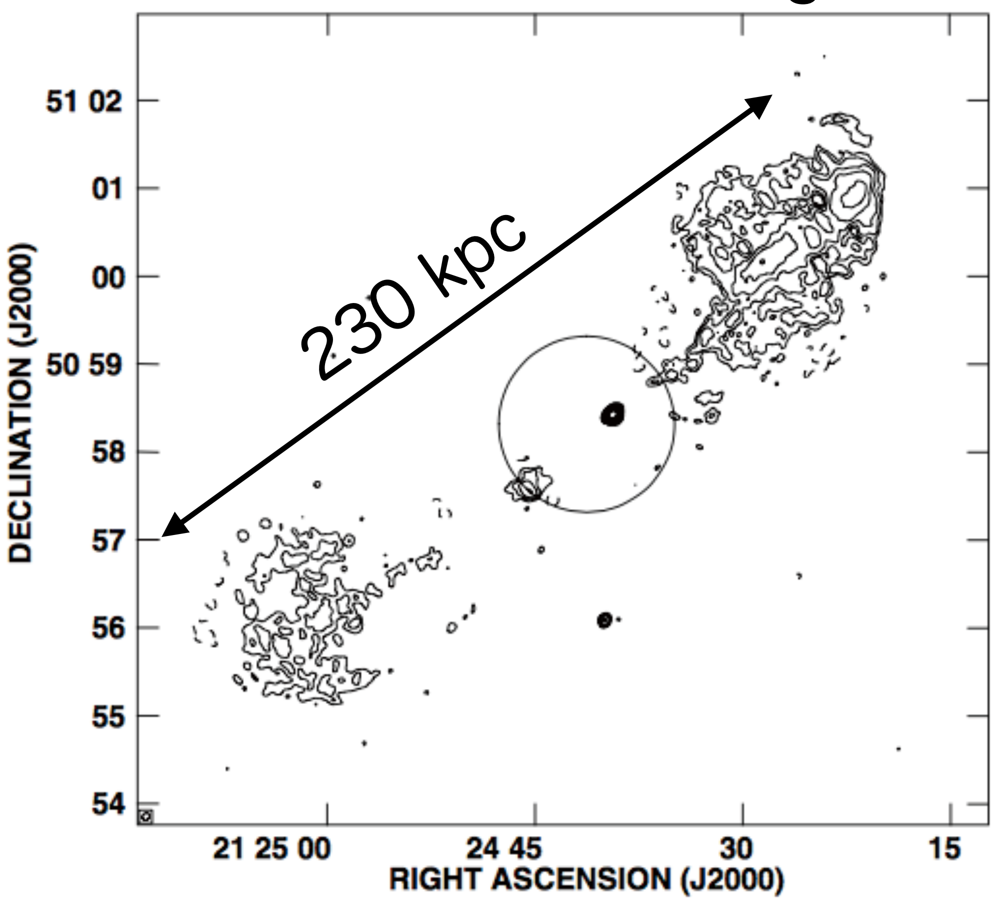

Large scale view of 4C 50.55 (Molina et al. 2007)

- FR II radio galaxy
- viewing angle ~ 35°
- Unknown which side is approaching

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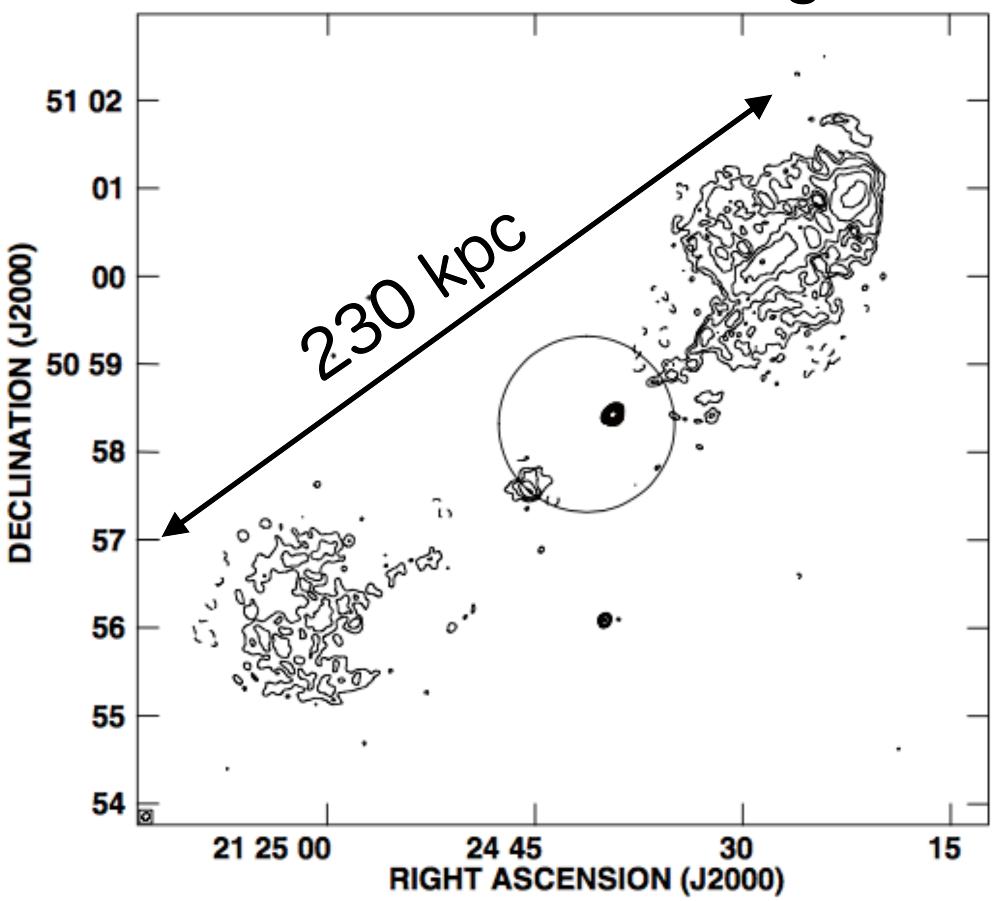

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- High Eddington ratio (L_{bol}/L_{Edd} ~ 0.4)
- Weak reflection from optically thick disk
- Optically-thick Compton corona

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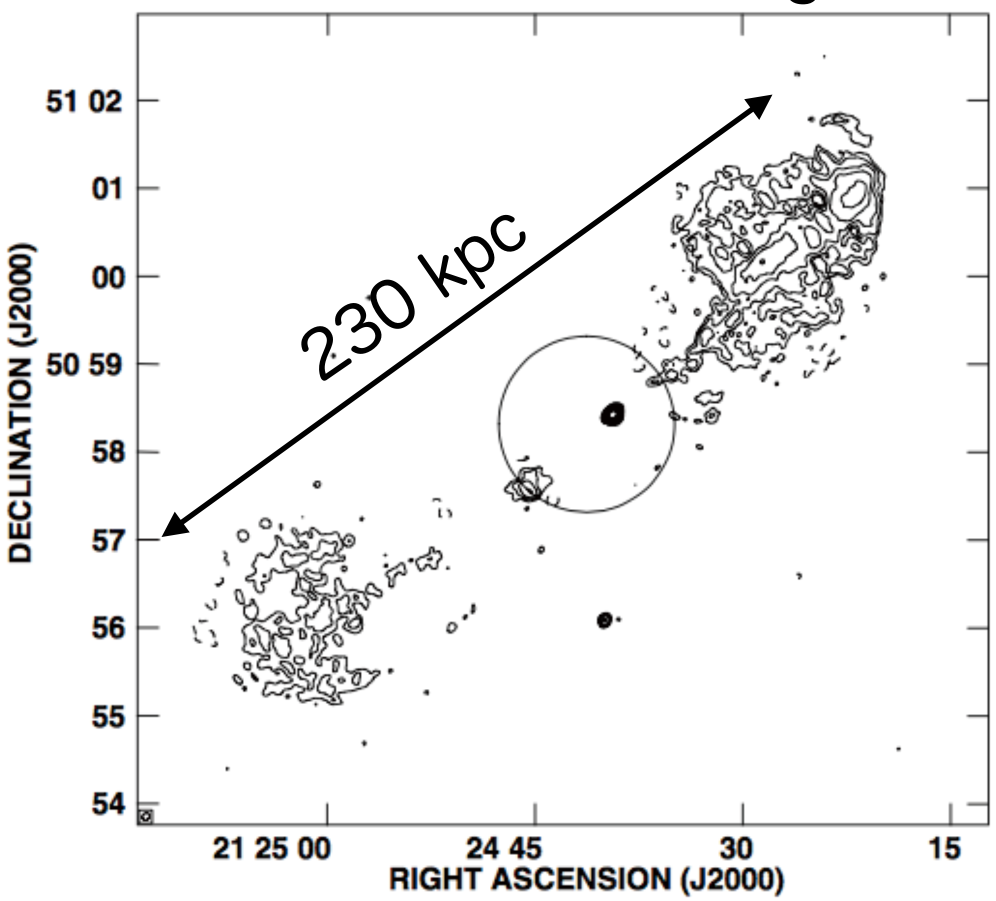

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How are FR II jets collimated?

Is AGN jet affected by high-rate accretion and Compton-thick corona?

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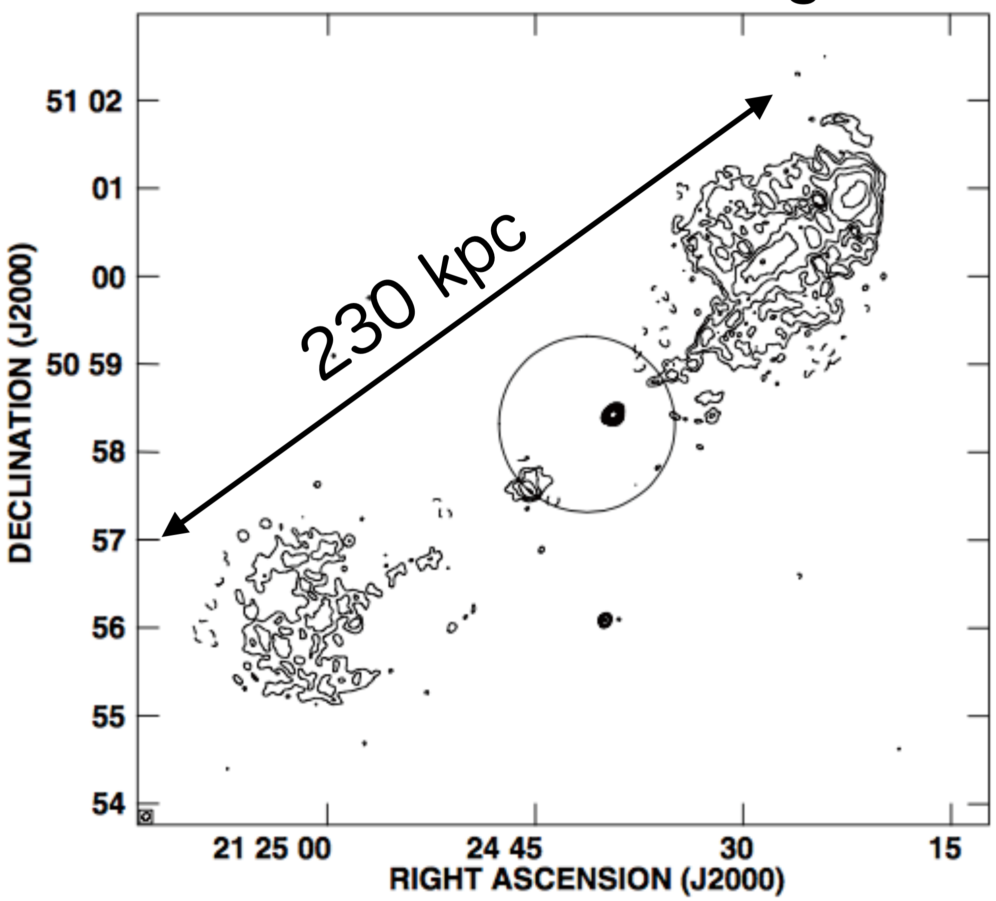

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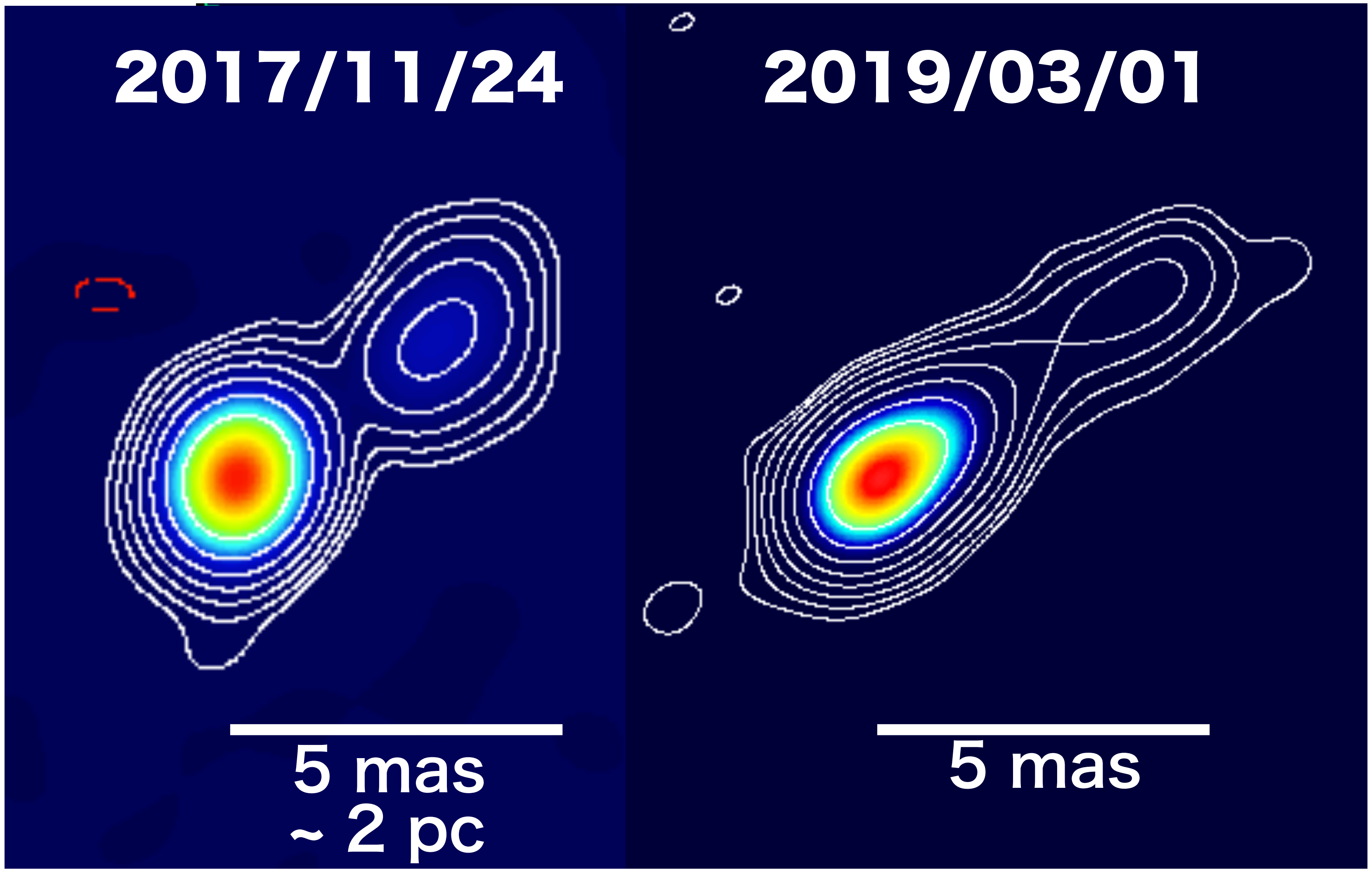
Is AGN jet affected by high-rate accretion and Compton-thick corona?

Sub-pc/pc scale image is important!

First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

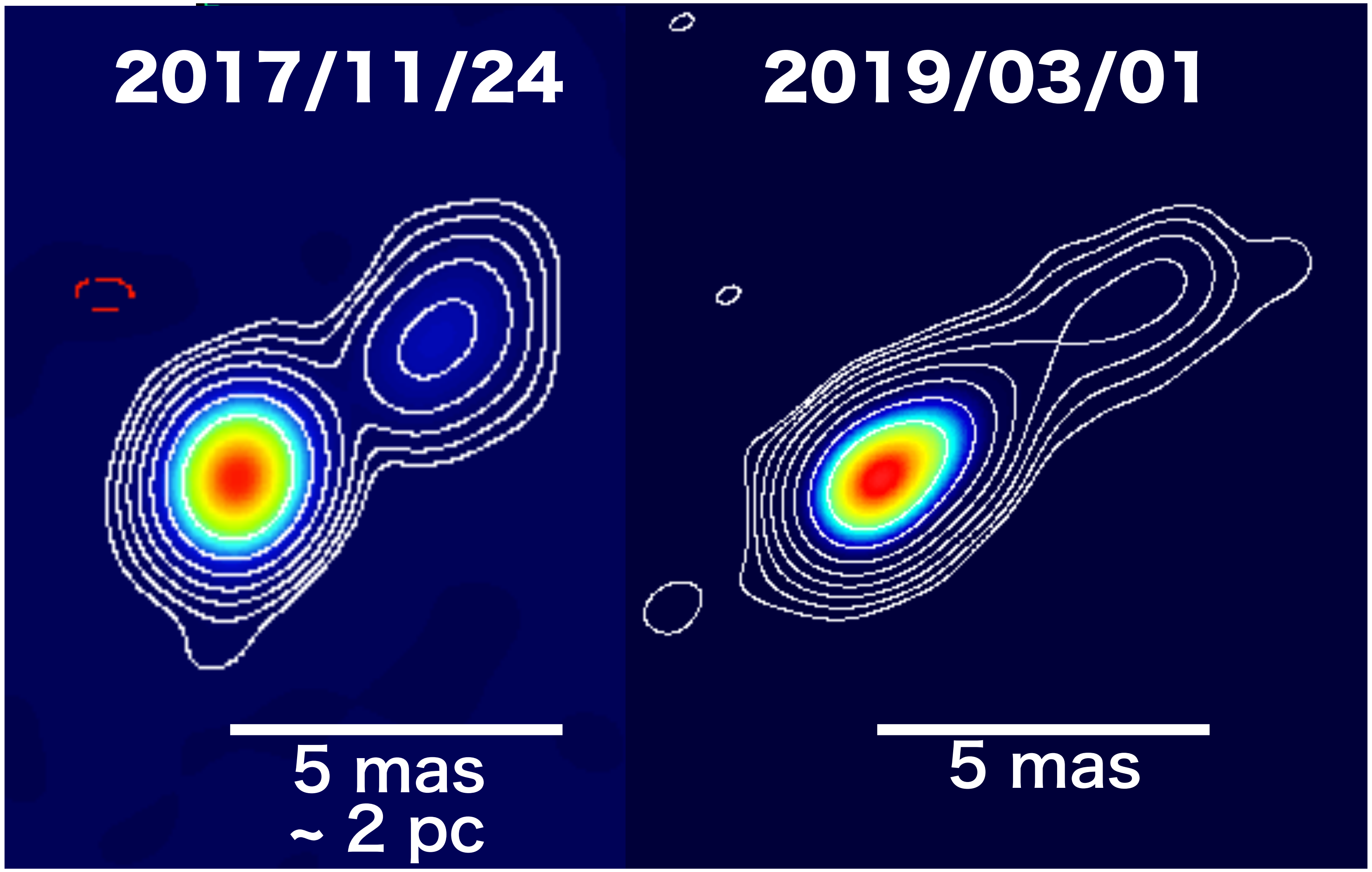
First VLBI Images of 4C 50.55



First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

First VLBI Images of 4C 50.55



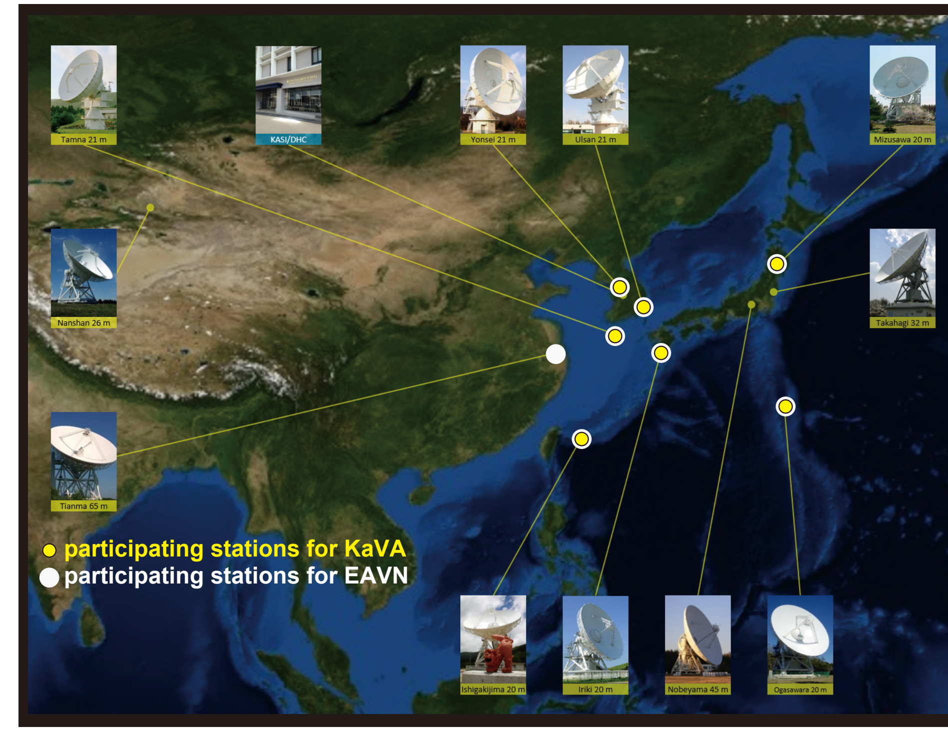


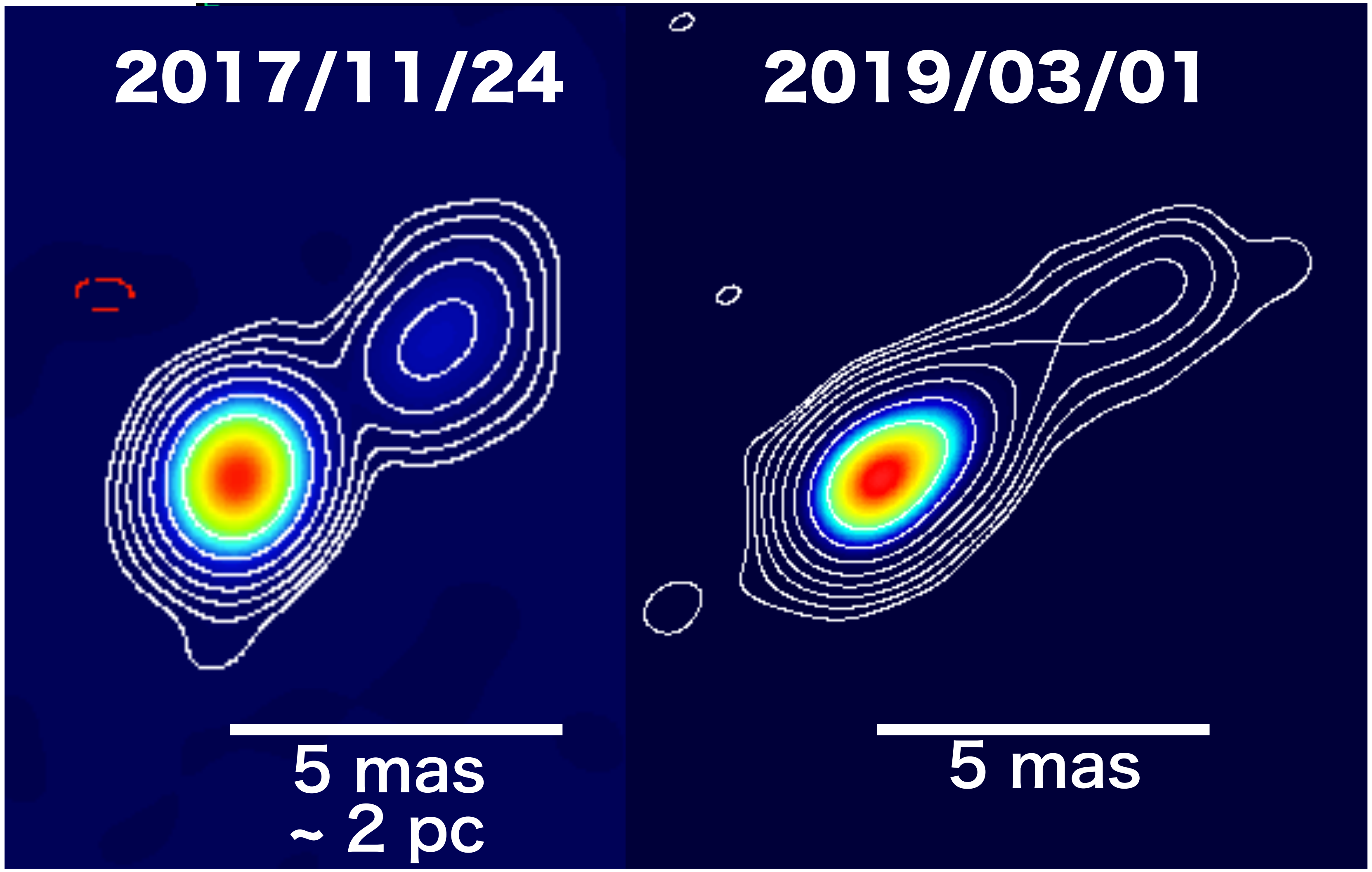
Fig. 3: Location of EAVN site. (Image credit of ground photo: NASA' s Earth Observatory)

Observed with KaVA
(Japan & Korea VLBI network)

First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

First VLBI Images of 4C 50.55



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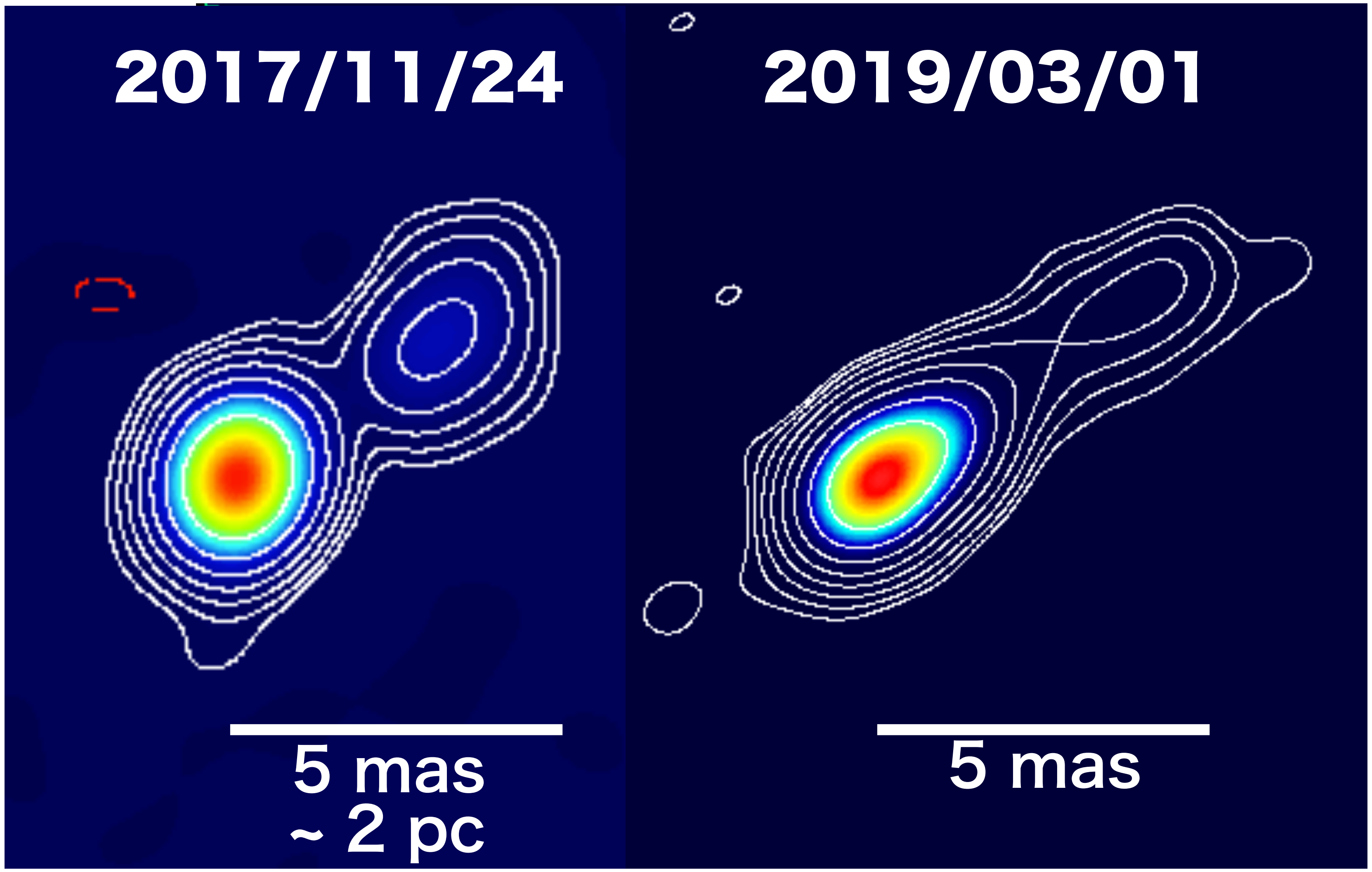

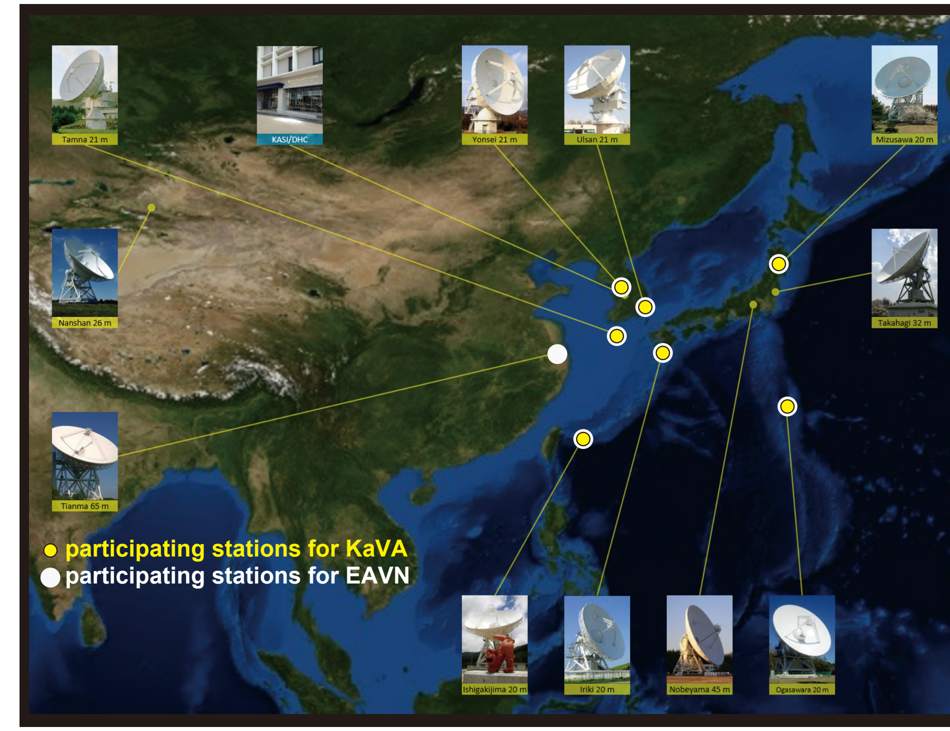

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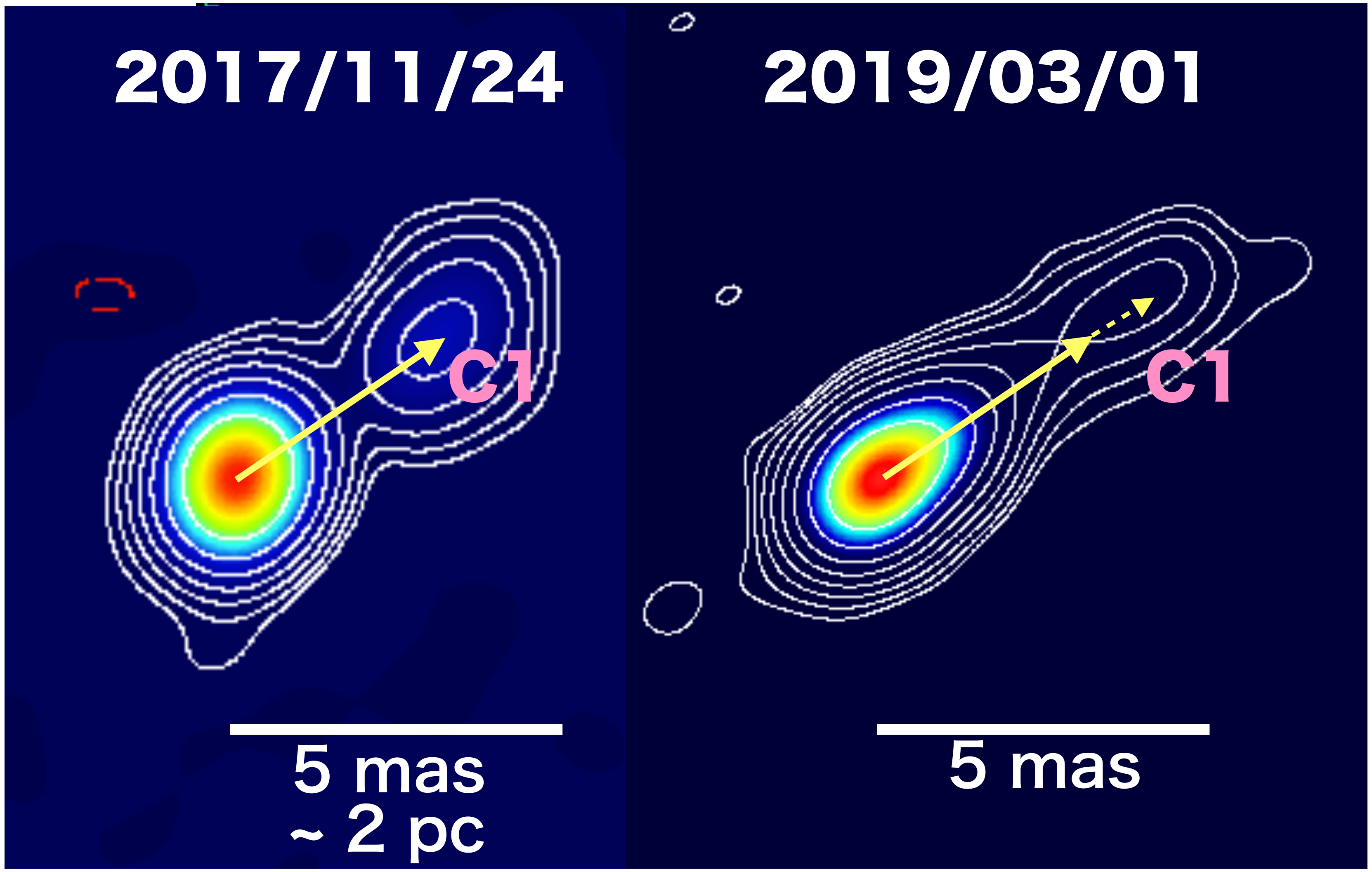
➡ **Approaching side is northwest!**

First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

Proper Motion & New-born Component



First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

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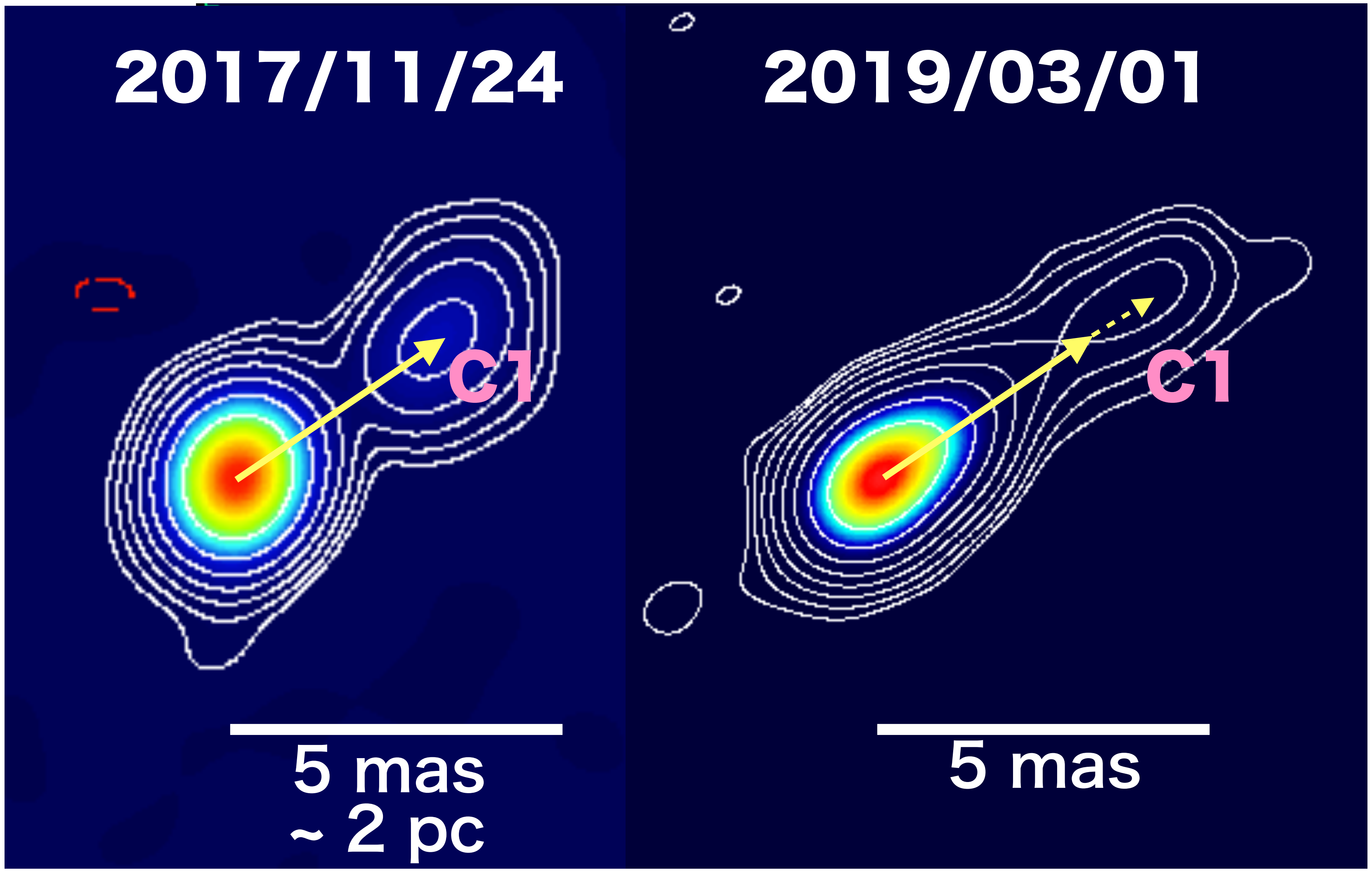


C1 component

Apparent velocity

~ 0.8 mas/year

~ 1.2c

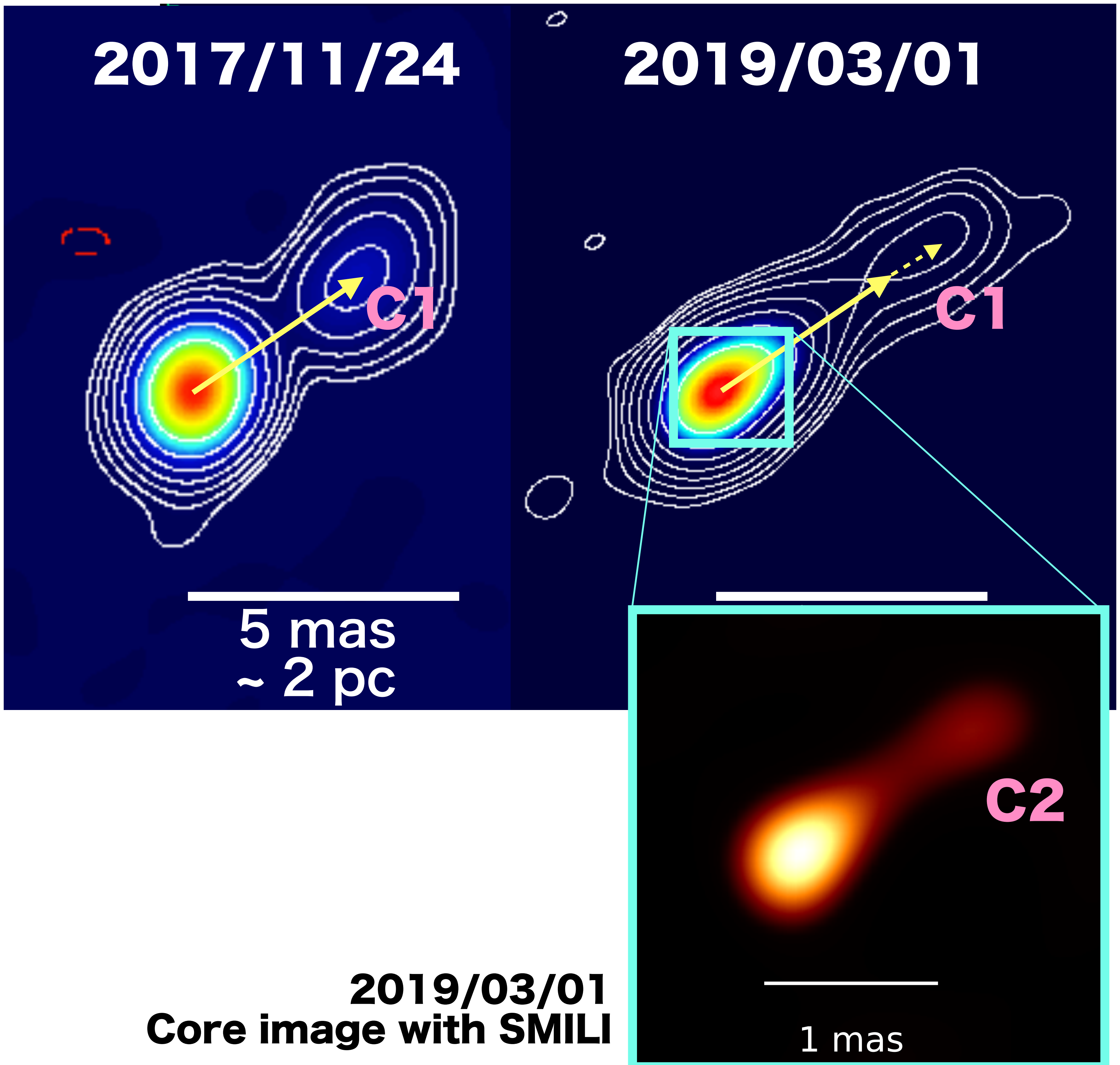
Intrinsic velocity (θ ~35°)

~ 0.8c

First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

Proper Motion & New-born Component



2019/03/01
Core image with SMILI

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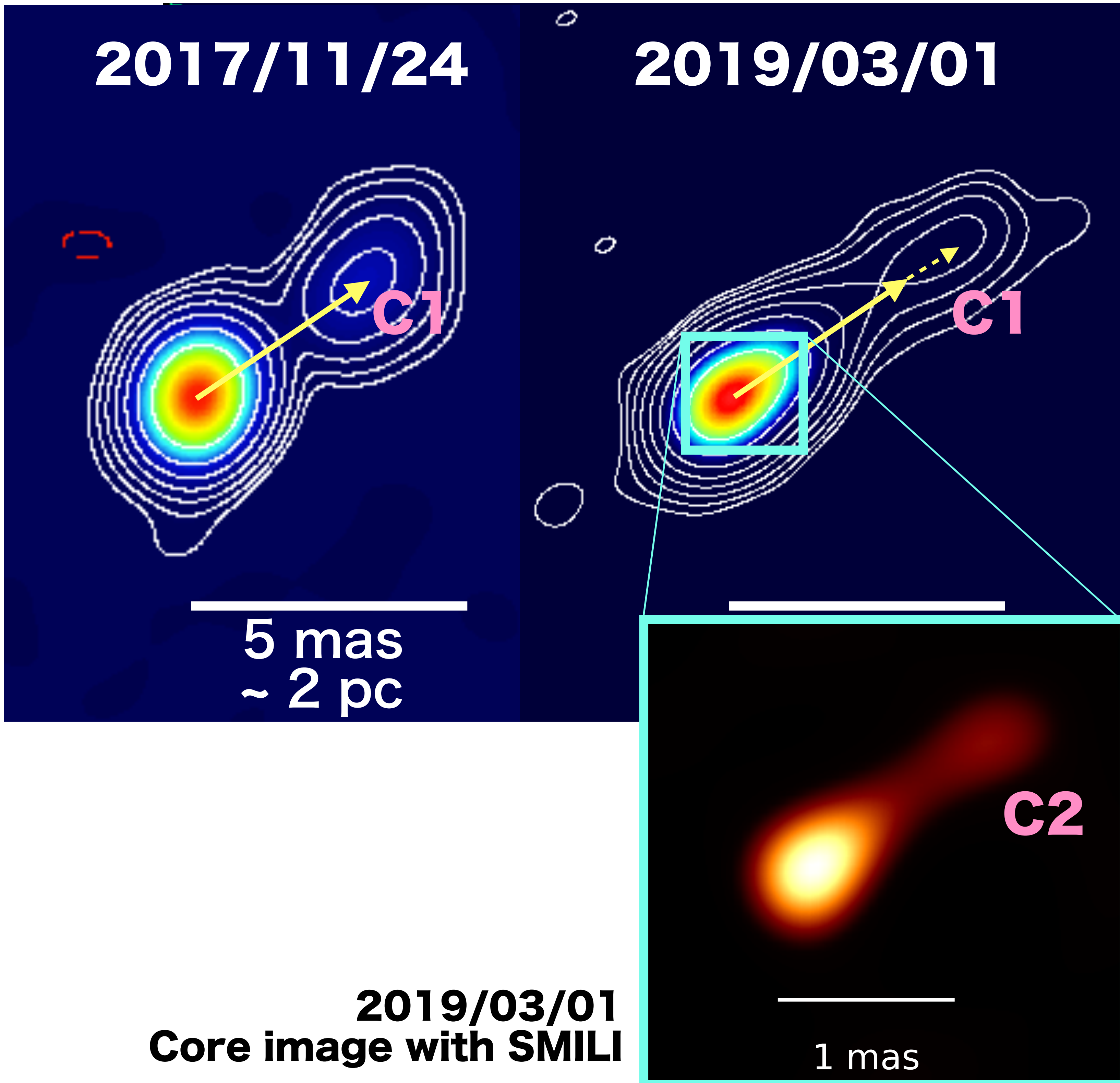


2019/03/01
Core image with SMILI

C1 component

Apparent velocity

~ 0.8 mas/year

~ 1.2c

Intrinsic velocity (θ ~35°)

~ 0.8c

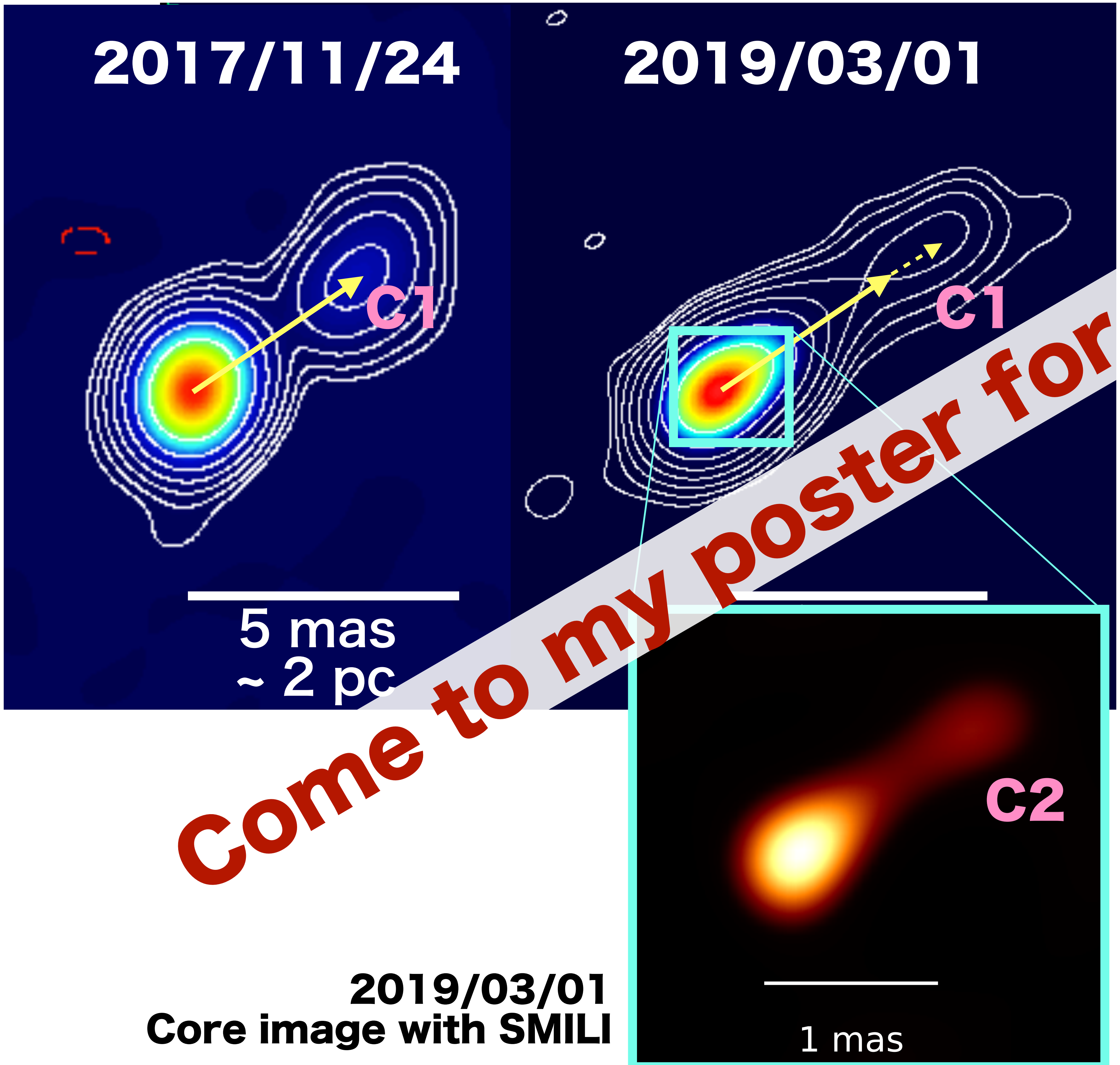
C2 component

New-born jet ~ 1.2 mas from the radio core.

First VLBI Study of FR II Radio Galaxy 4C 50.55

Fumie Tazaki (NAOJ)

Proper Motion & New-born Component



2019/03/01
Core image with SMILI

Come to my poster for discussion!

C1 component

Apparent velocity
~ 0.8 mas/year
~ [illegible].2c

Intrinsic velocity (θ ~35°)
~ 0.8c

C2 component

New-born jet ~ 1.2 mas from the radio core.

General relativistic radiation magnetohydrodynamics simulations of super-Eddington accretion disks around prograde and retrograde black holes

Aoto Utsumi[1)],Ken Ohsuga[1)]Hiroyuki Takahashi[2)],Yuta Asahina[1)] 1) Univ. of Tsukuba, 2) Komazawa Univ.

Purpose

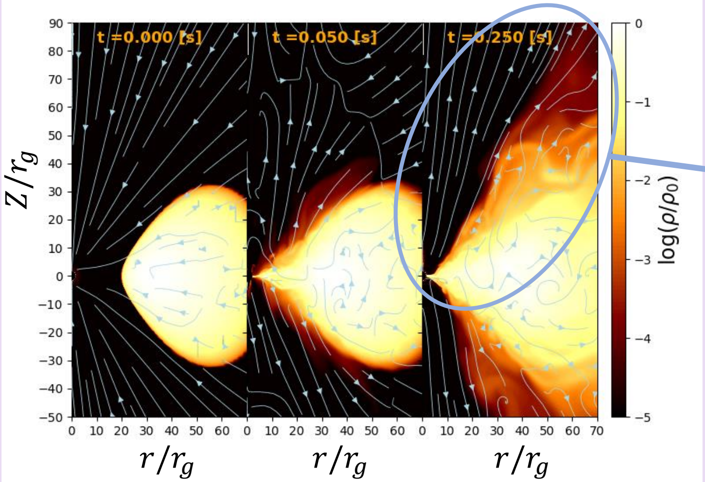
We investigate the dependence of luminosity and jet power on spin parameters in Super-Eddington accretion disks.

Overview

2.5-dimensional **G**eneral **R**elativistic **R**adiation **M**agneto**H**ydro**D**ynamics (GR-RMHD) simulation for $M_{BH} = 10M_{\odot}$.

Time-evolution of the density (color) and fluid velocity lines. (edge-on)

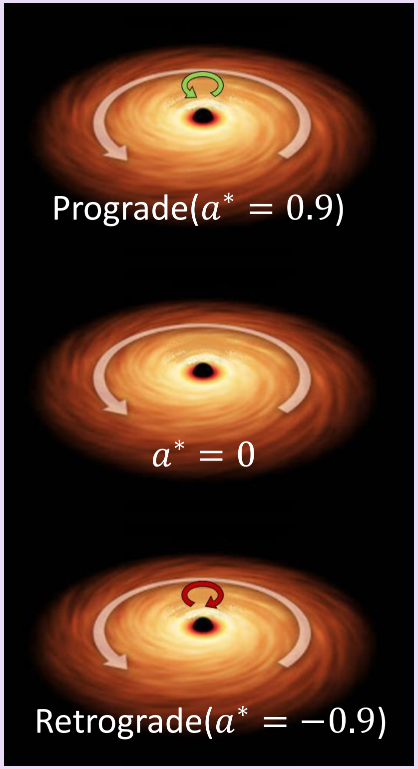
$a^* = 0$



Initial maximum mass density
$\rho_0 = 1.4 \times 10^{-2}\ \mathrm{g\ cm^{-3}}$

The Jet and the outflow and the Supercritical accretion flow are dominant in radiation.

Global structure does not depend on spin parameters.



Spin parameter dependence

	$\frac{\dot{M}_{BH}}{\dot{M}_{Edd}}$	$\frac{\dot{M}_{out}}{\dot{M}_{Edd}}$	$\eta_{tot}[\%]$	$\frac{L_{rad}}{L_{Edd}}$	$\frac{L_{kin}}{L_{Edd}}$	$\frac{L_{mag}}{L_{Edd}}$
$a^* = 0.9$	240	19	24	15	27	15
$a^* = 0$	410	2.7	3.4	8.0	5.6	0.1
$a^* = -0.9$	720	12	9.0	20	35	10

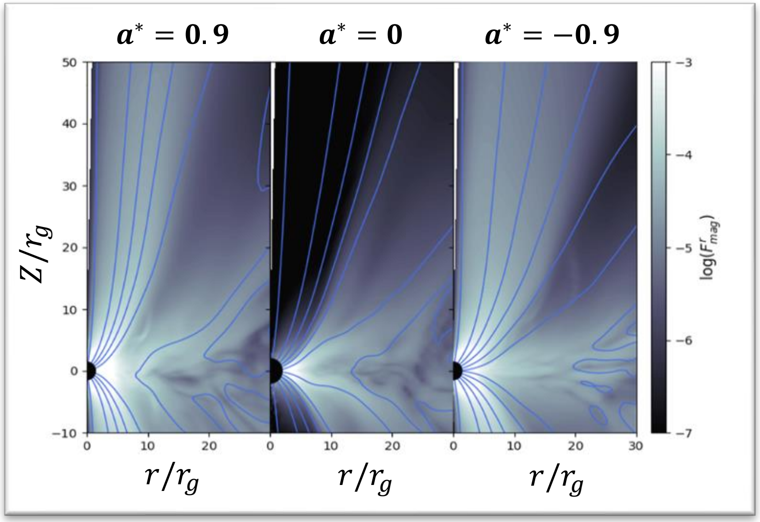
The mass inflow and outflow rate

$$\dot{M} = 2\pi \int \rho u^r \sqrt{-g}\, d\theta$$

Luminosity : L

The energy conversion efficiency

$$\eta_{tot} = \frac{L_{tot}}{\dot{M}_{BH} c^2} \times 100\ [\%]$$



Profiles of the outward Poynting flux.
Blue lines indicate the magnetic field lines.

- $\dot{M}_{BH}(a^* = 0.9) < \dot{M}_{BH}(a^* = 0) < \dot{M}_{BH}(a^* = -0.9)$
- $\dot{M}_{out}(a^* = 0) < \dot{M}_{out}(a^* = -0.9) < \dot{M}_{out}(a^* = 0.9)$
  We think that the mass ejection rate is related to the Poynting flux. (The Blandford-Znajek effect)
- $\eta_{tot}(a^* = 0) < \eta_{tot}(a^* = -0.9) < \eta_{tot}(a^* = 0.9)$

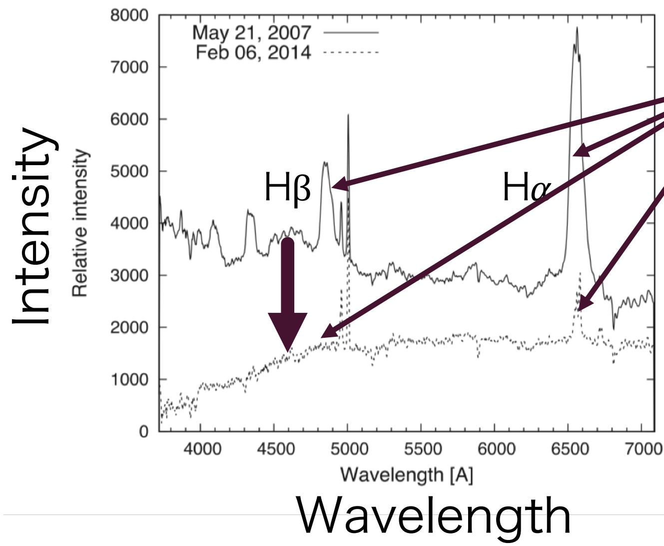
- **The non-spinning BH :** $L_{mag} < L_{kin} < L_{rad}$
- **The spinning BH :** $L_{rad} \sim L_{mag} < L_{kin}$

If you have any questions, please come to my poster.

RADIATION MAGNETOHYDRODYNAMIC SIMULATIONS OF CHANGING LOOK AGNS AND INTERMITTENT JET EJECTION

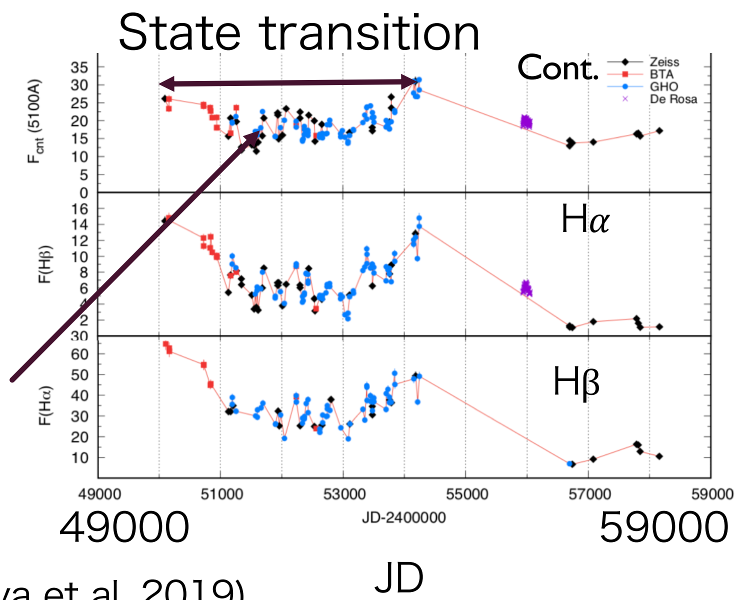
TAICHI IGARASHI (五十嵐　太一), CHIBA UNIV.
YOSHIAKI KATO, RIKEN
HIROYUKI TAKAHASHI, KOMAZAWA UNIV.
KEN OHSUGA, TSUKUBAI UNIV.
YOSUKE MATSUMOTO, CHIBA UNIV.
RYOJI MATSUMOTO, CHIBA UNIV.

CHANGING LOOK AGN (CLAGN)

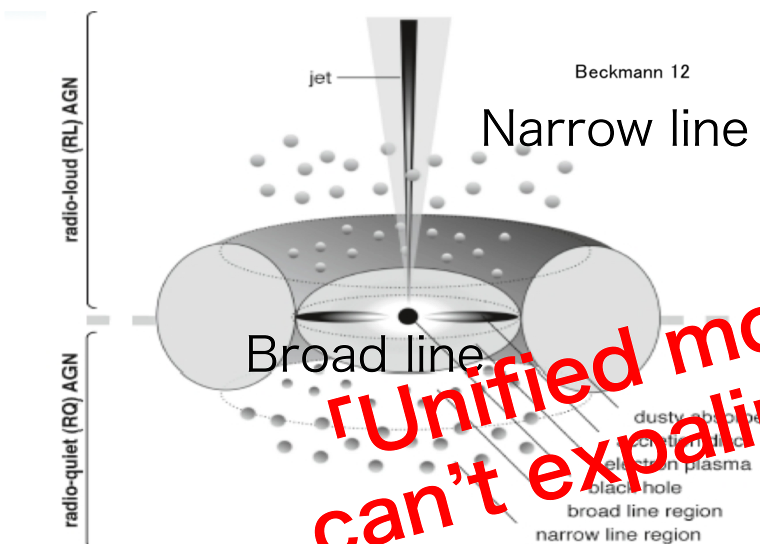


Disappear broad line!

Short time variation

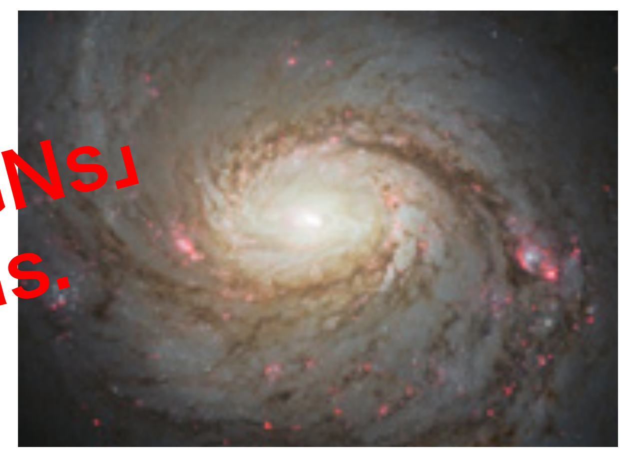


Optical spectrum & light curve of NGC 3516 (Shapovalova et al. 2019)



「Unified model of AGNs」 can't expaline CLAGNs.

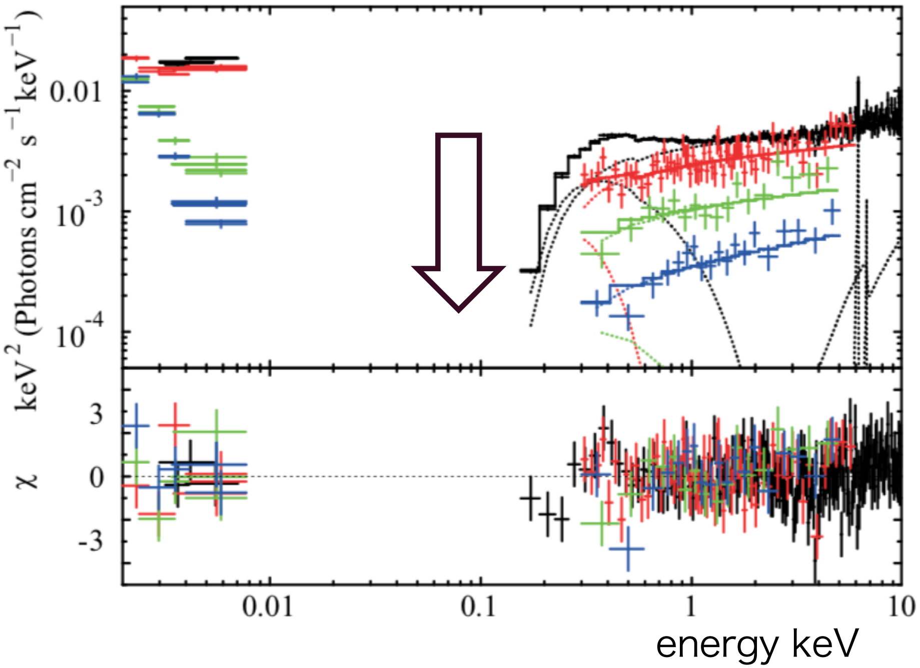
Schematic picture of「Unified model of AGN」Beckmann 2012



Optical image of Seyfert galaxy NGC 1068
NASA, ESA & A. van der Hoeven

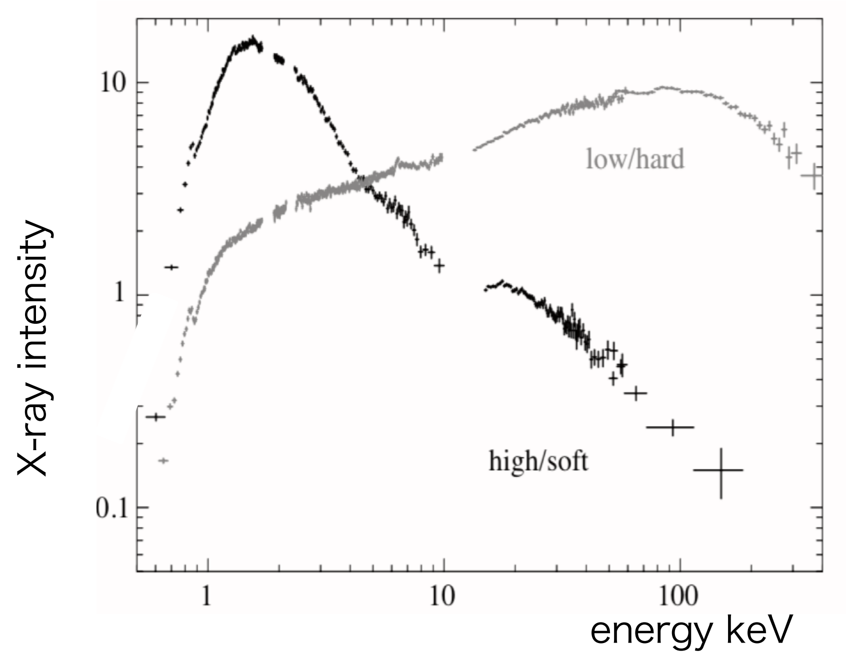
CLAGN : SOFT X-RAY EXCESS

AGN ($M_{BH} = 5\times10^7\ M_{\odot}$)



Spectrum of Mrk 1018
Noda & Done 20138

Stellar mass BH ($M_{BH} = 10\ \ M_{\odot}$)



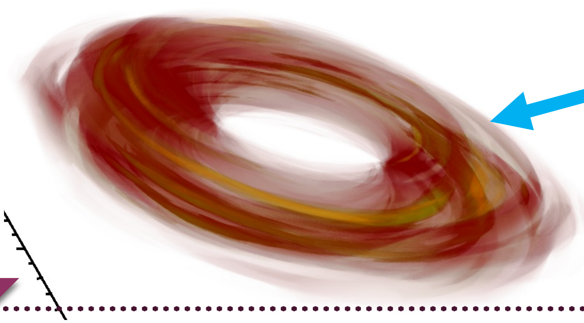
Spectrum of Cygnus X-1
Yamada et al.2013

- Soft X-ray excess is prominent when the source is bright.
- Similar to the hard-to-soft (soft-to-hard) transition in stellar-mass BH.

State transition exists in the accretion flow in the near region from BH.

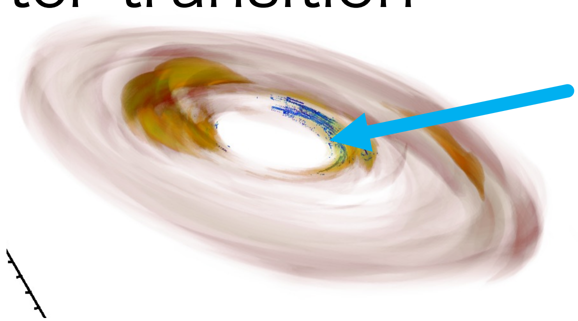
RESULT

Before transition



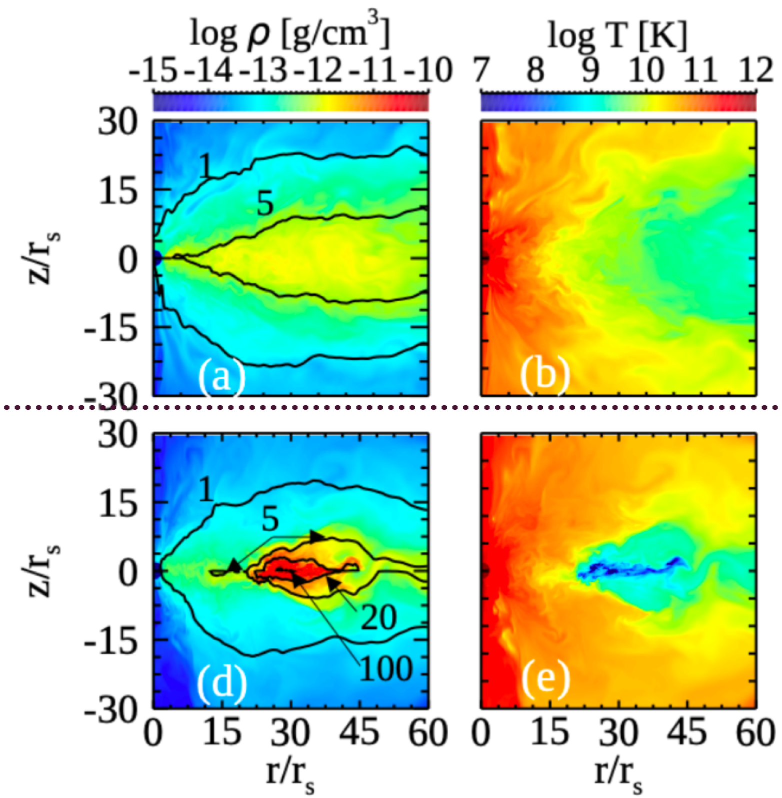
Hot accretion flow

After transition



Relatively cool ($\sim 10^7 - 10^8$ K) region formed.

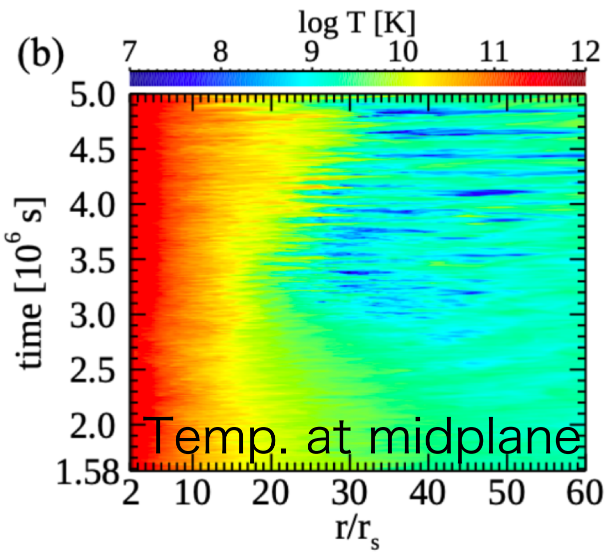
Temperature distribution

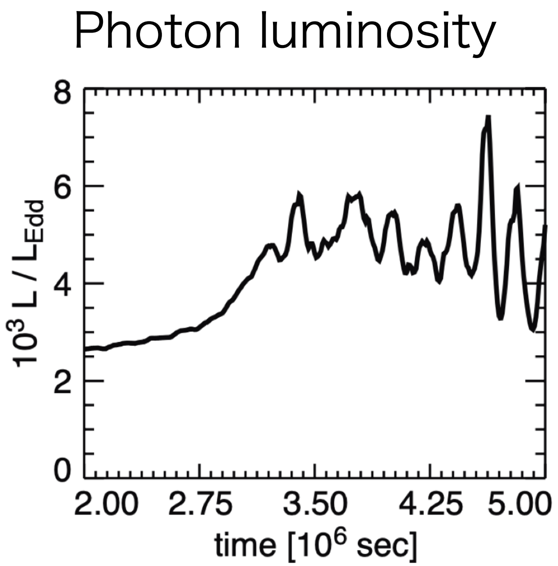


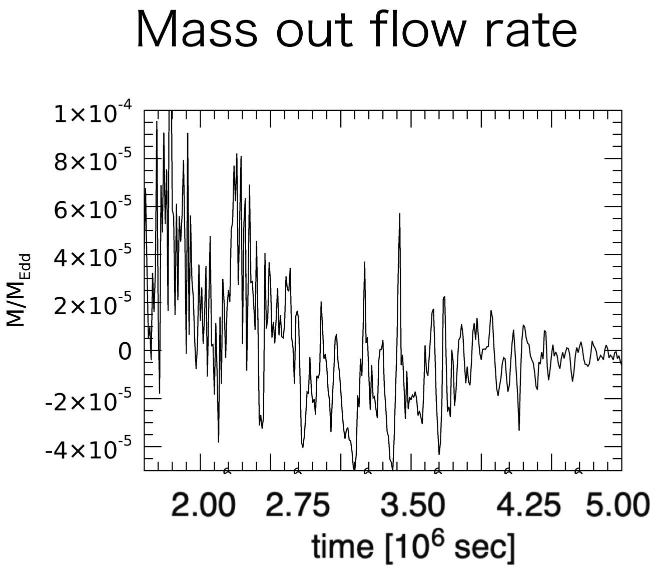
Rz slice of density and temperature

- Relatively cool ($\sim 10^7 - 10^8$ K)
- Non-axisymmetric structure (m=1)
- Strong radiation pressure
- Origin of Soft X-ray emission

RESULT







- Relatively cool region oscillates quasi periodically.
- We reproduce the short time variability.
- The variability follows the cool blob variability.
- Jet ejected intermittently.
- Jet suppressed in the later stage.

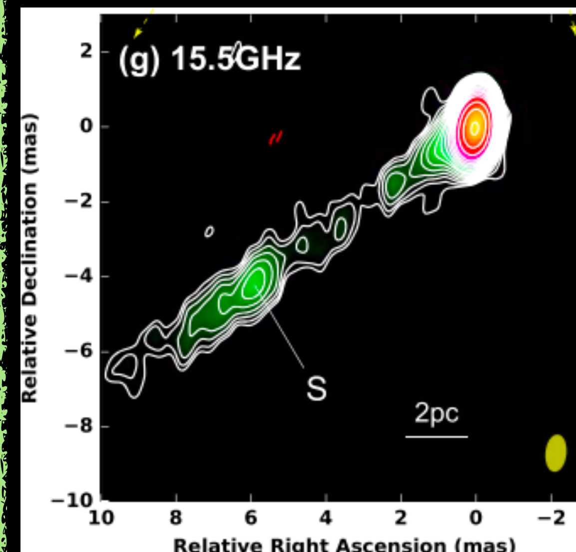
P4

Polarization study of the jet of gamma-ray emitting narrow-line Seyfert 1 galaxy 1H0323+342 with high-resolution VLBI

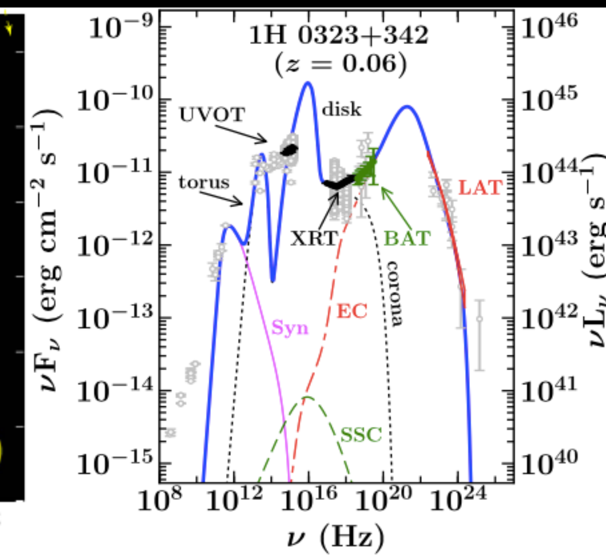
Mieko Takamura(UTokyo / NAOJ, M1)

Third class of AGN with powerful relativistic jets

Radio-loud NLS1	Blazar/Radio galaxy
Black hole mass $= 10^6 M_\odot - 10^8 M_\odot$	Black hole mass $= 10^8 M_\odot - 10^{10} M_\odot$
$\frac{L}{L_{Edd}}$ ~1	$\frac{L}{L_{Edd}}$ <1

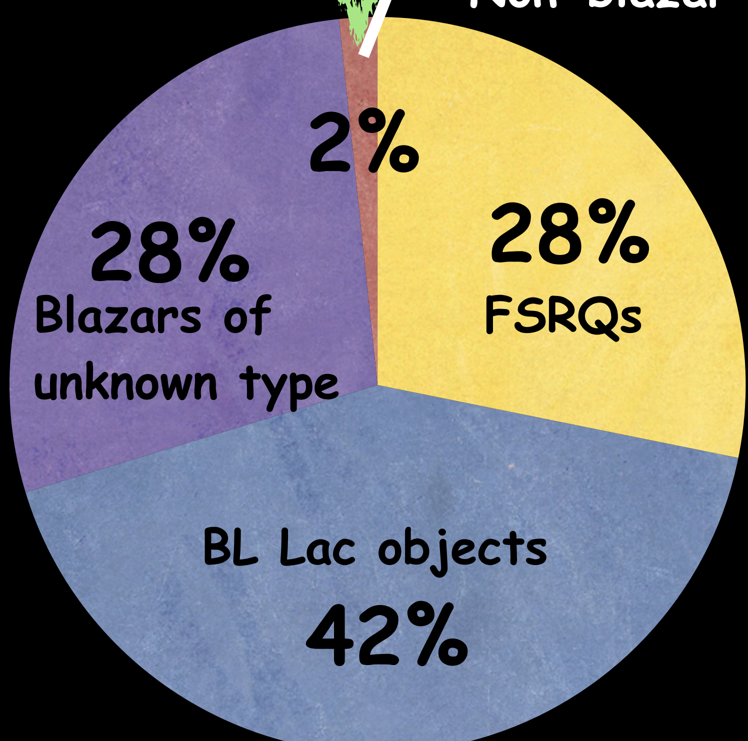


(Hada et al. 2018)



(Paliya et al. 2019)

Non-blazar



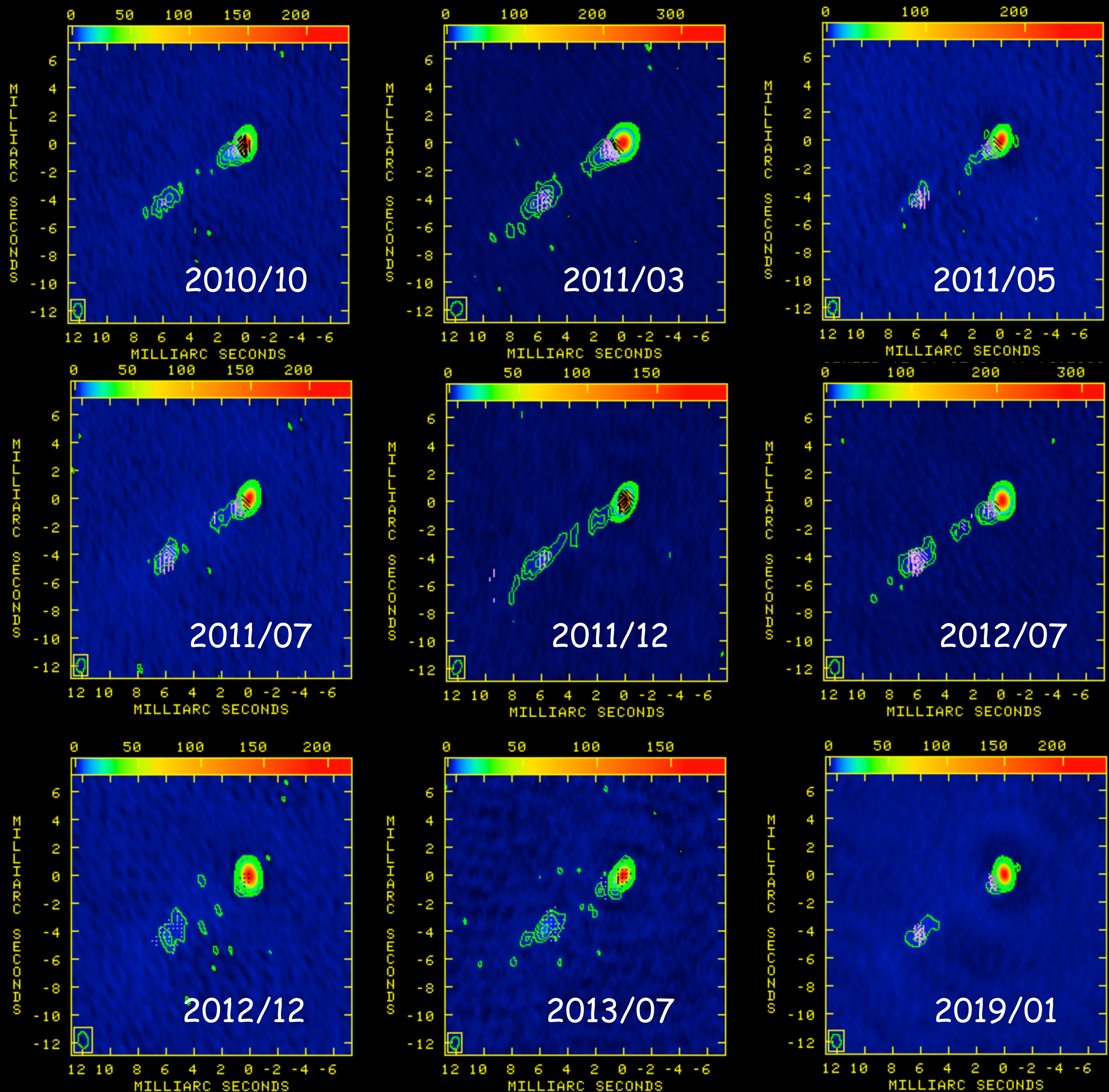
Gamma-ray AGN

(3LAC using the first four years of the Fermi-LAT data list 1444 gamma-ray AGN)

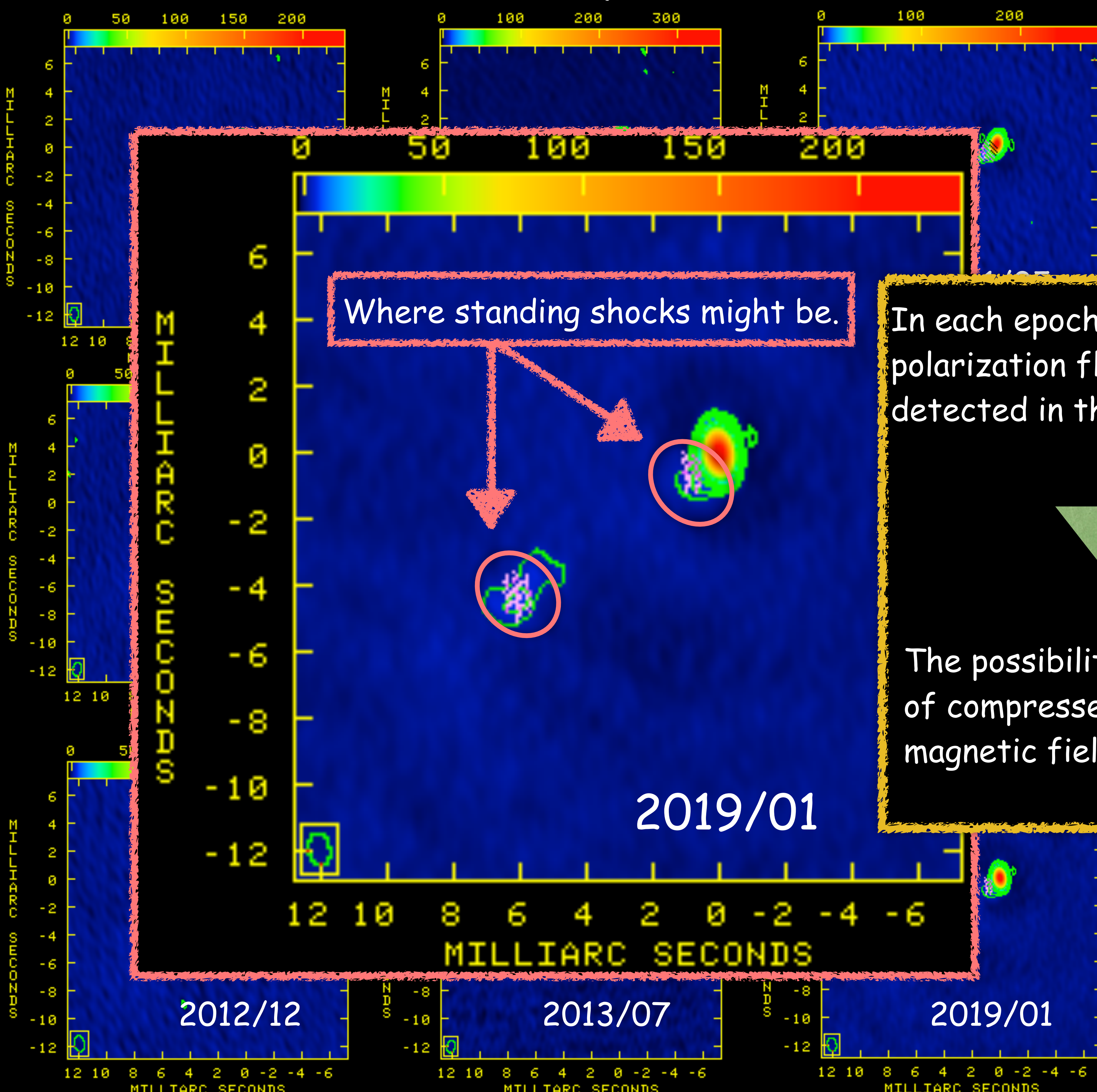
Object	Redshift z	Luminosity(erg/s)	$log(\frac{M_{BH}}{M_\odot})$
1H0323+342	0.061	2.1×10^{44}	7.17
SBS 0946+513	0.584	3.2×10^{46}	7.59
PMN J0948+0022	0.585	7.5×10^{46}	7.5
IERS B1303+515	0.787	6.9×10^{45}	–
B3 1441+476	0.705	4.7×10^{45}	7.4
PKS 1502+036	0.408	1.0×10^{46}	8.84
FBQS J1644+2619	0.145	2.7×10^{44}	8.32
PKS 2004-447	0.24	1.7×10^{45}	6.7
TXS 2116-077	0.26	7.2×10^{44}	7.21

→ It is important to investigate the relativistic jet launching, collimation and acceleration of NLS1s

Imaging & Polarization analysis



Imaging & Polarization analysis



In each epoch, strong polarization flux was detected in these two regions

The possibility of existence of compressed uniform magnetic field structures

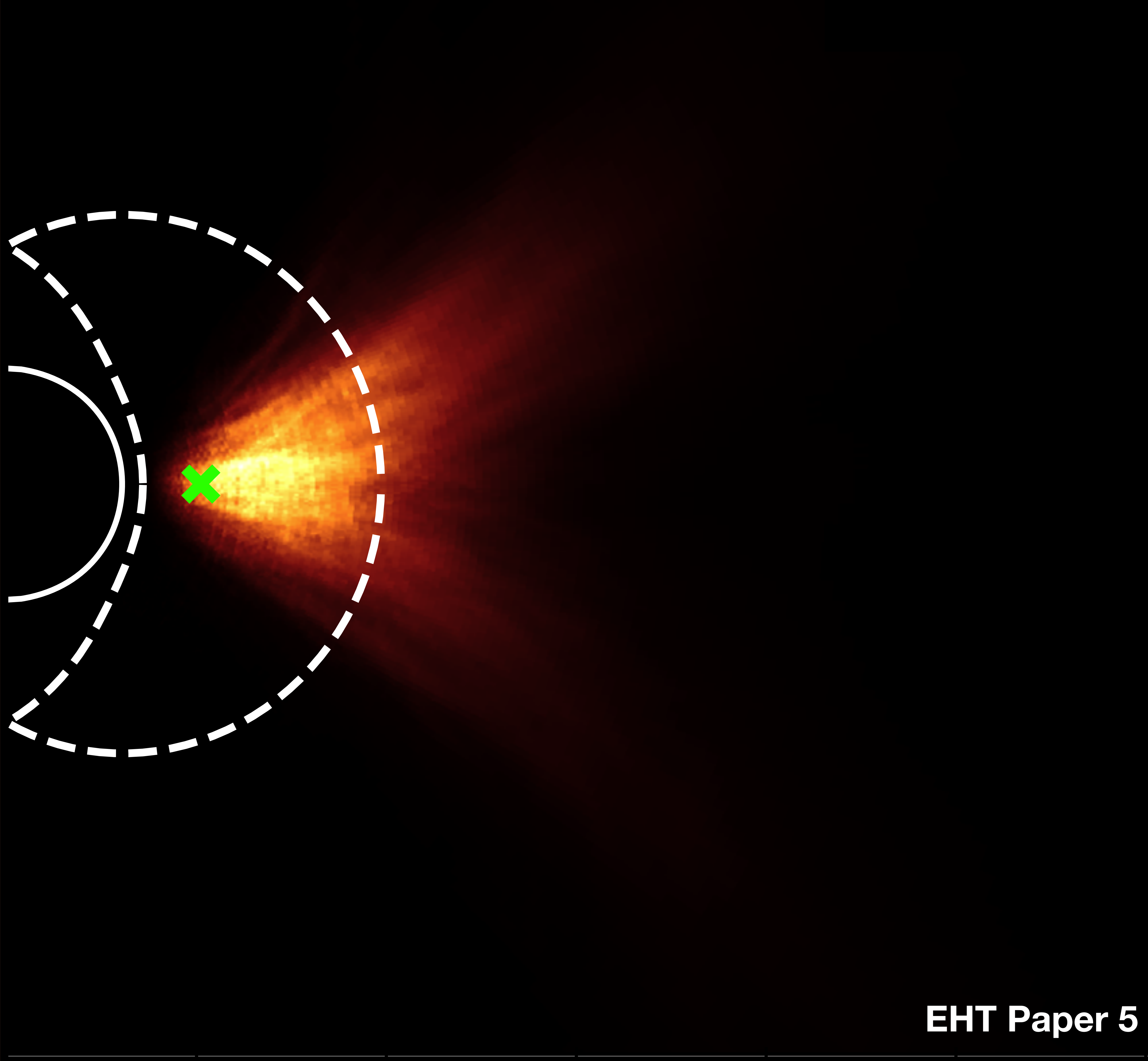
Constructing a GRMHD Approximate Solution for AGN Jets

Taiki Ogihara, Kenji Toma (Tohoku Univ.)

“Active Galactic Nucleus Jets in the Event Horizon Telescope Era”, 20 Jan. 2020 @Tohoku University

EHT image = Disk Emission

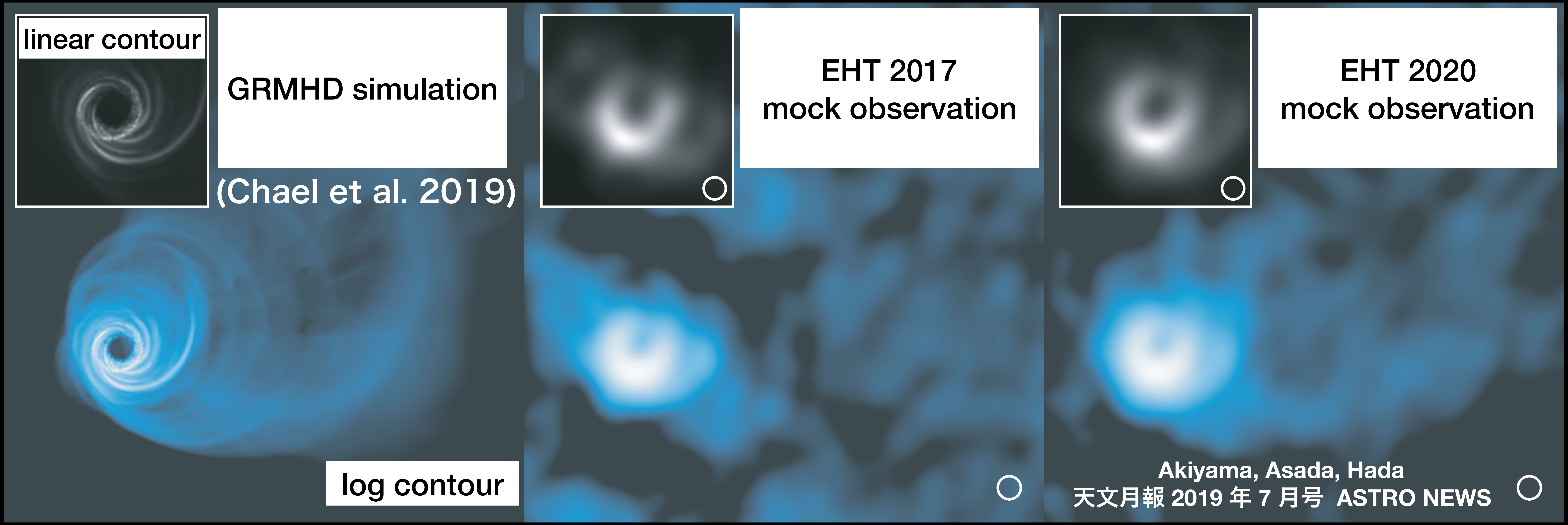
EHT Collaboration



EHT Paper 5

How about Jet Emission?

Detection is expected in EHT 2020 observations



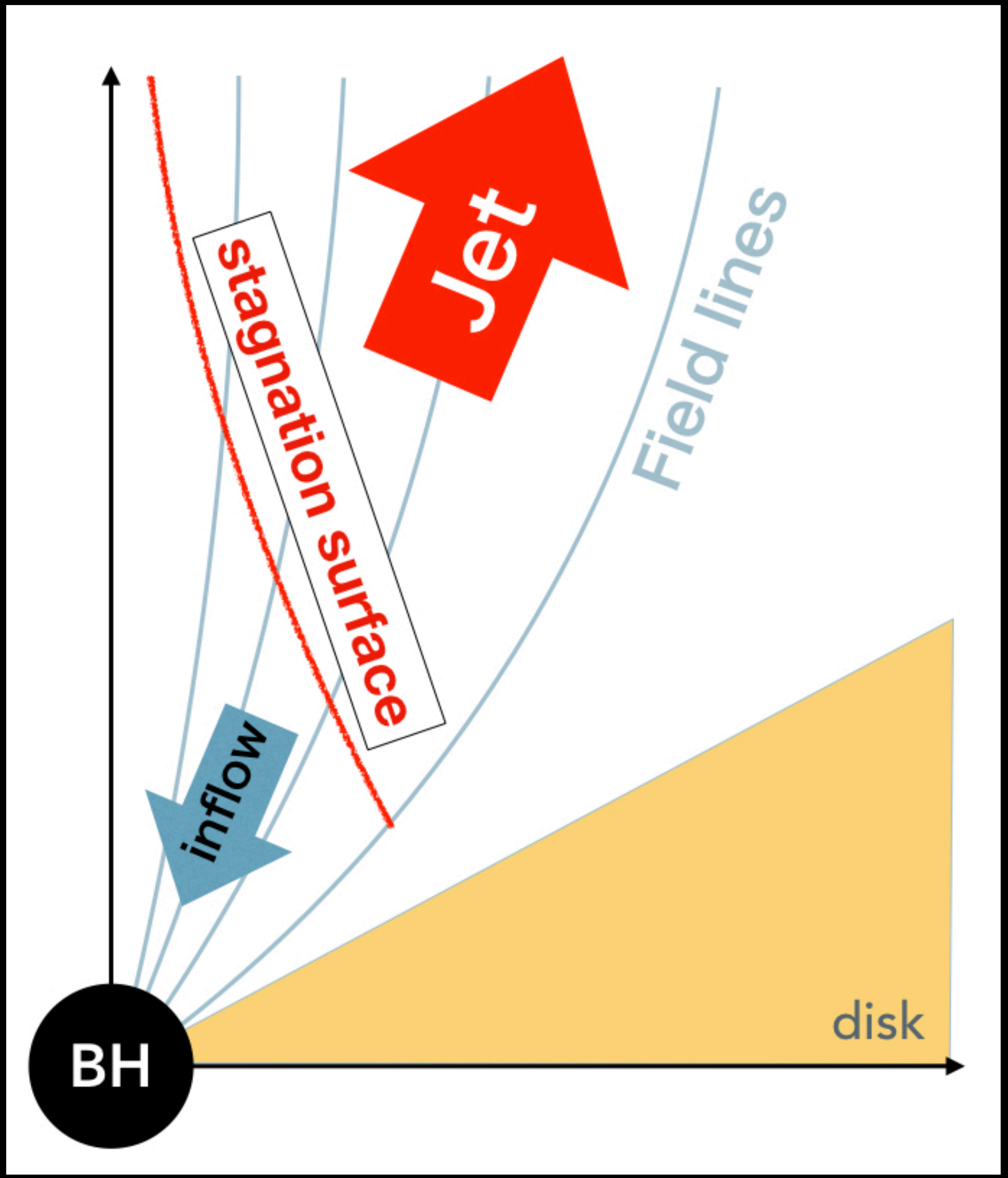
Produce jet image
with ANALYTICAL JET MODEL

Constructing a GRMHD Approximate Solution for AGN Jets

Taiki Ogihara, Kenji Toma (Tohoku Univ.)

- method
  - analytically solve GRMHD equations
  - assume poloidal magnetic field structure instead of solving GS equation (trans-field component of EoM)
  - constrain parameters to satisfy GS equation at the stagnation surface

=> derive density, velocity, magnetic field



Constructing a GRMHD Approximate Solution for AGN Jets

Taiki Ogihara, Kenji Toma (Tohoku Univ.)

- preliminary results
  - in force-free case,
    we obtained the appropriate solution at the stagnation surface
- future work
  - expand model to MHD
  - apply radiative transfer and make jet image