S16

High-velocity Dispersion Compact Clouds Hosting Point-like Radio Sources in the Galactic Center

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Background

High-velocity Dispersion Compact Cloud (HVCCs)

- ~**200** objects identified in the Central Molecular Zone (CMZ)
- **Compact**($d \lesssim 5$ pc) **with extremely broad velocity width** molecular cloud

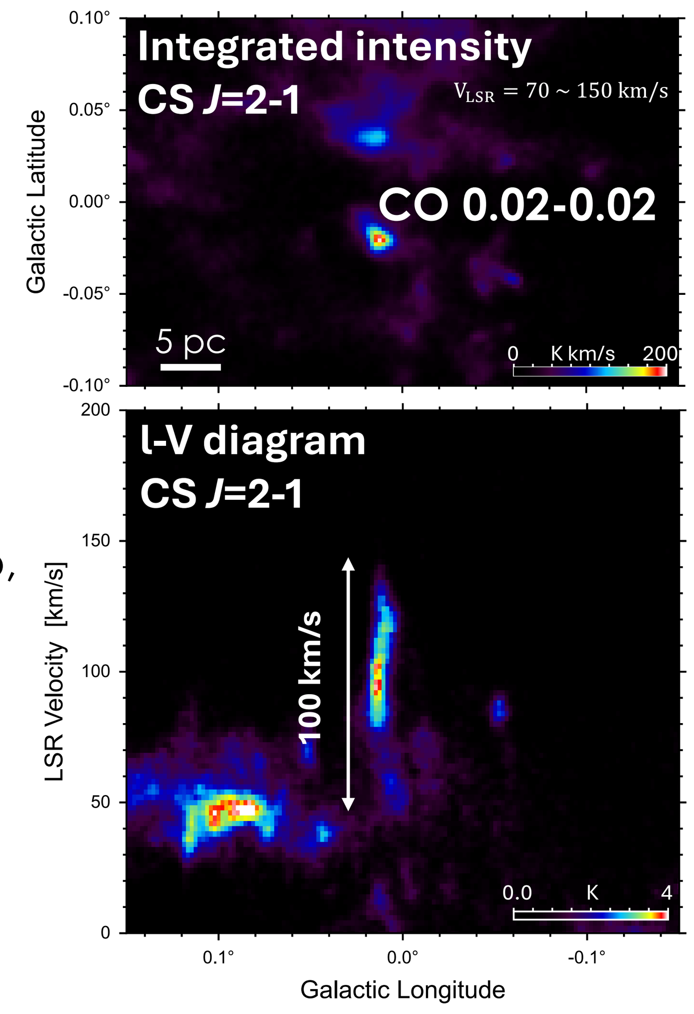
Typical molecular clouds: a few km/s   HVCCs: $\gtrsim 50$ km/s

Most HVCCs lack identified counterparts
→origin remains unknown

◯Proposed origins of HVCCs

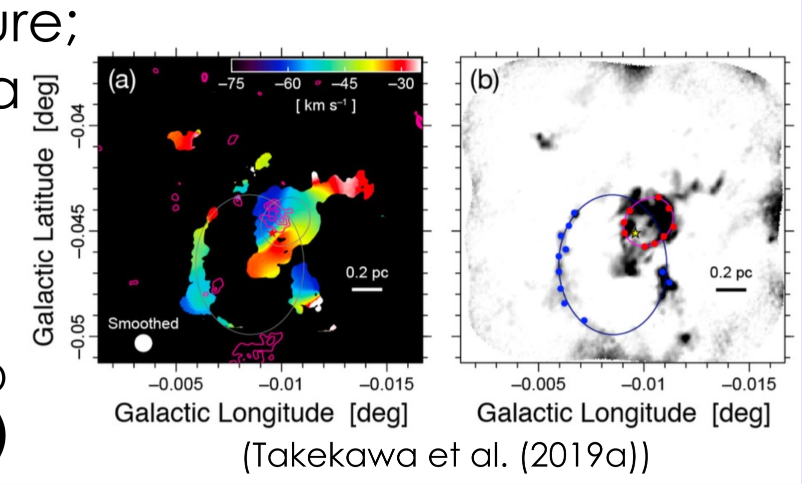
1. Gravitational acceleration by an **Intermediate-mass black hole (IMBH)**
(Oka et al. 2016, 2017, Takekawa et al. 2017, 2019a, 2019b, 2020, Kaneko et al. 2023)
2. Interaction with black hole jets
(Takekawa et al. in prep.)
3. Cloud–cloud collisions
(e.g., Ravi et al. 2017, Tanaka 2018)
4. Interaction with supernova
(e.g., Oka et al. 2008, Yalinewich & Beniamini 2017)
5. Protostellar outflows

IMBH is the key to understanding the origin of **SMBH**



Possible IMBH-hosting:HCN-0.009-0.004

No shell-like or V-shaped structure;
consistent with motion around a compact gravitational source
Enclosed mass from the Keplerian model
$M_{dyn} = (3.2 \pm 0.6) \times 10^4\ M_\odot$
(No compact source detected)



(Takekawa et al. (2019a))

Two HVCCs associated with compact radio sources → BH candidates (postar:S13)

Data

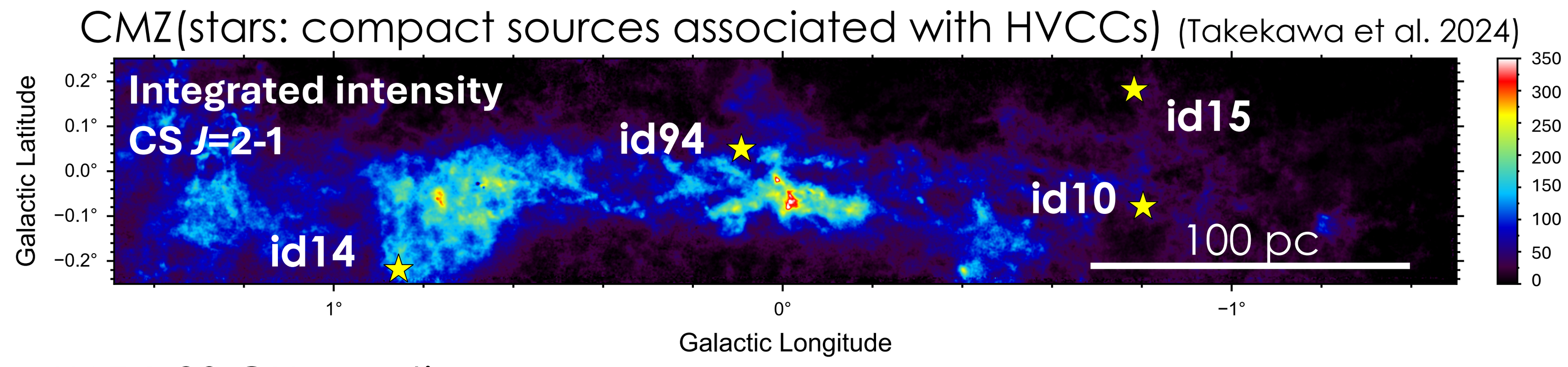
1. HVCC catalog (Oka et al. 2022)
2. MeerKAT 1.28 GHz continuum (Heywood et al. 2022)
3. Nobeyama 45-m CMZ survey (Takekawa et al. 2024)
   Integrated intensity ratios: CS/HCO⁺, HCN/HCO⁺
   SiO emission distribution
4. ALMA archival data ACES (Longmore et al. 2026)

Objective:
Systematic search for HVCCs with compact radio sources→Test a black hole–driven origin

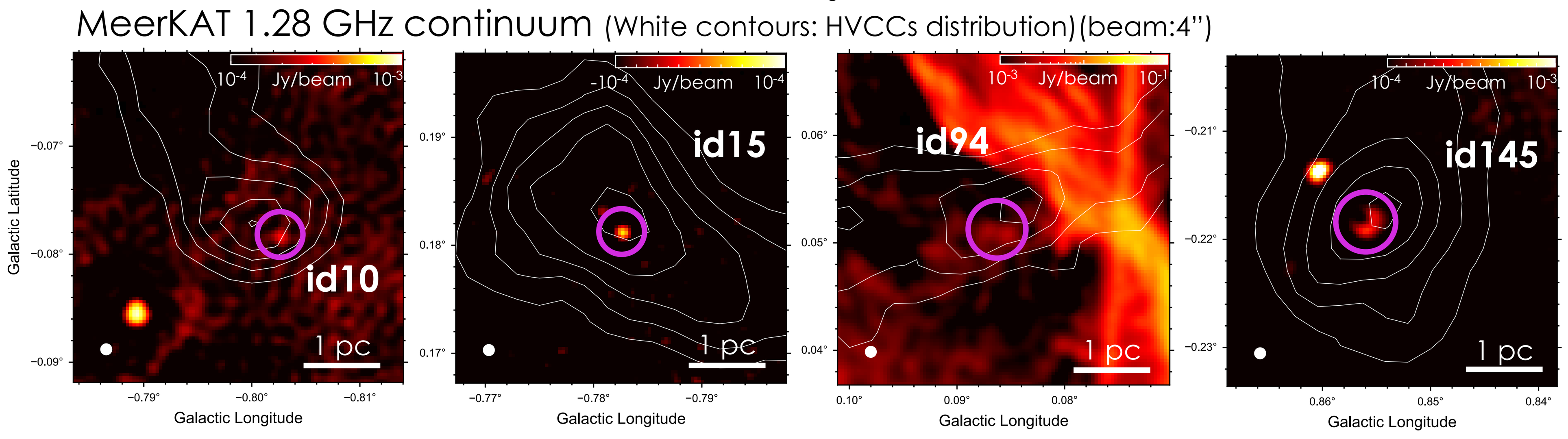
Results

4/184 HVCCs associated with compact radio sources

CMZ(stars: compact sources associated with HVCCs) (Takekawa et al. 2024)

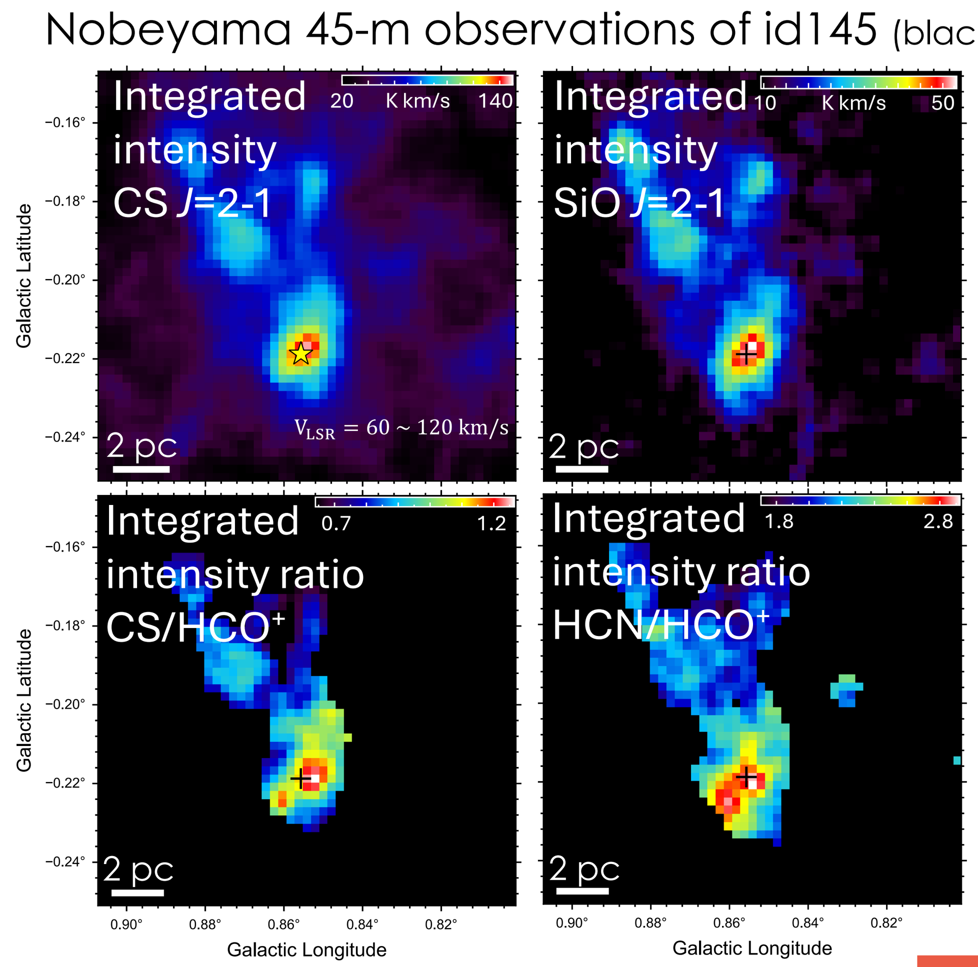


MeerKAT 1.28 GHz continuum (White contours: HVCCs distribution)(beam:4")



id94 and id145 **non-thermal radio source**
Spectral index α ($S_\nu \propto \nu^\alpha$) $\alpha \sim -0.4$ (synchrotron radiation?)

Nobeyama 45-m observations of id145 (black cross and star : compact radio source position)(beam:20")



HVCC Common Properties

1. SiO Detection
(SiO: shock tracer)
enhanced by dust destruction
↓
Strong shock activity

2. Weak HCO⁺ Near the Compact Source
Excess electrons?(BH-related ionization?)
HCO⁺ + e⁻ → H + CO
↓
HCO⁺ destruction

HVCC–compact radio source interaction?

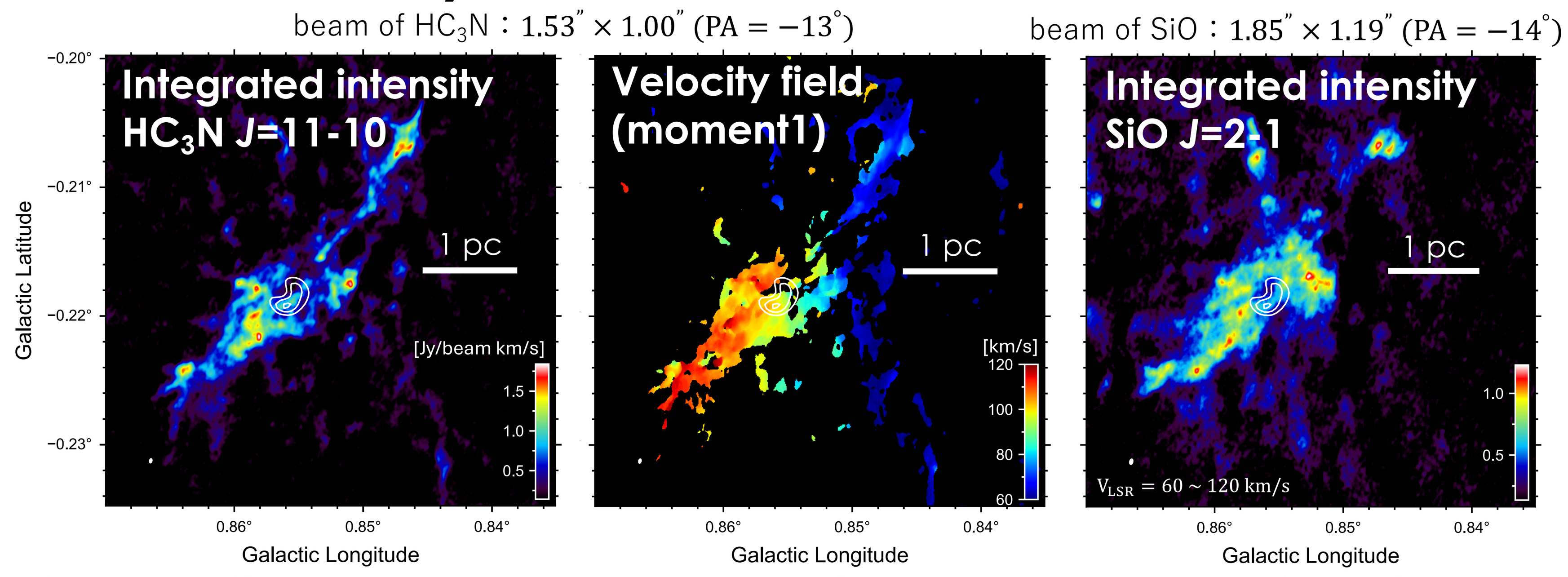
From the HVCC catalog (Oka et al. 2022)

- **Kinetic energy** $E_{kin} \gtrsim 1.0 \times 10^{49}$ **erg** ← larger than protostellar outflow
  (Protostellar outflow $E_{kin} \leq 1.0 \times 10^{47}$ erg) (Maud et al. 2015)
- Dynamical timescale $t_{dyn} \simeq 10^4$ yr
- $R_{3-2/1-0} \sim 0.8$ (CMZ typical $R_{3-2/1-0}$: 0.7) (Oka et al. 2007)

→Possibly BH-driven rather than protostellar
(Velocity gradient disfavors a supernova interaction scenario)
id10 and id15, whose spectral indices have not been measured, may belong to the same class of objects.

Analysis results of id145 from ACES

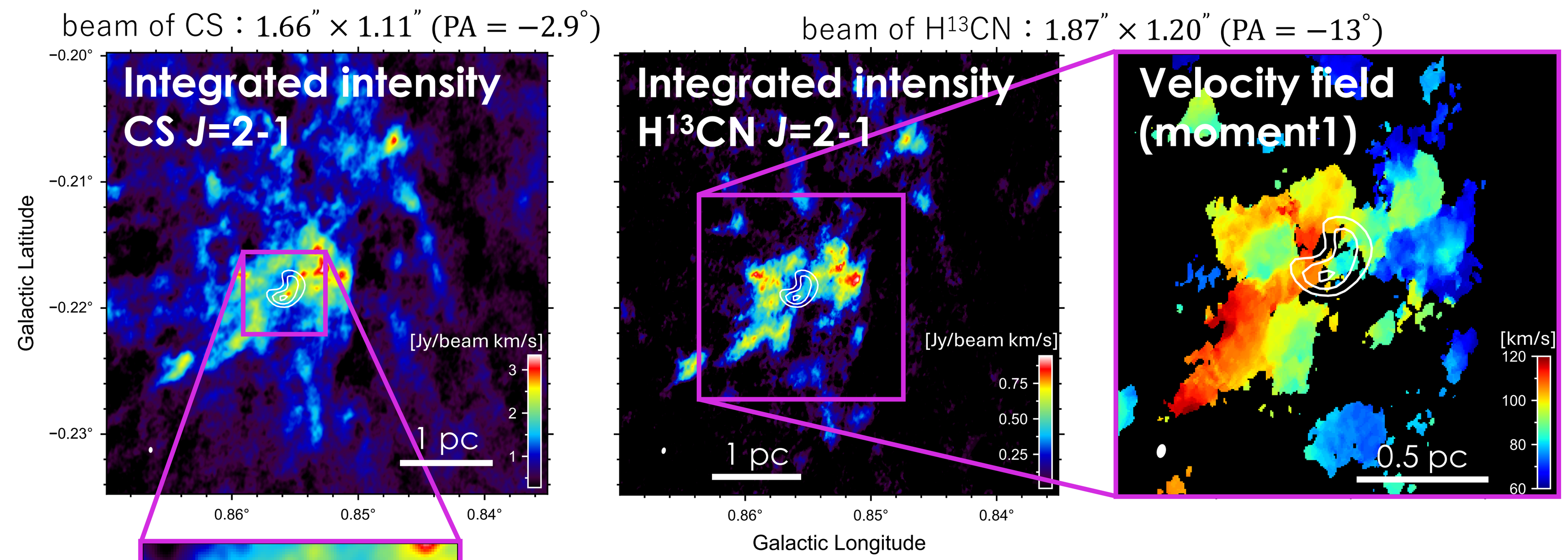
beam of HC$_3$N : $1.53'' \times 1.00''$ (PA = -13°)   beam of SiO : $1.85'' \times 1.19''$ (PA = -14°)

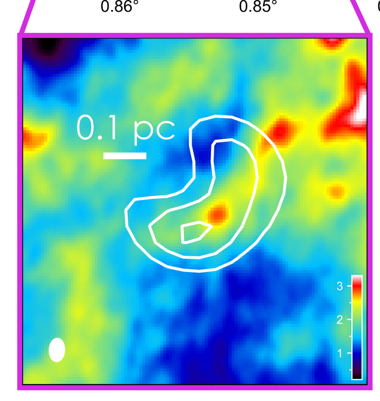


Bipolar filamentary structure in HC$_3$N extending from the compact source, with redshift and blueshift

Strong SiO emission at both filament ends (traces of shock)

beam of CS : $1.66'' \times 1.11''$ (PA = -2.9°)   beam of H^{13}CN : $1.87'' \times 1.20''$ (PA = -13°)





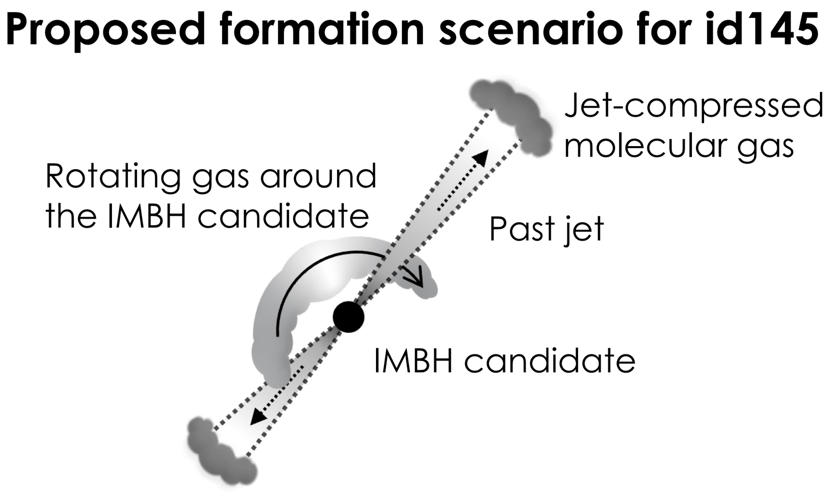
Ring-like structure in H^{13}CN suggesting rotational motion around the compact source

Compact central clump seen in CS

Central Clump
If the dense gas is gravitationally bound to a hidden driving source
Enclosed mass : $M \sim 10^3\ M_\odot$
(From line width and radius)

Enclosed mass from H^{13}CN rotation
$M \sim 10^5\ M_\odot$
→IMBH candidates

Proposed formation scenario for id145



Was id145 formed through **gravitational acceleration by an IMBH** and **past jet activity from the IMBH**?