Detection of the bullet-like SiO jet and dense CH_3CN envelope around the high mass protostellar object G353.273+0.641

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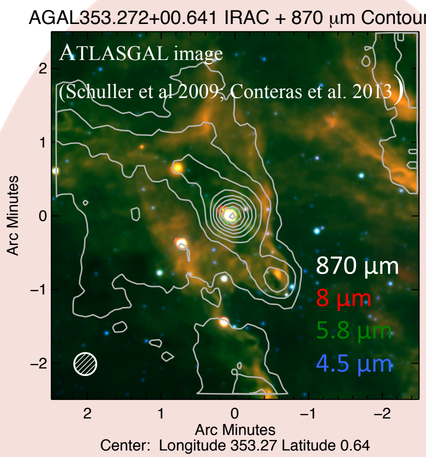
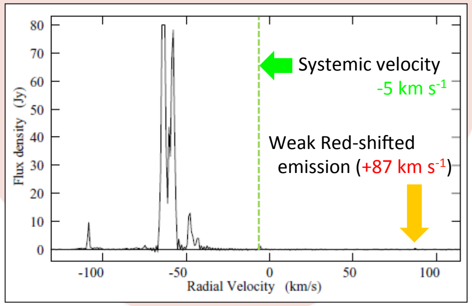
Abstract: We report on the millimeter observations towards the high mass protostellar object, G353.273+0.641 that is a candidate of a pole-on disk-jet system, and known to be the host of singular blue-shift dominated SiO jet. Our first imaging observations have shown that the SiO jet consists of point-like bullets. The hot (~230 K) rotation temperature of the bullet and its short dynamical time (360 yr) suggest that this extremely high-velocity molecular jet traces the innermost mass-loss activity. The SiO column density is very high (4 x 10^{15} cm^{-2}), suggesting the large outflow rate and/or high SiO abundance. We also detected warm (~115 K) and compact (< 2500 AU in radius) CH_3CN core that is probably tracing a face-on disk with dense envelope. The CH_3CN core is well optically thick and the H_2 column density is estimated to be higher than 10^{24} cm^{-2}. We are now planning the further high-resolution observation with the ALMA.

1. G353.273+0.641 …Southern (Dec -34°) high mass protostellar object at 1.7 kpc (e.g., Caswell & Phillips 2008).

☆MIR source of 10^4 L_{sun} in the NGC6357



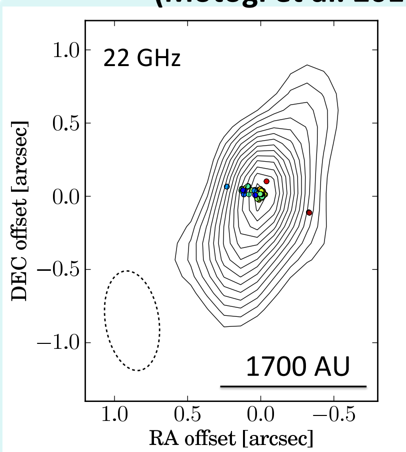
☆known as blue-shift dominated water maser



○ATCA Spectrum of the water maser (Caswell & Phillps 2008)

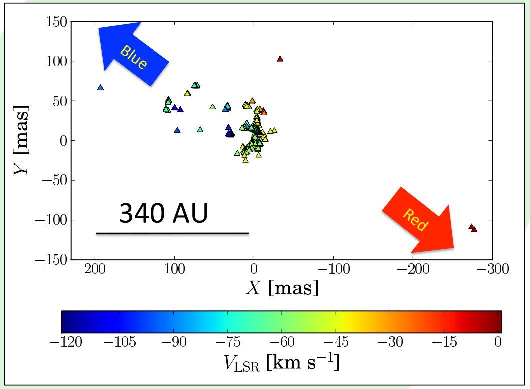
G353 is a candidate of "pole-on" disk/jet system

☆Optically thick 1.3 cm continuum …radio jet + ionized disk ? (Motogi et al. 2013)



○ K-band radio continuum detected by the ATCA. The contour starts from 3σ (111 µJy $beam^{-1}$) in the step of 37 µJy $beam^{-1}$. The synthesized beam is shown at the bottom left corner (0".69 × 0".36)。Color points show water maser spots.

☆22 GHz water maser jet (Motogi et al. 2011; 2013 in prep)



○ The distribution of water masers detected with the VERA. The coordinate origin of the map is $17^h26^m01^s.5883$, $-34^d15'14".905$ (J2000.0).

○ **Motogi et al. (2013) proposed "disk-masking"**
i.e., optically-thick face-on disk masks red-shifted masers causing blue-shift dominance.

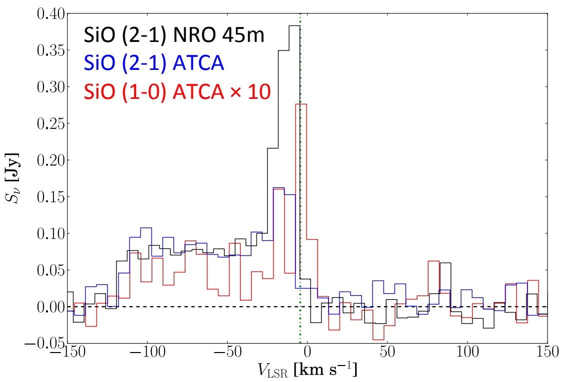
○ **3D kinematics of maser spots suggest**
inclination angle of the jet
20° - 30°
from the line-of-sight.

2. ATCA follow-up observations

Date: 2013 May. 1 - 3.
Configuration: 6C (7 mm), H214 (3 mm)
Targeted lines:
  SiO (J=1-0/2-1)
  CH_3CN (J=5-4, K= 0,1…)
Calibrators:
  Bandpass: 3C279, PKS1921-293
  Flux: Uranus
  Gain: 1714-336
Synthesized Beam:
  3".6 x 2".0 (3 mm)
  0".63 x 0".23 (7 mm)
Resolution: 6.9 km s^{-1}

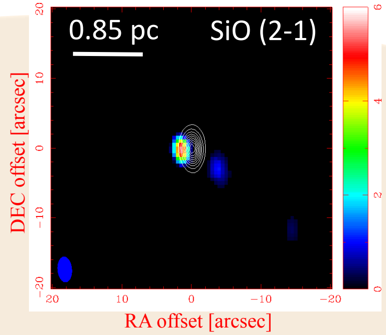
3. SiO jet – Compact bullets

☆SiO 1-0/2-1 spectra

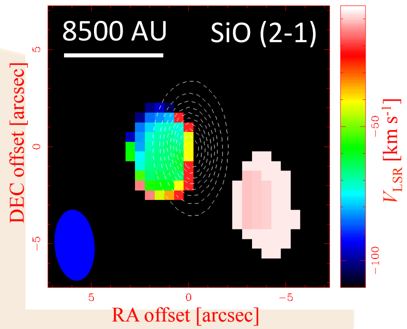


◯Interferometric spectra of SiO J = 1-0 (red) and 2-1 (blue) emission. The (1-0) spectrum is magnified ten times. The single-dish spectrum of SiO (2-1) emission taken with the NRO 45m telescope (Motogi et al. 2013) is also plotted for comparison.

☆0-th moment



☆1-st moment



◯0-th (left) and 1-st (right) moment map of SiO (2-1) emission. The white contour presents 3-mm continuum emission. The contour levels are 10, 20, 30… 100 % of the peak (56 mJy beam^{-1}).

◯NE-SW position angle

→consistent with the maser jet.

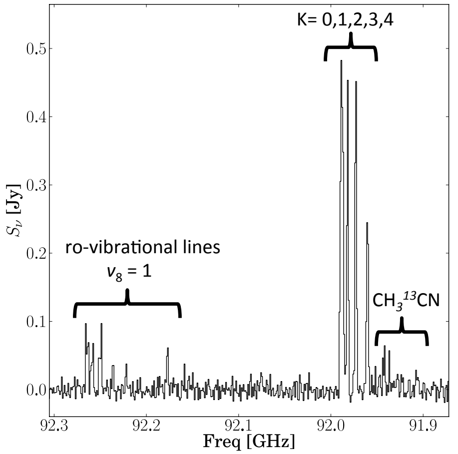
◯Innermost bullet

t_{dyn} = 130/tanθ_i **∼360 yr !!**

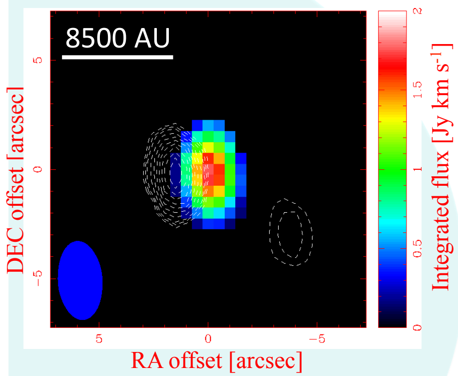
(θ_i : inclination angle ~ 20°)

4. CH_3CN core - Optically thick envelope (+ disk ?)

☆Spectra of CH_3CN (J=5-4) lines



☆0-th moment map of K=4 line



◯Color shows 0-th moment map of CH_3CN (J=5-4,K=4). White contour also shows that of SiO (2-1) emission. The contour levels are 10, 20, 30…100 % of the peak.

◯The core looks like a point source (< 2500 AU in radius).

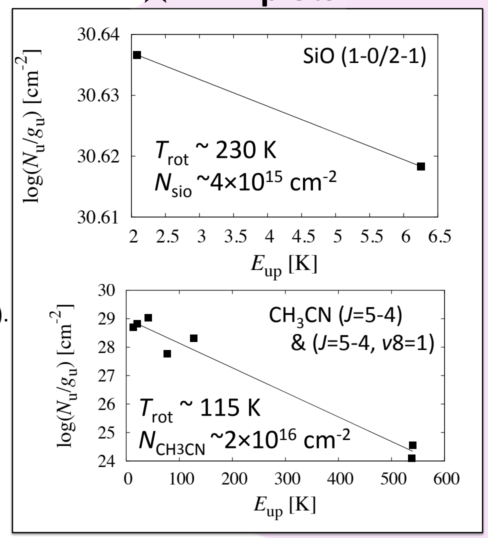
◯Purely rotational lines (J=5-4, K= 0…3) are optical thick.

→Weak $CH_3{}^{13}CN$ lines suggest optical depth of 3 – 10.

→This was used for opacity correction in the RD analysis.

5. Physical state – Rotation Diagram Method (Turner 1991)

☆RDM plots



◯Innermost SiO bullet

Outflow mass …

M_{bullet} = 0.75x(10^{-7}/X[SiO]) M_{sun}

(X[SiO]: relative abundance)

Mass loss rate

$\dot{M}$ = 2x10^{-3}x(10^{-7}/X[SiO]) M_{sun} yr^{-1}

→1-10 % of Si are in the form of SiO or $\dot{M}$ is extremely high !!

◯CH_3CN core

Envelope mass …

assuming X[CH_3CN] = 10^{-8} (Wang et al. 2010)

M_{env} = 25 M_{sun}

→consistenti with the dust and virial mass

Surface density…

N_{H2} > 2x10^{24} cm^{-2}

→Candidate of the masking disk !!