Applications of Precision Astrometry to Studies of Massive YSOs

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1-epoch VLBA and multiepoch GLOBAL observations of water masers towards IRAS 20126+4104

1-Epoch VLBA: Nov 21 1997

3-Epochs GLOBAL: Nov 9, Nov 26 2000 and Mar 1 2001

8 EVN antennas: Eb, Mc, Nt, On, Jb, Mh, Sh, Ro

VLBA: All

Phase-referencing mode to derive absolute maser positions
M* = 7 M

star

sun

IRAS 20126+4104

Cesaroni et al.; Moscadelli, Cesaroni and Rioja

(1-epoch VLBA)

(VLA)

(VLA)

(VLA)

(VLA)
Conical Bipolar Model
Best Fit Conical Outflow

Cone vertex close to continuum

\[ \Delta \text{RA}_v = 0.184 \text{ arcsec} \]
\[ \Delta \text{DEC}_v = -0.132 \text{ arcsec} \]

Well collimated

\[ \theta_{(\text{semi})} = 17^\circ \]

On the sky, parallel to proper motions

I-axis = 96°
P-axis = 122°

High velocity outflow

\[ a (\text{Hubble}) = 250 \text{ km s}^{-1} \text{ arcsec}^{-1} \]
Galactic Motion

![Graph showing Galactic Motion with labeled epochs and various motion components.](image-url)
Encouraging results for IRAS20126+4104. Call for a larger number of observations of that kind of objects.

1st epoch EVN observations of a selection of 5 high mass YSOs, in February 2004.

9 antennas: Cm, Jb, Eb, Nt, On, Mh, Sh.

Aim: Assess the precise association of maser spots and molecular outflows.

Follow up with proper motion measurements.
CONCLUSIONS AND FUTURE WORK

•) The results obtained towards IRAS 20126+4104 demonstrate that sensitive, multiepoch, phase-reference VLBI of water masers can unveil the gas kinematics near a high-mass YSO.

•) Towards IRAS 20126+4104, water masers are clearly tracing a well collimated outflow, which remains similar, also in position angle, at a distance from the origin ranging from 0".1 to 10".

•) We have extended the observations to a larger sample (5) of high-mass protostars in order to assess the association of the maser spots with the bipolar outflows and study the velocity field on scales of ca. 100 AU, in other sources.

•) We plan to follow up the study of these new sources with proper motion measurements.