IAU Colloquium 164: Radio Emission from Galactic and Extragalactic Compact Sources
ASP Conference Series, Vol. 144, 1998
J. A. Zensus, G. B. Taylor, & J. M. Wrobel (eds.)

VLBI Observations of a Megamaser in a Seyfert Galaxy IC 2560

N. Nakai, M. Inoue, & Y. Hagiwara
Nobeyama Radio Observatory, Minamimaki, Minamisaku, Nagano 384-13 Japan

M. Miyoshi
Mizusawa Astrogeodynamics Observatory, National Astronomical Observatory, 2-12 Hoshigaoka, Mizusawa, Iwate 023, Japan

P. J. Diamond
National Radio Astronomy Observatory, Socorro, NM 87801, U.S.A.

Abstract. VLBA observations of water-vapor maser emission in the active nucleus of a Seyfert 2, IC 2560, show linear velocity gradient along the north-south elongation, suggesting a compact rotating disk. The binding mass density within the disk is 7.7 x 10^6 $M_\odot$ pc^{-3}. We are also monitoring the velocity variations of the maser features with single dish telescopes. By combining the velocity drift with the linear velocity gradient, we would be able to determine the rotation speed and radius of the nuclear disk, and hence the central mass.

1. Introduction

Detection of a massive black hole and a thin molecular Keplerian disk around it in the nucleus of NGC 4258 (Miyoshi et al. 1995) has showed that water-vapor megamaser emission is a powerful tool to study the structure and dynamics of AGN at the 0.1 pc scale. IC 2560 is one of megamaser sources found by Braatz et al. (1995). The galaxy is a barred spiral (SBb) at the distance of 38 Mpc, showing Seyfert-2 nuclear activity (Fairall 1986). Its H_2O maser emission is at the systemic velocity of the galaxy (2900 $\pm$ 20 km s^{-1}) and has the isotropic luminosity of 130 Lo with the peak flux density of about 0.3 Jy. No high velocity feature has been detected. To study the structure and dynamics of its active nucleus, we mapped the maser emission with VLBI and is monitoring its velocity using single dish telescopes.

2. Observations

Mapping observations were made using the nearest four stations of the VLBA plus the phased VLA for 7 hours on 1996 March 1. The synthesized beam was 5.6 x 2.3 mas with the position angle of 3.9^o. As phase and amplitude calibrators, 4C 39.25 and 1037-295 were used. Maser features were detected at $V_{LSR} = 2868$ –2893 km s^{-1} which is same as velocity range detected with single dishes. We also mapped 22-GHz continuum emission at velocities off the maser features.
Time variations of peak velocities are being monitored using the Nobeyama 45-m and Parkes 64-m telescopes, several times in a year, from 1996 November. The velocity resolutions are 0.5 km s^{-1} and 1.7 km s^{-1} for the 45-m and 64-m.

3. Results

Maser spots are distributed in the region of about 0.3 x 0.7 mas elongating nearly along north-south direction which is inclined against the major axis of the galactic disk by about 45^o. The maser spots are located at the peak position of 22-GHz continuum emission. Along the declination, a linear velocity gradient can be recognized with $dV_{//}/dl = 373$ km s^{-1} pc^{-1} (figure), suggesting a compact rotating disk. The binding mass density is 7.7 x 10^6 $M_\odot$ pc^{-3}. On-going monitoring of the maser velocity $dV_{//}/dt$ also suggests a weak velocity drift. Combining the drift with the linear velocity gradient, we would be able to determine the rotation velocity, $V_{rot} = (dV_{//}/dt) / (dV_{//}/dl)$, and radius, $r = V_{rot} / (dV_{//}/dl)$, of the disk, and hence the central mass within the rotating disk, even without observations of high-velocity features such as NGC 4258 (Nakai et al. 1993).

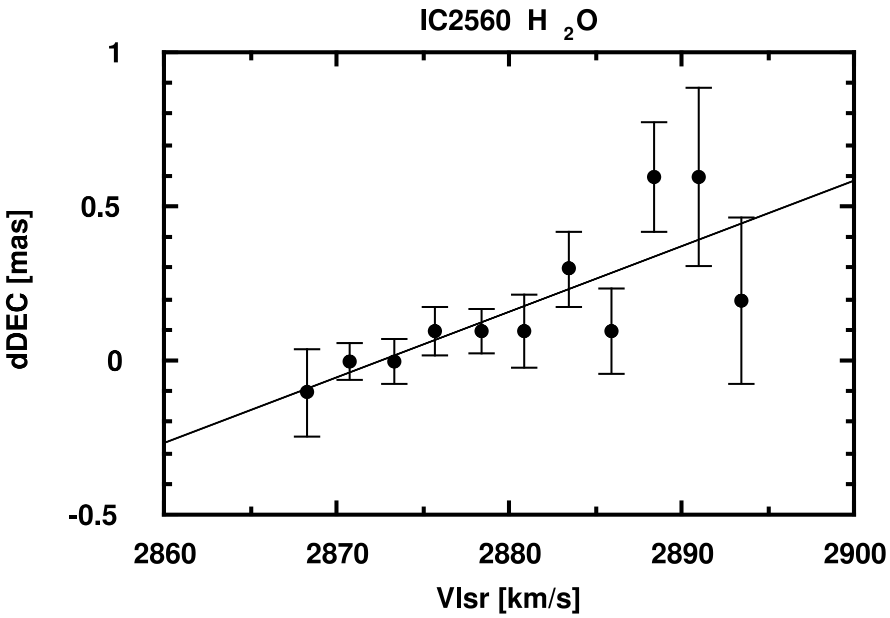

Figure 1. Velocity gradient along the North-South direction.

Acknowledgments. The National Radio Astronomy Observatory is a facility of the National Science Foundation, operated under a cooperative agreement by Associated Universities, Inc.

References

Braatz, J.A., et al. 1996. *ApJS*, **106**, 51–64.
Fairall, A.P. 1986. *MNRAS*, **218**, 453–455.
Miyoshi, M., et al. 1995. *Nature*, **373**, 127–129.
Nakai, N., et al. 1993. *Nature*, **361**, 45–47.