



Astrometry of the 'Twin' Star Forming Regions - NGC 6334I & I(N)

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Abstract:

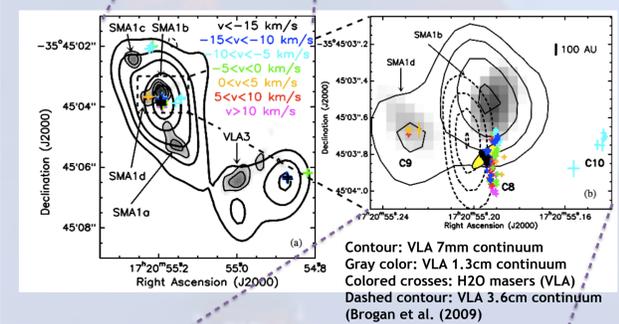
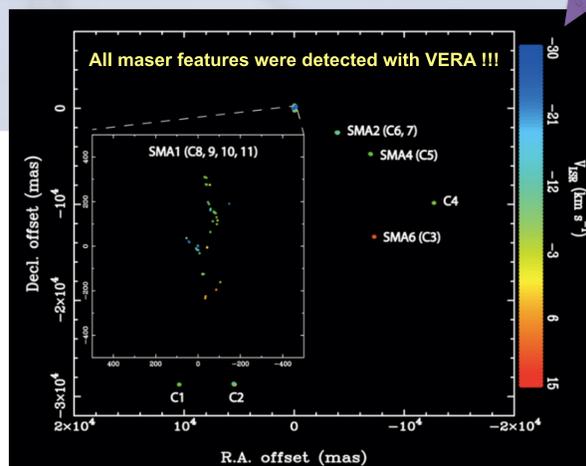
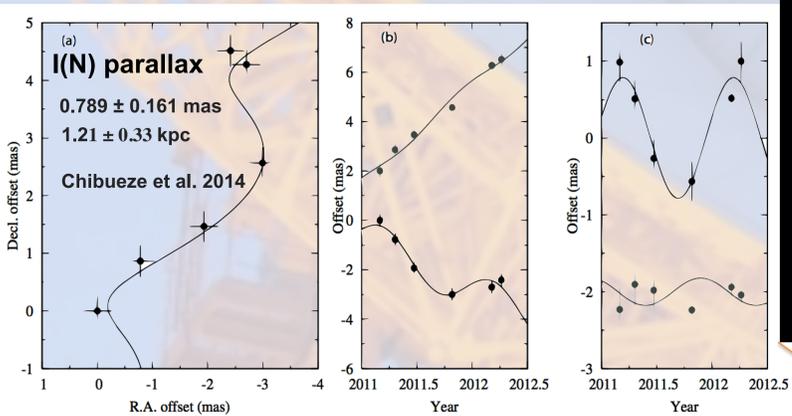
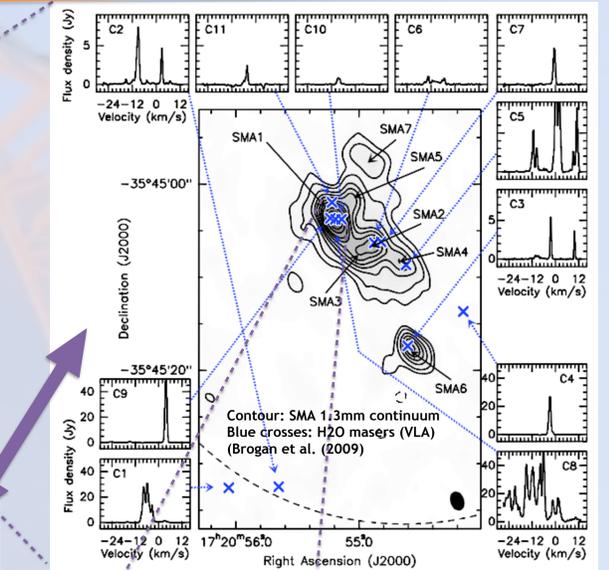
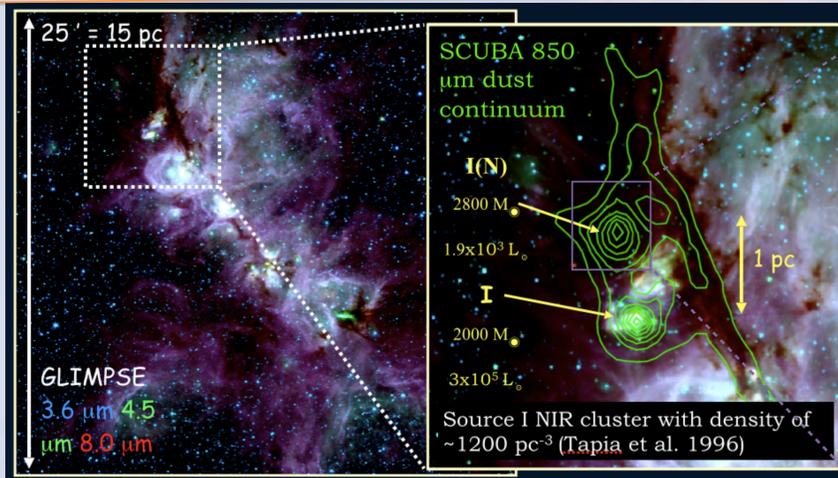
Using VERA, we measured the trigonometric parallax of an H₂O maser source associated with the massive star-forming regions NGC 6334I (on-going) and I(North), hereafter as NGC 6334I(N). The derived annual parallax of I(N) is 0.789 ± 0.161 mas, corresponding to a distance of 1.21 ± 0.33 kpc. We recalculated the physical parameters (masses and luminosities) of the dust continuum cores in I(N), and the revised parameters are only ~ 50% of their originally reported values. We also traced 23 relative proper motions of the H₂O masers associated with SMA1 (central millimeter source in the region) between epochs, which exhibit an average amplitude of maser proper motion of ~ 2.03 mas yr⁻¹ (~ 12.22 km s⁻¹), tracing a bipolar outflow. The bipolar outflow structure extends through ~ 600 mas (~ 720 AU), with a dynamical timescale of ~ 295 yr. Using an expanding flow model, we derived the most plausible dynamical center of the outflow, pointing to SMA1b (1.3 cm and 7 mm continuum source) as the outflow driving source. We derived the peculiar motion of NGC 6334I(N) to be -4 ± 1 km s⁻¹ toward the Galactic center, 8 ± 2 km s⁻¹ in the direction of the Galactic rotation, and 25 ± 2 km s⁻¹ toward the Galactic north pole.

Introduction

NGC 6334 is a giant molecular cloud in the Milky Way hosting multiple sites of high-mass star formation including the I and I(North) regions. These regions identified as "twin" cores are at early stages of massive star formation, but their physical condition indicates that I core is more evolved than I(N) (Walsh et al. 2010). The distance to interesting source has been disputed for decades. Thus, we observed the I and I(N) regions with VERA and measured the annual parallaxes.

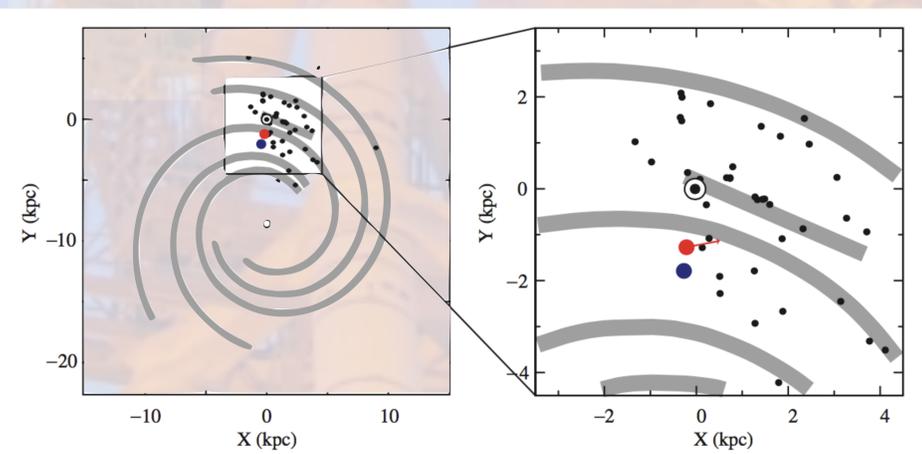
Observations & Results

The multi-epoch observations of the H₂O masers in the twin star forming regions were carried out with VERA at 22.23508 GHz and the data reduction was done with AIPS and VERA Data Analyzer (VEDA).

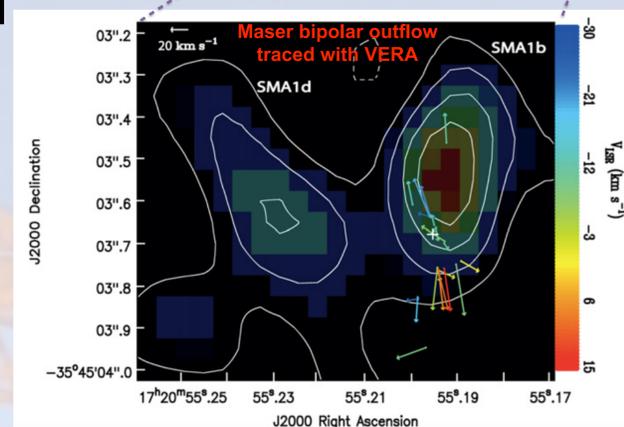


Peculiar Motion of I(N)

The peculiar motion of NGC 6334I(N) to be -4 ± 1 km s⁻¹ toward the Galactic center, 8 ± 2 km s⁻¹ in the direction of the Galactic rotation, and 25 ± 2 km s⁻¹ toward the Galactic north pole.

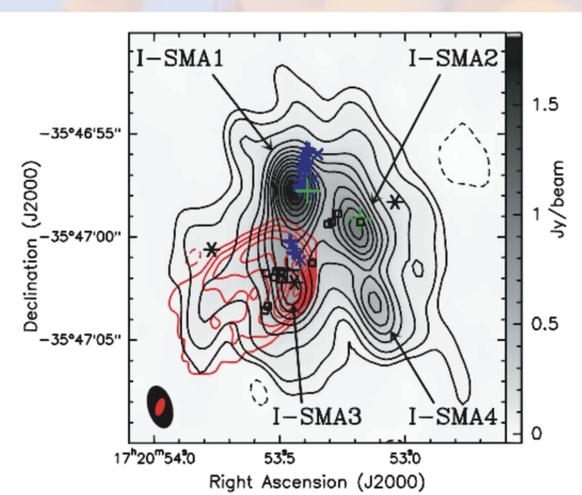


Bipolar outflow of SMA1b object of I(N)



NGC 6334I Region

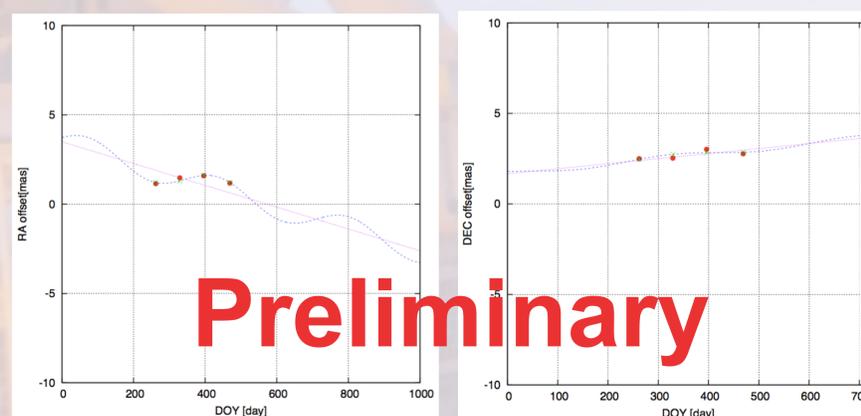
This region is more evolved than the I(N) but a lower in Declination than I(N) region. With VERA, we are making ongoing attempt to measure its annual parallax (see preliminary results of the parallax fitting with 4 observation epochs)



Gray scale and black contours: 1.3 mm continuum image of NGC 6334 I. Water masers are marked by the blue crosses (Migenes et al. 1999) and plus signs (Forster 1992; shifted by the amount suggested in a private communication from J. Forster in Carral et al. [1997]). Open squares mark class II CH₃OH masers (Walsh et al. 1998). The black plus sign marks IRS 1E, and the six-pointed stars mark the three mid-infrared sources from east to west: DPT00 2 (De Buizer et al. 2000), IRS-1 1, and IRS-1 2 (De Buizer et al. 2002). The green plus signs mark NH₃ peaks (derived from images of the hyperfine lines of Beuther et al. [2005]). Red contours: VLA 3.6 cm emission.

Hunter et al. (2006)

Current preliminary NGC 6334I region parallax fitting results (with 4 epochs) is 0.691 ± 0.369 mas corresponding to a distance of 1.45 ± 0.77 kpc



Preliminary