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VLBI monitoring of Mira variables with VERA

A. Nakagawa[1], T. Omodaka[1], K. M. Shibata[2] , T. Kurayama[2], H. Imai[1], S. Kameno[1], M. Tsushima[1], M. Shintani[1], N. Matsumoto[1], M. Matsui[1], S. Oizumi[1], T. Yasuda[1], Y. Arao[1] and the VERA project[2]

[1]Faculty of science, Kagoshima University, 1-21-35, Korimoto, Kagoshima, 890-0065, JAPAN
email:nakagawa@astro.sci.kagoshima-u.ac.jp

[2]Mizusawa VERA observatory, National Astronomical Observatory of Japan, 2-21-1 Osawa, Mitaka, Tokyo, 181-8588, JAPAN

Abstract. We have started a VLBI monitoring program for Asymptotic Giant Branch (AGB) stars at 22 and 43 GHz as part of a project of the VLBI Exploration of Radio Astrometry (VERA) for precisely obtaining the period-luminosity (PL) relation of Galactic Mira variables. Using accurate distances measured with VERA, we reveal PL relation in the Galaxy based on the absolute magnitudes of the sources. We selected the sources for VLBI monitoring so that they have a good coverage of various pulsation periods. Photometry in the infrared J, H, and K bands for over 600 AGB stars has also started since 2003 with the 1m telescope of Kagoshima University to obtain the pulsation periods and magnitudes. Current analysis of the phase referencing VLBI observations of S Crt shows that the parallax of 2.3±0.2 milliarcsec (mas) corresponds to a distance of 435^{+41}_{-35} pc. From the infrared monitoring data, pulsation periods and magnitudes in K band for 248 sources were obtained.

Keywords. astrometry, masers, AGB and post-AGB, interferometric, photometric

1. Introduction

Mira variables are stars pulsating with periods in the range 100 to 1000 days and showing rapid mass loss before ejecting their outer layers as planetary nebula shells. Although a narrow PL relation in the Large Magellanic Cloud (LMC) was reported by van Leeuwen *et al.* (1997), the same relation for the Galactic Miras have not been precisely obtained (Feast *et al.* 1989). Such uncertainty arises from the ambiguities of absolute magnitudes suffering directly from inaccurate distances of the objects. Using absolute magnitudes derived from accurate distance measurements with VERA, we can precisely investigate PL relation of the Galactic Miras. Furthermore, this program is important in a sense that once we have provided the calibration for the PL relation as for use as a relative distance estimator, we can convert the relative distance measurements to an absolute scale.

2. Observations in radio and infrared

Single dish flux monitoring of ∼500 sources at 22 and 43 GHz for grasping the radio bright state are in progress and one third of these samples are observed monthly at 22 GHz. This monitoring is used to select sources that are bright enough to give successful detections of VLBI fringes. The unique dual beam system installed in VERA allows simultaneous observations of target maser and extragalactic reference sources.

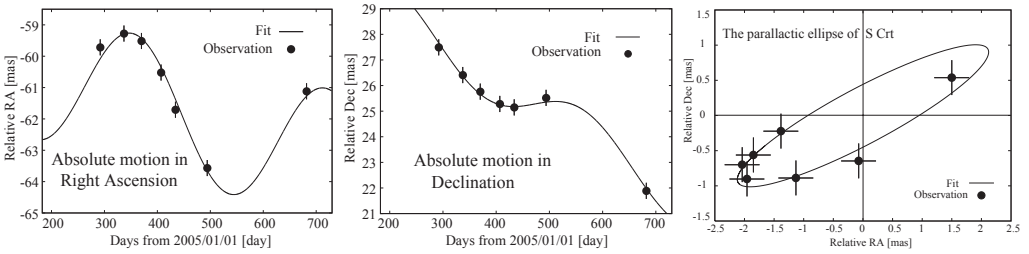

Figure 1. Position offset of the 34.7 kms^{-1} maser spot in S Crt in right ascension and declination are presented with filled circles in left and middle panels, respectively. Solid lines show a best fit model to the measured positions. The right panel is the parallactic ellipse of S Crt.

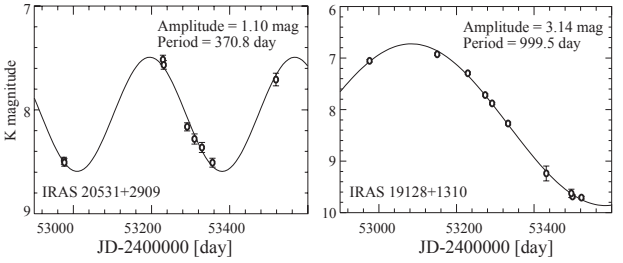

Figure 2. Light curves in the infrared (2.2 μm) of IRAS 20531+2909 (left) and IRAS 19128+1310 (right) indicate a pulsation period of 370.8 and 999.5 days, respectively.

Photometries in the infrared J, H, and K bands (λ=1.2, 1.6, and 2.2 μm, respectively) are also in progress. The sources for photometry are selected mainly from the IIIa, IIIb, IV, and VIb regions of the two-color diagram of the IRAS point source catalog (van der Veen & Habing 1988), where sources have a high mass loss ratio and are expected to be accompanied by H_2O/SiO masers.

3. Results

Multi-epoch VERA observations revealed the absolute motion of a maser spot in S Crt using the extragalactic continuum source J1147−0724 as a reference (see figure 1). The measured parallax of 2.3±0.2 mas corresponds to the distance of 435^{+41}_{-35} pc. Zenith atmospheric delay residuals, the structure of the maser, and model errors account well for the positional errors in our analysis. Our distance measurement of S Crt is larger than previous results of 285 pc (Patel *et al.* 1992) and 420 pc (Bowers & Johnston 1994) estimated from the PL relation. We are conducting monthly phase referencing VLBI monitoring for the following sources, AP Lyn, R UMa, Z Pup, SY Scl, and WX Psc.

Figure 2 represents examples of the light curves obtained with our infrared monitoring. We have obtained pulsation periods ($\leqslant$1000 days) and magnitudes for more than 200 sources at the present time and continuing work will find the sources with even longer periods. We are planning radio surveys for these sources to find new VLBI targets.

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