ASTROMETRY ACTIVITIES WITH THE MIZUSAWA VLBI OBSERVATORY, JAPAN

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ABSTRACT

The Mizusawa VLBI observatory of the National Astronomical Observatory, Japan has currently been making astrometry observations on stars in the Milky Galaxy by using a VLBI network formed by four 20-m radio telescopes deployed over Japanese islands (VERA). The annual parallax measured with the VLBI array makes clear the distance to the star, which is essentially important to know the absolute mass of the star. The distance and the infinitesimal motion on the sky are also important to elucidate the galaxy dynamics and the structure. I will report the recent scientific results and new astrophysical discoveries made by VERA.

1. Introduction

In 2000, the VERA project started aiming at obtaining precise astrometry data for stars in the Milky Galaxy [1]. The VERA is formed with four 20-m radio telescopes deployed over Japanese island, of which baseline length is 2270 km in the maximum. Since 2004, the Mizusawa VLBI Observatory has been conducting astrometry observations on stars in the Milky Galaxy. The total observing time in a year is about 4,000 hours, 400 hours in a month in average and 2 months for maintenance (Figure 1).

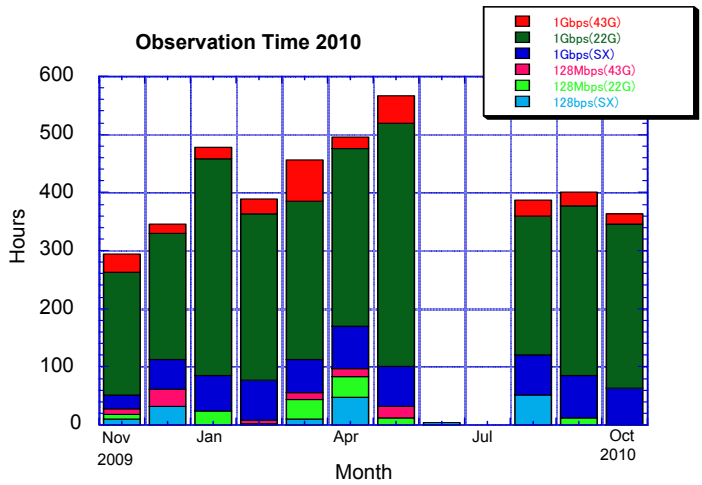

Figure 1 Monthly operation records of VERA

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The major port of the observing time is allocated to the water vapor masers in 22-GHz band with a data recording rate of 1,024-Mbps. A fairly amount of time is paid for 2/8-GHz observations for geodetic regulations of the telescope positions.

2. Astrometry Observations

The VERA first achieved very precise astrometry measurements by using specially designed radio telescopes equipped with dual steerable beam receivers [1], which enable us to measure the angular distance between the star and the potion reference, that is the Quasi Stellar Object of billions light year away from us [2]. So far almost 30 stars has been observed and astrometry solutions were obtained as seen in figure 2.

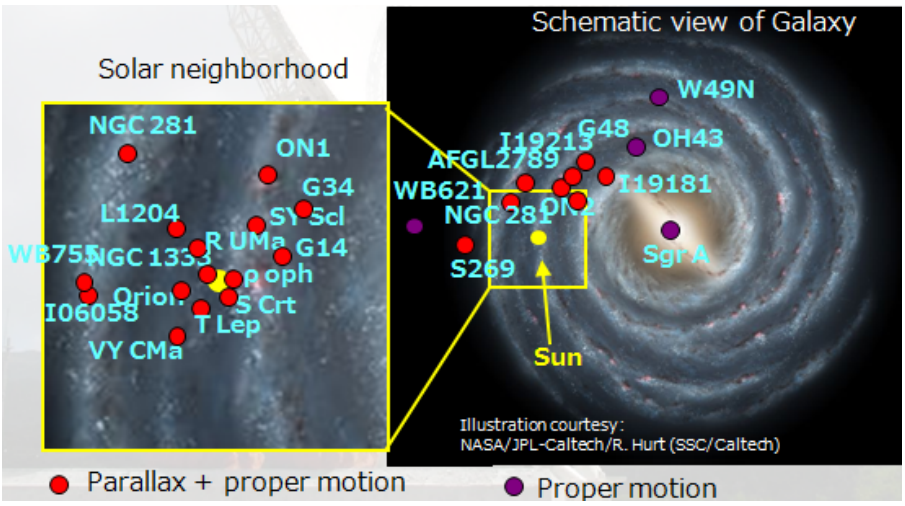

Figure 2. The stars in the Milky Galaxy fixed for the position with VERA

3. Recent Scientific Outputs

The distant to the star is quite important to estimate the mass from the photometric measurement. The trigonometric measurement is the most reliable way to measure the distance like as obtained with the VERA.

	D = 3.7 kpc Kinematic dist.				D = 1.4 kpc Parallax			
	MM1	MM2	MM3	MM4	MM1	MM2	MM3	MM4
Virial mass	1130	1510	1370		428	571	518	
LTE mass	330	1460			47	209		
Dust mass	1187	1284	301	253	170	184	43	36
L_{bol}	32000		9000	12000	4580		1290	1720
Sp. Type	O9.5		B0.5	B0.5	B1		B3	B3

Figure 3 Mass budget of an Infrared Dark Cloud MSXDC G034.43+00.24 revised by VERA

As shown in the figure 3, precise parallax measurements by VERA reveal that the distance to an infrared cloud MSXDC G034.43+00.24 is quite different from the kinematic distance being referenced so far [3]. The mass of the dark cloud is now revised as seen in the figure 3.

The rotation curve is also important to know the mass distribution of the Milky Galaxy.

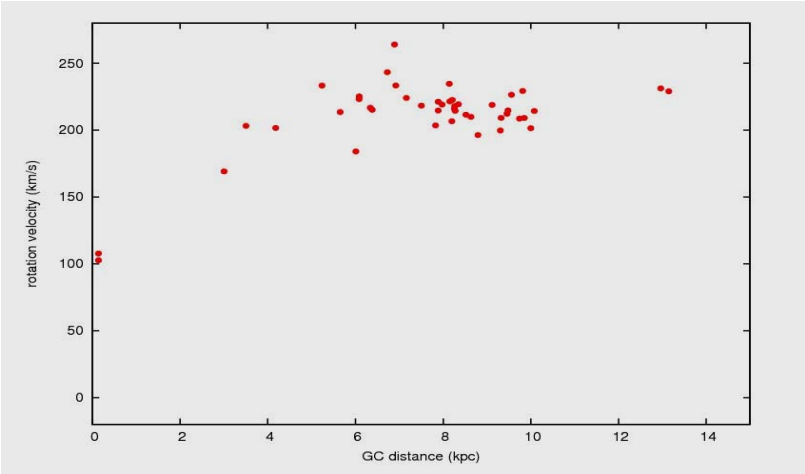

Figure 4. Galaxy Rotation curve obtained by astrometry observations by VERA

In figure 4, I show the rotation velocity in km/s against the distance from the galaxy center. The outer rotation curve has been quite difficult to draw because we could only estimate the distance from the Doppler measurement, receding speed of the star, so far. But now we can directly know the distance by trigonometric observations by VERA as can be seen in the figure 4 at the galactic distance beyond 8 kpc.

4. Technical Developments

The 1-Gbps VLBI observation is supported by up-to-date technologies, 1-Gbps data recording/ reproducing and correlation processing. The VERA is intending to collaborate with the KVN to expand the network. The KVN is the Korean VLBI network formed by three 21-m radio telescopes deployed over the Korean Peninsula [4]. Existing correlator now working for he VERA correlation is limited to the maximum number of stations to five at the data rate of 1,024 Mbps. To combine the VERA with the VERA a much power full correlation machine is necessary to develop. The VERA and KVN agreed to collaborate in developing the new correlator which is capable of processing data from 16 stations at the data rate or 2,024 Mbps. The processing speed is possible to make higher up to 8-Gbps in future.

The outlook of the new correlaator is shown in figure 5. Data playback from the magnetic tapes, the left hand most in the figure, and a huge volume of data buffer in the next and three racks located in the almost center is a Giga-bit correlator and the another end of the correlator two other data buffer is prepared for

temporal data storage. The correlator is now under evaluation and will soon start the regular operation in 2011.

Figure 5 The outlook of the new correlator in Seoul, Korea

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