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43 GHz SiO Masers and Astrometry with VERA in the Galactic Center

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Abstract. We present Very Large Array (VLA) observations of 43 GHz SiO ($J = 1 \rightarrow 0$, $v = 2$ and $v = 1$) maser emission in a sub-sample of late-type stars in the Inner Galaxy selected on their relatively strong (> 0.5 Jy) 86 GHz SiO masers, and located within 2.5° of the galactic center. Furthermore we combine these results with a summary of previous surveys for 43 GHz SiO masers in the galactic center and comment on their use as calibrators for the Japanese "VLBI Exploration of Radio Astrometry" (VERA) network, which is intended to perform sub-milli-arcsecond astrometry in the Galaxy and the galactic center.

1. Introduction

Circumstellar masers (Habing 1996) are probably the best objects to probe the gravitational potential in the inner *tens* of parsecs around the galactic center (GC) (Lindqvist, Habing & Winnberg 1992; Reid et al. 2003). The circumstellar masers are very prominent at radio wavelengths, and instantaneously reveal the line-of-sight velocities accurately. Because the masers are readily found and the stars are rarely influenced by non-gravitational forces, the kinematics of these stars are ideal 'point-mass' probes to measure the gravitational field in the inner Galaxy, i.e., the region at the onset of the galactic bar. Many 1612 MHz OH, 22 GHz H_2O, and 43 and 86 GHz SiO masers have been found in the past (e.g. Morita et al. (1992); Shiki, Ohishi & Deguchi (1997); Deguchi et al. (2002); Imai et al. (2002); Sjouwerman et al. (2002) and references therein), but due to severe interstellar scattering (e.g. van Langevelde et al. (1992); Frail et al. (1994)), only the highest frequency (> 20 GHz) masers are useful for astrometry.

The new Japanese 'VLBI Exploration of Radio Astronomy' (VERA) array is intended to perform astrometry with 22 GHz H_2O and 43 GHz SiO masers in the Galaxy, i.e. *including* the GC (Honma, Kawaguchi & Sasao 2000b). VERA utilizes dual beams to simultaneously track tropospheric phase fluctuations at high observing frequencies between a strong, instantaneously detectable phase calibrator and a weak target source separated between $\sim 0.3^\circ$ and $\sim 2.2^\circ$ from the calibrator (Honma et al. 2000a, 2003). This technique of dual beams removes the necessity of having an in-beam calibrator or moving the telescope between reference and target sources. It is assumed that the atmosphere toward the target and phase-reference is similar. This demands the availability of strong sources at the target observing frequency for phase calibration as close as possible to the target source. Normally, in the GC region one would use the ~ 1 Jy (at 43 GHz) source Sgr A* itself as calibrator (see e.g. Sjouwerman et al. (2002); Reid et al. (2003)), but almost all the interesting target stellar masers – the ones that really probe the inner galactic gravitational potential – are distributed closer than VERA's minimum separation of $\sim 0.3^\circ$ from Sgr A*. Using Sgr A* directly as a calibrator in one of the dual beams of VERA is therefore impossible. Because no known and strong quasars are sufficiently nearby to be used by VERA for phase calibration, perhaps some of the 43 GHz SiO masers located further out are good calibrators.

We fully reported on 43 GHz detections with the Very Large Array (VLA) of relatively strong 86 GHz masers in the GC (Messineo et al. 2002) and investigated their potential to serve as calibrators for VERA in the GC region in the *Publcations of the Astronomical Society of Japan Vol. 56, p45-50.*

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