Towards stellar proper motions in the Galactic Center.

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Prologue:

At the Galactic Centre (GC) a large sample of OH/IR stars has become available (Habing et al., 1983; Lindqvist et al., 1992a; Van Langevelde et al., 1992a). These stars are outstanding tracers of the gravitational potential in the inner 100 parsecs of the Galaxy. We have searched for H_2O maser emission in all the (known OH masering) stars and for SiO maser emission in a subsample. The results of such a survey will be valuable for the study of the maser emission mechanisms and the stellar population of the GC. *Most importantly it will enable future VLBI measurements of stellar proper motions at the GC within a few years.*

Introduction:

Because the OH masers in the circumstellar envelopes of the OH/IR stars directly reveal the radial velocity, these objects can be used for studies of the dynamics of the inner Galaxy (Fig. 1). In a first analysis the results have been modelled using a spherical potential and isotropic velocity distribution (Lindqvist et al. 1992b). Further work on more realistic models is in progress (Sevenster and Habing, private communication). But in all approaches it is clear that the interpretation is limited by the fact that only two components of the true position and one component of the velocity of the stars are measured. This is frustrating, because already there is some evidence that there is interesting structure in the stellar dynamics near the GC; stars with peculiar high velocity are present and apparently different populations of OH/IR stars can be distinguished near the GC. In particular it is of great importance to know the velocity distributions, not only in the *radial* (line-of-sight) direction, but in the *transverse* directions as well. Only knowledge of the true velocity distribution can reveal the true mass distribution in the GC (Binney & Tremaine, 1987) and therefore measurements of proper motions of these stars are required.

A VLA survey:

A typical velocity of 100 km/s at the GC corresponds to about 2.5 mas/yr. Unfortunately, such a motion cannot be detected with VLBI observations of the OH maser close to the GC, because of heavy interstellar scattering at decimeter wavelengths (e.g. Van Langevelde et al., 1992b; Frail et al., 1994). Therefore we have embarked on a project to search for H_2O maser emission in all 150 OH/IR stars and for SiO maser emission in a subsample of 50 OH/IR stars closest to Sgr A*. In the H_2O line this has been moderately successful, with a 15% detection rate. However, it is clear that SiO masers are even more promising in this respect. Not only would SiO observations yield even higher resolution ($\approx$ 1 mas), allowing a 10 km/s accurate proper motion *measurement* within a year. But the SiO masers have the advantage that they originate very close to the star (Diamond et al., 1994; Miyoshi et al., 1994), making it easier to interpret VLBI data in terms of proper motions. From our first VLA SiO observations we were already able to detect 7 out of 24 sources.

The Future:

The total sample of strong SiO masering OH/IR stars, together with the ones that show H_2O maser emission, should be enough to model the distribution of proper motions of OH/IR stars in the GC. Up till now we have good quality, strong (over 300 mJy) detections of 19 SiO and 9 H_2O stellar masers. We are still extending the list with our latest VLA observations and hope to confirm about 10 detections each in SiO and H_2O in the next months (Fig. 2).

In addition to the study of the stellar dynamics at the GC, a direct comparison of radial and transverse velocities and velocity disppersions would provide us with a direct geometrical value of R_0, the distance to the GC (Reid et al., 1988).

In particular the VLBA characteristics for these frequencies are most suited to detect these high brightness maser proper motions. With the full VLBA being operational, we proposed to observe three epochs of the H_2O and SiO masering OH/IR stars within the next year. Because we also have some stars that show both SiO and H_2O maser emission we will be able to check the resulting proper motions (referenced to Sgr A*) independently and start to build a catalogue of accurate relative proper motions ($\lesssim$ 1 mas/yr or 40 km/s at 8 kpc).

This should enable us to reach our final goal: to model the mass disrtibution of the immediate environment of Sgr A*; the dynamical center of our Galaxy.

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Figures:

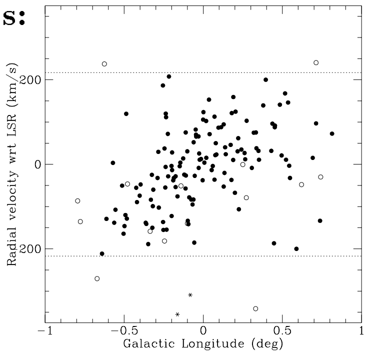

Figure 1: Radial velocities of OH/IR stars close to the GC as a function of Galactic Longitude. The dotted lines show the velocity limits of Lindqvist et al. (1992a). Open circles taken from Habing et al. (1983) and asterisks from Van Langevelde et al. (1992a). The correlation between the velocity and longitude is commonly explained by a net galactic rotation.

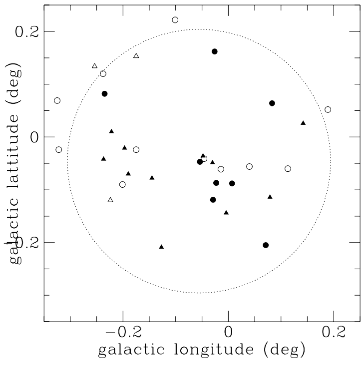

Figure 2: SiO emission from OH/IR stars close to Sgr A. The circle is drawn at 14′ from Sgr A*. Triangles are tentative detections; open symbols taken from Lindqvist et al. (1991), filled symbols are detections from our VLA survey.*