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THE STUDY OF SCATTERING IN THE ISM WITH HIGH RESOLUTION OBSERVATIONS OF OH MASERS

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ABSTRACT

The research of OH maser emission sources with high angular resolution is complicated by the effects of interstellar scattering: more over, most of the OH maser sources are located in the galactic plane where the scattering is largest. However, the data available from pulsar studies on the spatial distribution of the amount of scattering indicate that there is a strong non-uniformity in the distribution of the amount of scattering material. There are directions in the galactic plane where the scattering is an order of magnitude higher than the average, as well as directions where the scattering is much lower. The latter provide an opportunity to investigate OH masers with the full angular resolution offered by very long baseline interferometry instruments, like the VLBA, and measure their true angular size, shape and brightness temperature. We have observed approximately 100 OH maser sources, distributed all over the northern hemisphere, with the VLBA in order to study the scattering properties of the interstellar medium.

Key words : masers — ISM:scattering — Techniques:interferometric

I. INTRODUCTION

Pulsar studies on the spatial distribution of the amount of scattering indicate that there is a strong non-uniformity in the distribution of the scattering material (Burke et al. 1968; Cordes 1992). There are directions in the galactic plane where the scattering is an order of magnitude higher than the average, or much lower. The latter provide an opportunity to investigate OH masers with highest angular resolution, and measure their true angular size, shape and brightness temperature. Masers are mainly point-like sources, for most VLBI arrays, so any size measured would be mainly caused by dispersion in the interstellar medium. One of the possible ways to reveal directions of low interstellar scattering is to survey a large number of of OH masers with VLBI. Such a project is being carried out as a survey for future space VLBI missions. The goal of the survey is to select sources of small angular size for further study with space baseline interferometers.

In 1988 Kemball, Diamond & Mantovani carried out a VLBI survey of 16 strong OH maser sources with a single baseline. Medicina-Hartebeesthoek, providing an angular resolution of 5 mas. Fringes were found from three sources; the rest were resolved and had angular sizes exceeding 5 mas. Hansen et al. (1992) with a seven station VLBI array observed 39 OH maser sources in order to study the effect of interstellar scattering on their angular size. Rough estimates of the angular size were obtained for 20 masers ranging from 2 to 70 mas. A weak correlation between angular size and distance was found, supporting the scattering origin hypothesis for the angular size of OH masers. A large range of measured angular sizes conforms with the strongly non-uniform distribution of the scattering material. In 1996 Slava et al. testing the new S2 recording system for Australian VLBI, observed 5 OH maser sources using an array composed of Ussuriisk (70m), Parkes (64m) and Hobart (26m). The measured angular size of the maser spot was about 2-4 mas. The dispersion results which again sustained the results of other surveys.

We have conducted a similar type of VLBI measurements of OH masers with the VLBA providing better sensitivity. We have observed approximately 100 sources in snapshot mode of 6-min duration. The velocity resolution was 0.176 km s^{-1}, with 256 spectral channels covering 45 km s^{-1} in each of the OH main lines at 1665 MHz and 1667 MHz. Observing at these 2 frequencies gives us the opportunity to decide whether the size of the maser spot is intrinsic or due to scattering. Since the scattered size should be almost equal at both frequencies (the scatter size frequency dependence is a power law with index -2.2).

II. DISCUSSION

So far, high resolution OH maser surveys seem to show, and it is supported by our preliminary results, that there is a large proportion of unscattered masers in the galactic plane. The measured upper limits on the scattered angular size are an order of magnitude

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lower than the average scattered size calculated from the galactic model of scattering distribution by Cordes et al (1985). This is consistent with the patchy distribution of the scattering material in the galactic disk, with some masers located in regions of low interstellar scattering. Perhaps there is a strong large scale inhomogeneity of scattering in the ISM. Further observations will be needed to determine why do Pulsar and maser results don't agree.

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