IMAGING OF EXTRAGALACTIC RADIO SOURCES WITH THE VSOP SPACE VLBI MISSION

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Abstract. In September 1996 the first dedicated VLBI spacecraft, VSOP, will be launched. This Japanese spacecraft operating in conjunction with ground-based VLBI arrays such as the EVN or VLBA will enable observers to routinely undertake VLBI observations with maximum baseline lengths of 2.6 Earth diameters and a resolution of 55 μas at the highest operating frequency of 22 GHz. In this paper we present a brief overview of the imaging capability of the VSOP mission together with an example of an imaging simulation.

Unlike ground-based VLBI experiments, the (u,v) coverage for a space VLBI experiment is a function of both source coordinates and the epoch of observation, since the precession of the orbit plane with a 1.8 year period causes the orientation of the source with respect to the orbit plane to change with time. Furthermore the spacecraft cannot observe sources within 70° of the sun or when the spacecraft is in eclipse. In the nominal 6.6 hour orbit (apogee height = 22000 km and perigee height = 1000 km) with an inclination of 31°, eclipse length will vary with long periods of short ($<$ 40 minutes) or no eclipses to short periods of long ($>$ 80 minutes) eclipses. Sources in or near the orbit plane have linear (u,v) coverages whereas sources that lie along the orbit normal directions have the highest resolution two-dimensional (u,v) coverages. Due to the precession of the orbit plane it will be possible to obtain good two-dimensional (u,v) coverage on any source at least once for a period that lasts several months during the observing period covered by the first VSOP AO (17-months).

In Figure 1 we illustrate the result of a typical imaging simulation with VSOP and the VLBA. Figure 1(a) shows the (u,v) coverage that is obtained for a 4-orbit observation. In this example the (u,v) coverage is intermediate between a source that lies along the orbit normal and one that lies in the

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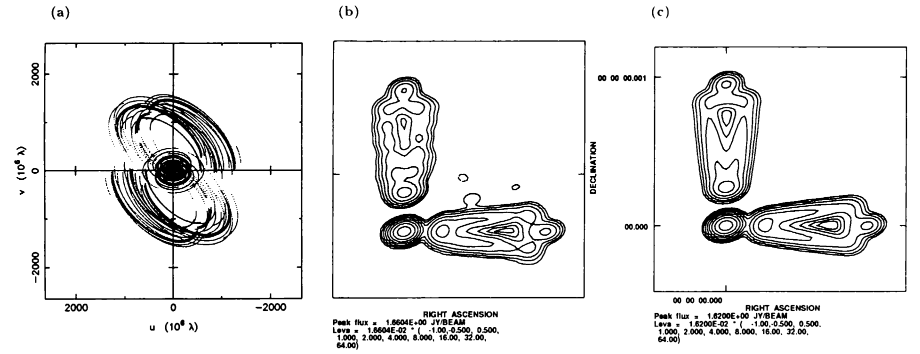

Figure 1. **Image Simulation: (a) 4-orbit (u,v) coverage; (b) Simulated image ; (c) Source model.**

orbit plane. The simulated visibility data have both random antenna-based phase errors and 10% antenna-based amplitude errors. An unbiased 'hands-off' iterative scheme was used to make the image. First of all a low order polynomial is fitted to the upper envelope of the correlated flux versus projected baseline plot. This polynomial is then used to determine what lower (u,v) limit to use in the self-calibration stage of the self-calibration/mapping loop. As the image improves (more CLEAN components up to the first negative) the (u,v) limit is slowly decreased from a high initial value to finally include all the visibility data. This scheme is found to produce a good image with very few spurious features.

The simulated image is shown in Figure 1(b). This can be directly compared to the source model shown in Figure 1(c), convolved with same beam used for the VSOP+VLBA image. The image has a RMS noise level off-source of 0.7 mJy/beam which compared with a peak flux density of 1.7 Jy/beam gives a dynamic range of 2400:1. However the difference between the image and the model shows that on-source there is RMS error of 12 mJy/beam. Thus the true dynamic range is only 140:1. The main source of error in the image can be traced to the large holes in the (u,v) coverage. Higher fidelity images can be made at the expense of loss in angular resolution by choosing to observe sources when the size of the (u,v) holes are minimized by projection effects.

Simulations, such as the one shown in Figure 1, have demonstrated that it will be possible to image compact extragalactic radio sources with the VSOP mission. By the time of the next IAU meeting on extragalactic radio sources 'real' space VLBI images not just simulations will be available.

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