The VSOP-2 Mission

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Abstract

A next generation Space VLBI mission, tentatively called VSOP-2, is already in the planning stages. In this paper, we report on the current status of this mission.

1 Introduction

Since May 1997 a Japanese working group for the next generation Space VLBI mission, tentatively called VSOP-2, has been studying possible mission concepts. Given a variety of constraints, it is likely that the VSOP-2 mission will use a single spacecraft in orbit co-observing with various ground telescope arrays in a similar fashion to the current VSOP mission. However, the VSOP-2 mission will provide a large increase in capability over the VSOP mission due to its higher frequency bands, larger maximum baseline length, and improved sensitivity. The VSOP-2 project would be a collaboration led by ISAS and the National Astronomical Observatory of Japan (NAOJ), with several participating university groups in Japan. Potential international partners include the space agencies NASA and ESA, as well as various foreign radio telescopes and VLBI arrays (such as the VLBA and EVN). The Japanese VERA array, now funded (Sawada-Satoh et al., these proceedings), will also be able to participate at both 22 and 43 GHz.

2 Strawman Mission

Based on a series of discussions, the parameters for a strawman model of the VSOP-2 have been developed and are given in Table 1. Thus, the operation of the VSOP-2 mission would be very similar to the operation of the VSOP mission. Major VLBI networks operate as facilities, and are open to the world-wide scientific community via peer-reviewed observing proposals and VSOP-2 will follow this practice, as does VSOP.

However, like the VSOP mission, a mission led survey program also seems an attractive observing strategy which nicely complements the peer-reviewed observing time.

3 Spacecraft Overview

A possible concept for the VSOP-2 spacecraft is shown in Figure 1. The main antenna has a diameter from 10–15 m and will be an offset parabolic reflector. The optical scheme of the telescope will include a secondary reflector (Cassegrain optics). A single $\approx$ 50 cm (37 GHz or 15 GHz) telemetry antenna will support a downlink data rate of 1 Gbps. The projected lifetime of the spacecraft is 5 years.

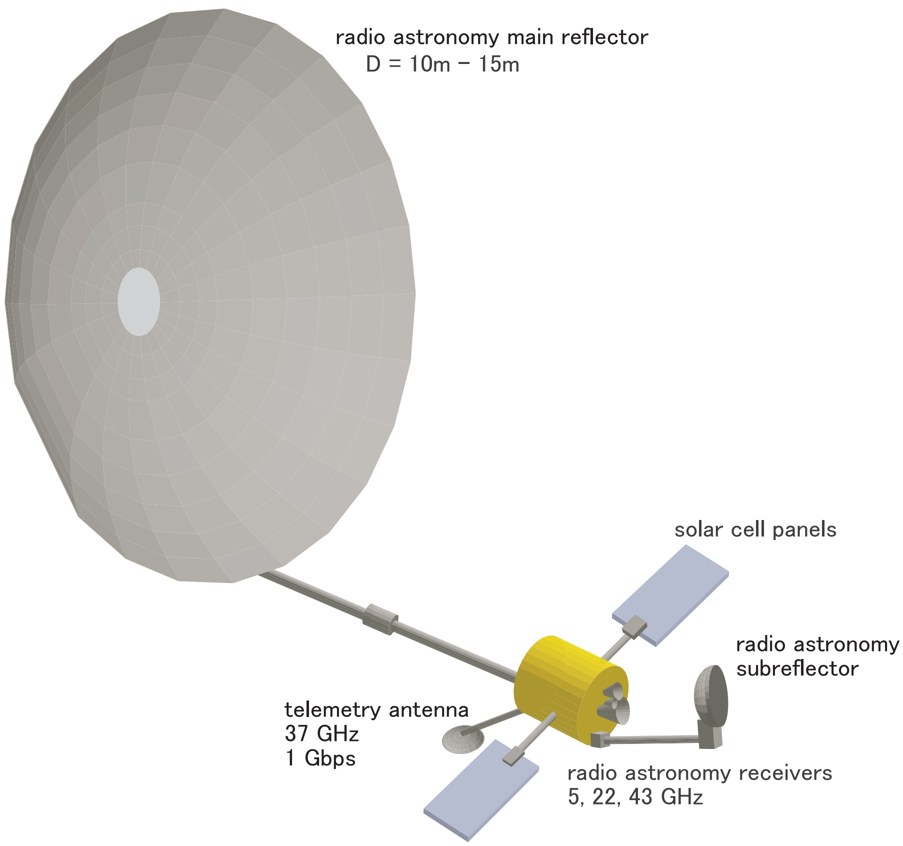

Figure 1: A concept of the VSOP-2 spacecraft

Table 1: Provisional VSOP-2 Mission Properties

Spacecraft: Properties			
Lead Agency	ISAS (Japan)		
Antenna Diameter (m)	12.0		
Antenna Design	Off-set parabola		
Total Spacecraft Mass (kg)	900		
Lifetime (years)	5		
Spacecraft: Launch			
Launch Vehicle	M-V		
Launch Site	Kagoshima (Japan)		
Launch Date	September 2007		
Spacecraft: Orbit			
Apogee Height (km)	30,000		
Perigee Height (km)	1,000		
Period (hours)	8.9		
Inclination (°)	31°		
Perigee Precession Rate ($\dot{\omega}$) ($^\circ yr^{-1}$)	+206		
Orbit Plane Precession Rate ($\dot{\Omega}$) ($^\circ yr^{-1}$)	−132		
Spacecraft: Science Subsystem			
Polarization	LCP and RCP		
Bandwidth/Polarization (Mbps)	512		
Observing Bands	5 GHz	22 GHz	43 GHz
Resolution (μas)	130	50	25
Aperture Efficiency	0.5	0.4	0.3
System Temperature (K)	30	30	30
System Equivalent Flux Density (Jy)	1000	1300	1800
7-σ Detection Limit (mJy)[1]	10	30	70
Spacecraft: Tracking Network			
Commanding	Kagoshima (Japan)		
VLBI Data Acquisition	ISAS/NASA/ESA/NRAO-sites		
Ground Radio Telescopes			
Worldwide including VLBA, EVN and VERA			
Science Programs			
Investigation of radio/X-ray/γ-ray emission mechanisms			
Brightness temperature Measurements			
Studies of Super-luminal Sources			
Studies of nearby AGN			
Cosmological Tests			
Extragalactic masers and circum-nuclear disks			
Galactic masers and the ISM			

1. Co-observing with a single 25-m antenna on the ground with integration times of 350, 150, 60 seconds for the three observing bands, respectively.

Table 2: Comparison of VSOP and VSOP-2 Spacecraft and orbit

	VSOP	VSOP-2
Antenna diameter (m)	8	10–15
Frequency bands (GHz)	1.6, 5, (22)	5, 22, 43
Typical aperture efficiency	40%	60%
Typical system temperature	200 K	30 K
Polarization	LCP-only	LCP& RCP
Data rate	128 Mbps	1024 Mbps
Maximum Baseline (km)	30,000	40,000

4 Comparison of VSOP and VSOP-2

In Table 2, we compare some of the properties of the VSOP and VSOP-2 missions. With the spacecraft improvements the detection limit on a Earth-space baseline is reduced by more than an order of magnitude. Furthermore, the highest frequency VSOP-2 observations will have an order of magnitude increase in resolution compared with VSOP observations at 5 GHz. Also, the VSOP-2 dual polarization capability will allow all 4 Stokes parameters to be measured. Thus, crudely speaking, the VSOP-2 mission will be 400 times more capable than the VSOP mission. This increased capability will allow large areas of astrophysics to be explored than were inaccessible to the VSOP mission.

5 Future Developments

The VSOP-2 mission is still in the early planning stages and many things may change between what has been presented and the final mission configuration. It is expected that a proposal will be submitted to ISAS within the next year to obtain ISAS approval for this mission. If this proposal is accepted then development of the VSOP-2 mission will progress rapidly.

Acknowledgements. We acknowledge the efforts of many individuals and organizations around the world who have contributed to the success of the current VSOP mission and look forward to working closely with these groups in the development of the VSOP-2 mission.