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SPACE GROUND INTERFEROMETER

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ABSTRACT A space project for studying ecological Earth problems is being carried out by means of radio techniques. A 30 m prototype antenna has already been deployed and tested. The radio telescope will be launched in 1994 into a circular orbit having an altitude 600 km and an inclination of 65°. The planned mission time is ≥ 1.5 year; 25% of this will be available for VLBI observations at wavelengths 6 and 18 cm.

Studies of the fine structure of quasars and radio galaxies have shown that clouds of relativistic plasma are injected from their nuclei and form "jets". The observed velocity of these clouds appears to exceed the velocity of light. Their brightness temperature T_b attains 10^{12}K, the value determined by scattering by the inverse Compton effect (Kellermann and Pauliny-Toth 1969). Star formation processes in region of gas and dust are accompanied by maser emission and protostars are surrounded by protoplanet disks and rings. The brightness temperature of compact OH masers are typically $T_b \sim 10^{12}$K, for H_2O masers they are 10^{14}K, but for the "megamaser" in Orion KL brightness temperature reaches 10^{17}K (Matveyenko 1981).
For further studies of the structure and evolution of compact radio sources a higher angular resolution and a larger dynamic range are required; the latter implies a better coverage of the U,V plane (Kogan 1972; Kostenko and Matveyenko 1982; Sagdeev 1984; Kardashev and Slysh 1987). The angular resolution of the Space-Ground interferometer is limited by sensitivity and by scattering of the

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emission by the interstellar medium. The maximum baseline as determined by the sensitivity is

$$B\ [m] \le \frac{\pi}{4n} \left[\frac{T_b\ \gamma\ d_1\ d_2\ \left(K_1 K_2\right)^{0.5} \left(\Delta f \tau\right)^{0.5}}{b\ N\ \left(T_1 T_2\right)^{0.5}} \right]^{0.5} \quad (1)$$

where d_1, d_2, K_1, K_2 are diameters and efficiencies of the antennas, T_b is the brightness temperature of the source, T_1, T_2 are the system noise temperature at the telescopes, Δf is the bandwidth, τ is the coherent integration time, b is the "b-factor" and $n = \varphi / \theta$ is the ratio of the angular size of the source to the fringe spacing. For n=0.5, visibility γ =0.5, $(K_1 K_2)^{0.5}$ = 0.5 and a signal to noise ratio N equal 10

$$B\ [m] \le 0.04 \left[\frac{T_b\ d_1\ d_2\ \left(\Delta f \tau\right)^{0.5}}{\left(T_1 T_2\right)^{0.5}} \right]^{0.5} \quad (2)$$

The scattering angle is given by

$$\theta_{scat} = 10^{-2}\ \lambda^2\ \left|\sin b\right|^{-0.5} \quad (3)$$

where λ is the wavelength in meters and b is galactic latitude. The corresponding baseline would be

$$B\ [m] \le 10^7\ \lambda^{-1}\ \left|\sin b\right|^{0.5} \quad (4)$$

In Soviet Union a space project for studying ecological Earth problems is being carried out by means of radio techniques. A space radio telescope, 30 m in diameter, will be used: a full scale prototype antenna has already been deployed and tested. The antenna surface consists of stainless steel filaments 50 μm in diameter with RMS deviation from a paraboloid smaller than a few mm. Its pointing would be accurate to $\le$ 1 arcmin. For space-ground interferometry the antenna would be

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used at wavelengths of 6 and 18 cm with system noise temperatures of 100 and 60 K respectively. The expected antenna efficiency is 0.5; the bandwidth for transmitting data to the ground would be either 2 or 16 MHz. A rubidium clock, locked to a high quality crystal oscillator would provide the on board frequency and time standard; the resulting coherence time of 50-100 sec would be limited by the source structure. The radio telescope will be launched in 1994 by the "Proton" vehicle into a circular orbit having an altitude of 600 km and an inclination of 65°. The planned mission time is ≥ 1 years and 25 % of this will be available for VLBI observations. The angular resolution of the Space-ground interferometer will be about 1 mas. The synthesis of the aperture with a diameter of about 13000 km will require about 12 hours. The sensitivity of the space antenna with a 70 m ground antenna is about 15-20mJy for 16 MHz data bandwidth and 2 Jy for 1kHz bandwidth (spectral line studies). The sensitivity is sufficient to study compact continuum sources with $T_b \geq 10^{10}$K; for the same sensitivity and $T_b = 10^{12}$K, a baseline of 5.10^4 km corresponding to the scattering limit at 18cm could be used. The scattering of OH sources located in the galactic plane limits the useful baselines to a few thousand km.

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