5. Radioastronomy from Space

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Radioastronomy can use space technology either to go close to the source of the radioemission to increase the sensitivity of the observations and have different viewing geometry, or to avoid the effect of the Earth's environment, i.e. to extend the useful frequency range below the ionospheric cut-off of a few megahertz and at submillimeter wavelengths. A third field which will certainly develop in the future is the use of space to increase the spatial resolution of radio-interferometry for imaging radiosources.

Exploration of the solar system

The exploration of the solar system, where most of the results of space radioastronomy have been obtained recently includes outer planets, comets and the Sun.

The continuous success of the NASA Voyager mission brought the spacecraft V2 to an encounter with Uranus on January 24, 1986. Radioemission below 800 KHz has been detected from that planet only three days before the time of closest approach, and has been received by the Planetary Radio Astronomy (PRA) instrument for about three weeks (Warwick et al, 1986 ; Gurnett et al, 1986). Uranus is then the forth planet, after the Earth, Jupiter and Saturn, known to be strong source of radioemissions. Its study is particularly interesting because of the special geometry of the planet : rotation axis in the ecliptic plane and magnetic dipole axis highly inclined on the rotation axis.

Between the encounter and June 1987 a dozen of papers have been published, or are in press to date in a special issue of the Journal of Geophysical Research to appear at the end of 1987. The subjects are the auroral emissions, emissions from electrostatic discharges and several related topics like the study of grain impacts, low frequency whistlers and plasma waves, etc ...

Other papers have been published between June 1984 and June 1987 about results of the PRA experiment on Jovian and Saturnian emissions. Review papers can be found in Gehrels and Matthews, 1984, and Rucker and Bauer, 1984. Voyager 2 is now on its way to Neptune. Their encounter will take place in August 1989.

The study of the radioemissions of the outer planets is complemented by that of the Earth, specially the Auroral Kilometric radiation (AKR). Several Earth oribting satellites have been used with great success, particularly the Dynamic Explorer (NASA) and Viking (Sueden).

Other results have been obtained by the NASA "ICE" spacecraft (ex ISEE 3) on Comet Giacobini-Zinner by the on board radioastronomy experiment. They refer principally to the plasma environment of the comet (Meyer-Vernet et al, 1986).

Finaly solar radioemissions, which have been the first detected from space at subionospheric frequencies in the 70's have been studied from different spacecraft. Type III solar bursts have been used to study the interplanetary medium (Dulk et al, 1985 and references herein).

Space radioastronomy projects

The second part of this report concerns the plans for future space experiments which are presently under study by the different Space Agencies.

In the field of the Solar System two missions, Galileo and Ulysses, equiped with radioastronomy instruments, were planned to be launched in the mid 80's. They have been postponed to around 1990 due to the Chalenger tragedy and will arrive at Jupiter

around 1995. Galileo will remain in a Jovian orbit for several years while Ulysses will continue its Journey in an out-of-ecliptic trajectory from which it will study the solar radiobursts. Other projects of interest for radioastronomers are CRAFT, Cassini (Saturn orbiter and Titan probe), and Cluster (Study of Earth's magnetosphere). They are planned for the mid 90's.

Going out of the solar system, the main radioastronomy project is to use space for VLBI, together with a ground based network of radiotelescopes. "Quasat" is discussed jointly by NASA and ESA (Quasat, 1984) and "Radioastron" is a soviet project which includes a radiotelescope on a highly excentric orbit. The space VLBI technique has been tested using a TDRSS-NASA satellite and several ground based radiotelescopes : interferometric fringes have been successfully obtained (Levy et al, 1986). Another "première" in this field is the obtention of interferometric fringes from the source of Auroral kilometric radiation by the Iowa group using the two Earth orbiting satellites ISEE1 and 2 (Baumback et al, 1986).

The last topic we must include in this report is the submillimeter radioastronomy, which must be essentially performed from space. The progress of the heterodyne technology will certainly extend astronomical observations in this domain during the next few decades. Submillimeter high performant satellites are presently studied, and will be launched only in the next century. But, preliminary experiments are done from aircraft or planned in the near future with balloon born instruments.

References

Baumbach, M.M., Gurnett, D.A., Calvert, W., Shawhan, S.D. : 1986, Geophys. Res. Lett. 13, p. 1105.

Dulk, G.A., Steinberg, J.L., Lecacheux, A., Hoang, S., MacDowall, R.J. : 1985, Astron. Astrophys. 150, L 28.

Gehrels, T., Matthews, M.S., : 1984, "Saturn", The University of Arizona press, Tucson, U.S.A.

Gurnett, D.R., Kurth, F.L., Scarf, W.S., Poynter, R.L. : 1986, Science, 233, p. 106.

Quasat "a VLBI Observatory in Space" : 1984, ESA Report SP 213, Paris, France.

Levy, G.S. et al. : 1986, "VLBI observations made with an orbiting radiotelescope", Science, 234, p. 117.

Meyer-Vernet, N., Couturier, P., Hoang, S., Perche, C., Steinberg, J.L., Fainberg, J., Meetre, C. : 1986, Science, 232, p. 370.

Rucker, H.O., Bauer, S.J. : 1984, "Planetary Radio Emissions", Proceedings of an International Workshop held at Graz, Austria.

Warwick, J.W., Evans, D.R., Romig, J.H., Sawer, C.B., Desch, M.D., Kaiser, M.L., Alexander, J.K., Carr, T.D., Staelin, D.H., Gulkis, S., Poynter, R.L., Aubier, M., Boischot, A., Leblanc, Y., Lecacheux, A., Pedersen, B.M., Zarka, P. : 1986, Science, 233, p. 102.