

PLANETARY RADIO EMISSION AS A TOOL OF MAGNETOSPHERIC RESEARCH

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The study of non-thermal planetary radio emissions had its origin in a serendipitous discovery made more than three decades ago, when Burke and Franklin (1955b), while mapping cosmic radio noise at 22.2 MHz, realized that the “interference”, they were encountering repeatedly at about the same sidereal time, came from the planet Jupiter.

Whereas the discoverer of Jovian decametric radiation implied that this radio emission might be due to electrical disturbances in the atmosphere of Jupiter, T.D. Carr, one of the pioneers of Jupiter radio research, as early as 1958 suggested that the observed elliptical polarization of decametric waves could be explained if the radio emissions were due to cyclotron radiation from electrons spiralling along field lines of a Jovian magnetic field. This idea anticipated the concept of a magnetosphere – a term coined by T. Gold in 1959 – soon to be established for earth as the result of satellite observations in near-earth-space. (The term magnetosphere is now generally used for that region of the planetary environment where the magnetic field has dominant control over the motion of charged particles).

The microwave radiation from Jupiter observed by the late fifties, on the other hand, seemed best be explained by synchrotron radiation, requiring electrons of relativistic energies, an explanation promulgated by G. Field, again related to another serendipitous discovery by the first Explorer satellites, that of trapped radiation or radiation belts found by J.A. Van Allen (cf. Smith and Carr, 1964). Synchrotron radiation would later be used as a ground-based diagnostic tool for the surveillance of the “artificial radiation belts” in the earth’s magnetosphere (Hess, 1968).

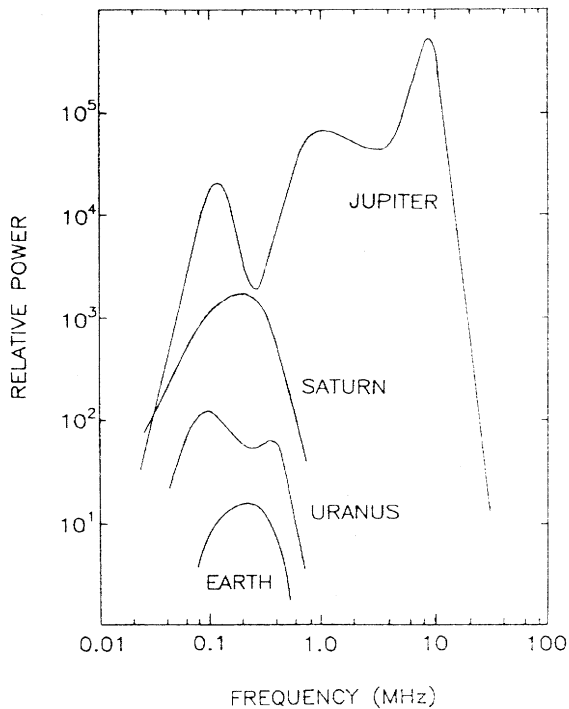
In the first two decades after its discovery, research of Jovian decametric radiation was exclusively the domain of ground-based observations and established a wealth of information including the Io-related emissions and estimates of the field intensity of Jupiter’s magnetic field. However, it was recognized even then that great advances could be expected from in situ observations by planetary missions. To quote Piddington (1969): “The present studies of Jupiter’s magnetosphere and Io suggest the likelihood of ample rewards from spacecraft measurements of particles and fields near this planet”.

Spacecraft missions to the outer planets in the 1970’s, and particularly Voyager made these hopes come true. They not only greatly expanded our knowledge about the radio emissions from Jupiter but also discovered non-thermal radio emissions from Saturn and Uranus as well as their magnetospheres (Ness, 1988; this issue).

Jupiter is the only radio planet that seems accessible from the earth's surface. Even the terrestrial radio emission, named auroral kilometric radiation (AKR) for its source region in the magnetosphere, can only be observed from satellites because of the shielding effect of our ionosphere. The intimate connection between non-thermal radio emission and magnetospheric characteristics, thus, allows a kind of ground-based magnetospheric research. This aspect also provided the rationale for our involvement here at Graz in this field of research (Rucker and Mostetschnig, 1988; this issue). The study of planetary radio emissions also represents an extension of our long tradition of investigating the terrestrial ionosphere by ground-based radio methods, started after World War II by O. Burkard (1956).

Ground-based observations of Jovian radio emissions still seem to hold promise for the future, not the least in connection with planned space missions such as Galileo and Cassini as long-term data base as well as complement to spaceborne observations.

The emphasis on Jupiter as the principal radio planet is also evident in the present workshop where a large part of the presentations is devoted to Jovian radio emissions.



In addition to the four known radio planets whose characteristic power spectra are shown in Figure 1, there is good reason to believe that at least another planet – Neptune – has an extended magnetosphere and thus is a potential radio source (Desch, 1988; this issue).

Fig. 1: Relative power output of non-thermal emissions from the four radio planets (Bauer, 1987).

Although the details of source regions and mechanisms are still a matter of continuing debate, non-thermal radio emission as a characteristic property of a planetary magnetosphere is well established; radio emissions can thus also serve as an exploratory tool of magnetospheric research, sometimes – as is the case for Jupiter – even from the surface of the earth.