PLANETARY RADIO EMISSIONS – A HISTORICAL PERSPECTIVE

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A brief overview of the important historical milestones in the field of planetary radio emissions together with an enumeration of the presently known types of emissions is given in order to set the stage for the following presentations and discussions of the workshop.

The present workshop is devoted to a truly planetary phenomenon: the non–thermal radio emissions from – up to now – three planets, the Earth, Jupiter and Saturn. The radio emission from our planet Earth, however, was not the first to be discovered. Just about 30 years ago, Burke and Franklin (1955) accidentally discovered high frequency (decametric) radio emissions from Jupiter. Later it was recognized that this decametric radiation (DAM) from Jupiter had been recorded as early as 1950 by Shain in Australia, but was then not recognized as such.

Between 1955 and 1958 such diverse theories for the origin of Jupiter's DSt radiation, as electrostatic noise from lightning discharges, ionospheric plasma waves generated by atmospheric turbulence and ionospheric oscillations generated by volcanic(!) shock waves, were proposed. Since the Sixties, the generally favored view holds that radio wave emission is a general feature of a planetary magnetosphere due to the generation of elactrosta- tic and electromagnetic waves by energetic particle beams, but the theoretical details are as yet far from complete (Goldstein and Goertz, 1983).

Twenty years ago, Bigg (1964) discovered the surprising fact that some of Jupiter's radio emission is closely related to the Galilean satellite Io. Today, as the result of space observations, the Io control of these radio emissions is recognized as the consequence of a complicated electrodynamic system, consisting of Io with its ionosphere and plasma torus within Jupiter's magnetosphere.

Space observations were also needed to discover radio emissions from our own planet. The suggestion that the Earth should be a strong radio source in the standard broadcast band was made in the early 1960's by J. W. Warwick of the University of Colorado and by G. R. A. Ellis of the University of Tasmania. Among the first to recognize these (kilometric) radio emissions from the terrestrial magnetosphere, were Soviet scientists who observed sporadic noise bursts on the Electron–2 satellite in 1964. Later observations by the American RAE–1 and IMP–6 satellites established, that the terrestrial kilometric emission originates above the auroral region (Carr et al., 1983). The reason for the fact that Jupiter's DAM radio emissions could be observed at the surface of the Earth, whereas

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the terrestrial radio emissions could not, is tied to the probable source location and origin of these emissions. Since these emissions are related to the gyrofrequency of charged particles in a magnetic field, groundbased observations of the Jovian DMA radiation with an upper cutoff of 40 MHz, already led to the suspicion of a strong magnetic field on Jupiter, while the polarization of these waves pointed to a reversed polarity relative to the Earth's dipole field, well before in situ magnetometer measurements on Pioneer 10 and 11 established these facts. Radio astronomy and plasma wave experiments on the two Voyager spacecraft in the late Seventies extended the coverage to even lower frequencies and discovered two types of kilometric emissions (Carr et al., 1983). The discovery of intense non-thermal radio emission from Saturn with the Voyager spacecraft (Kaiser et al., 1980) provides us now with a third planetary radio source in our solar system. By the end of this decade, the number may grow to five, after Voyager's flyby of Uranus early in 1986 and of Neptune in 1989, since both planets are expected to have intrinsic magnetic fields and together with their charged particle environments thus qualify as potential radio sources.

At present we recognize the following types of "long–wave", nonthermal planetary radio emissions (the "short–wave" non–thermal emissions, the decimetric (DIM) radiations from Jupiter and Earth, are due to synchrotron radiation from their radiation belts):

1) Jupiter decametric emissions (DAM)
2) Earth auroral kilometric radiations (AKR)
3) Jupiter broad–band kilometric emission (bKOM)
4) Jupiter narrow–band kilometric radiation (nKOM)
5) Saturn kilometric emission (SKR)
6) Terrestrial, Jovian, and Saturnian continuum radiation
7) Saturn electrostatic discharges (SED)

During this workshop we shall have discussions of the observational and theoretical aspects of all seven types of planetary radio emissions enumerated above, including the now recognized solar control of some of these emissions.

It is hoped, that through the interaction among scientists of different nations participating in this workshop, new collaborations and new ideas will emerge that eventually may lead to a better understanding of these enigmatic phenomena known as planetary radio emissions.

References

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