Cyclotron maser radiation from planetary magnetospheres (abstract)

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For over 20 years it has been known that the Earth is an intense radio emitter in the frequency range from about 100 to 500 kHz. This radiation is generated at altitudes of about one Earth radius over the northern and southern auroral zones, and is closely correlated with the occurrence of discrete auroral arcs. During active periods, the total radiated power is very large, averaging from 10^7 to 10^8 W, with peaks possibly as high as 10^9 W. It is now widely believed that this radiation is generated by a process known as a cyclotron maser instability. This process involves a Doppler-shifted cyclotron resonance interaction between the free-space *R-X* mode and the auroral electrons. The most recent data, from the Viking satellite, indicate that the free-energy source driving the instability is produced by electrons trapped by the magnetic mirror force and the electric field response for the auroral particle acceleration. In addition to the Earth, it is now known that four other planetary magnetospheres, at Jupiter, Saturn, Uranus, and Neptune, all have similar types of radio emissions. Also, it has been suggested that certain types of microwave emissions from the Sun, and from binary star systems may also be produced by this same mechanism. Thus, in addition to being a relatively new, interesting plasma physics phenomenon, the cyclotron maser mechanism appears to be important for a broad range of astronomical radio sources.

Plasma fluctuation measurements in tokamaks using beam-plasma interactions (abstract)[a]

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High-frequency observations of light emitted from the interactions between plasma ions and injected neutral beam atoms allow the measurement of moderate-wavelength fluctuations in plasma and impurity ion densities. To detect turbulence in the local plasma ion density, the collisionally excited fluorescence from a neutral beam is measured either separately at several spatial points or with a multichannel imaging detector. Similarly, the role of impurity ion density fluctuations is measured using charge exchange recombination excited transitions emitted by the ion species of interest. This technique can access the relatively unexplored region of long-wavelength plasma turbulence with $k_{\perp}\rho_i \leqslant 1$, and hence complements measurements from scattering experiments. Optimization of neutral beam geometry and optical sightlines can result in very good localization and resolution ($\Delta x \leqslant 1$ cm) in the hot plasma core region. The detectable fluctuation level is determined by photon statistics, atomic excitation processes, and beam stability, but can be as low as 0.2% in a 100 kHz bandwidth over the 0–1 MHz frequency range. The choices of beam species (e.g., H^0, He^0, etc.), observed transition (e.g., H_α, L_α, He I singlet or triplet transitions, C VI $\Delta n = 1$, etc.) are dictated by experiment-specific factors such as optical access, flexibility of beam operation, plasma conditions, and detailed experimental goals. Initial tests on the PBX-M tokamak using the H_α emissions from a heating neutral beam show low-frequency turbulence in the edge plasma region.

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