DPP08-2008-000026

Abstract for an Invited Paper
for the DPP08 Meeting of
the American Physical Society

Waves in Space Plasmas

DONALD GURNETT, University of Iowa

Although low-frequency radio waves of extra-terrestrial origin were known over a century ago, it wasn't until the beginning of the space era fifty years ago that the origin of these waves could be adequately investigated. Since then spacecraft-borne instruments have shown that space plasmas exhibit an almost bewildering variety of wave phenomena, sometimes referred to as the plasma wave zoo. In this talk I will focus on two types of waves that occur in the magnetospheres of the strongly magnetized planets. They are whistler mode emissions and cyclotron maser radiation. Whistler mode emissions are generated in the now famous plasma wave mode known as the whistler mode, and cyclotron maser radiation is emitted mainly in the right-hand polarized free space mode. Both involve a cyclotron resonant interaction and require a perpendicular anisotropy to achieve wave growth. However, the origin of the anisotropy is different in the two cases. Whistler mode emissions occur in planetary radiation belts and are driven by the loss-cone anisotropy imposed by the planet. The resulting waves play a major role in the scattering and loss of radiation belt electrons. In contrast, the cyclotron maser radiation is generated in the auroral regions where parallel electric fields accelerate down-going electrons to high energies. The wave growth is driven by the shell distribution that arises from a combination of the parallel electric field and the magnetic mirror force. The resulting radiation is extremely intense and can be detected at great distances as an escaping radio emission. Both the whistler mode emissions and the cyclotron maser radiation display an amazing amount of fine structure. This structure is thought to be due to nonlinear trapping of the resonant electrons. The exact nonlinear mechanisms involved are still a topic of current study.