Geophysical Research Abstracts
Vol. 14, EGU2012-12135, 2012
EGU General Assembly 2012

Numerical simulation of auroral magnetospheric cyclotron emission processes

D. C. Speirs (1), R. Bingham (1,2), R. A. Cairns (3), B. J. Kellett (2), S. L. McConville (1), K. M. Gillespie (1), I. Vorgul (3), A. D. R. Phelps (1), A. W. Cross (1), and K. Ronald (1)

(1) SUPA, Department of Physics, University of Strathclyde, Glasgow, G4 0NG, U.K., (2) Space Physics Division, STFC Rutherford Appleton Laboratory, Didcot, OX11 0QX, U.K., (3) School of Mathematics and Statistics, University of St Andrews, St Andrews, KY16 9SS, U.K.

A variety of astrophysical radio emissions have been identified to date in association with non-uniform magnetic fields and accelerated particle streams. Numerous such sources, including planetary and stellar auroral radio emission are spectrally well defined with a high degree of extraordinary (X-mode) polarisation [1]. In particular, for the terrestrial auroral case it is now widely accepted that such emissions are generated by an electron cyclotron-maser instability driven by a horseshoe shaped electron velocity distribution [2,3]. Such distributions are formed when particles descend into the increasing magnetic field of planetary / stellar auroral magnetospheres, where conservation of the magnetic moment results in conversion of axial momentum into rotational momentum forming an electron velocity distribution having a large spread in pitch factor. Theory has shown that such distributions are unstable to cyclotron emission in the X-mode [4].

Experiments and simulations have been conducted at the University of Strathclyde investigating the electrodynamics of an electron beam subject to significant magnetic compression [5]. More recently, a background plasma of variable density has been introduced to the interaction region of the laboratory experiment and the resultant stability of the cyclotron-maser instability investigated [6]. Corroboratory simulations have been conducted using the PiC code VORPAL to investigate the cyclotron emission process in the presence of a background plasma and in the absence of radiation boundaries [7]. Simulations have investigated the spatial growth of the instability in a sheet electron beam in the presence of a background plasma whose density increases along the path of beam propagation. These simulations demonstrate a significant enhancement in spatial growth over the larger cross-sectional dimension of the sheet beam, and can simulate the upward refraction of the generated radiation – consistent with theoretical predictions and geophysical observations of enhanced emission / growth of terrestrial AKR tangential to the auroral cavity boundary and upward refraction of the resultant radiation due to the increasing background plasma density with decreasing altitude [8].

[1] R. Bingham, R.A. Cairns and B.J. Kellett, Astron. Astrophys., **370**, 1000 (2001).

[2] R.E. Ergun, C.W. Carlson, C.W. McFadden et al., Astrophys. J., **538**, 456 (2000).

[3] I. Vorgul, R.A. Cairns and R. Bingham, Phys. Plasmas **12**, 122903 (2005).

[4] R.A. Cairns, I. Vorgul, R. Bingham et al., Phys. Plasmas **18**, 022902 (2011).

[5] K. Ronald, D.C. Speirs, S.L. McConville, et al., Phys. Plasmas, **15**, 056503 (2008).

[6] S.L. McConville, M.E. Koepke, K.M. Gillespie et al., Plasma Phys. Control. Fusion, **53**, 124020 (2011).

[7] D.C. Speirs, K. Ronald, S.L. McConville, Phys. Plasmas, **17**, 056501 (2010).

[8] J.D. Menietti, R.L. Mutel, I.W. Christopher et al., J. Geophys. Res., **116**, A12219 (2011).