Generation, propagation and escape of astrophysical cyclotron-maser emission


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

Numerous astrophysical plasma environments exist where a combination of particle acceleration, non-uniform magnetic fields and a sufficiently large ratio of electron cyclotron frequency to plasma frequency are present to support electron cyclotron-maser emission [1]. The resultant radiation signatures typically comprise of well-defined spectral components (around the relativistic electron cyclotron frequency) with near 100% left or right handed circular polarization when viewed out-with the source region. Although the generation mechanism has been well documented [1][2], there are numerous potential hindrances to the propagation and escape of the radiation from the source region, including second harmonic cyclotron absorption [3] and the obstacle of coupling onto the dispersion branch connecting with vacuum propagation.

In the present context we consider a number of candidate astrophysical sources for the cyclotron-maser emission model, including stars having a dipole-like magnetic field structure and blazar jets / astrophysical shocks. In all cases we consider the mechanisms by which the required ring / horseshoe electron velocity distributions are generated, and potential processes that may inhibit propagation and escape of the generated radiation. These arguments are backed up by the results of PiC (Particle-in-cell) simulations, where the potential for backward-wave coupling is investigated as a viable precursor to a model of upward refraction and field-aligned beaming of the generated radiation [4].

References