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Cyclotron Maser Emission - Stars, Planets and Laboratory

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X-ray and radio observations of active stars over many years have shown that they frequently generate X-ray bursts that are quickly followed by radio bursts. In many cases the radio bursts are highly polarised. More recently, the star CU Virginis has been found to exhibit pulsar-like behaviour. In both these situations we believe that the radio emission can be best explained by a cyclotron maser type instability initiated by electron beams funnelling down converging magnetic field configurations typical of a dipole magnetic topology. Just such a geometry also exists in the Earth's auroral zone and so our model can explain the Earth's auroral kilometric radiation (AKR). Via a similar process, all the gas giant/magnetised planets in the solar system also emit radio emission. We have established a laboratory-based facility that has verified many of the details of our original theoretical description. The experiment has demonstrated, for example, that an electron beam entering a strongly converging magnetic field geometry does indeed produce a "horse-shoe" (or crescent-shaped) distribution in velocity space. It is the generation of this horse-shoe distribution, also observed in the Earth's auroral zone, which is vital for our theoretical model. It leads to a population inversion in the perpendicular velocity distribution and generation of electromagnetic waves close to the cyclotron frequency. We will discuss recent developments in the theory and simulation of the instability and relate these to the laboratory, space and astrophysical observations. The research was supported by UK Engineering and Physical Sciences Research Council. The input of R.A. Cairns, R. Bingham, B.J. Kellett and the experimental and computer modelling team at Strathclyde University, Glasgow is gratefully acknowledged.