Radiation from CMI Emission in Auroral Cavities: New Results on the Shell-Driven Maser and Angular Beaming Patterns

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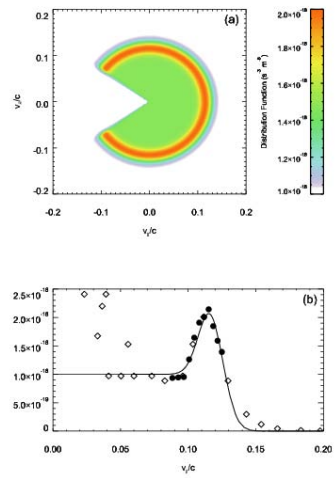
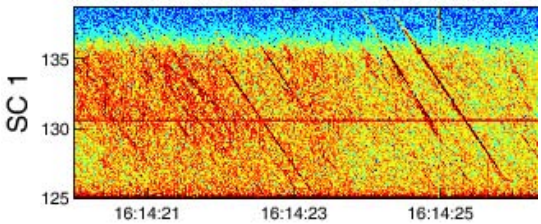
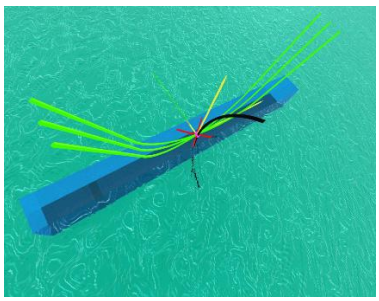
We present new results on several long-standing problems in auroral kilometric radiation (AKR) studies: the relationship between observed AKR intensities and *in situ* electron distribution functions, the origin of striated fine structure, and the angular beaming properties of AKR. We computed the growth rates and emergent intensities associated with X and O-mode radiation from the cyclotron maser instability as a function of the ambient electron velocity distribution and k-vector orientation using an analytic horseshoe velocity distribution closely fitted to FAST observations of energetic electron distributions in the auroral cavity. The growth rate is sharply peaked at perpendicular propagation ($k_{\parallel}$=0). The maximum observed intensities ($E \sim 10^{-4}$ V m^{-2} Hz^{-1}) are obtained with convective growth lengths 20-40 km at perpendicular propagation.





Perturbation of the velocity distribution by small-scale ion solitary structures (ISS), closely matched to observed ISS sizes, speeds, and velocity profiles, can enhance the emergent intensity by 40-50 dB, consistent with observed AKR striated fine structure. This may also apply to perturbation by electromagnetic ion-cyclotron waves, but not to electron holes, which always diminish growth rates.



We also used the 4-spacecraft Cluster array in VLBI mode to determine the angular beaming patterns of more than 11,000 terrestrial AKR bursts. By combining the locations of AKR bursts with the known spacecraft locations, we show that the angular beaming pattern is closely confined (~10°) to a 'tangent plane' containing the local magnetic field direction and tangent to the auroral oval, consistent with numerical models of AKR generation. We find a pattern that is consistent with radiation escaping from deep within a long, thin rectangular cavity. In addition to shedding light on the beaming pattern of AKR, this result also helps re-interpret the distribution of AKR source locations previously determined from Cluster WBD waveform data (Mutel et al., 2003, JGR 108, CiteID 1398). These locations are now seen to be only a subset of all sources on the auroral oval - specifically, those locations for which a direct line-of-sight exists between all four Cluster spacecraft and the longitudinal extension of the long, thin density cavity containing the AKR source.