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Relativistic Electron Precipitation Driven by EMIC Waves

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Relativistic electron fluxes in the Earth's radiation belts pose a significant hazard to spacecraft operations. Their high variability remains a challenge to accurate prediction and forecasting of the outer radiation belt dynamics, which is driven by various acceleration, transport, and loss processes. It has been commonly accepted that wave-driven precipitation plays an important role in relativistic electron losses. In particular, local and rapid dropouts are usually attributed to resonant interactions with electromagnetic ion cyclotron (EMIC) waves. Although there is abundant support for relativistic electron losses due to precipitation from EMIC wave scattering, this mechanism is yet to be systematically quantified. The spatially-localized signature of EMIC waves and the possible effects of hot ions on the EMIC wave dispersion relation significantly complicate the evaluation of EMIC wave contribution to electron losses in the radiation belts.

Professor Richard Thorne was among the first to propose and investigate the resonant pitch angle scattering by electromagnetic ion cyclotron (EMIC) waves as a viable mechanism to efficiently precipitate relativistic electrons from Earth's outer radiation belt [1]. Since then, significant contributions to the role of EMIC waves in relativistic electron dynamics have been made by Prof. Thorne and his coworkers, using a combination of spacecraft observations, theory, and modeling [2]. In this presentation, we will summarize major findings on this topic that were largely inspired by Prof. Thorne's ideas. We will also discuss recent advances on the quantification of EMIC wave driven electron precipitation, which are enabled by conjugate observations at the magnetic equator (from THEMIS and Van Allen Probes spacecraft) and at LEO (from ELFIN CubeSats).

1. R. M. Thorne, and C. F. Kennel, "Relativistic electron precipitation during magnetic storm main phase," *J. Geophys. Res.*, **76**(19), 1971, 4446-4453, doi:10.1029/JA076i019p04446.

2. R. M. Thorne, J. Bortnik, W. Li, and Q. Ma, "Wave-Particle Interactions in the Earth's Magnetosphere," in *Magnetospheres in the Solar System*, **6**, 2021, 93-108, doi:10.1002/9781119815624.ch6.