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Survey of EDR-associated Magnetopause Flux Ropes with MMS

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Flux ropes are twisted magnetic field structures produced during magnetic reconnection. They are thought to be important for energy transport and particle acceleration and are commonly observed throughout space plasma environments, including at the Earth's magnetopause. Flux Transfer Events (FTEs), which typically contain flux ropes, have been observed to grow in size and flux content as they are convected over the magnetopause and into the magnetotail, contributing to flux transport in the Dungey cycle. More recently, small-scale flux ropes have been observed inside the Electron Diffusion Region (EDR) during magnetopause reconnection.

In this study, we investigate the link between the EDR and flux ropes, presenting a survey of 245 flux ropes observed by the Magnetospheric Multiscale (MMS) mission on days during which the spacecraft also encountered the EDR. MMS measures the thermal electron and ion 3D distributions at 30 msec and 150 msec time resolution, respectively, and at spacecraft separations down to a few kilometres allowing the study of such electron-scale phenomena. We find that flux ropes are more likely to be observed closer to the EDR, and that flux ropes observed closer to the EDR tend to have greater axial magnetic field strength and therefore greater flux content. We suggest that we could be sampling a subset of flux ropes that are recently formed by the EDR and discuss how this impacts current theories for flux rope evolution on the magnetopause.