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The physics of magnetic reconnection onset at the subsolar magnetopause: MMS observations

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Magnetic reconnection is a fundamental process occurring in thin current sheets where a change in the magnetic field topology leads to fast magnetic energy conversion into charged particles energy. A key yet poorly understood aspect is how reconnection is initiated in the diffusion region by microphysical processes occurring at electron scales, the so-called onset problem. Reconnection onset leads to the energization of particles around reconnection sites, yet the exact energization mechanisms are also not yet fully understood. Simulations have provided some suggestions on the mechanisms responsible for onset and particle energization, however direct observations have been scarce so far. The four-spacecraft Magnetospheric Multiscale Mission (NASA/MMS) has been launched in March 2015 and allows, for the first time, in-situ observations of reconnection diffusion regions with adequate resolution to study electron scales. Here we present MMS observations in diffusion regions at the subsolar magnetopause and we investigate the conditions for reconnection onset. We select a few events with multiple crossings of the magnetopause current sheet for which signatures of absence of reconnection are rapidly followed by signatures of reconnection, and compare the measured electric field with the electric field due to both kinetic effects (electron pressure tensor, electron inertia terms) and to anomalous resistivity associated to different wave modes (e.g. lower hybrid waves, whistler waves, etc.). We also analyze electron distribution functions to study the mechanisms of electron energization in the diffusion region.