290th Regular Open Seminar（2022 /11/16）

Title：The Magnetic Reconnection Mystery: Tree Rings, Electron Distributions, and the Magnetospheric Multiscale Mission

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Related RISH mission：Mission 3: Sustainable Space Environments for Humankind

Abstract：

The mystery of how magnetic reconnection operates in a collisionless plasma environment has puzzled space plasma physicists for decades. This talk is focused primarily on recent numerical simulations and groundbreaking spacecraft observation results from NASA's Magnetospheric Multiscale (MMS) mission relevant for elucidating the microphysical processes believed to power energetic plasma flows associated with the reconnection energy conversion process. Remarkably, the topological patterns which arise during the study of magnetic reconnection are reminiscent of patterns commonly found in tree rings and aircraft vortex contrails, likely due to a similar mathematical form of the underlying equations describing each system. Specifically in this work, each term of the electron Vlasov equation is determined from direct observations of electron phase-space density gradients measured by the four MMS spacecraft that fly in tetrahedral formation in the vicinity of magnetic reconnection sites found at Earth's magnetopause. The unprecedented temporal, spatial, and velocity-space resolution offered by the MMS tetrahedron enables us to identify the electron distribution function that supports fast plasma outflow jets within thin, electron-scale current layers. These results are immediately relevant to the study of fundamental energy conversion processes, including electron diffusion regions fueling magnetic reconnection, kinetic-scale turbulence, and collisionless wave-damping mechanisms such as Landau damping that were recently reported using MMS data from Earth's turbulent magnetosheath.