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Plasma transport through rolled-up Kelvin-Helmholtz vortices at the flank of Earth's magnetosphere

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It is known that a significant amount of solar wind plasmas enters Earth's magnetosphere under northward solar wind magnetic field conditions when magnetic reconnection–the dominant entry mechanism during southward solar wind magnetic field periods–is less efficient at the low-latitude magnetopause. One of candidate mechanisms for the plasma entry under such conditions is the Kelvin-Helmholtz instability (KHI) that can be excited along the flank magnetopause across which a substantial velocity shear exists. Recent numerical simulations show that transport of plasma is inevitably established when the KHI has grown nonlinearly to form highly rolled-up vortices. Based on this expectation, search of the rolled-up vortices has been attempted with coordinated four-point observations by the Cluster spacecraft that permit us to resolve spatial structures in and around the magnetosphere, and they were indeed discovered at the flank magnetopause along with evidence of plasma transport across the boundary. The exact microphysical transport process operating in the vortices is yet to be determined, however. While particle transport/mixing is accomplished by collisions in ordinary neutral fluids, since Coulomb collisions seldom occur in the near-Earth space, the plasma transport must be achieved by some collisionless mechanism. We present proposed transport mechanisms that could operate within the rolled-up vortices. Prospects for the mechanism to be resolved by future multi-spacecraft observations are also discussed.