

## Kármán Vortex Street, Strouhal Number, Hairpin Vortex in 3D global Magnetohydrodynamic MHD simulations in Northward IMF

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A Kármán vortex street is a repeating pattern of two rows of paired swirling vortices and appears after some obstacles or stagnation areas in fluid or plasma flows. It is caused by a process known as a vortex shedding where vortices leave the shear layer. Recently, several studies have discussed the Kelvin-Helmholtz (K-H) instability and its related waves and vortex structures by using 2D / 3D global (Magneto Hydro Dynamics) MHD simulations in the northward IMF (Interplanetary Magnetic Field). These found a double-vortex sheet in which a vortex train propagates, respectively, along the inner and outer edges of the magnetopause. In the present paper, we show that these two rows of vortices form the Kármán vortex street, and we discuss its generation mechanism with the help of 3D global MHD simulations. These Kármán vortex stretches and elongates in the night side and becomes to be the so-called the Hairpin vortex that is essential for the coherent structure. We also identify the non-dimensional number vortex so-called the Strouhal number in our simulation. The Strouhal number is ubiquitous and represents one of the most significant features in the Kármán vortex street.

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