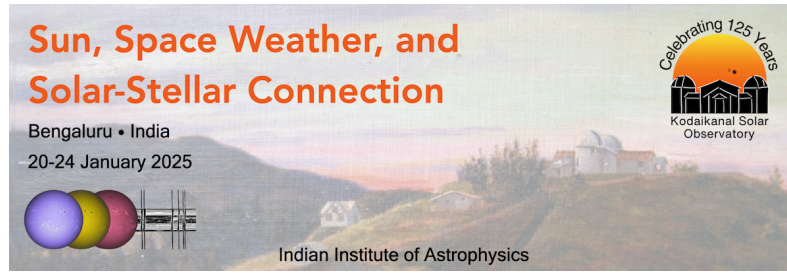


Sun, Space Weather, and Solar-Stellar Connection



Contribution ID: 2

Type: **Contributed talk**

Vortex Dynamics in Various Solar Magnetic Field Configurations

Tuesday, January 21, 2025 12:00 PM (15 minutes)

We investigate vortex dynamics in three magnetic regions, viz., Quiet Sun, Weak Plage, and Strong Plage, using realistic three-dimensional simulations from a comprehensive radiation-MHD code, MURaM. We find that the spatial extents and spatial distribution of vortices vary for different setups even though the photospheric turbulence responsible for generating vortices has similar profiles for all three regions. We investigate kinetic and magnetic swirling strength and find them consistent with the Alfvén wave propagation. Using a flux tube expansion model and linear magnetohydrodynamics (MHD) wave theory, we find that the deviation in kinetic swirling strength from the theoretically expected value is the highest for the Strong Plage, least for the Weak Plage, and intermediate for the Quiet Sun at chromospheric heights. It suggests that Weak Plage is the most favoured region for chromospheric swirls, though they are of smaller spatial extents than in Quiet Sun. We also conjecture that vortex interactions within a single flux tube in Strong Plage lead to an energy cascade from larger to smaller vortices that further result in much lower values of kinetic swirling strength than other regions. Fourier spectra of horizontal magnetic fields at 1 Mm height also show the steep cascade from large to smaller scales for Strong Plage. These findings indicate the potential of vortex-induced torsional Alfvén waves to travel higher in the atmosphere without damping for weaker magnetic regions such as the Quiet Sun, whereas vortices would result in dissipation and heating due to the vortex interactions in narrow flux tubes for the strongly magnetized regions such as Strong Plage.

Contribution Type

Theme

Solar Magnetism in High-Resolution

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