Vortex Flow Properties in Simulations of Solar Plage Region: Evidence for their role in chromospheric heating

N. Yadav[1,2], R. H. Cameron[2] and S. K. Solanki[2]

[1] *Centre for Mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Celestijnenlaan 200B, B-3001 Leuven, Belgium*
[2] *Max Plnack Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany*

Vortex-flows exist across a broad range of spatial and temporal scales in the solar atmosphere. Small-scale vortices are suggested to play an important role in the energy transport in the solar atmosphere. However, their physical properties remain poorly understood due to the limited spatial resolution of the observations. Using the three-dimensional (3D) radiative magnetohydrodynamic (MHD) simulation code 'MURaM' we analyzed the physical properties of small-scale vortices inside magnetic flux tubes, and investigated whether they contribute to heating the chromosphere in a plage region. We concentrate on small-scale as they are the strongest and carry most of the energy. We explore the spatial profiles of physical quantities viz. density, horizontal velocity, etc. inside these vortices. Moreover, to apprehend their general characteristics, a statistical investigation is performed. We found that magnetic flux tubes have a complex filamentary substructure harbouring an abundance of small-scale vortices. At the interfaces between vortices strong current sheets are formed that may dissipate and heat the solar chromosphere. Statistically, vortices have higher densities and higher temperatures than the average values at the same geometrical height in the chromosphere. We conclude that small-scale vortices are ubiquitous in solar plage regions, and they are denser and hotter structures that contribute to chromospheric heating, possibly by dissipation of the current sheets formed at their interfaces.