Udaipur Solar Observatory/ Physical Research Laboratory

P.Box.No 198, Dewali, Badi Road, Udaipur-313001

SEMINAR

MHD relaxation in astrophysical plasmas

(Sanjay Kumar, USO/PRL)

Parker's magnetostatic theorem suggests the formation of tangential discontinuities or current sheets (CSs) in solar coronal plasma following random foot point shuffling at the photosphere. Importantly, in such a high Reynolds number (R_M) plasma, the CSs provide natural sites where the plasma gets locally diffusive because of a reduction of R_M and leads to subsequent magnetic reconnections (MRs). The field line frozen into the post-reconnected mass outflow may then pushes the other field lines and may create secondary CSs which lead to further reconnections, supporting the idea that the solar corona is heated by distributed reconnection events. The process of secondary CS development and their decay through MRs, is then expected to be continued, intermittent in space and time, until the plasma relaxes to minimum magnetic energy relaxed state determined by global constraints of the dynamics. The relaxed states are observed to be relatively quiescent and long lived. For example, observed life time of solar coronal loops is few hours to days whereas any cylindrical or toroidal high R_M plasma is known to become unstable at Alfven time scale which is of the order of seconds for the coronal plasma. This more than expected life time of the coronal loops qualify them as relaxed states.

With the above scenario in mind, it is important to understand the dynamics of CSs in order to determine the sites of MRs. Our MHD simulations show development of the CSs in ideal plasma relaxing towards qausi-steady state from initial non-equilibrium state. To have better visualization of the process, we have utilized the magnetic flux surface description of magnetic field.

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