Shockwave Interaction in Magneto-Hydrodynamics Environment

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Magneto hydrodynamics (MHD) is the study of the nature of conducting fluids like plasma which has some specific magnetic properties which gives rise to various astronomical phenomenons like sunspots on the photosphere of the sun, coronal mass ejection, solar flares etc. Sun acting as a giant dynamo has azimuthal magnetic field lines around its photosphere, with the movement of the plasma an electric field is generated which in turn gives rise to an induced magnetic field. This induced magnetic field distorts the original magnetic field of the sun and the field lines becomes 'literally frozen' in the plasma. The differential rotation of the sun gives rise to bending and twisting of magnetic field lines which is the cause of major solar activity like sunspots, coronal loops, flares. The loops generally formed to the accumulation of high current density in any layer which thrusts the magnetized plasma into the atmosphere of the sun. The loops may consists of negative or positive polarity, when two oppositely charged loops collide magnetic reconnection occurs and huge magnetic energy is released, which can see as solar flares. In many cases a part of the loop detach from the ground and is thrown into the space with high velocity. The charged partices (plasma) travels with high velocity reaches near earth collide with the earth's magneto sphere, these particle clouds generates shocks and also interacts with them to produce exotic waves like alfven and MHD waves. The uniqueness of this interaction as made many researchers to focus on the matter; various computational techniques are used to simulate this interaction. The governing equation of MHD consists of coupled Euler's equation of hydrodynamics with Maxwell's equations of Electromagnetics. These equations are solved simultaneously to generate the MHD environment, Due to complexities; it is difficult to solve MHD equations with ordinary techniques like Lax-wendroff or Maccormack. To remove high oscillations, they are solved with high resolution schemes like TVD, Gudonov. Higher order schemes, Essentially Non-Oscillatory (ENO) schemes are applied for higher accuracy. OpenFoam is software which is being used to simulate several fluid problems due to its open field manipulation and vast library codes. It is very popular among the researchers. In this project thesis we are presenting an algorithm in OpenFoam which will solve MHD equations numerically and simulate the different shocks generated due to MHD effect and unique interaction between the earth and plasma waves

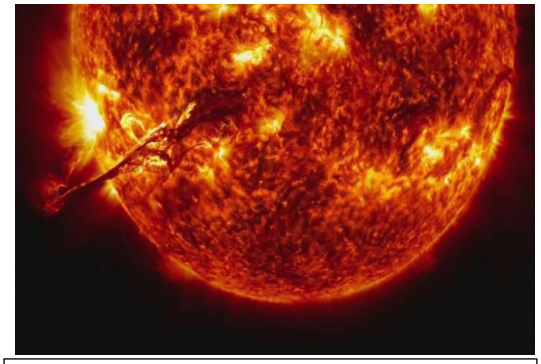

Fig: Formation of Coronal loop due to high Lorentz force

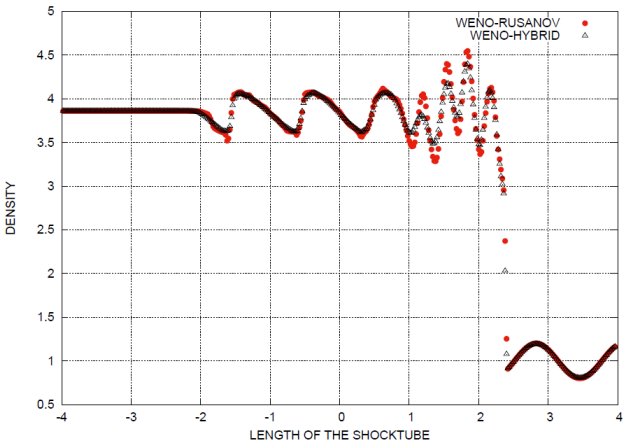

Fig: Estimated Diffusion