PLASMA CHARACTERISTICS

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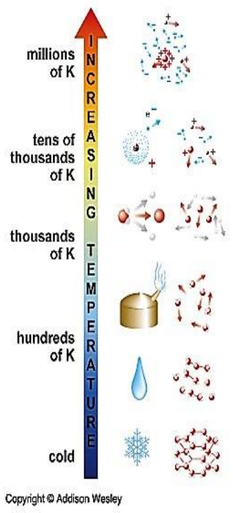
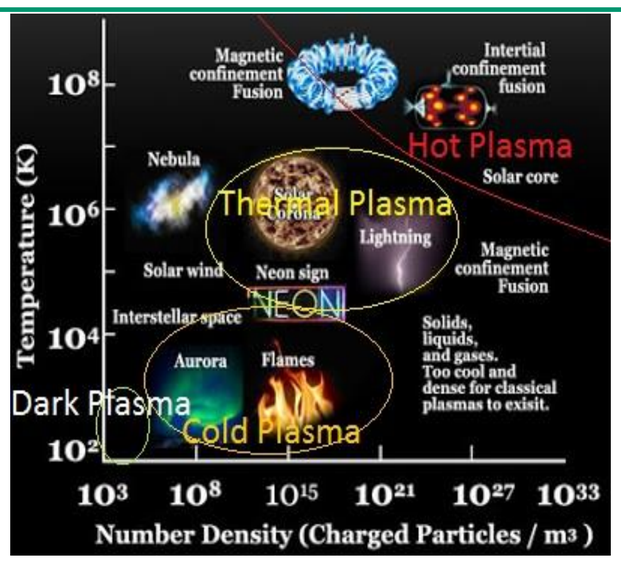
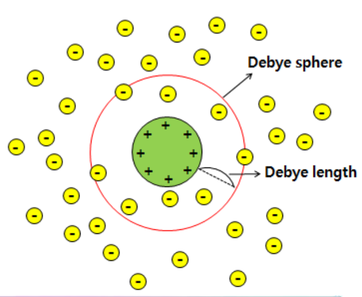


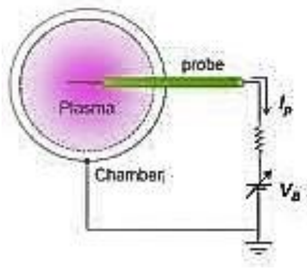


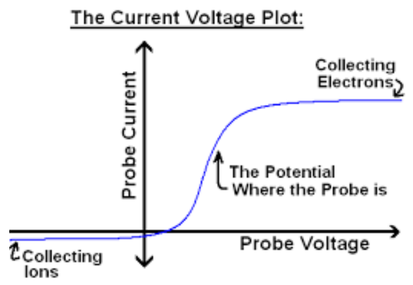
Depending upon the ionization level and temperature has been classified several ways. In general Cold Plasma 1 eV to 10^4 keV,. Hot Plasma 1 KeV ~ 10^7 KeV . The Ultra cold plasma occurs at temperatures as low as 1K.

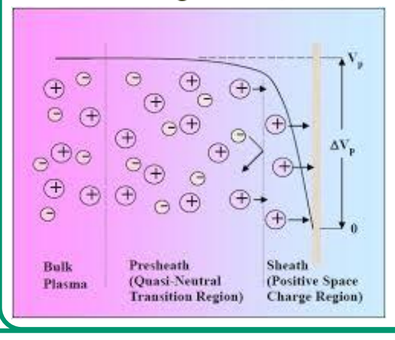
Plasma generally consist of Electrons, Ions and , in highly ionized state , protons neutrons and characterised by Very High electrical conductivity to the level infinity. Interact with electric and magnetic fields Behave independently with different bulk velocities High population of unusually fast particles when local equilibrium is disturbed by external forces Very High energy Densities etc.

Plasma, in spite of its charged particles ,charged regions and electric fields, overall remains electrically neutral. The property is known as **Quasi-neutrality – a defining property of Plasma** .



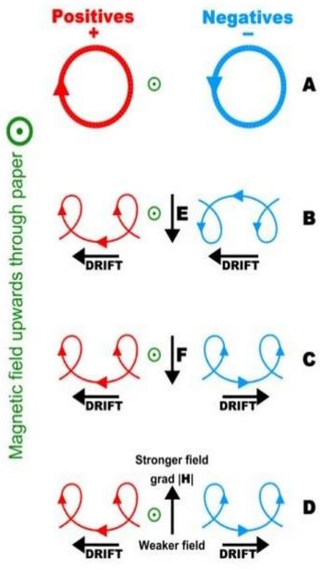




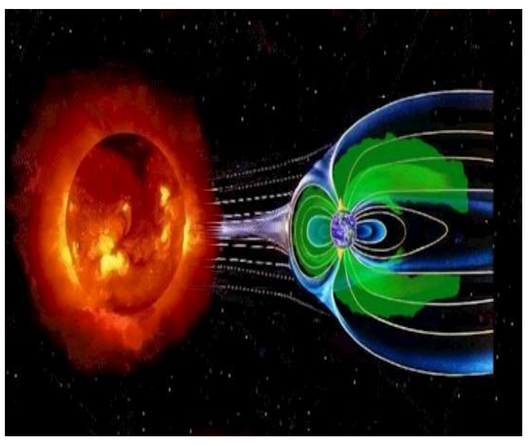


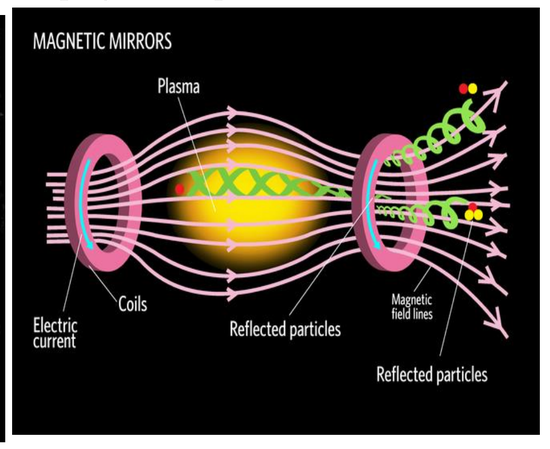
The distance over which quasi-neutrality break down is described by the **Debye length or Debye sphere.** It is less than a millimetre in plasmas in fluorescent lamps, tokamaks and ionosphere. About 10m in the interplanetary interstellar mediums. Up to 10km in intergalactic space. This property also results **double layer formation** and related effects.

Plasma exhibits distinct electromagnetic properties: Constituents of plasma strongly subjected to electromagnetic forces as illustrated by James Clerk Maxwell and Hendrik Antoon Lorentz. This strong interaction with electromagnetism leads plasmas to display a complex structures and waves.



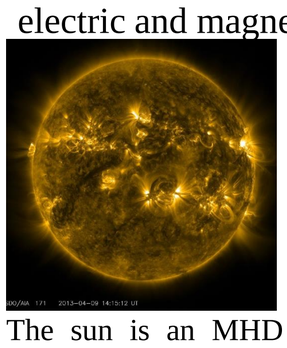
Charged particle drifts in homogenous magnetic fields :(A) Only Magnetic Field , no disturbing force (B) When electric Field applied (C) When subjected to an independent force like gravity (D) In an inhomogeneous magnetic field, grad H

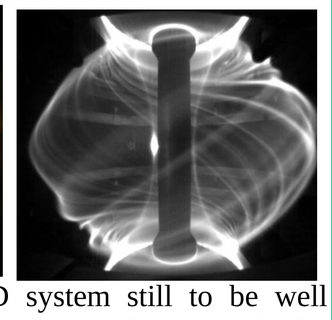




Plasma is self acted upon by electric and magnetic fields created within . Electric fields accelerate plasma particles to very high energies and the magnetic fields tend to guide the charged particles. This interplay in plasma is one of the reason for life to sustain on earth shielding it from the Sun.

Plasma highly exhibits **Magneto Hydrodynamics**(MHD- magnetofluid mechanics or hydromagnetics) as expected from all electrically conducting fluids in the presence of electric and magnetic fields

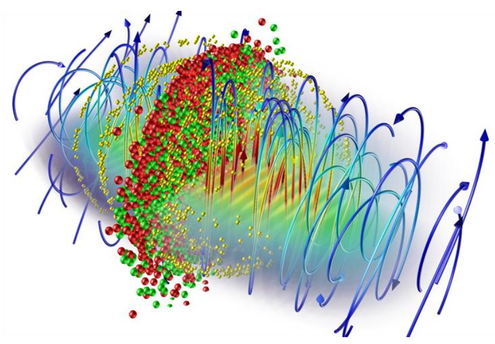




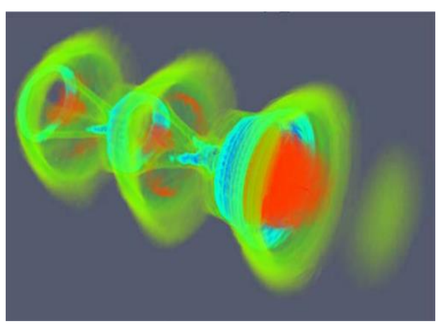
The sun is an MHD system still to be well understood ! A 3D image of a plasma inside the MAST tokamak shown at right.

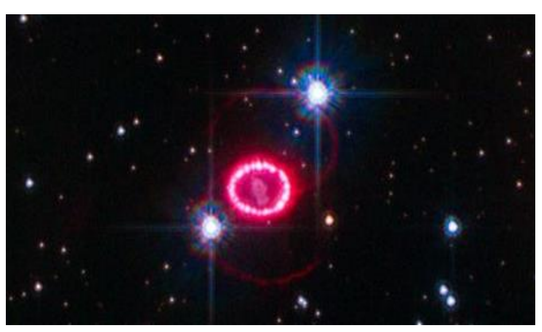
Electromagnetic fields applied externally and self generated within in plasma make it to exhibit wide range of phenomena

Plasma, just like swarms of birds and fish and herds of animals, exhibits **collective behaviour !**



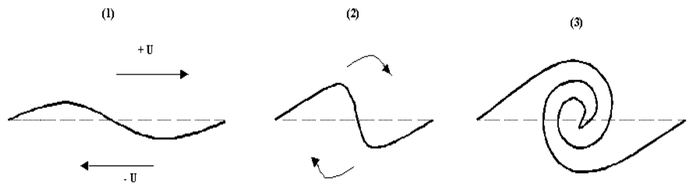
Filamentation is regular phenomena in plasmas and has its origin in the availability of free electrons. As charged particles move in a plasma a ring of magnetic field forms around the current which can pinch it into filamentary current strands



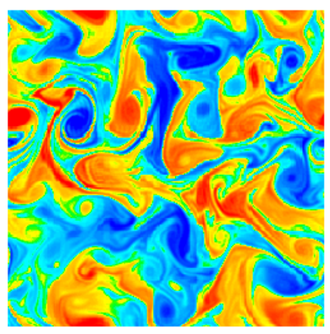


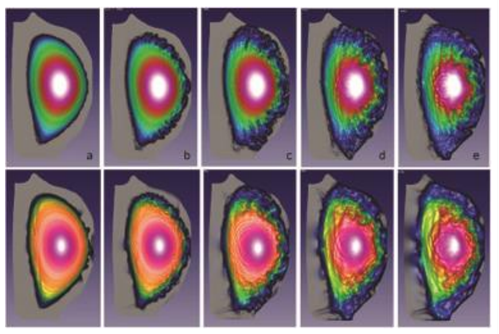
Shockwaves are induced in plasma in different ways. Simulation shown left what happened when powerful laser is fired into plasma .Image below right shows t shock wave around Supernova 1987A captured by the Hubble Space telescope

Instabilities chaosity and nonlinearities; Plasma gets easily disturbed. The movement of a single element can make whole of plasma agitating in different ways. These instabilities are hydrodynamic or kinetic in nature. Net forces with in plasma create new accelerations and small perturbation grows and destabilise the whole of plasma causing energy loss and destruction of plasma itself. Some of the well known instabilities are **Dicotron instability**, **Kink instability, sausage instability** etc.

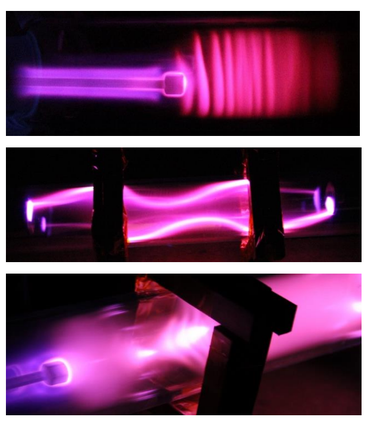


Kelvin–Helmholtz instability in fluids) is similar to Dicotron instability in Plasma





Sausage Instability is created when high current pass through plasma . It narrows down to points due to induced magnetic fields and current



It is as if Plasma has a mind of its own !

Turbulence is inherent factor that plays out in plasma and is one of the major concern in tokamak plasma control. It results in major heat loss in the fusion process. Whirlpools of water is an example of this phenomenon