PG Sem II
Physics

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Plasma Phy

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Plasma Physics

The best definition of a Plasma is then not as a hot gas but in terms of its collective behaviour. Plasma are a collection of charged particles, both +ve and -ve that behave in a collective way because of attractive and repelling electric forces. So this is the important feature Plasmas behave collectively. The interaction that makes them behave together is the electric fields created by the free charges.

In the Centre of a Plasma it is considered to be electrically neutral, that is the same number of -ve electrons as +ve ions in any given volume. The net charge is zero and the average electrical field is zero. If you put a metal probe into a Plasma and put a voltage of +100 Volts on the metal probe the Plasma would react to shield the probe so that the electrical field created by the probe would go to zero very close to the probe. This shielding is called Debye shielding.

Elementry Concepts of Plasma

Plasma can be considered as an ionized gas. Also called "Fourth State of matter."

Heating: Solid → Liquid → Gas → Plasma.

"Plasma is a collection of charged and neutral particles which exhibit the collective behaviour and obey the condition of quasi-neutrality."

1.) Collective Behaviour :-

Charged Particles can communicate to the other charged particles situated at large distance through long-range EM forces. Due to this connectivity. The Plasma responds collectely to any perturabation.

2.) Quasi neutrality :-

Number density of electrons (n_e) is approximately equal to number density of ions (n).

Examples of Plasma Systems :-

It is believed that around 99% visible matter in the

universe is in plasma state.
Lightning, Sun, Nebula, Auroras.

Plasma Temperature :-

A gas in Thermal equilibrium the most Probable distribution of velocities of the particles is given by the Maxwellian distribution.

$$f(v) = A \exp(-mv^2/2KT)$$

where $A = n(m/2\pi KT)^{1/2}$ with n representing the number density. Then the averaged Kinetic energy of particles is calculated as

$$E_{av} = \left(\int_x^x (mv^2/2) f(v)\, dv \right) \Big/ \int_x^x f(v)\, dv$$

$$= 1/2\, KT$$

Averaged Kinetic energy is $1/2\,KT$ for 1D and $3/2\,KT$ for 3D. Therefore, temperature is nothing but the averaged Kinetic energy of the Particles in equilibrium.

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