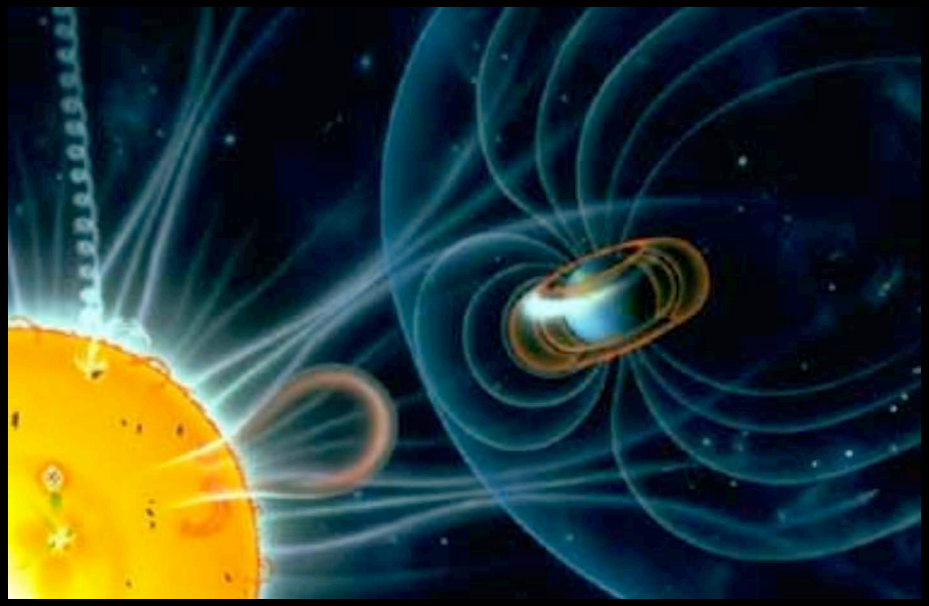
The Sun *and* ***Earth*** *forms an* ***integrated system*** *composed of* ***magnetic field*** *&* ***plasma****...*

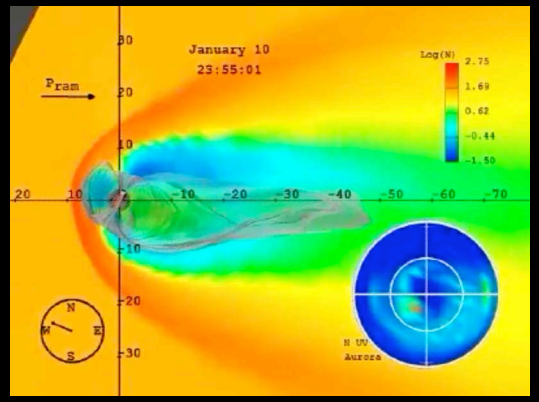


A view of ***the Earth inside the Sun****,*

or ***the Earth in the solar fields*** *is*

(solar gravitational field, solar radiative field, solar magnetic field)

important when we study the ***system****.*



The physical state of the Earth where we are living depends on short and long-term solar activity.

What is plasma?

Plasma...

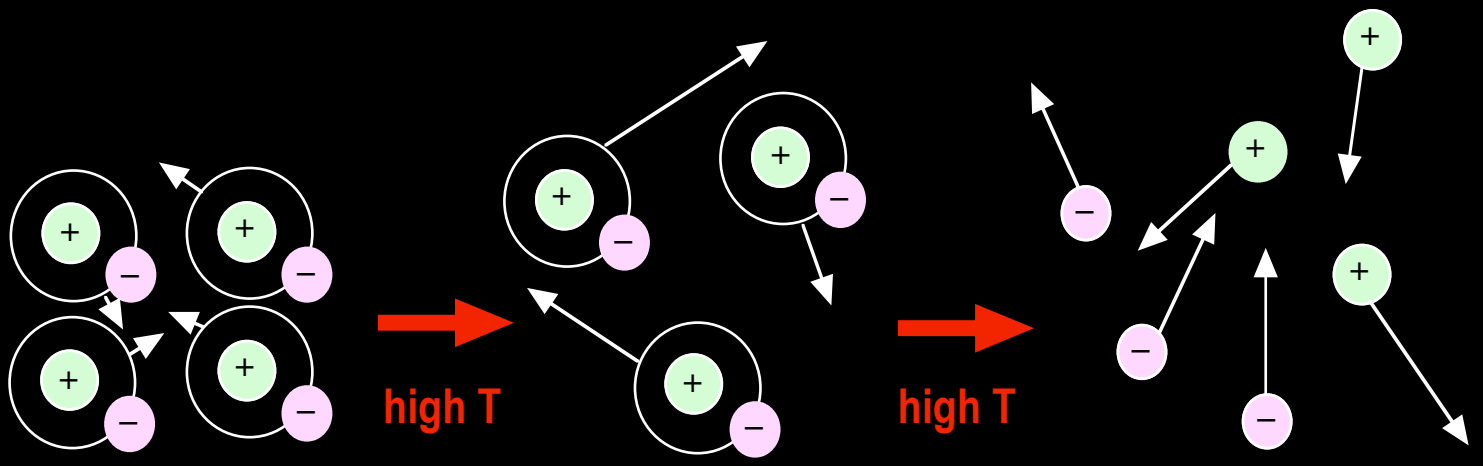
the 4th-state of matter, following solid, liquid, and gas

High temperature ($T \geq 10^4$ K)

→ neutral particles are *dissociated* into positive ions and negative electrons (*ionization*)

↓

plasma



Two types of plasma

Cold plasma (partially ionized plasma)...

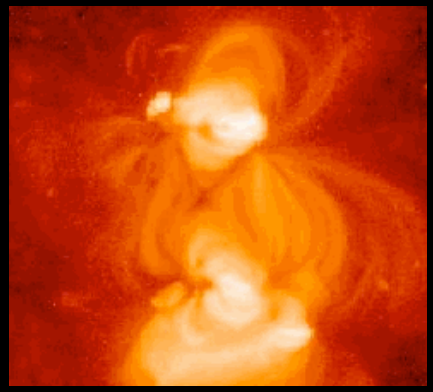
low temperature, only ***part*** of neutral particles are ionized

T ~ several thousands K

Hot plasma (fully ionized plasma)...

high temperature, ***all*** neutral particles are ionized

T >> 10^4 K



Examples of plasmas

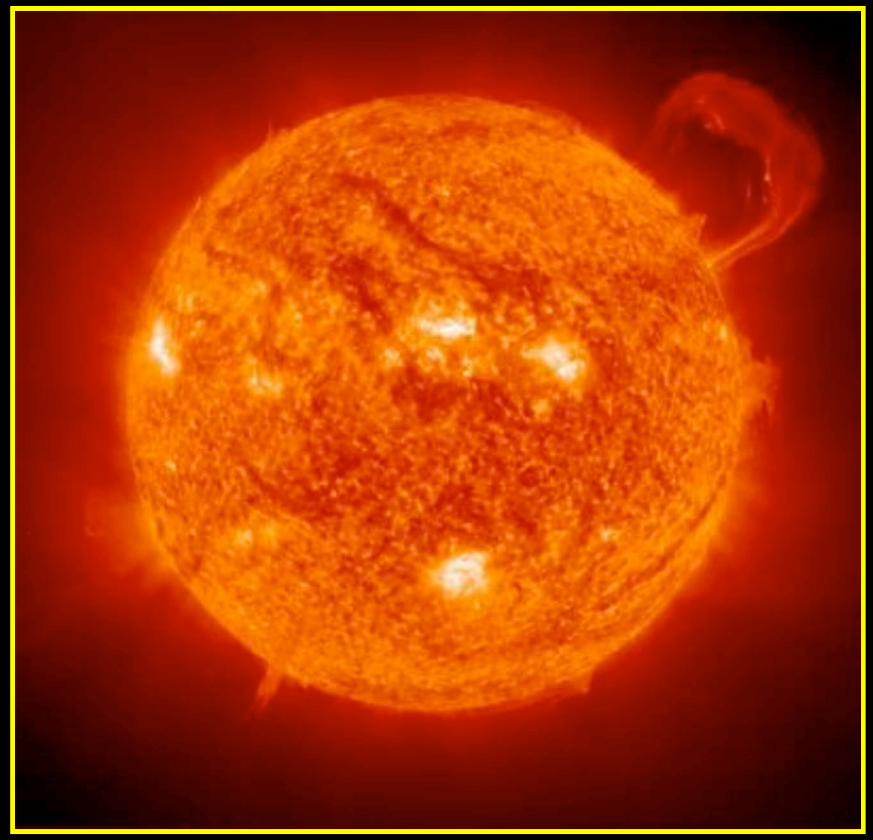
Plasmas in our daily life (cold plasma)

plasma television

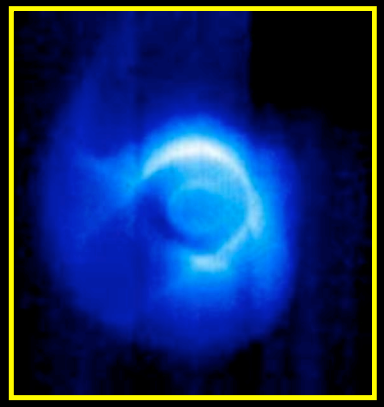
fluorescent lamp

Plasmas in the universe (hot plasma)

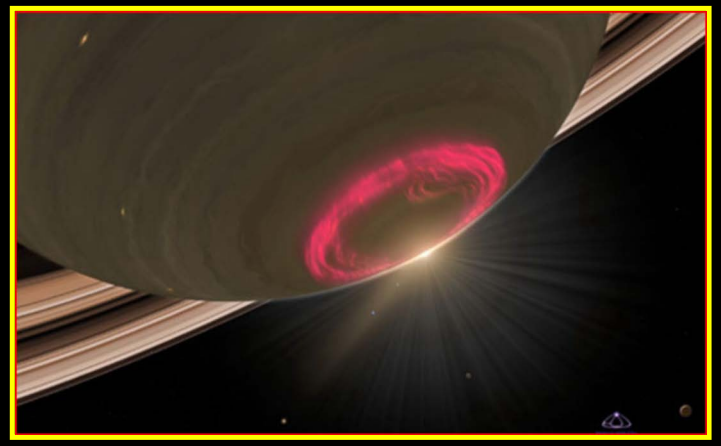
Solar atmosphere (chromosphere)



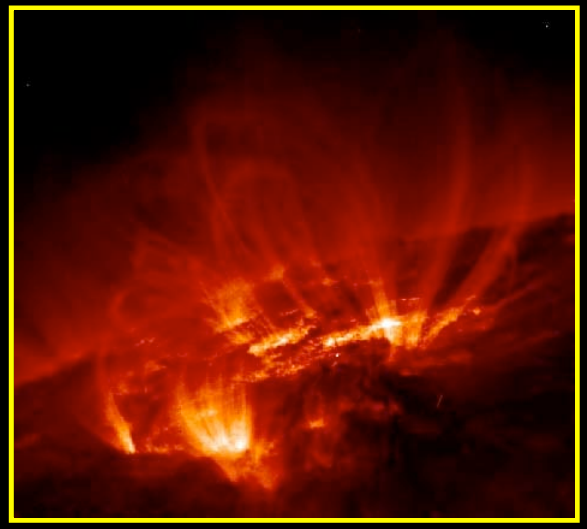
Temperature is higher than 10,000 K.



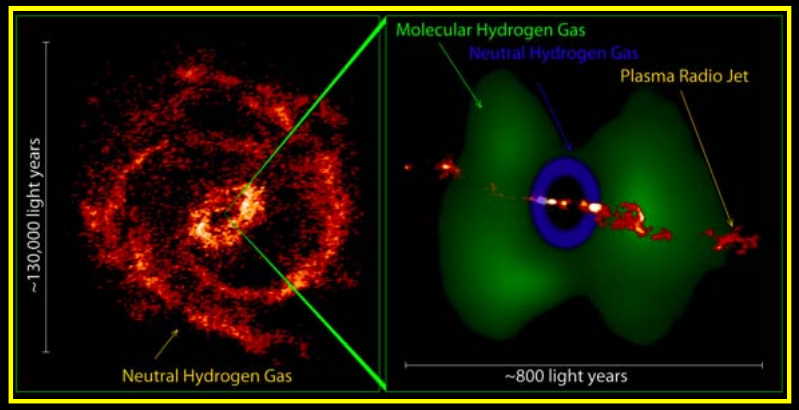
Magnetosphere



Saturn



Active region on the Sun

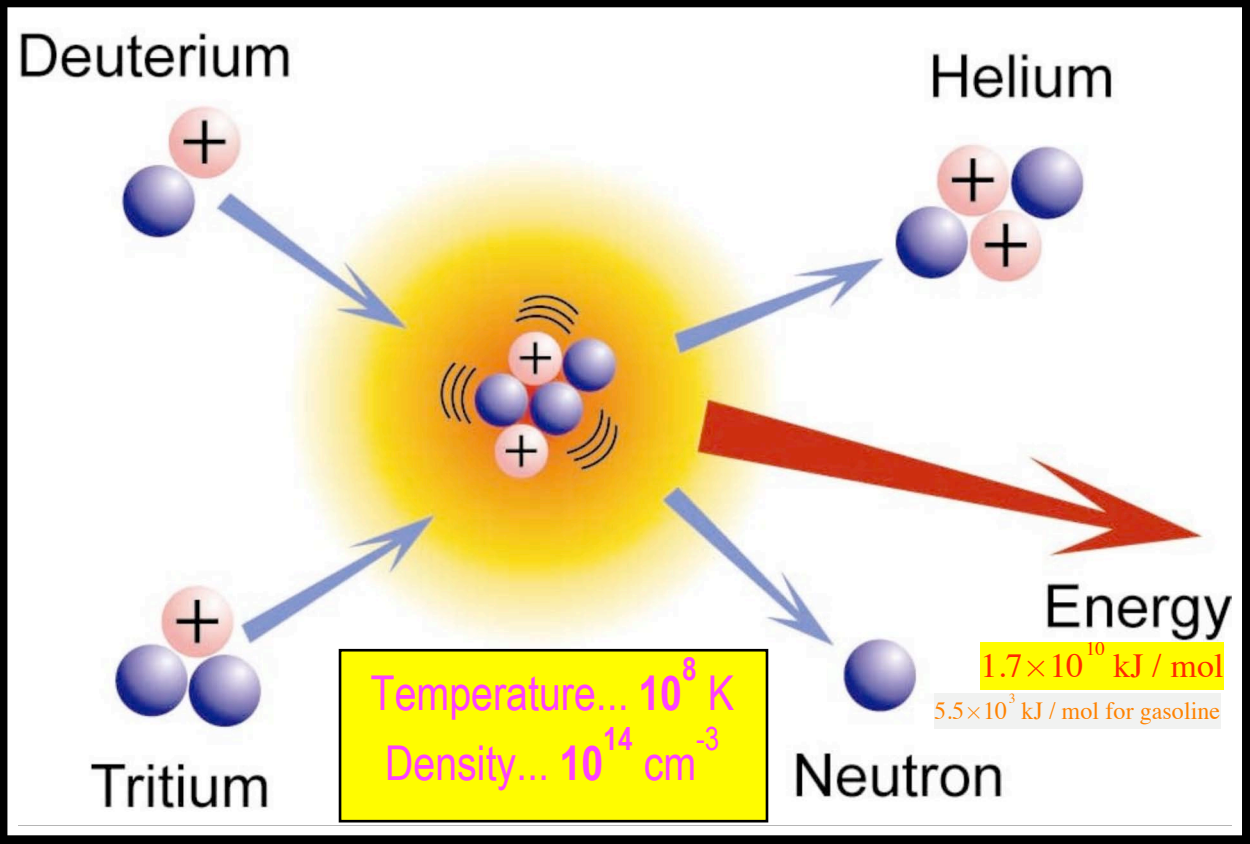


Jet from an active galactic nucleus (AGN)

Laboratory plasma (hot plasma)

tokamak

Plasmas... future energy resource (via **nuclear fusion**)



$T_{\text{solar center}} \sim 1.5\times10^{7}$ K

$n_{\text{solar center}} \sim 10^{26}$ cm^{-3}

Surface of the Earth

T ~ **300** K,

Density ~ 10^{19} cm^{-3}

How can we confine a 100,000,000 K plasma?

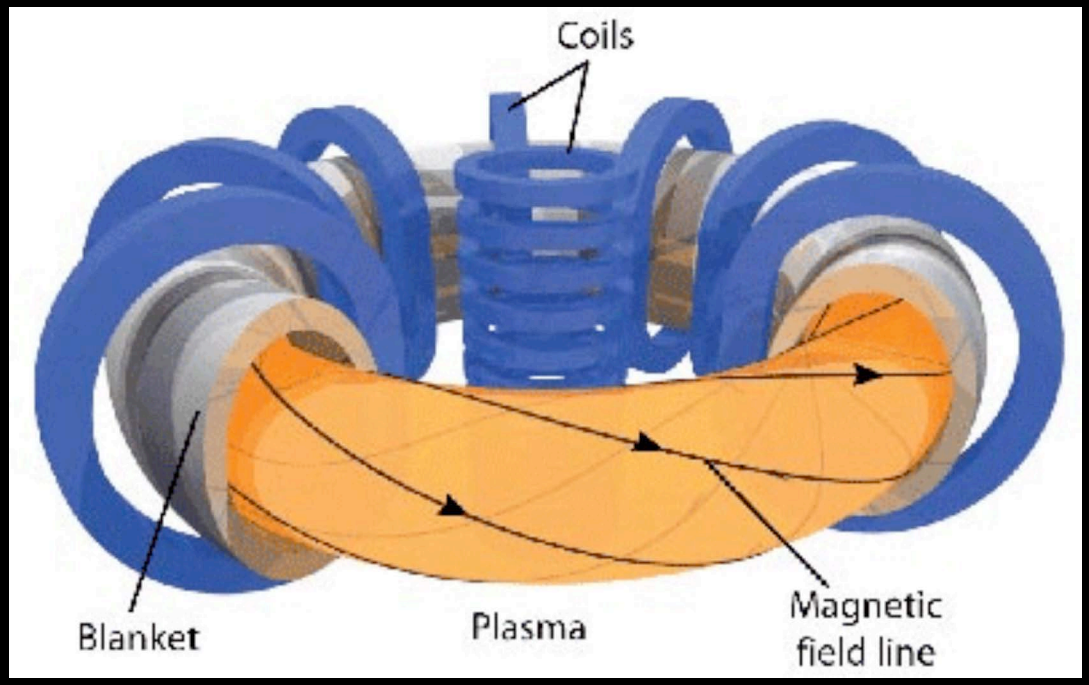
Even for the matter that has the highest melting point, this is less than 4000 K ('***tungsten***' whose melting point is about 3695 K).

This means that even if ***tungsten*** is used for the confinement of a plasma, it will be melted and vaporized immediately.

Therefore, we cannot use any solid material to confine the plasma.

Instead, we use ***magnetic field*** to confine the plasma.

Magnetic field is used to confine a hot plasma...



Iron's melting point... T ~ 1808 K
Tungsten's melting point... T ~ 3695 K

Plasma... T > 10000 K