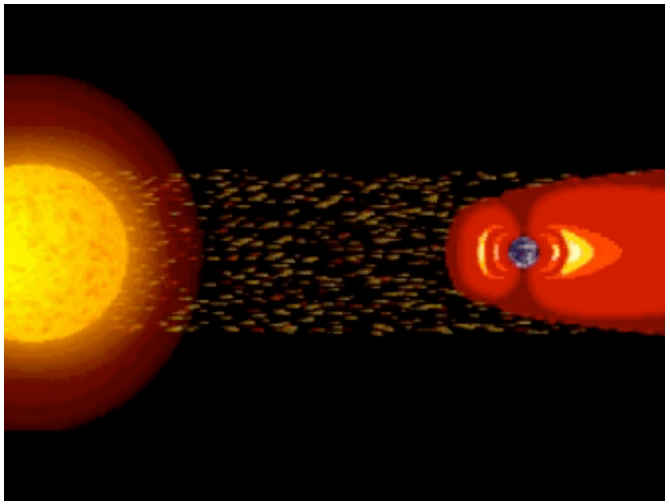
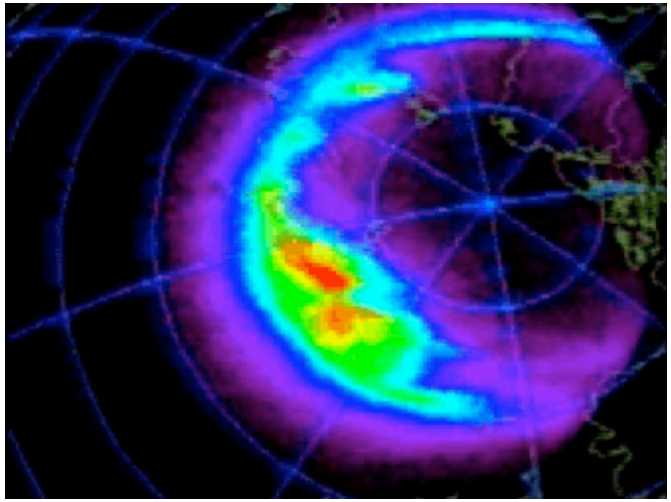
Interactions between solar magnetic fields and terrestrial magnetic fields

Solar wind (schematic model)

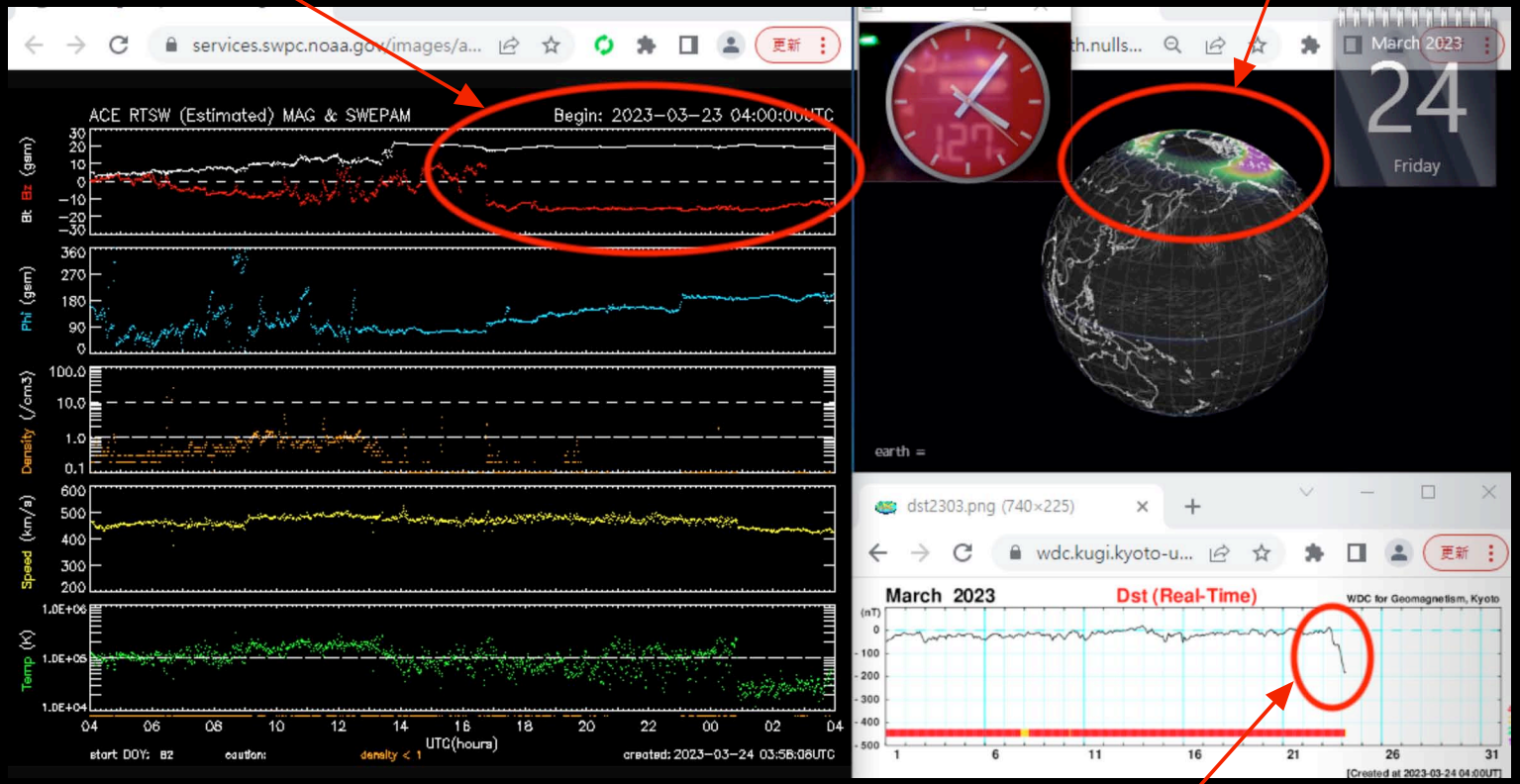


Aurora *observed from* ***the space***

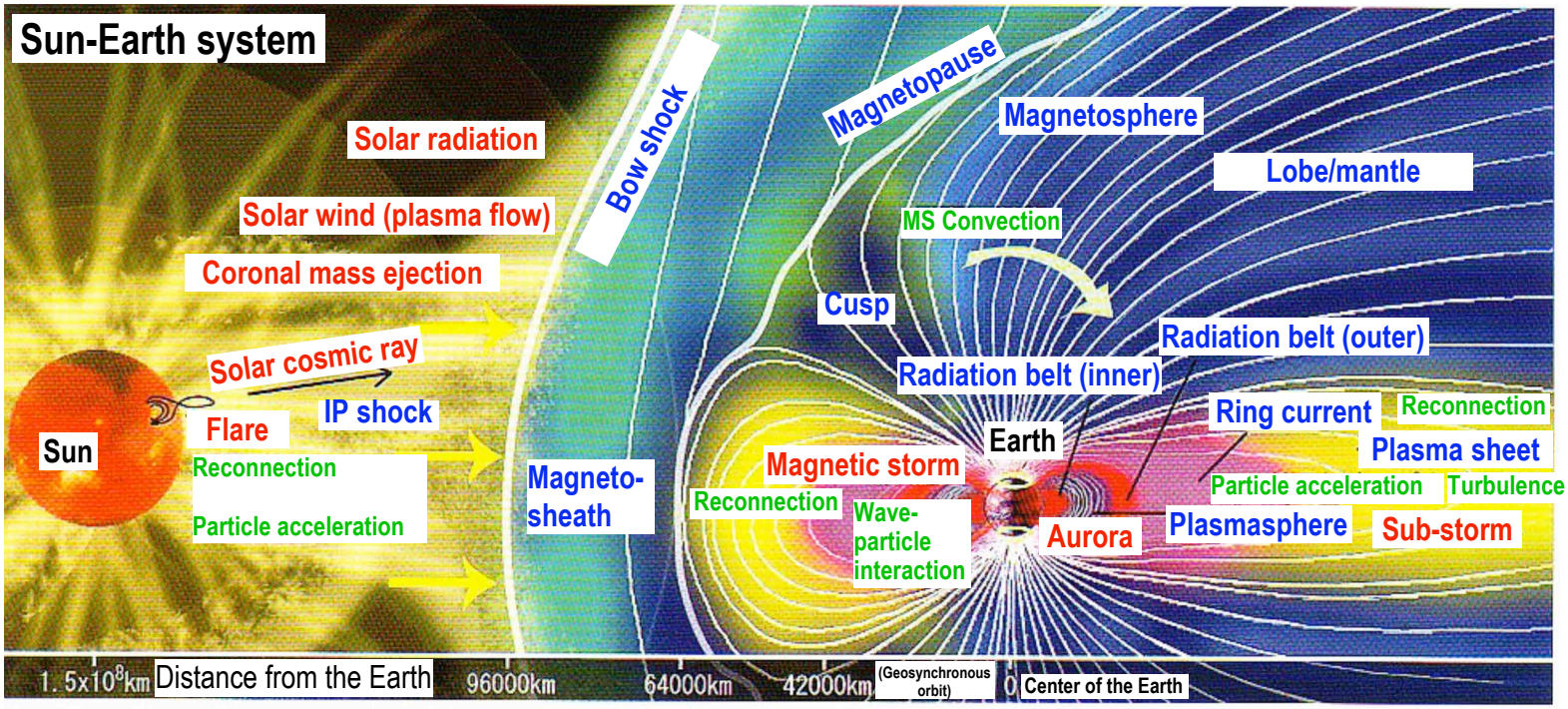


Aurora *observed from* ***the ground***

An energetic event in the space (24 March, 2023)



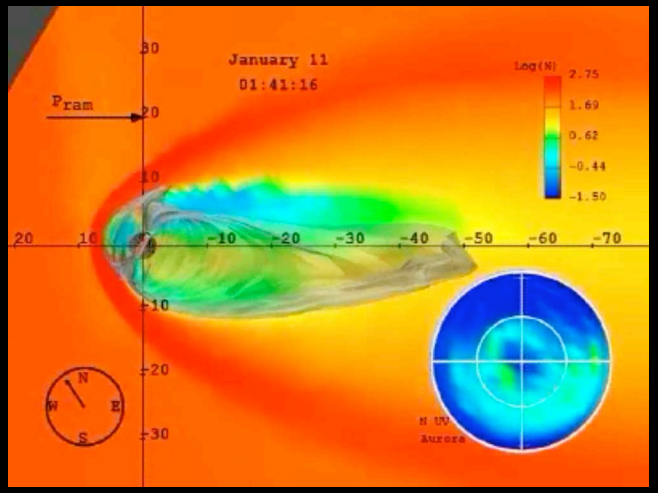
Phenomena, *physical processes*, and *structure* in *Sun-Earth system*

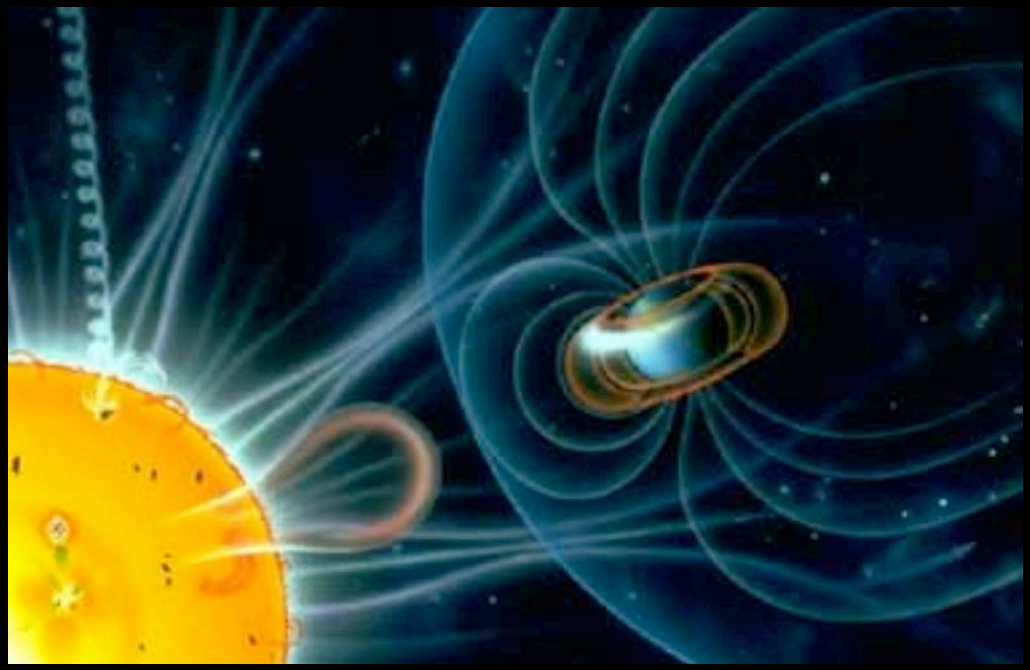


From T. Seki

Magnetic field and **Plasma**... **main components of Sun-Earth system**

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





A view of
'the Earth inside the Sun'
is important when we
study Sun-Earth system.

Brief review of plasma

What is plasma?

Plasma...

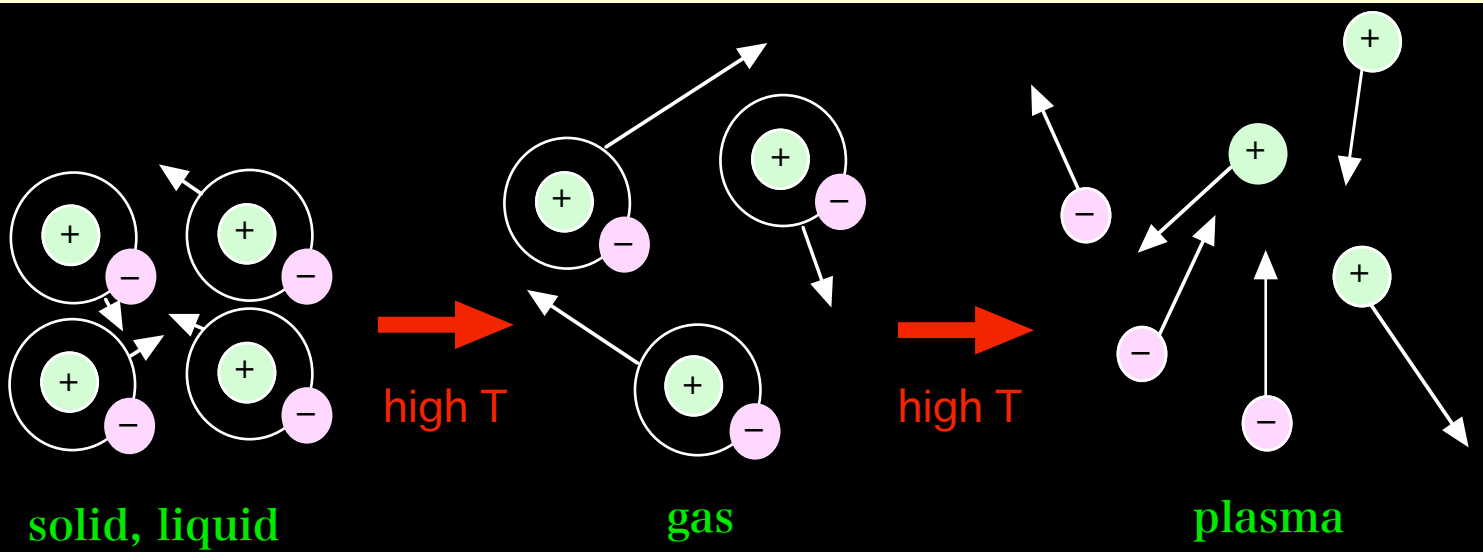
the 4th-state of matter, following solid, liquid, and gas

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)...

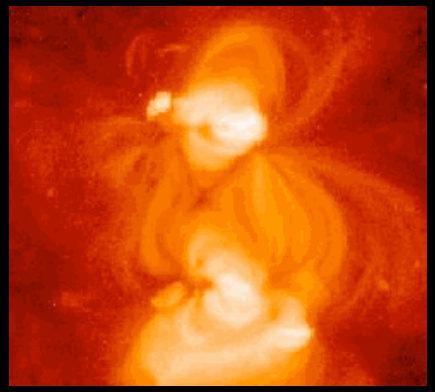
low temperature, only part of particles are ionized

T ~ several thousands K

Hot plasma (fully ionized plasma)...

high temperature, all particles are ionized

$T >> 10^4$ K



Examples of plasmas

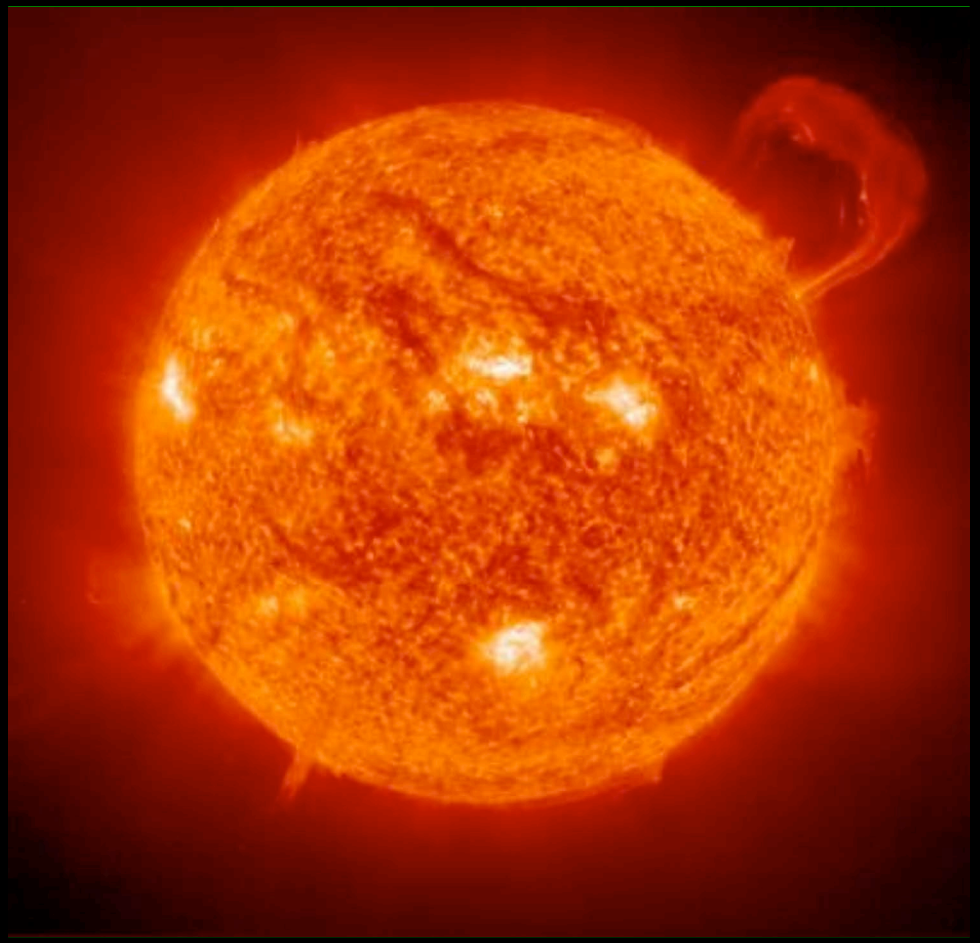
Plasma in our daily life (cold plasma)

plasma television

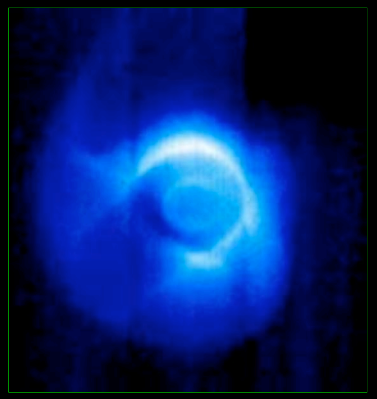
fluorescent lamp

Plasma in the universe (hot plasma)

Solar atmosphere
(chromosphere)

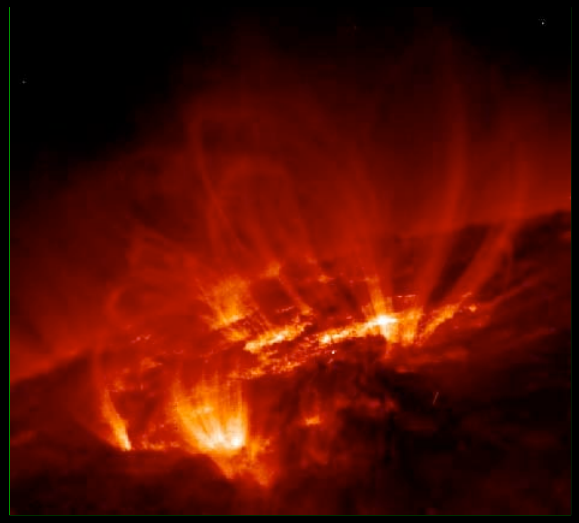


Since the temperature is very high (higher than 10,000 K), matter is in a plasma state.

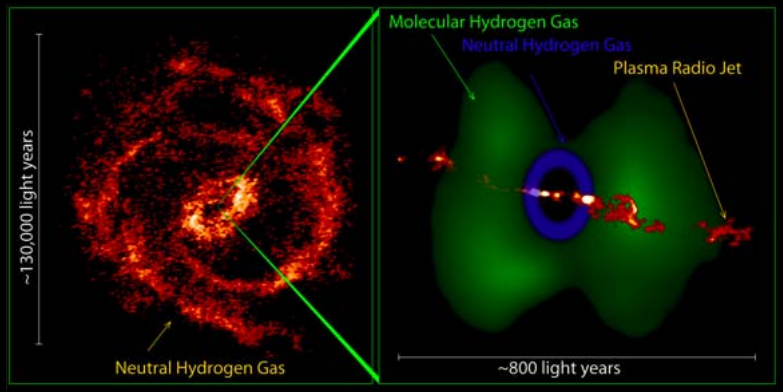


Magnetosphere

Saturn



Active region on the Sun

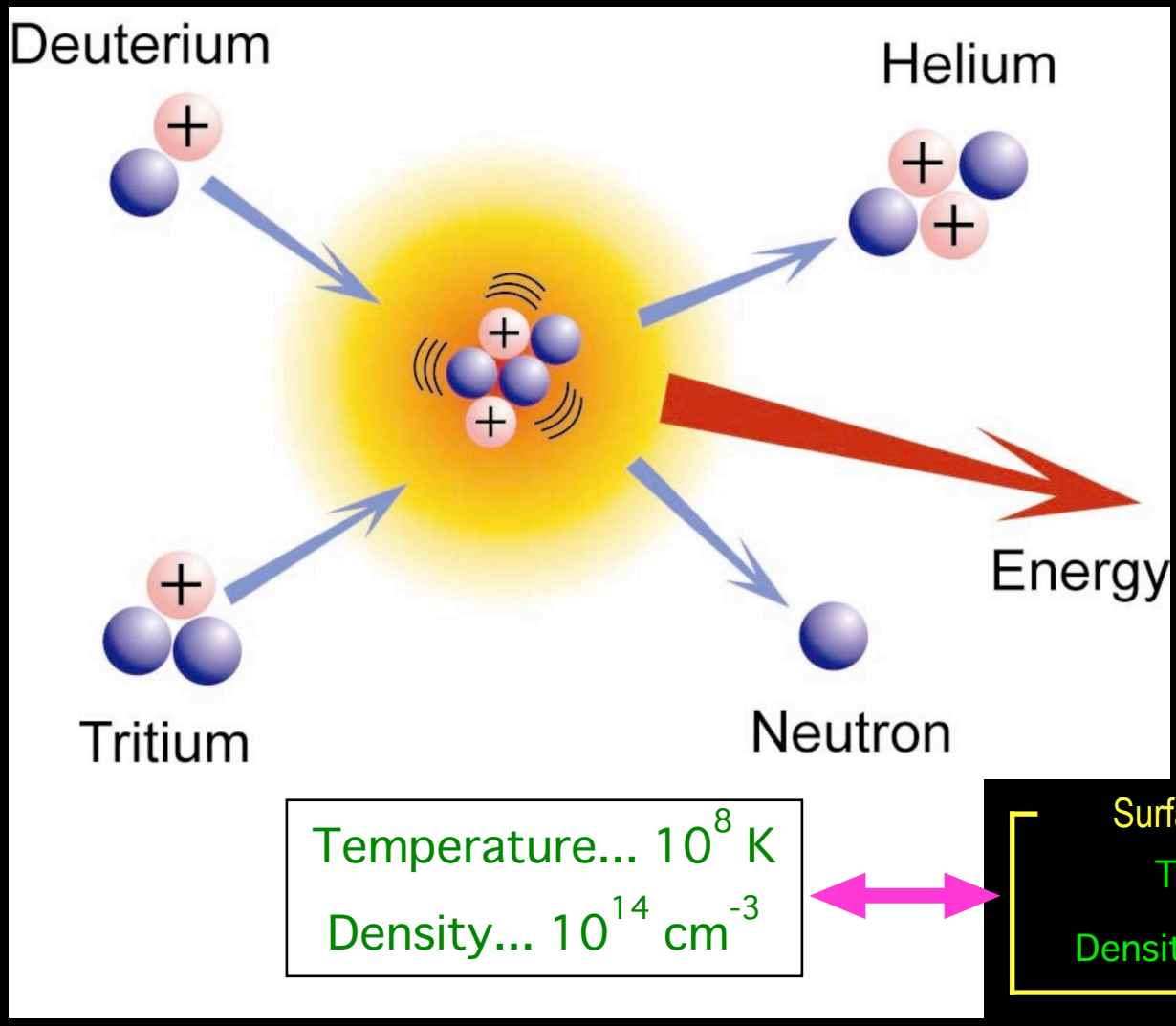


Jet in an active galactic nucleus (AGN)

Laboratory plasma (hot plasma)

Plasma in a tokamak

Plasma... future energy resource (via nuclear fusion)



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

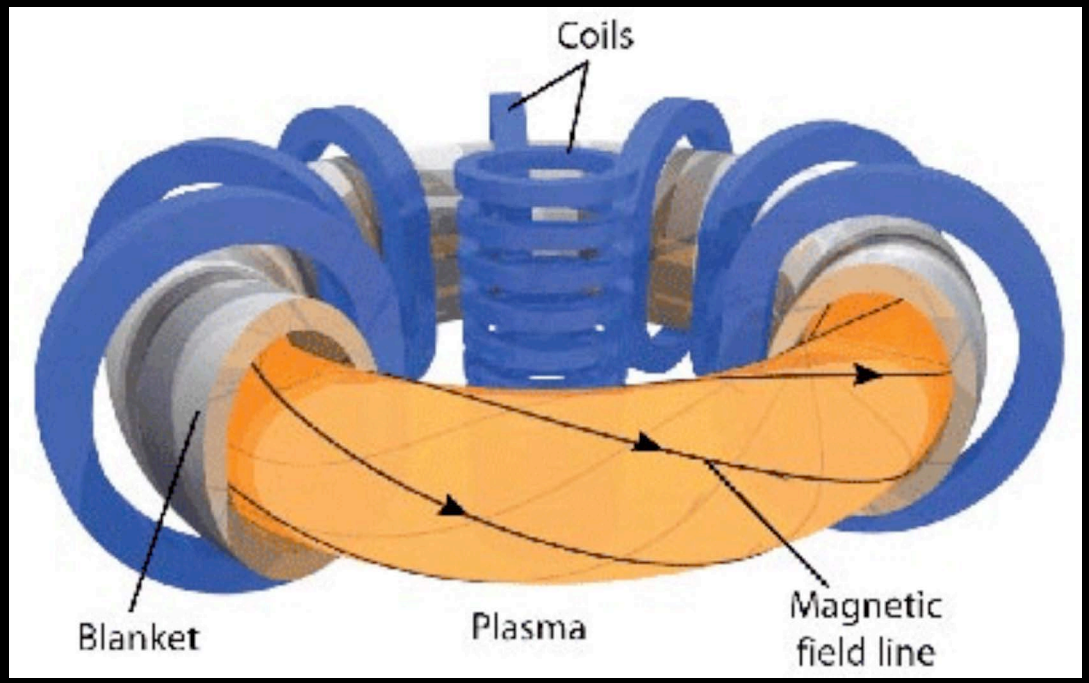
Even for the matter that has the highest melting point, this is less than 4000 K ('***tungsten***' whose melting point is about 3695 K).

This means that even if ***tungsten*** is used to try to confine a plasma, it will be melted and vaporized immediately.

Therefore, we cannot use a solid body to confine a plasma.

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

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



Iron... melting point ~ 1808 K
Tungsten... melting point ~ 3695 K

Plasma... T > 10000 K