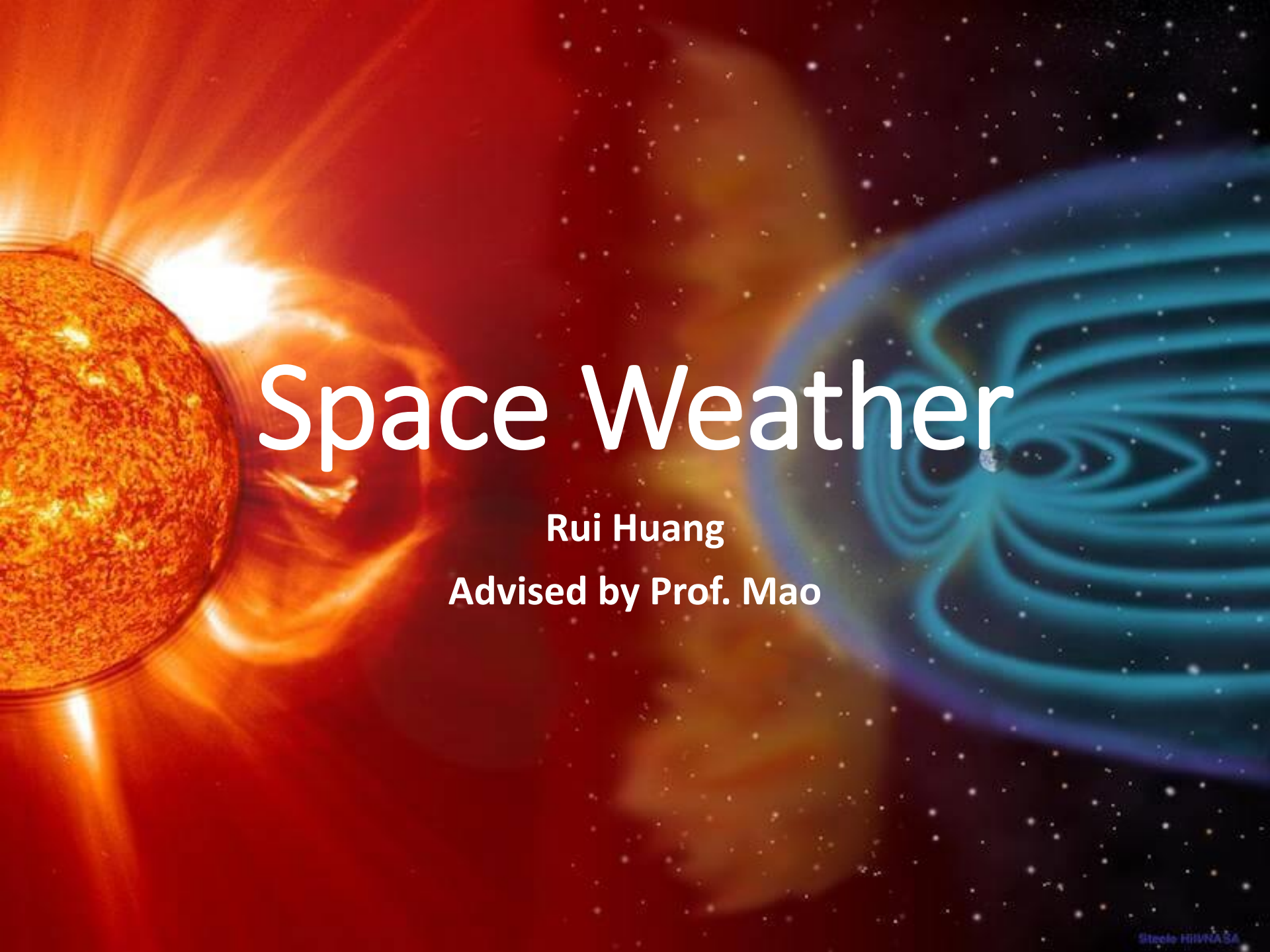


Space Weather

Rui Huang

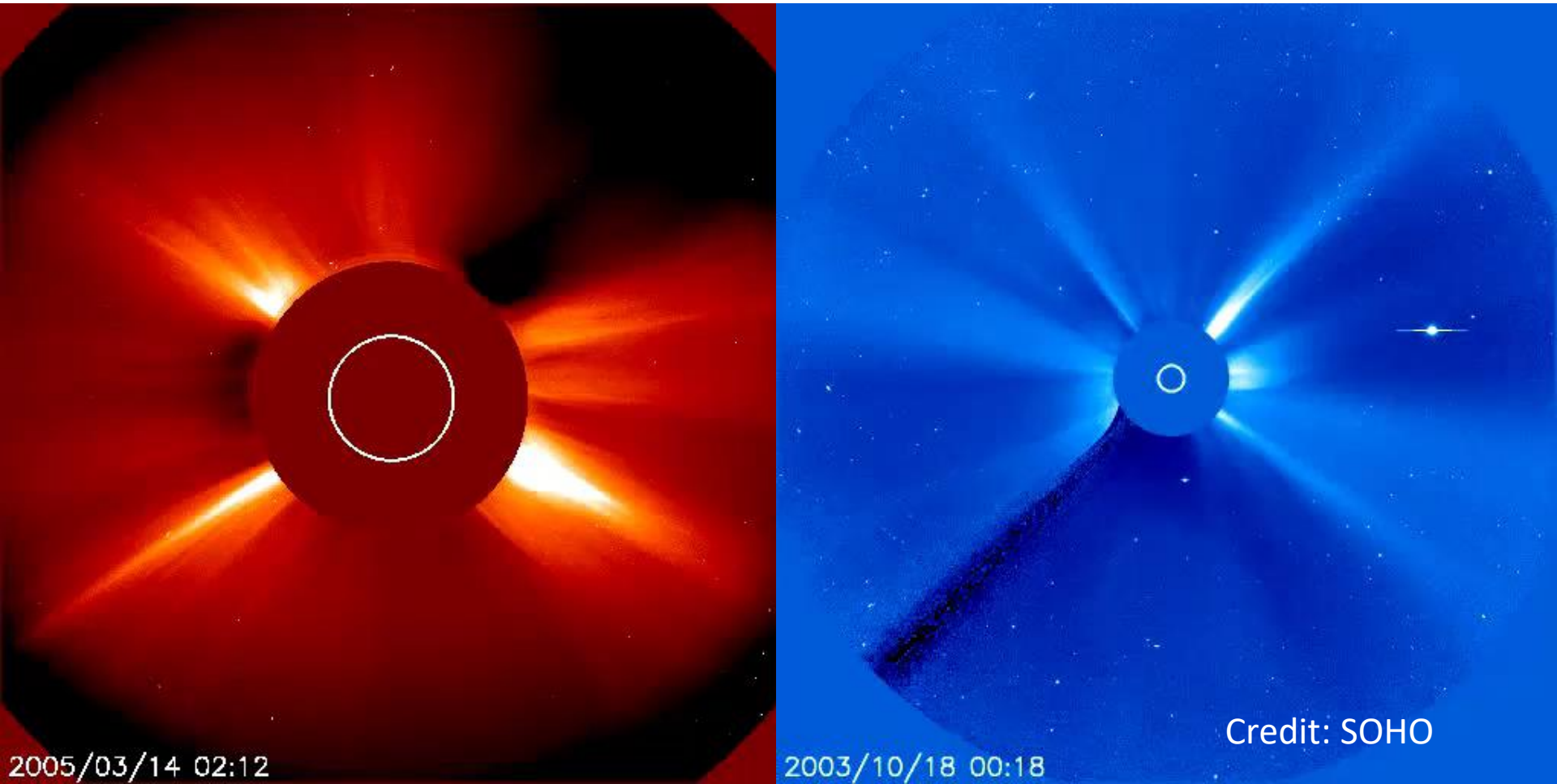
Advised by Prof. Mao

Outline

- Introduction
- Solar parts
  - Solar wind
  - Solar flare
  - Coronal Mass Ejections
- Magnetosphere
  - Aurora
  - Val Allen belt
- Effects
- Summary

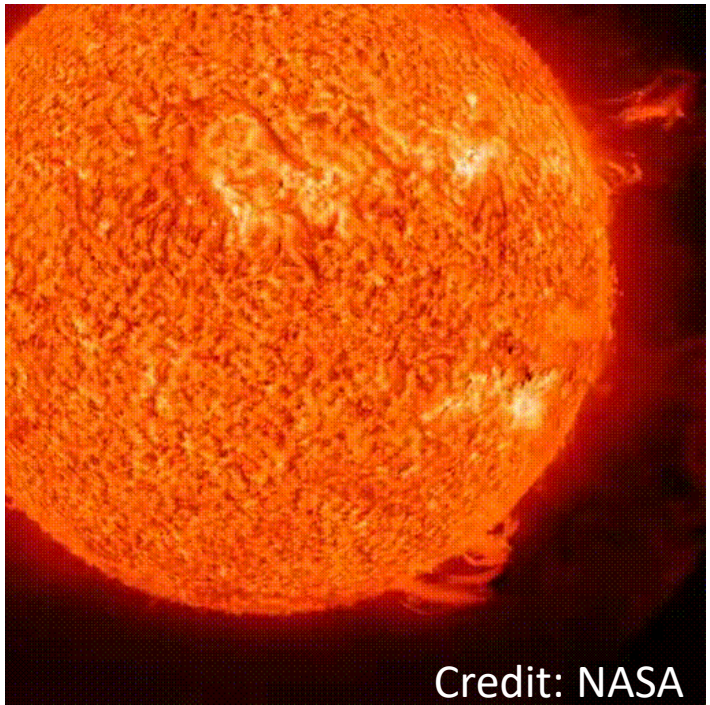
Solar wind

- a stream of charged particles releas from the upper atmosphere of the S called the corona.
- mostly electrons, protons and alpha particles with kinetic energy betwee 0.5 and 10 keV.
- Carry interplanetary magnetic field (IMF)
- ~400km/s
- Continually

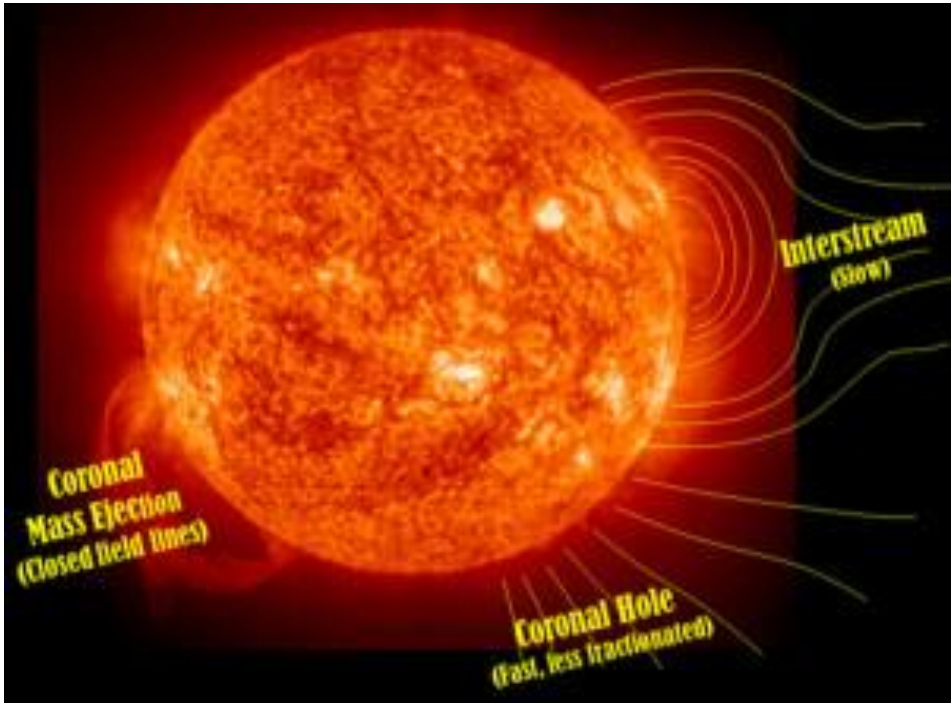

2005/03/14 02:12
2003/10/18 00:18
Credit: SOHO

Coronal Mass Ejections (CMEs)

- Definition: an observable change in coronal structure that
  - 1) occurs on a time scale of a few minutes and several hours
  - 2) involves the appearance (and outward motion) of a new, discrete, bright, white light feature in the coronagraph field of view.



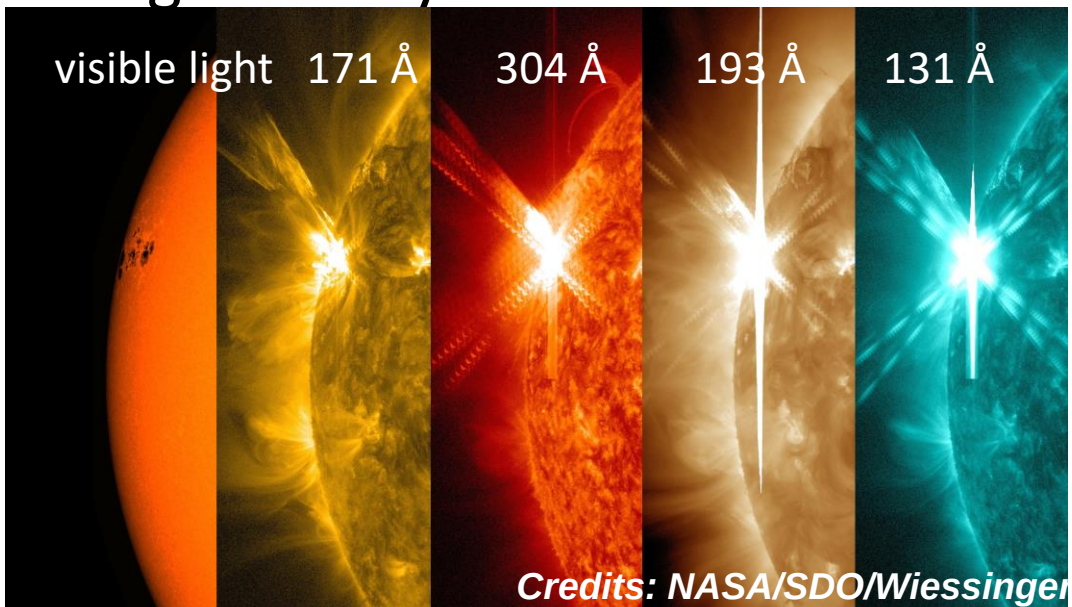
- a magnetized plasma consisting primarily of electrons and protons.
- from a few km/s (near the Sun) to nearly 3000 km/s



Solar Flares

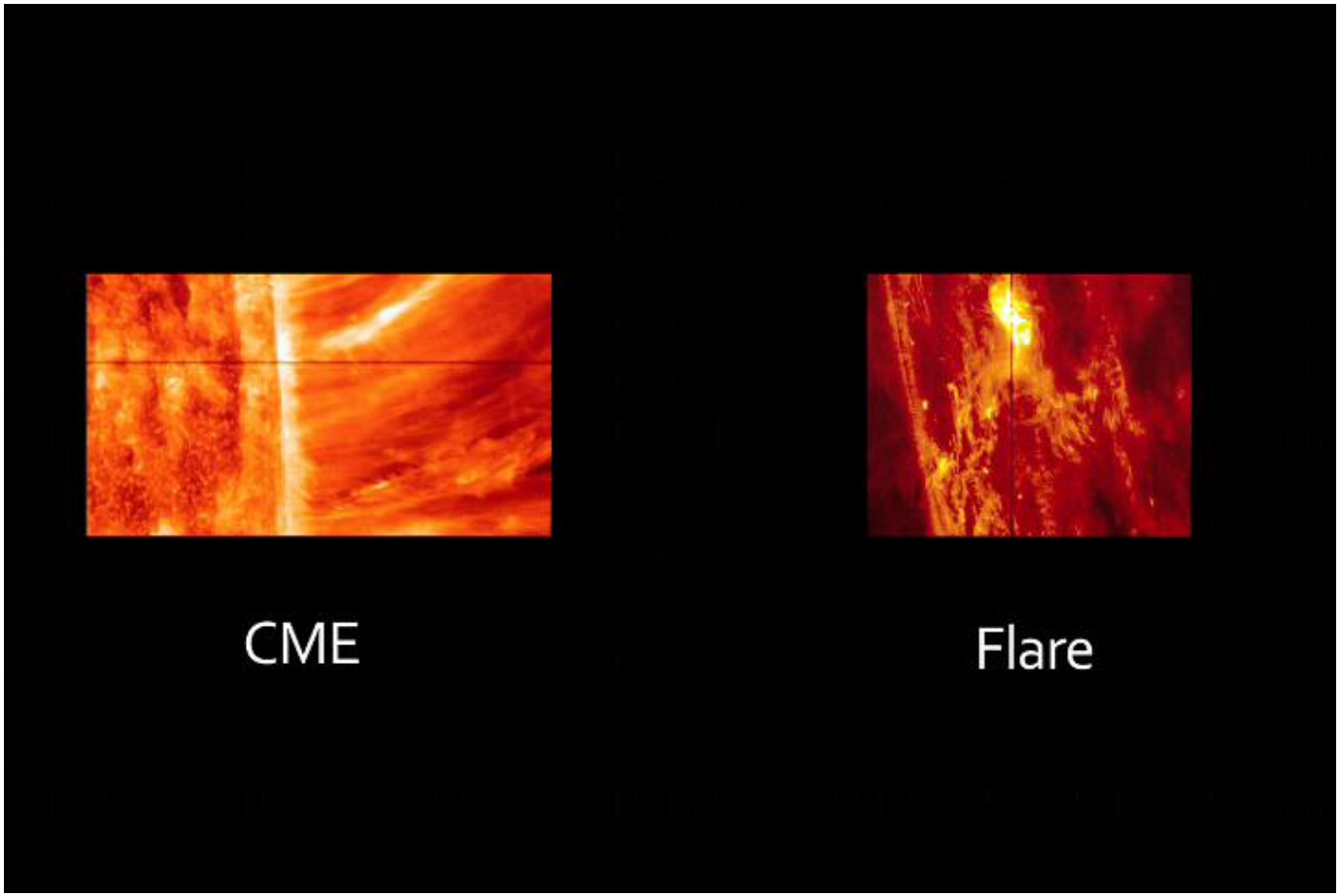
A sudden flash

- The flashes of electromagnetic radiation released within seconds to minutes
- thermal soft x-ray flare first
- CME → shock wave → accelerated electrons → bremsstrahlung → X-ray



Solar flares vs CMEs

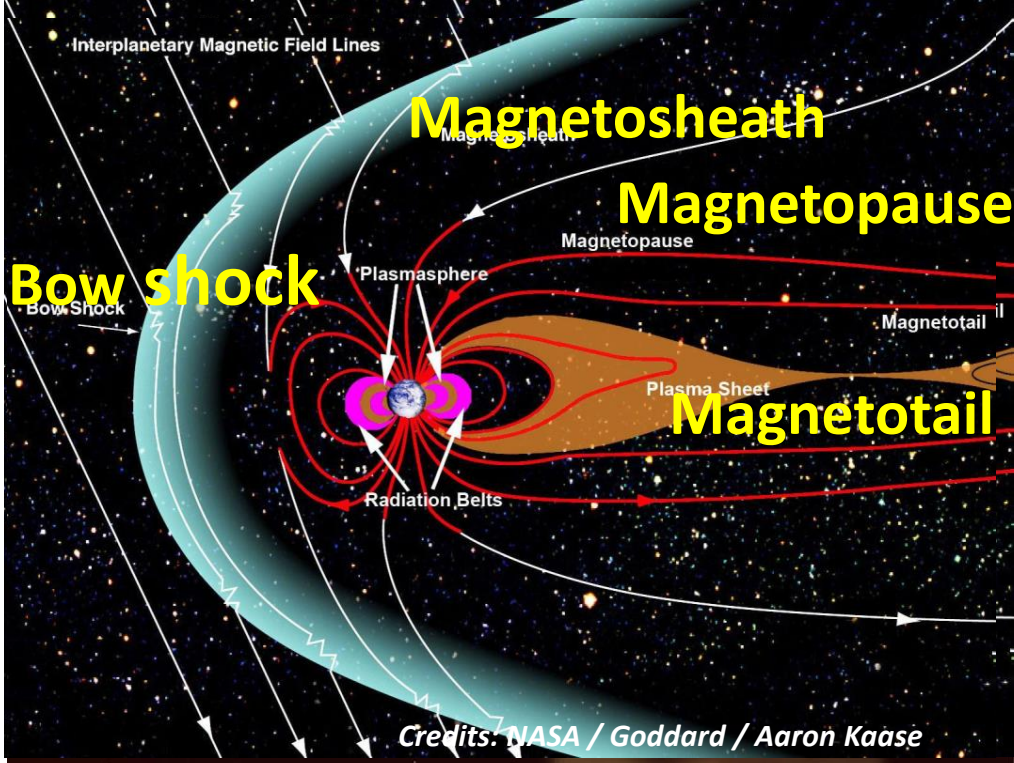
Flares look like bright flashes of light on the sun. Coronal mass ejections look like clouds zooming out into space.

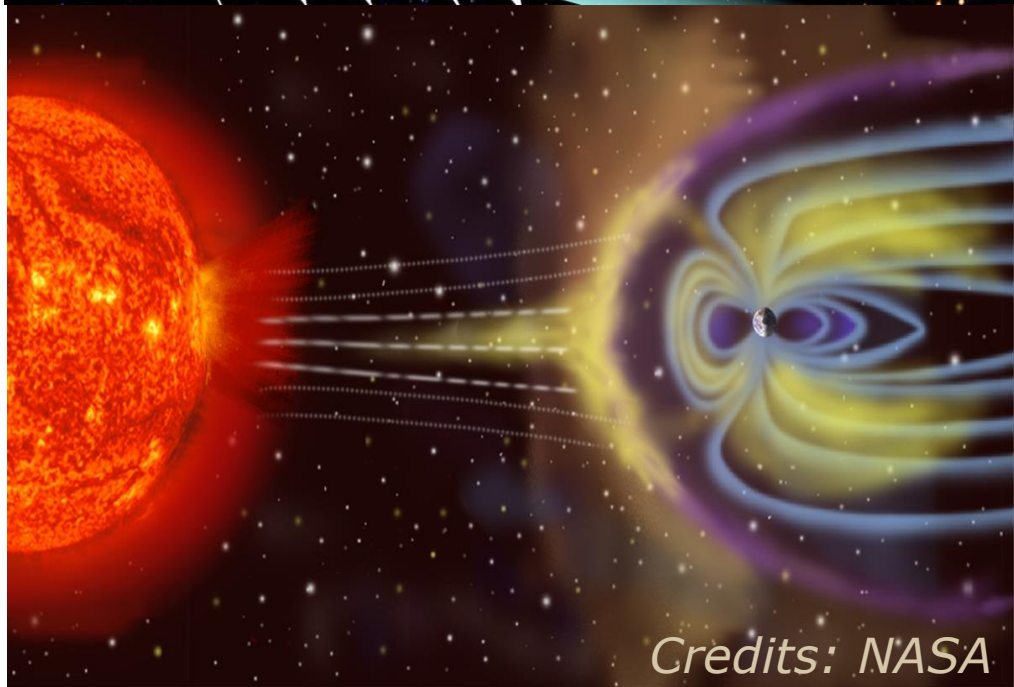


CMEs interaction with Magnetosphere

Magnetosphere

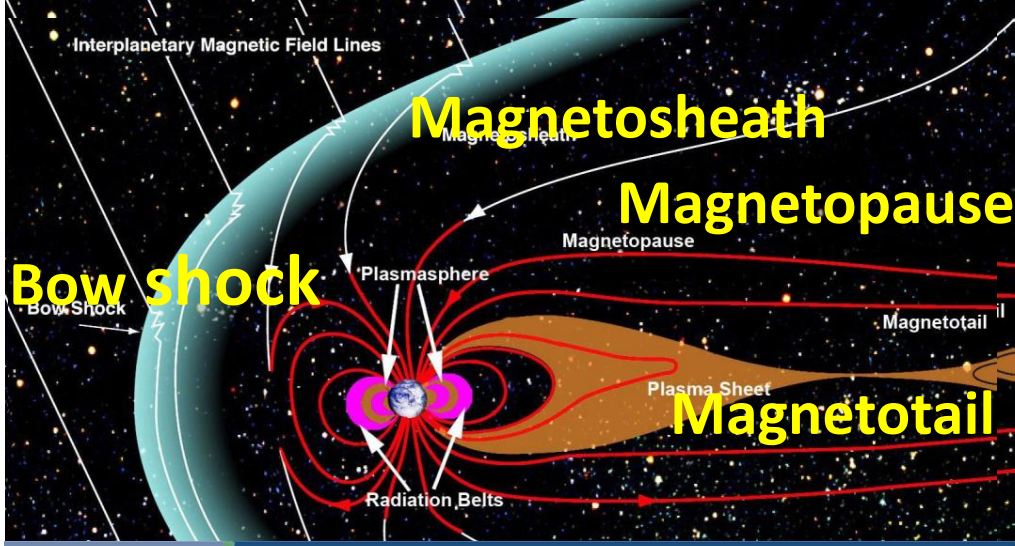
- **Bow shock**
  - outermost layer
- **Magnetosheath**
  - between the bow shock and the magnetopause
  - speed of the solar wind there decreases
- **Magnetopause**
- **Magnetotail**

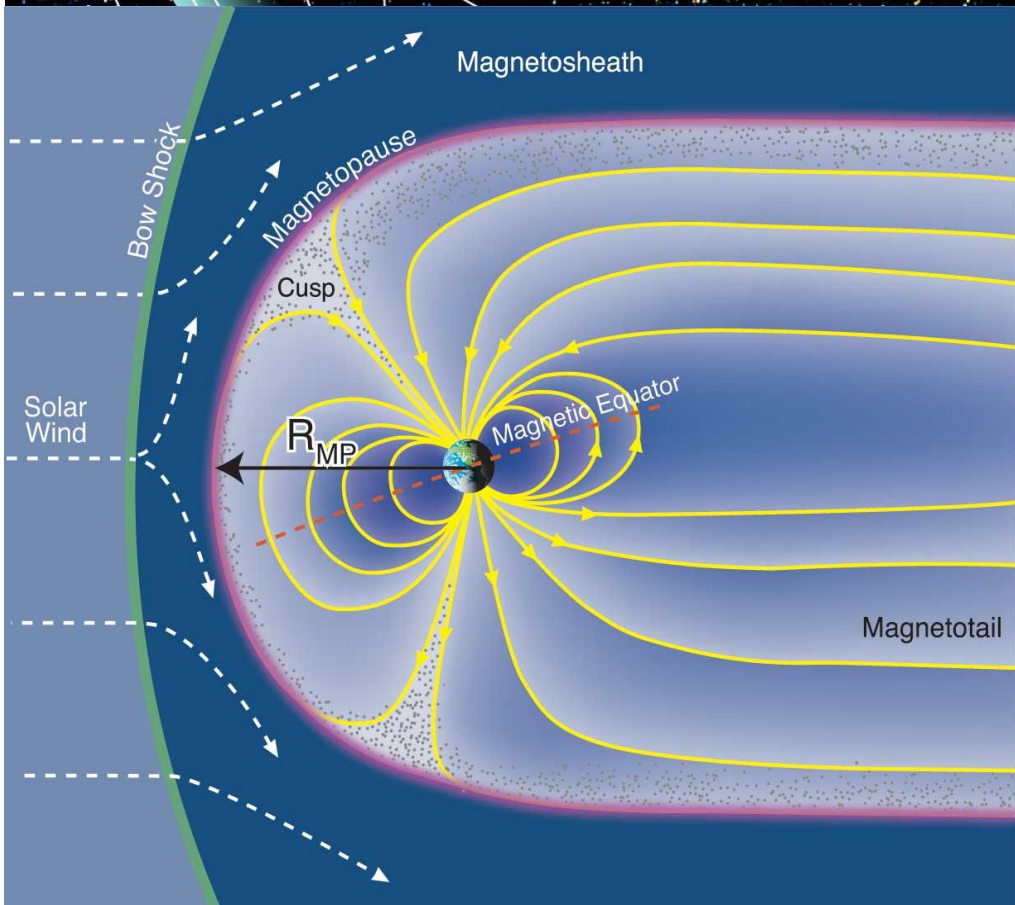




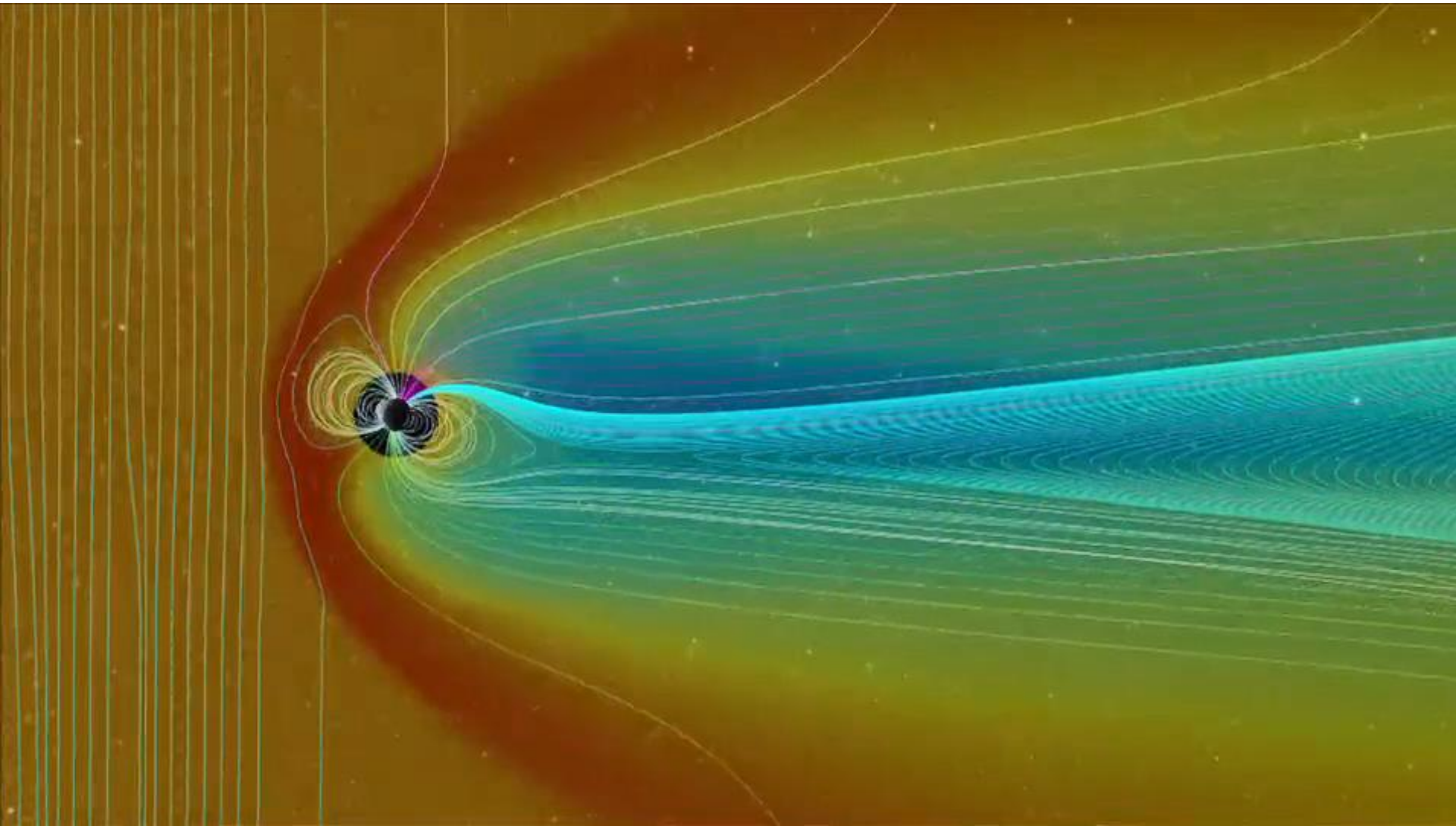
Magnetosphere

- **Bow shock**
- **Magnetosheath**
- **Magnetopause**
  - pressure from the planetary magnetic field is balanced with the pressure from the solar wind
- **Magnetotail**
  - Opposite the compressed magnetic field
  - almost empty



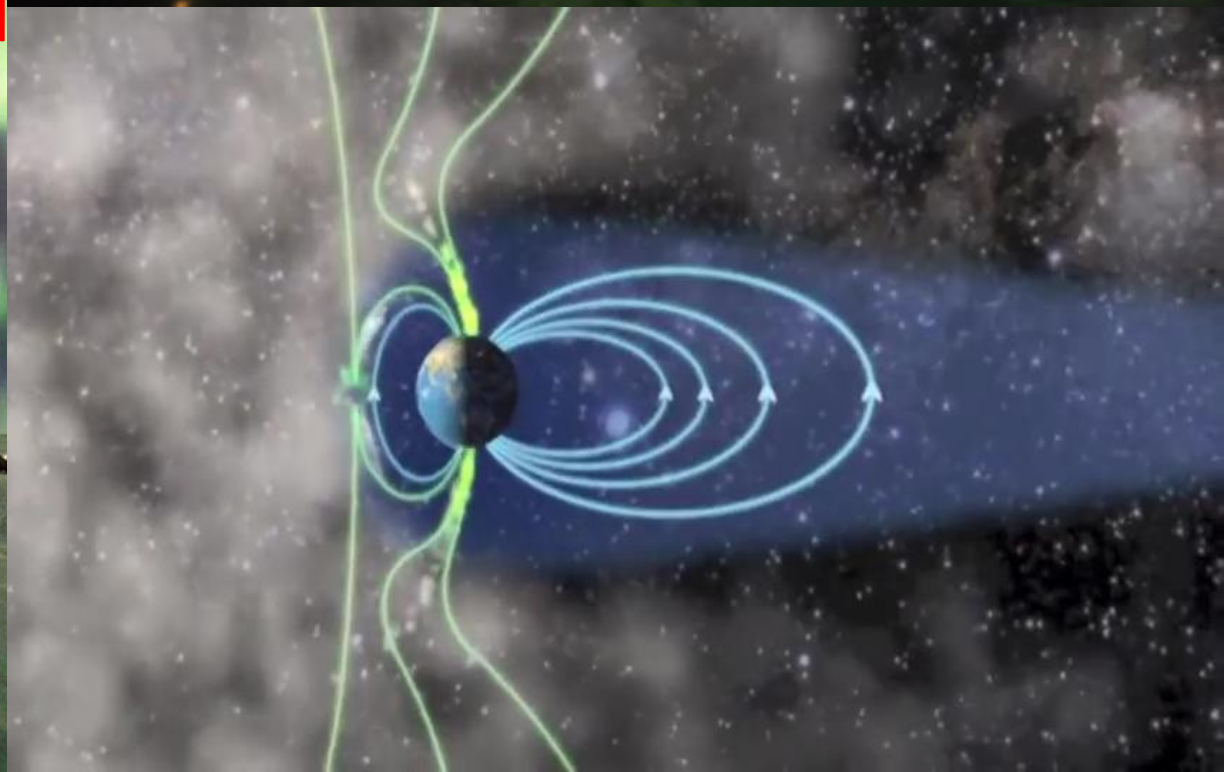


Magnetosphere



Aurora

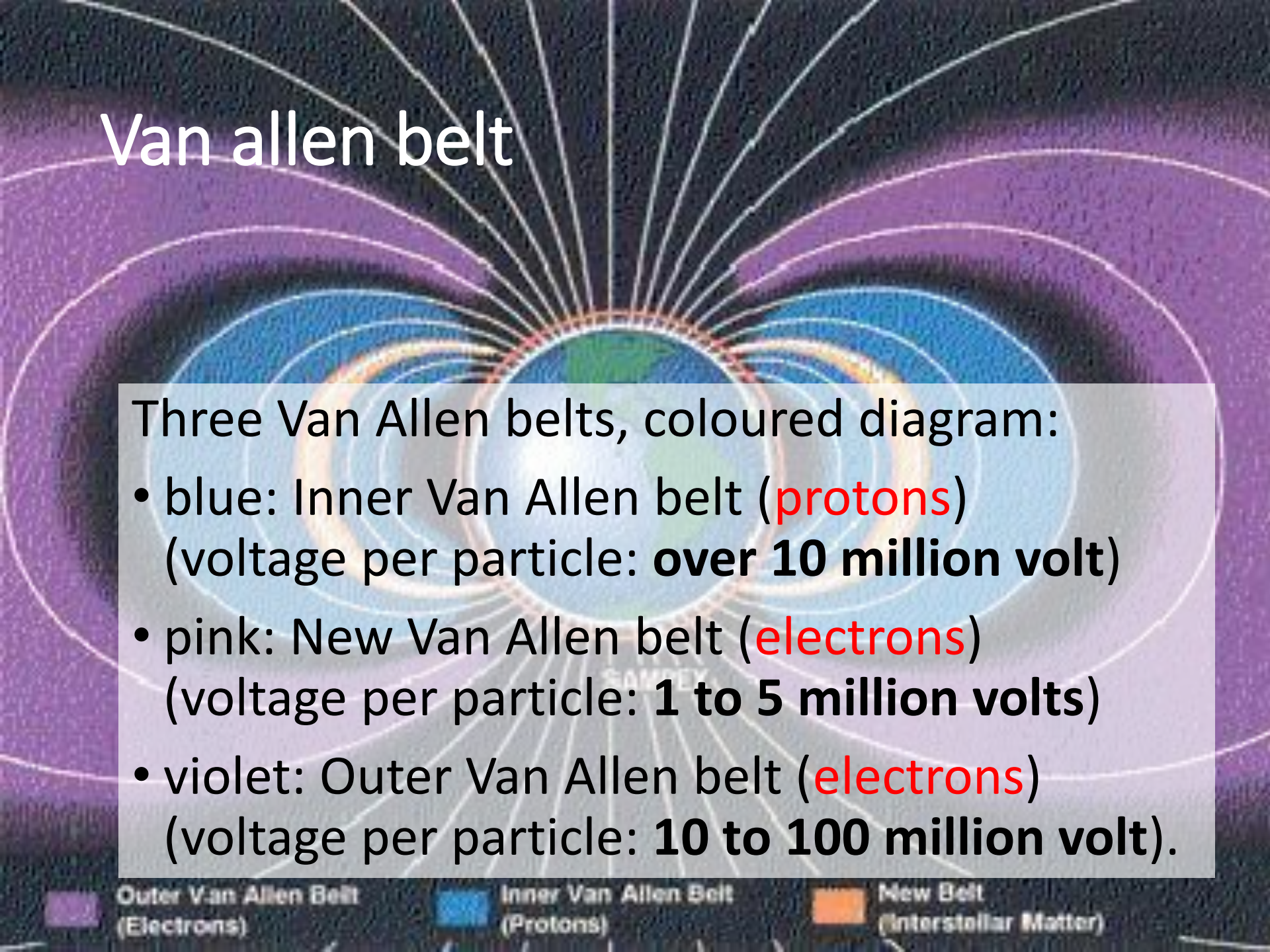
- Auroras are the result of disturbances in the magnetosphere caused by solar wind
- The resulting ionization and excitation of atmospheric constituents emits light of varying color and complexity

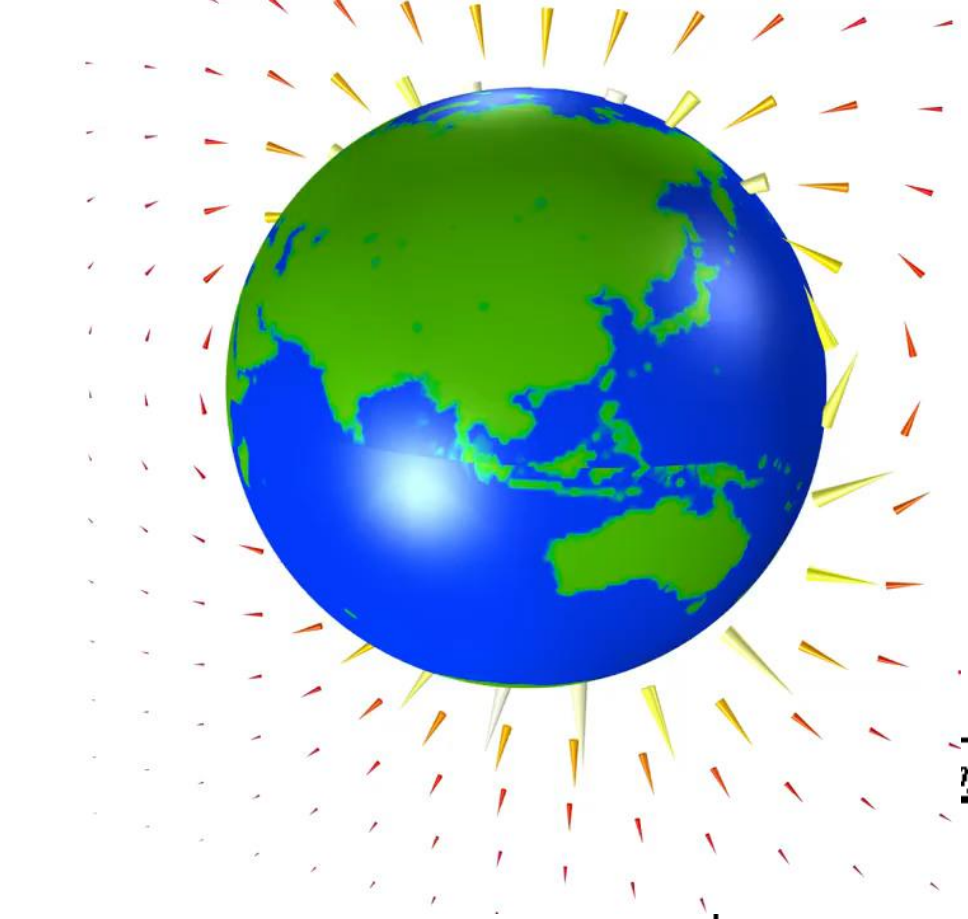


Van allen belt

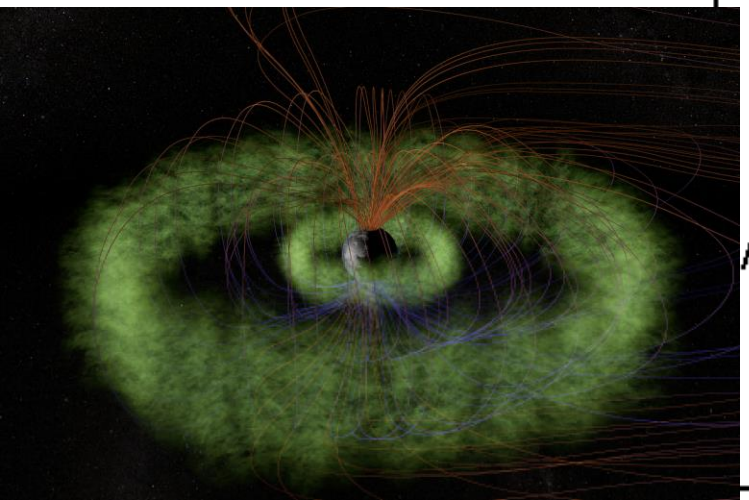
Three Van Allen belts, coloured diagram:

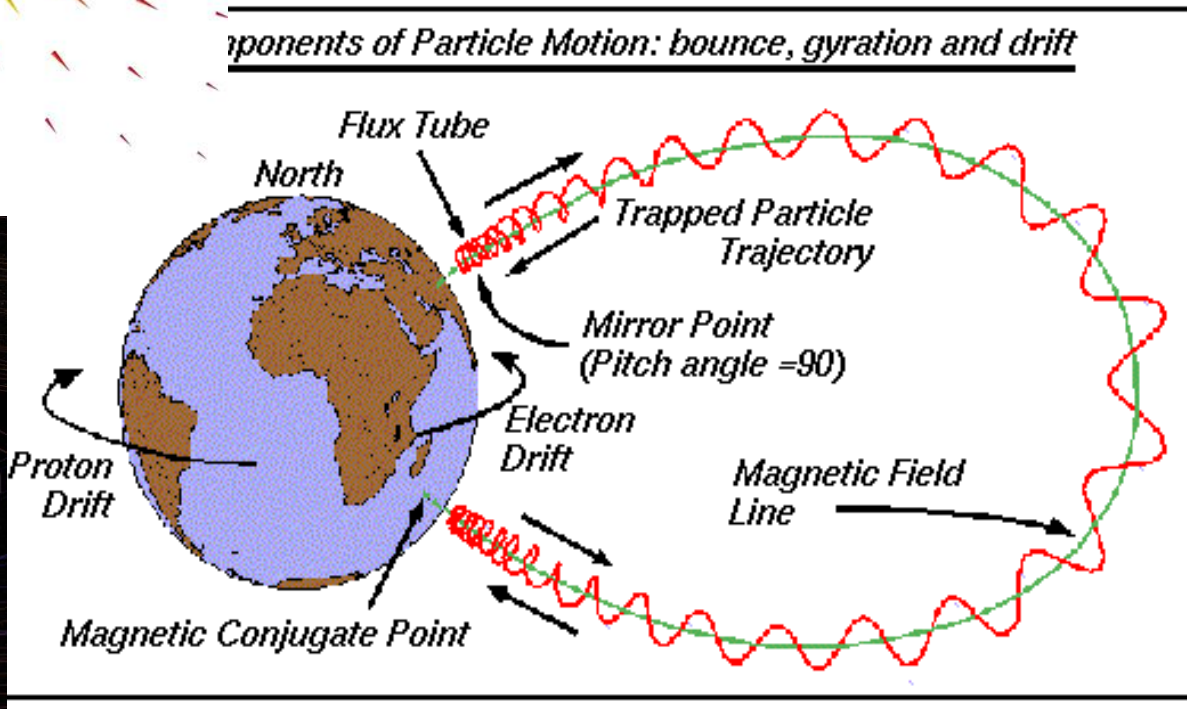
- blue: Inner Van Allen belt (protons) (voltage per particle: **over 10 million volt**)
- pink: New Van Allen belt (electrons) (voltage per particle: **1 to 5 million volts**)
- violet: Outer Van Allen belt (electrons) (voltage per particle: **10 to 100 million volt**).



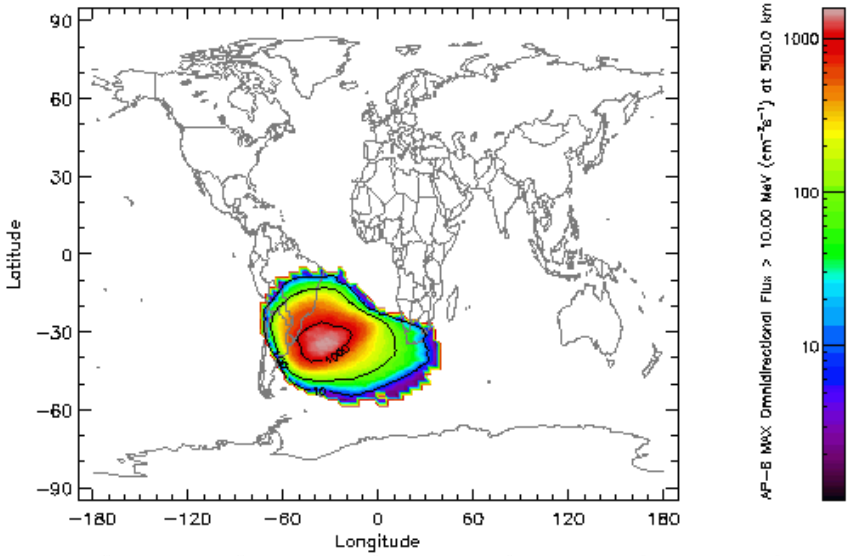


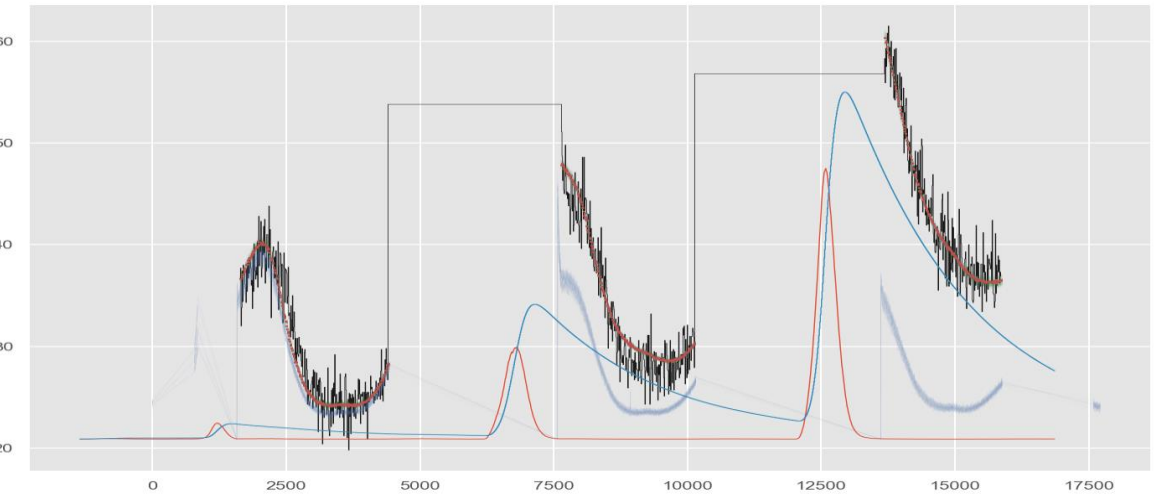
- Diagram of the particle path in the Van Allen radiation belts

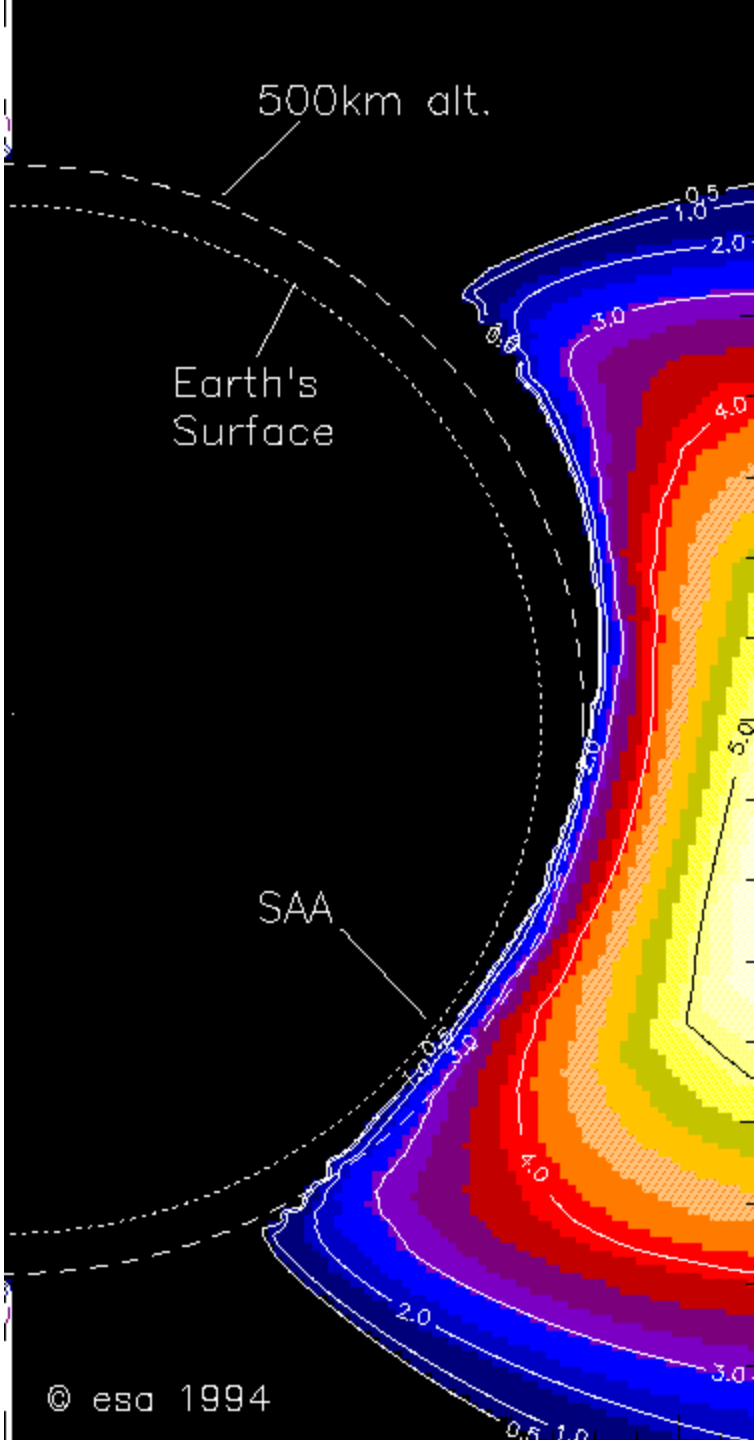




South Atlantic Anomaly (SAA)







Space Weather Effects

- **Spacecraft electronics**
  - causes an erroneous signal
  - spacecraft activation and charging.
- **Spacecraft orbit changes**
  - instantaneous heating and expansion of atmosphere → a sudden drag that lowers satellites' orbits
- **Humans in space**
- **weather; communication; ……**

Summary

- Solar parts:
  - Solar wind
  - Solar flare
  - Coronal Mass Ejections

- **Magnetosphere**:
  - Bow shock
  - Magnetosheath
  - Magnetopause
  - Magnetotail

  - **Aurora**
  - **Van allen belt**
- **Influence to human life**