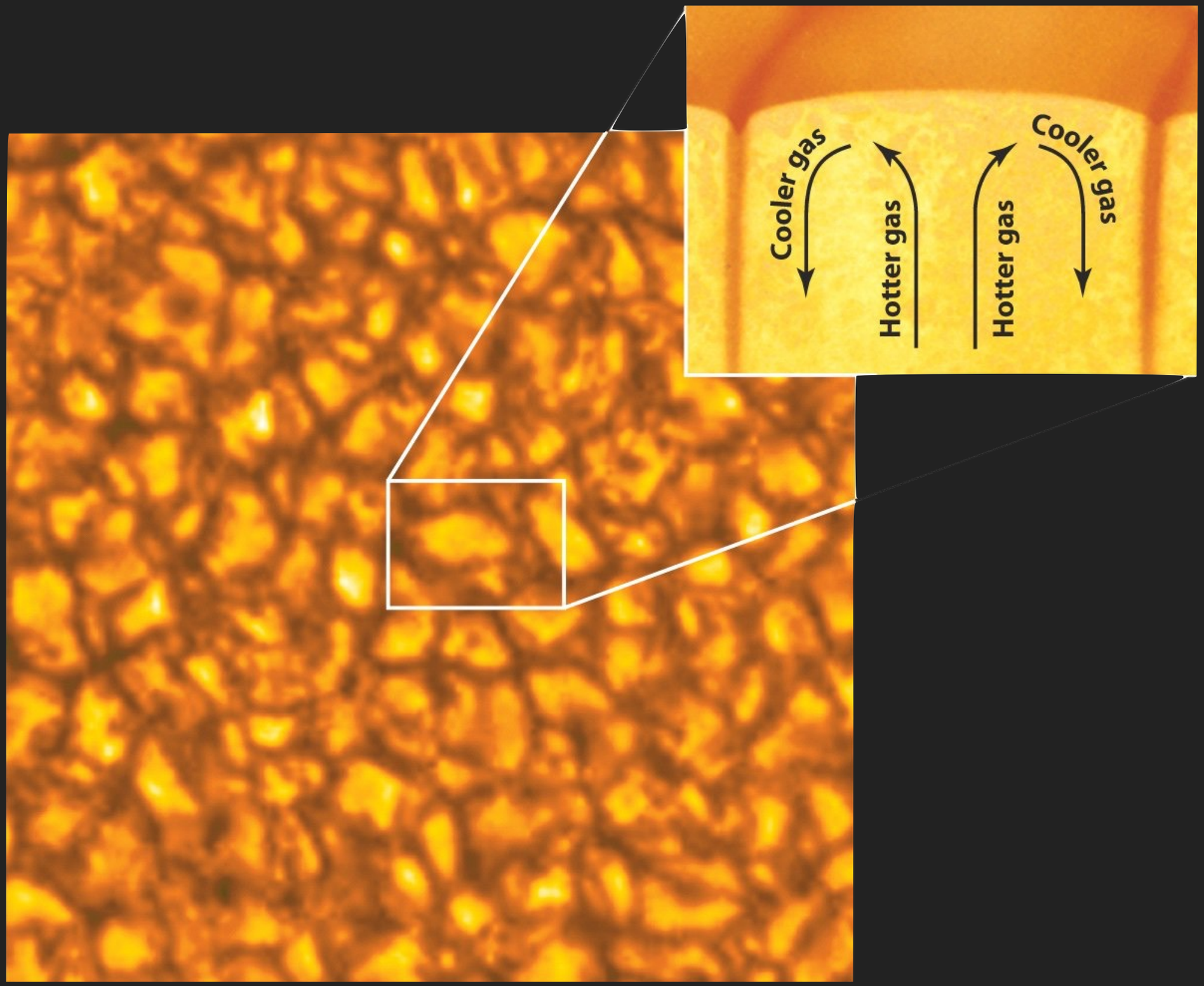
THE SUN

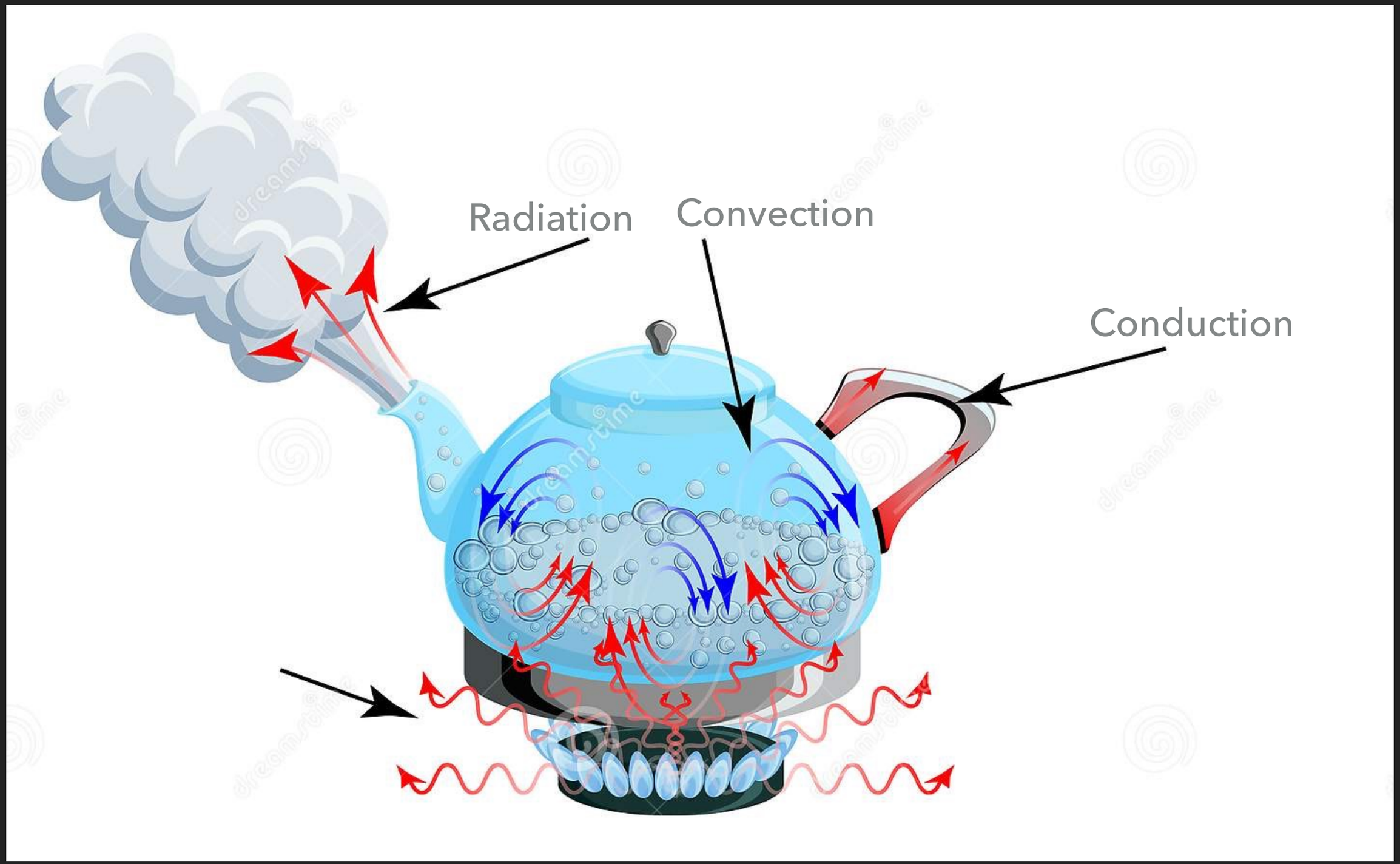
ASTROPHYSICS

Dr H.T.Sener

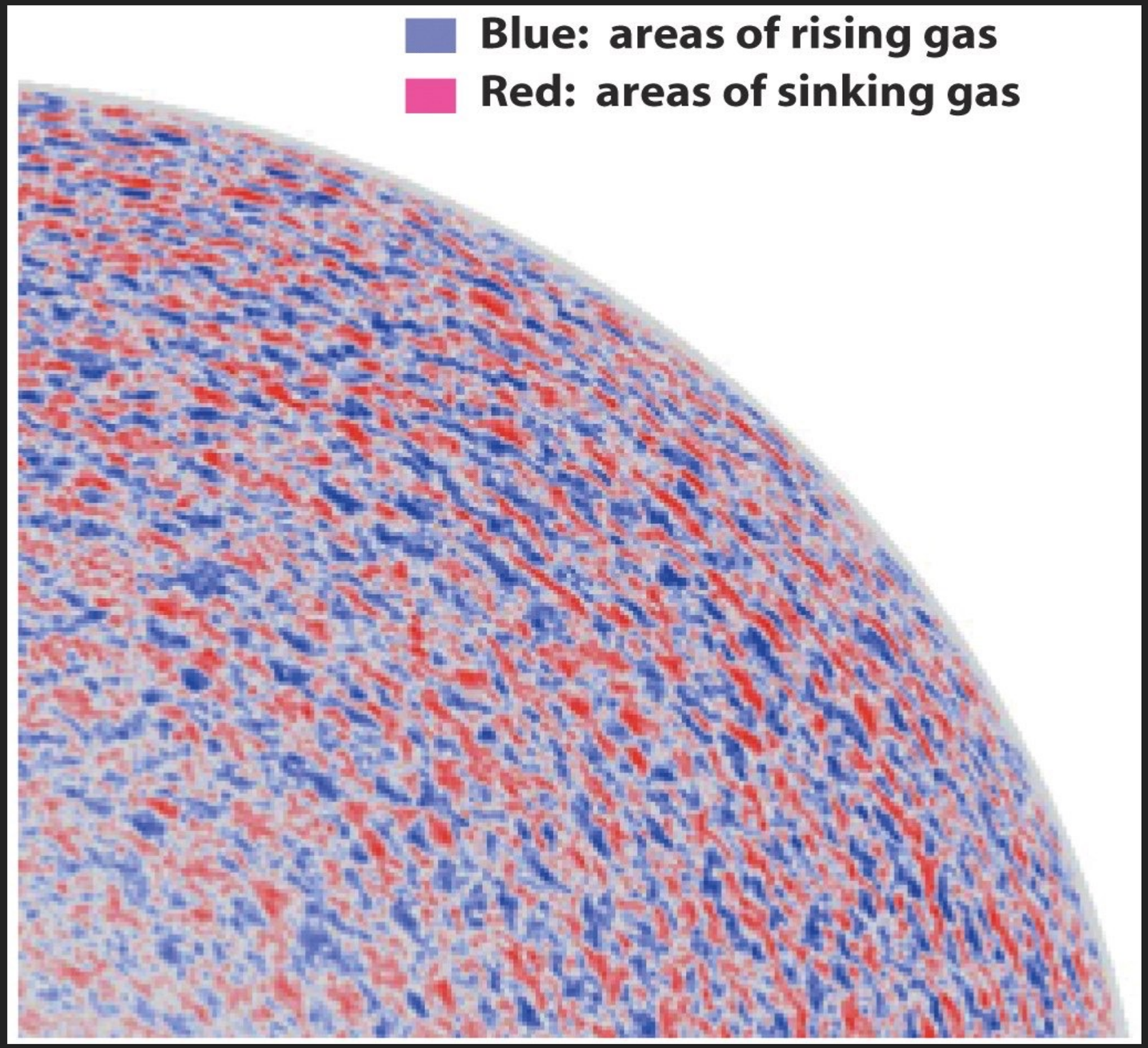
GRANULATION



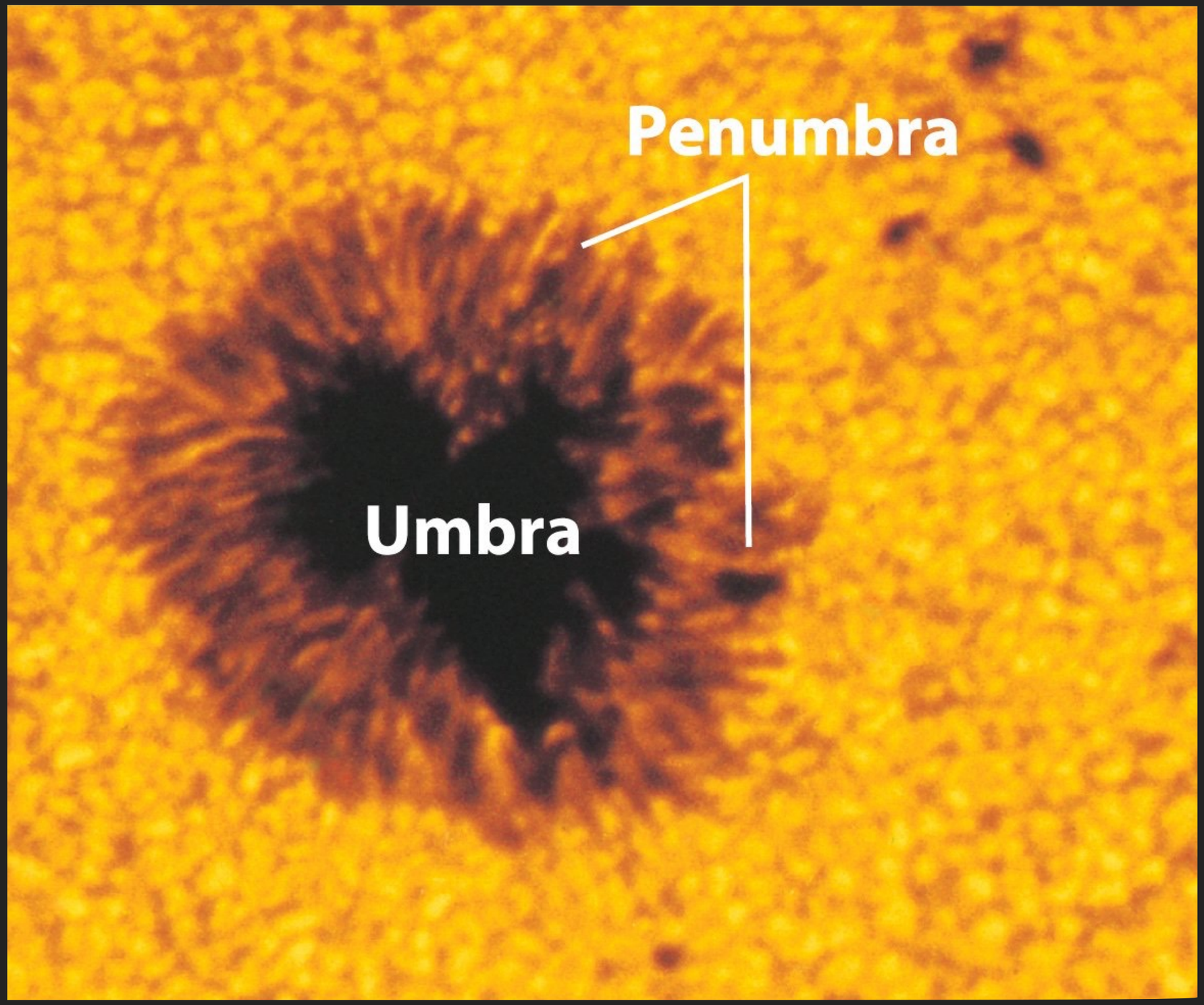
ENERGY TRANSFER METHODS



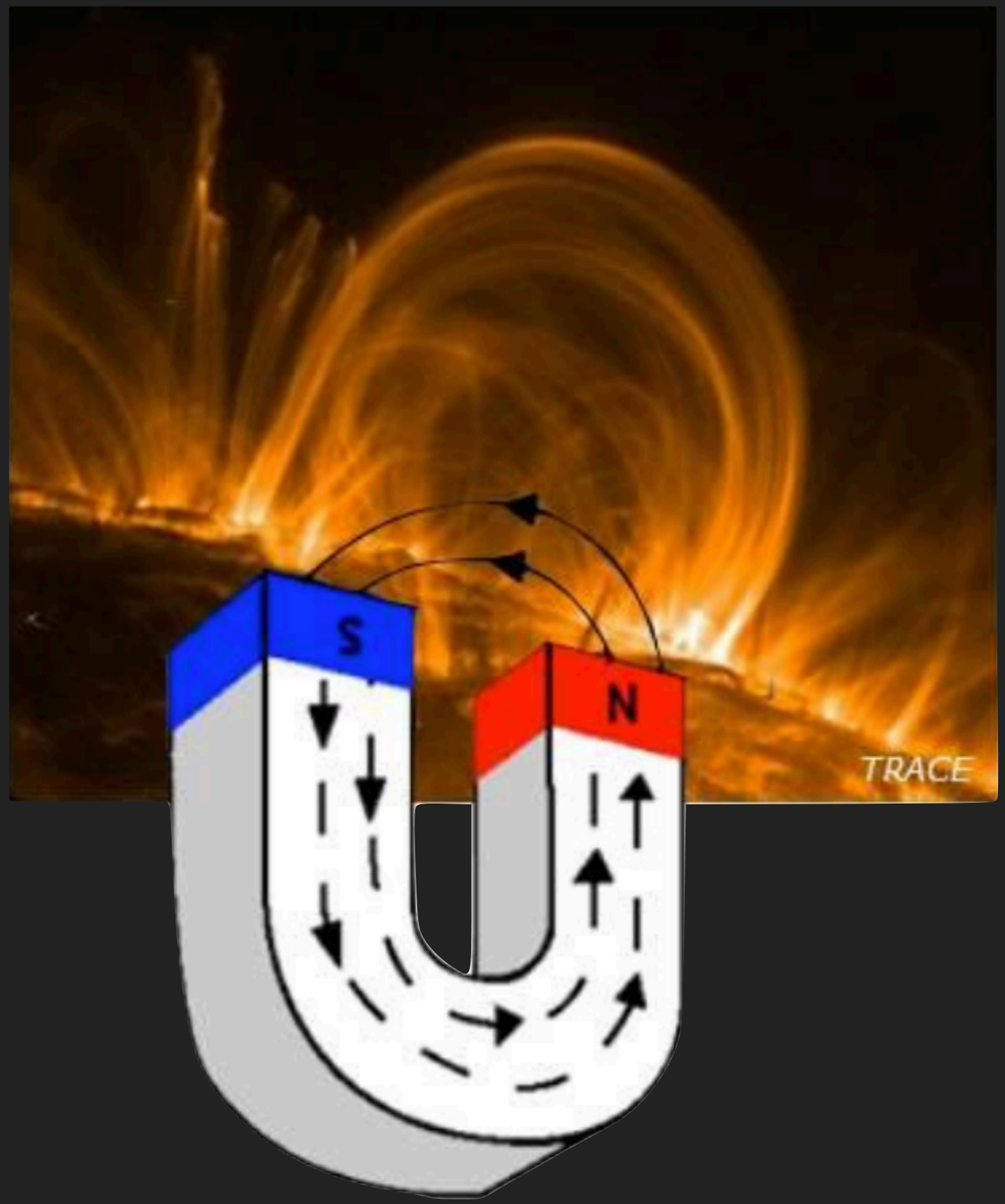
GRANULATION – CONVECTION



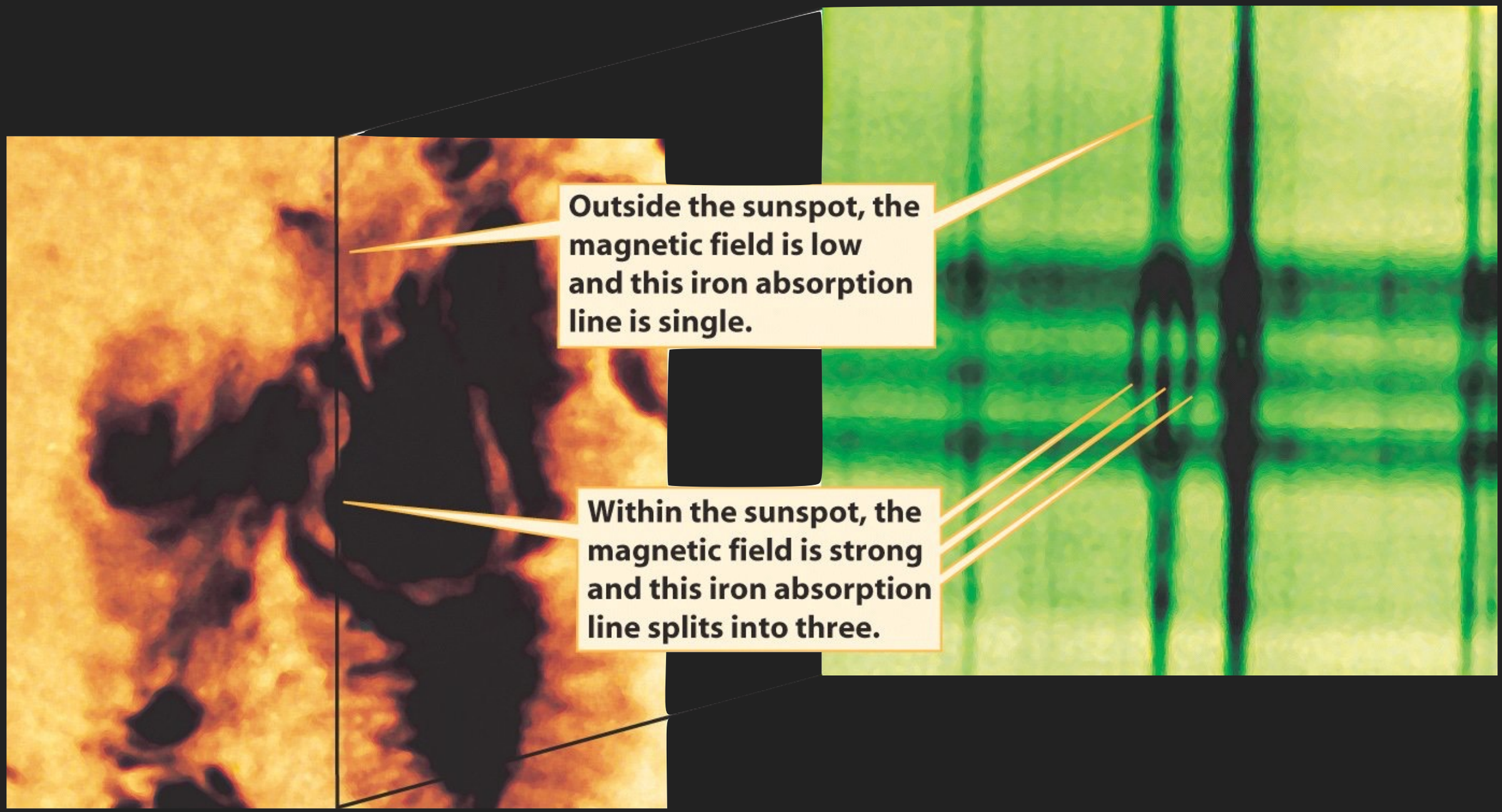
SUNSPOTS



MAGNETISM



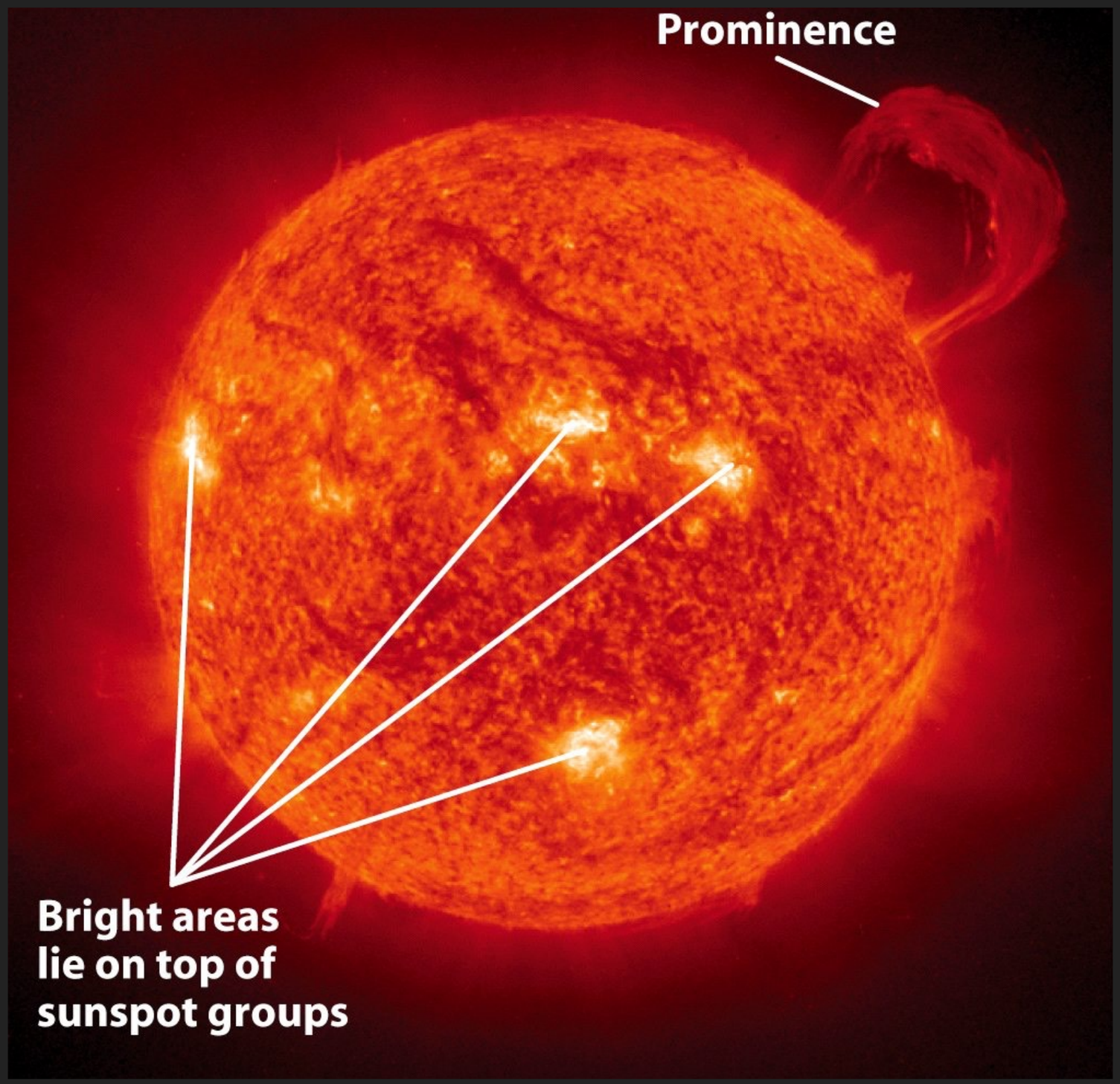
ACTIVE REGIONS



MAGNETISM – FLARES

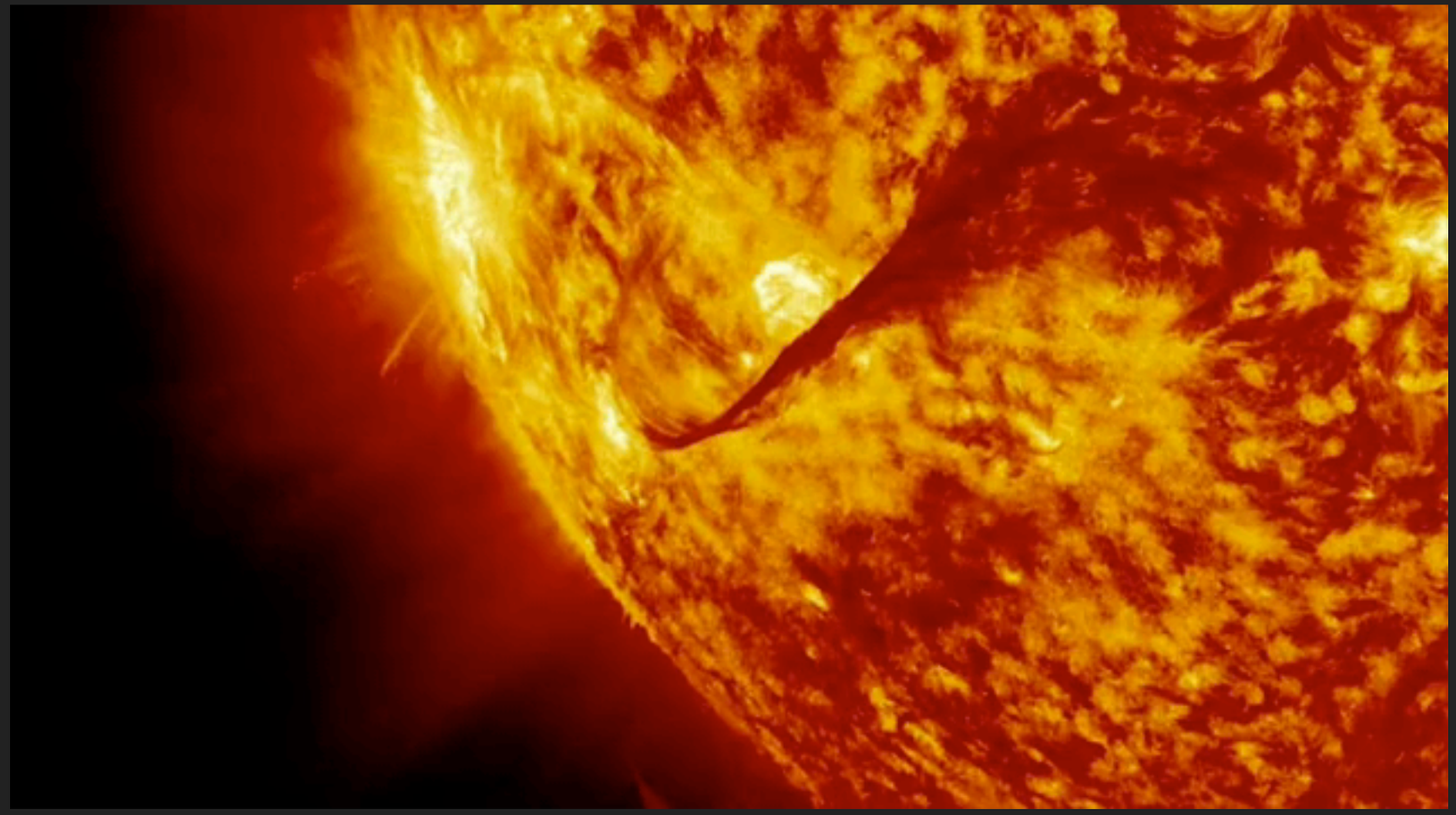
- Existence of magnetic field in a star makes it dynamic and active
  - Sun spots
  - Flares: Huge explosions in which energy is emitted into space.

MAGNETISM – PROMINENCES

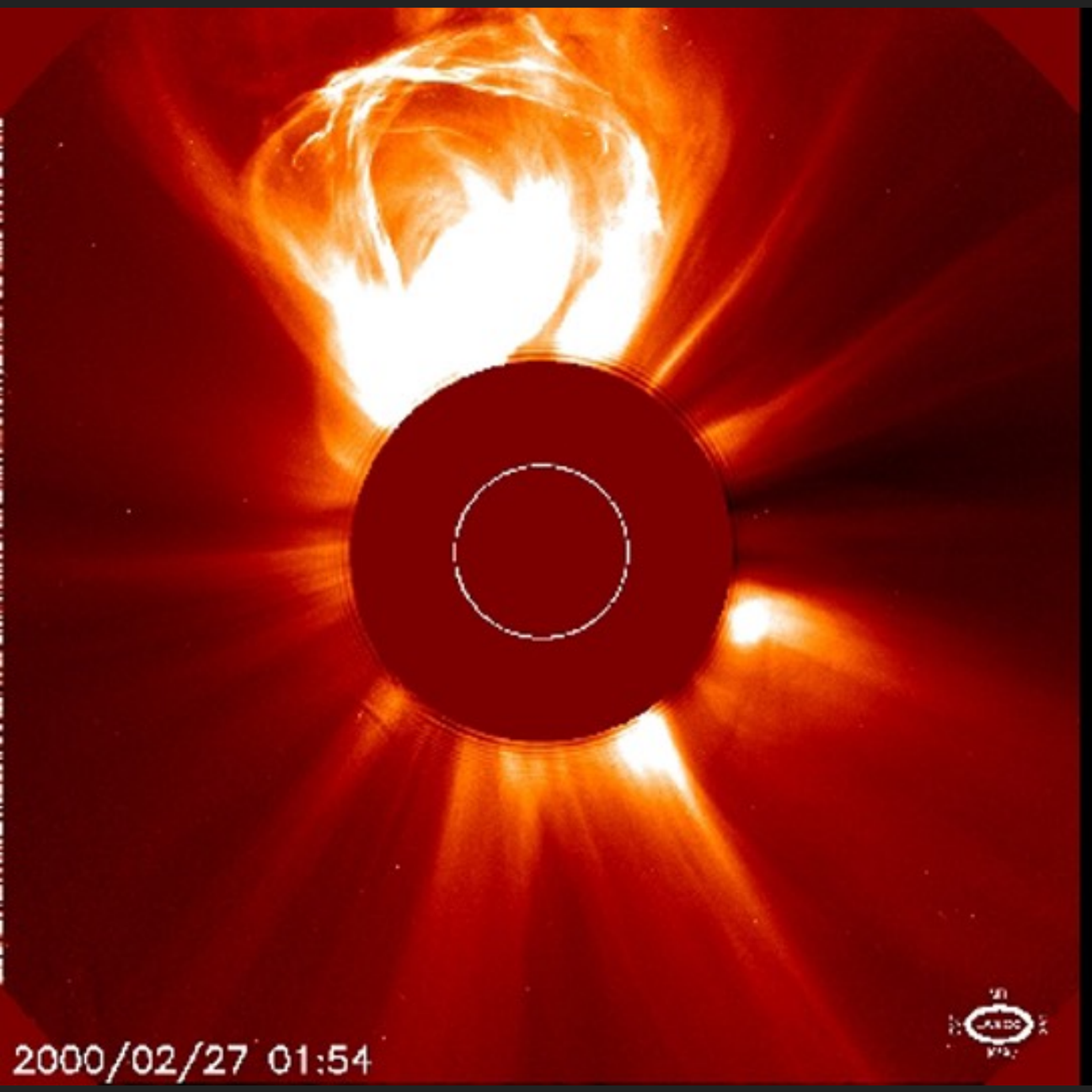


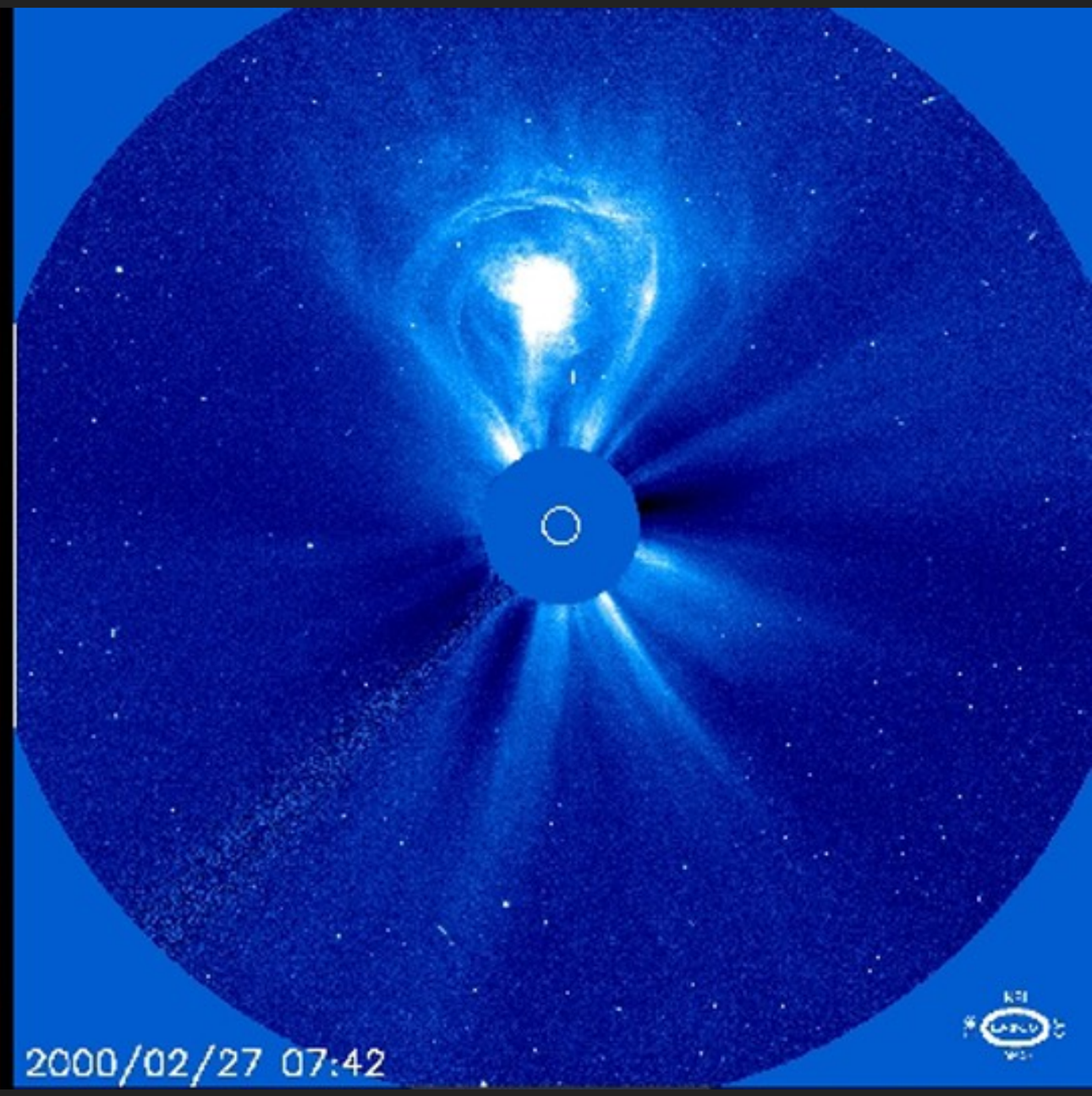
MAGNETISM – CMES

- Coronal Mass Ejections (CMEs): Solar Flares are active regions can give rise to CMEs, when billions of tonnes of matter are flung into space at speeds reaching 3000km/s.
- CMEs are often associated with solar flares but can also occur independently.



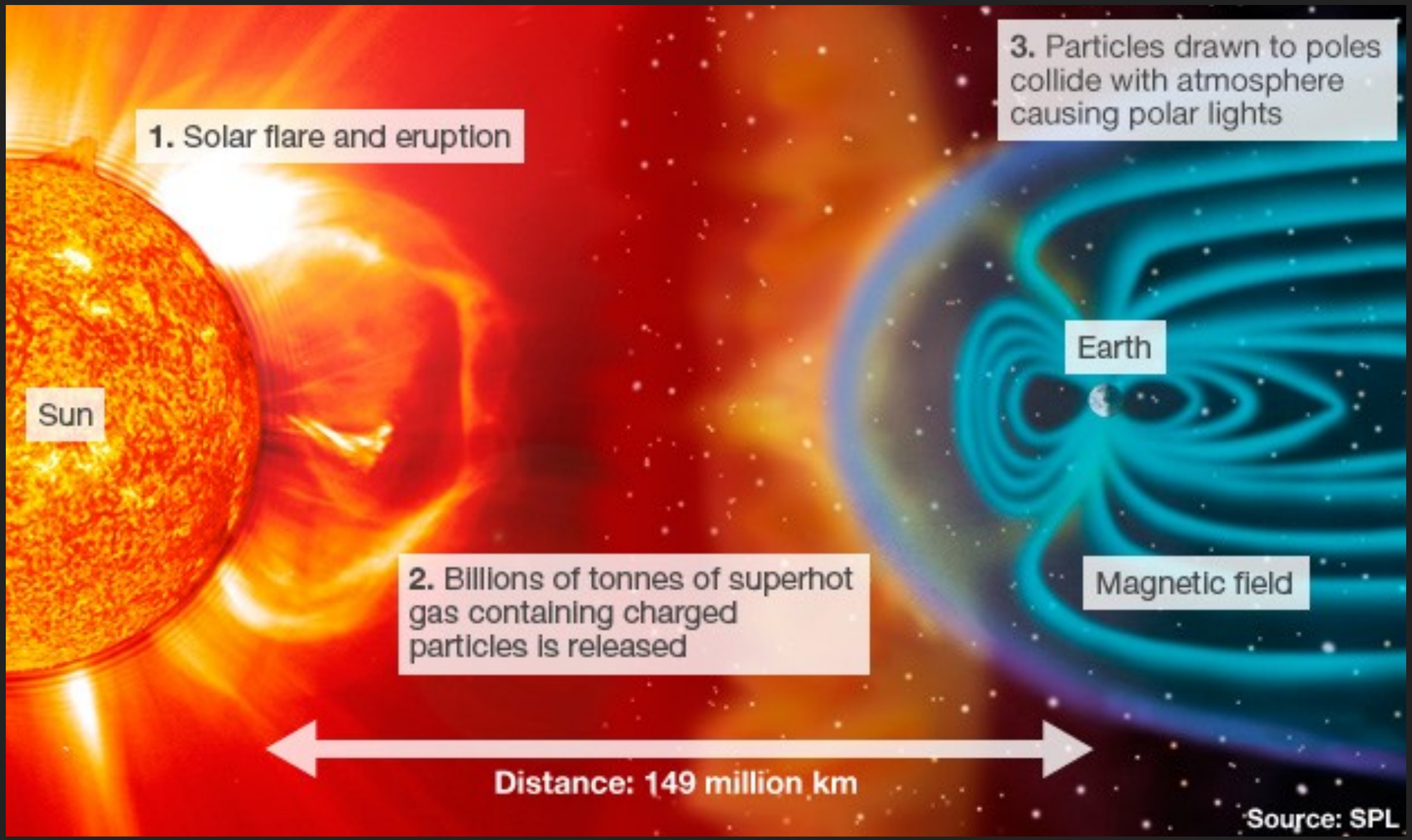
MAGNETISM – CMES





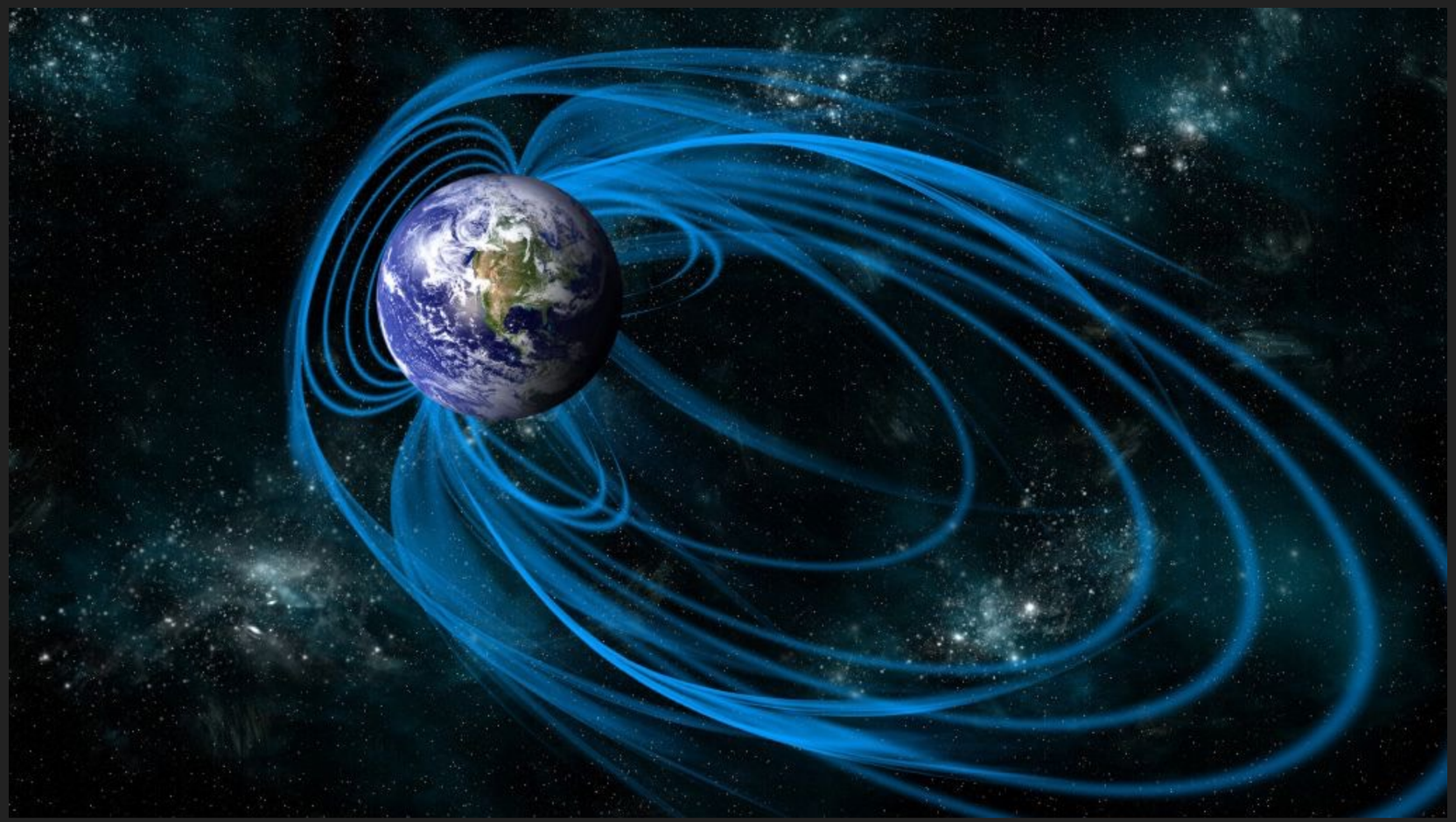
- When a CME hits Earth’s magnetic field, it can trigger a geomagnetic storm that affects the satellites in space and critical infrastructure on ground such as power grids.

SOLAR WINDS AND STORMS

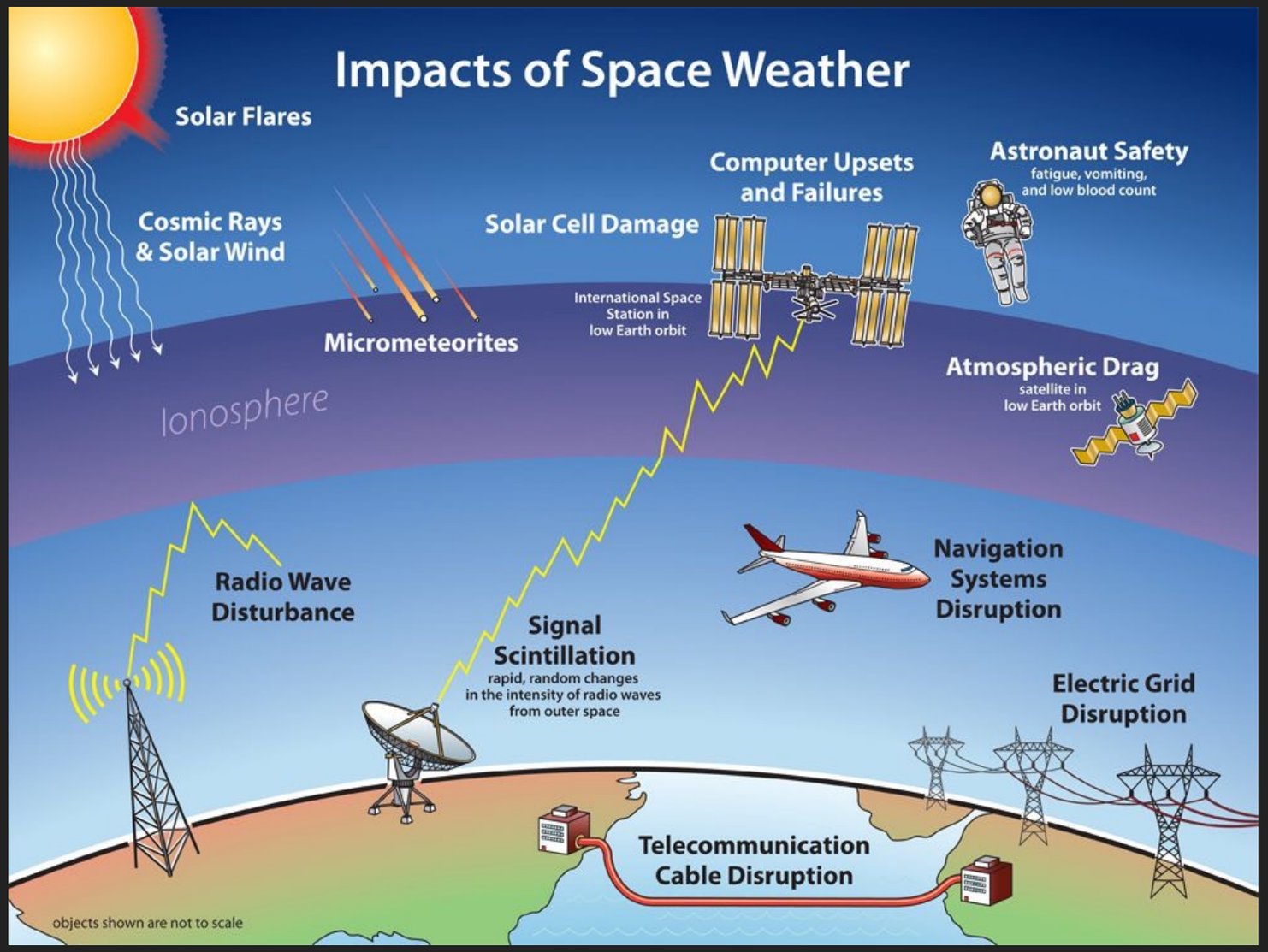


SPACE WEATHER

- Solar wind is a continuous stream of electrons, protons and heavier particles rom the upper atmosphere of the Sun.
- Pressure from the solar wind gives Earth's magnetic field its characteristic shape, compressed on the day side and extended into a long tail on the night side.

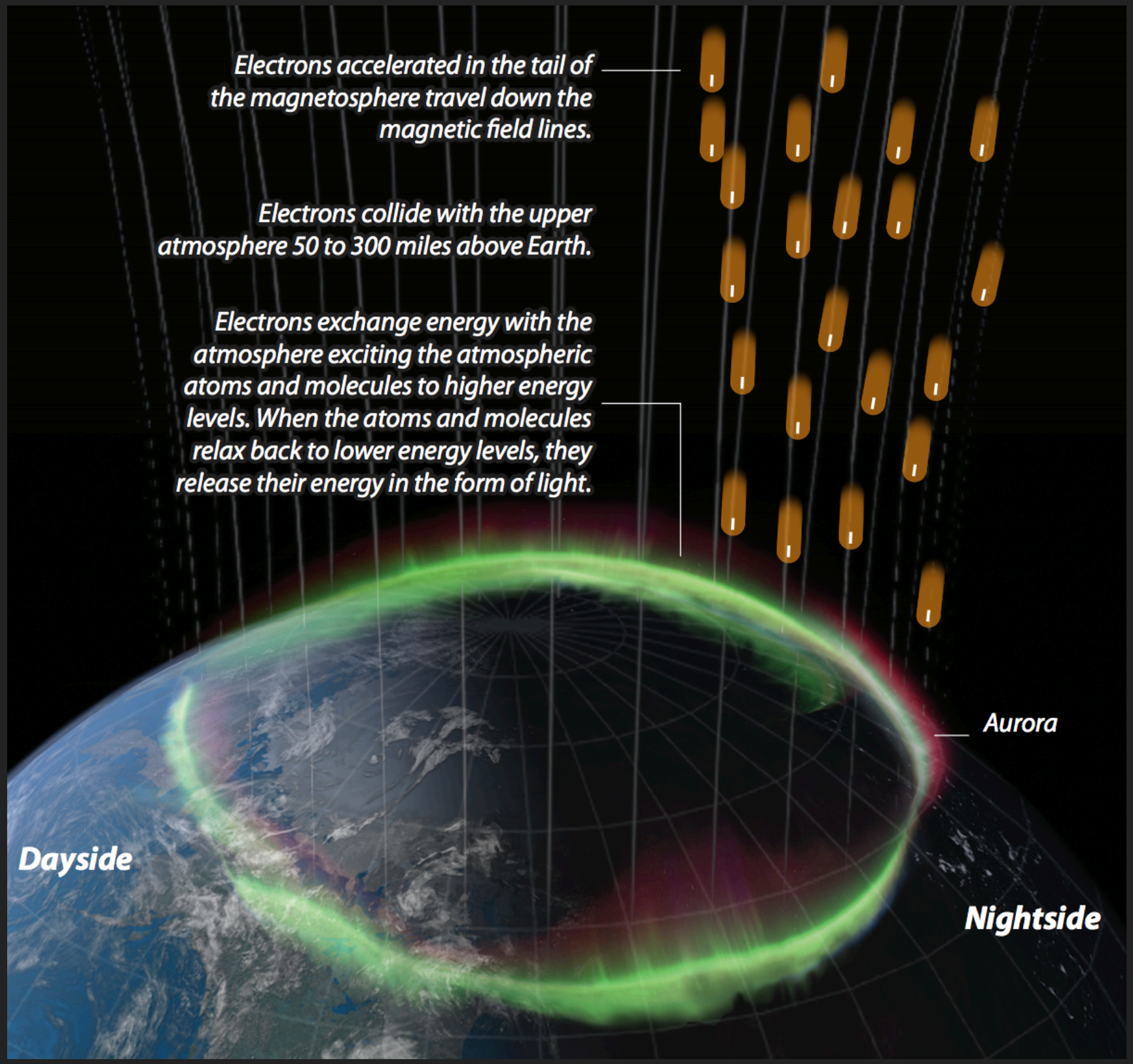


SPACE WEATHER – IMPACTS

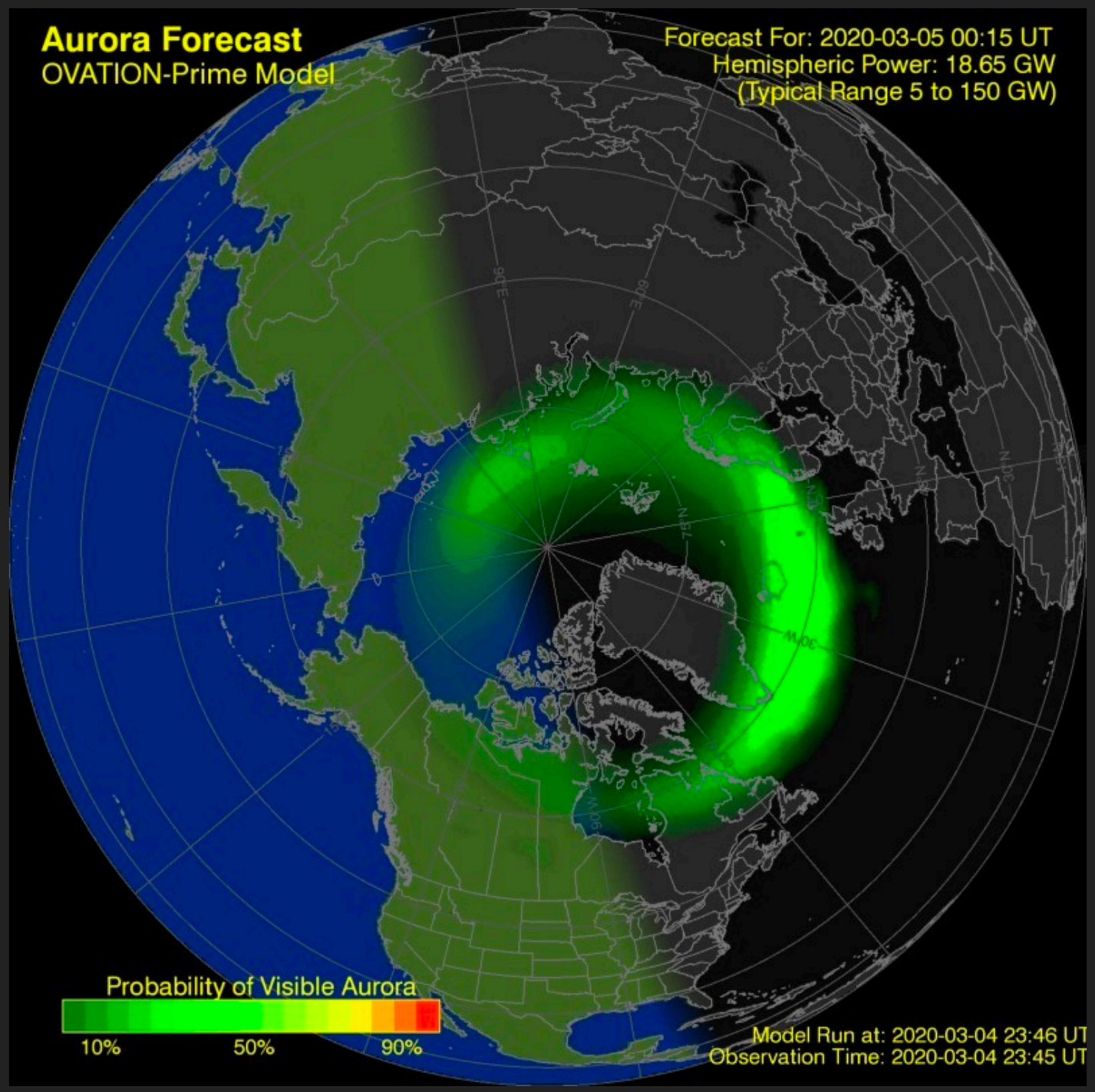


- In 1989 a CME caused a geomagnetic storm that caused 9 hour power cut in Quebec (The Great Quebec Blackout of 13 March 1989).
- In 2003, many satellites were damaged and temporarily affected by the “Halloween storms” a series of powerful solar events.
- In 2012, a massive CME just missed the Earth. We were lucky!

EFFECTS ON EARTH

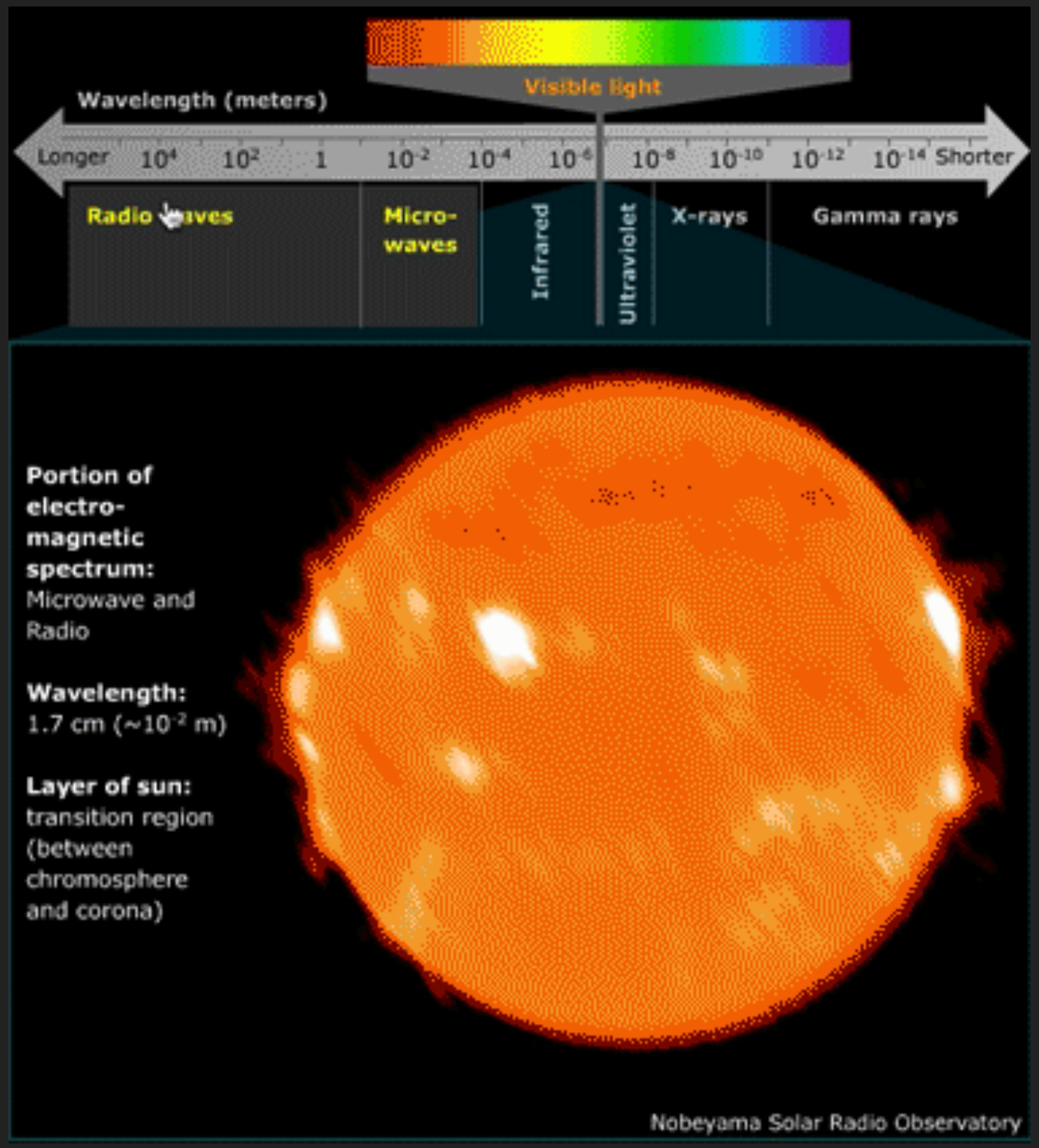


AURORA FORECAST

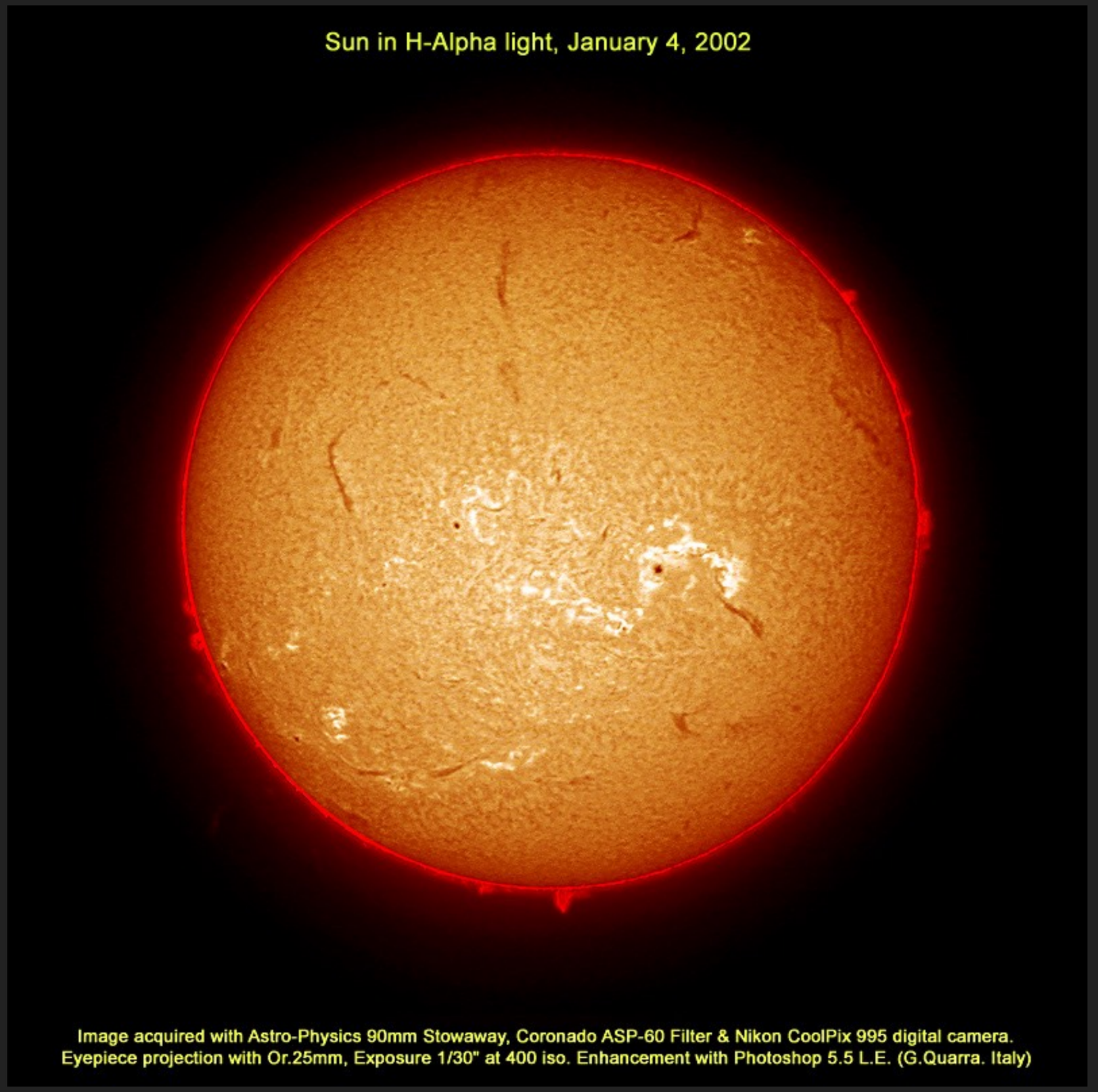


https://www.swpc.noaa.gov/products/aurora-30-minute-forecast

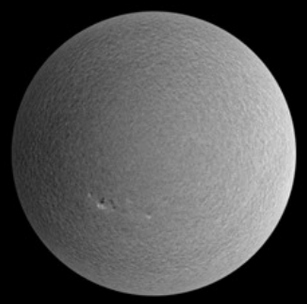
SUN AT DIFFERENT WAVELENGTHS



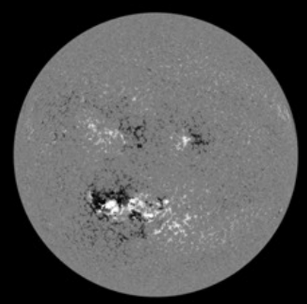
H-ALPHA


Sun in H-Alpha light, January 4, 2002
Image acquired with Astro-Physics 90mm Stowaway, Coronado ASP-60 Filter & Nikon CoolPix 995 digital camera.
Eyepiece projection with Or.25mm, Exposure 1/30" at 400 iso. Enhancement with Photoshop 5.5 L.E. (G.Quarra. Italy)

SUN AT DIFFERENT WAVELENGTHS

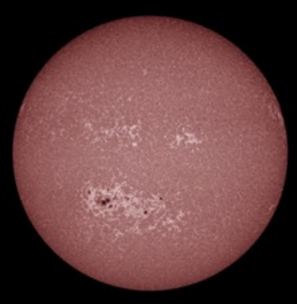


HMI Dopplergram
Surface movement
Photosphere

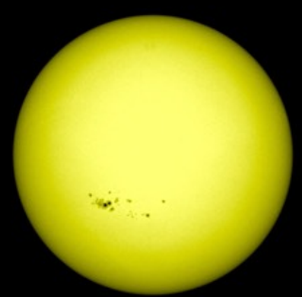


HMI Magnetogram
Magnetic field polarity
Photosphere

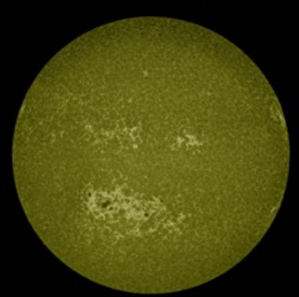
HMI Continuum
Matches visible light
Photosphere



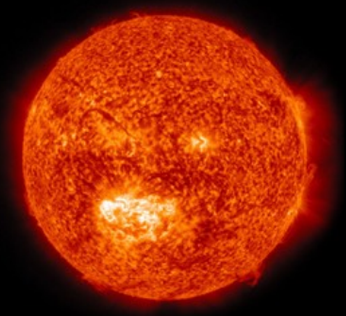
AIA 1700 Å
4500 Kelvin
Photosphere



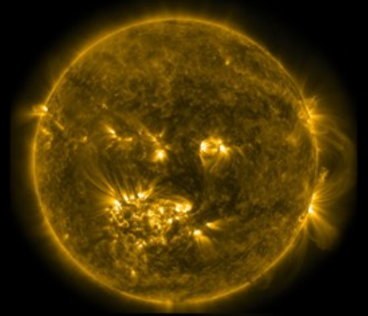
AIA 4500 Å
6000 Kelvin
Photosphere



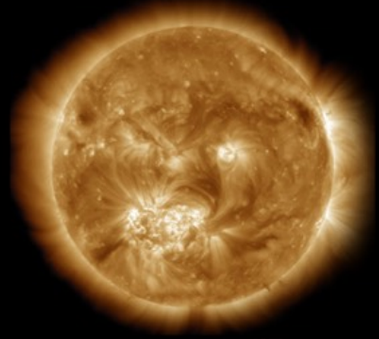
AIA 1600 Å
10,000 Kelvin
Upper photosphere/
Transition region



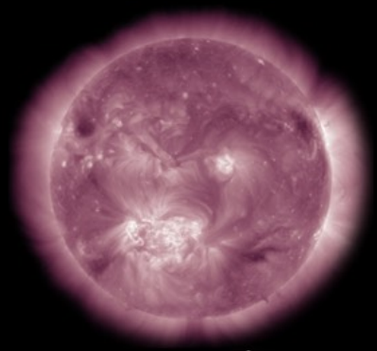
AIA 304 Å
50,000 Kelvin
Transition region/
Chromosphere



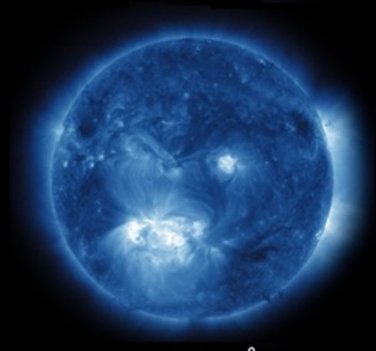
AIA 171 Å
600,000 Kelvin
Upper transition
Region/quiet corona



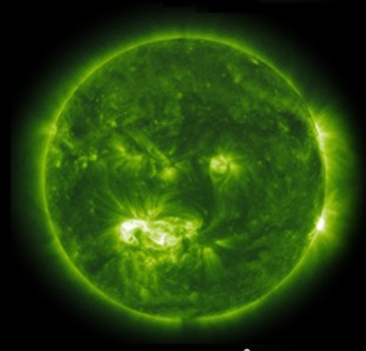
AIA 193 Å
1 million Kelvin
Corona/flare plasma



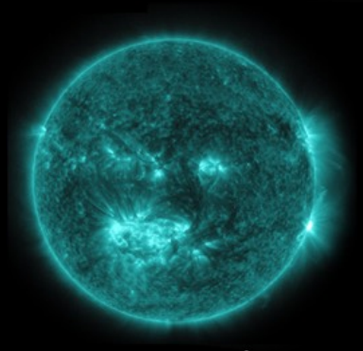
AIA 211 Å
2 million Kelvin
Active regions



AIA 335 Å
2.5 million Kelvin
Active regions

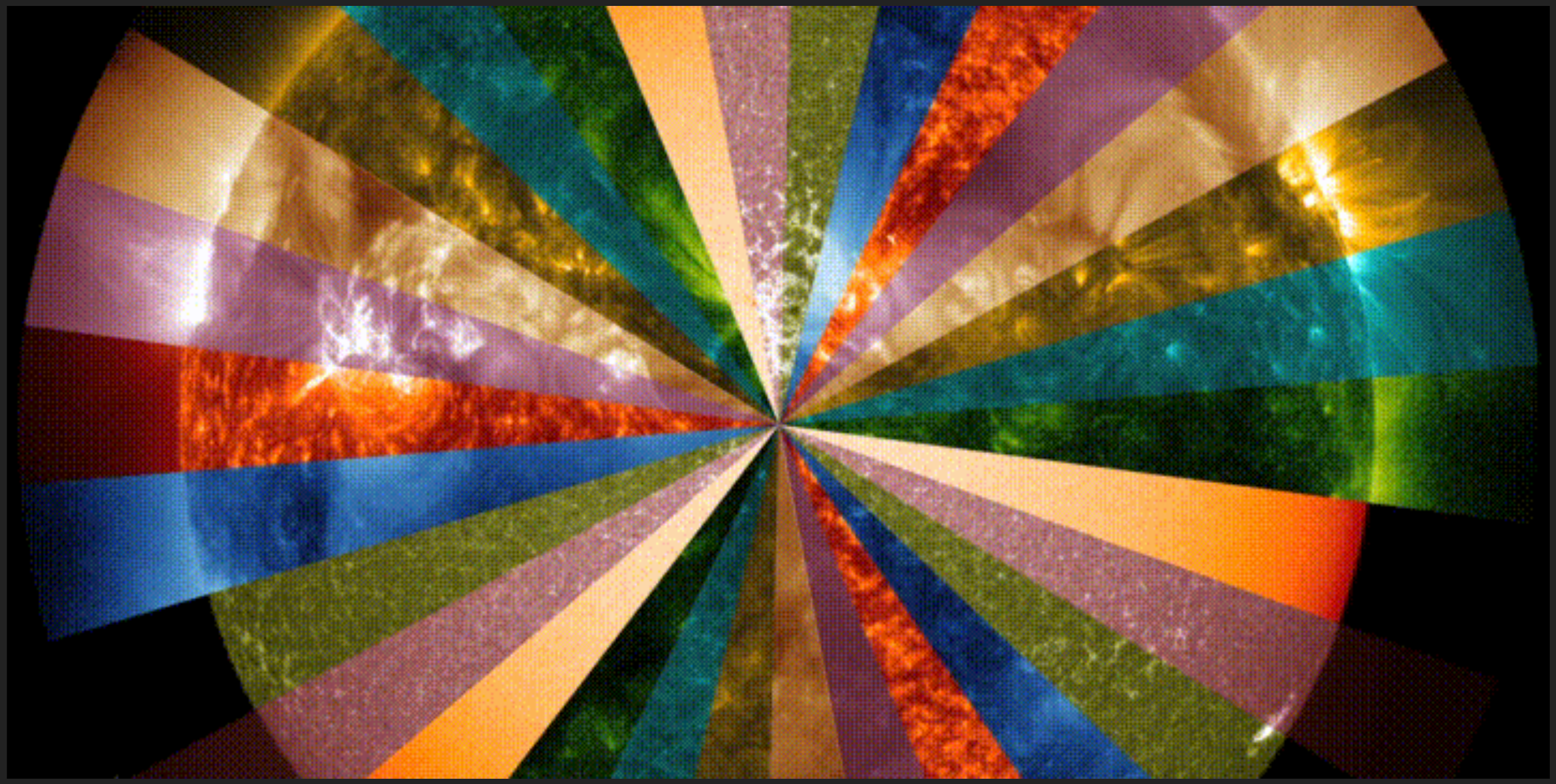


AIA 094 Å
6 million Kelvin
Flaring regions



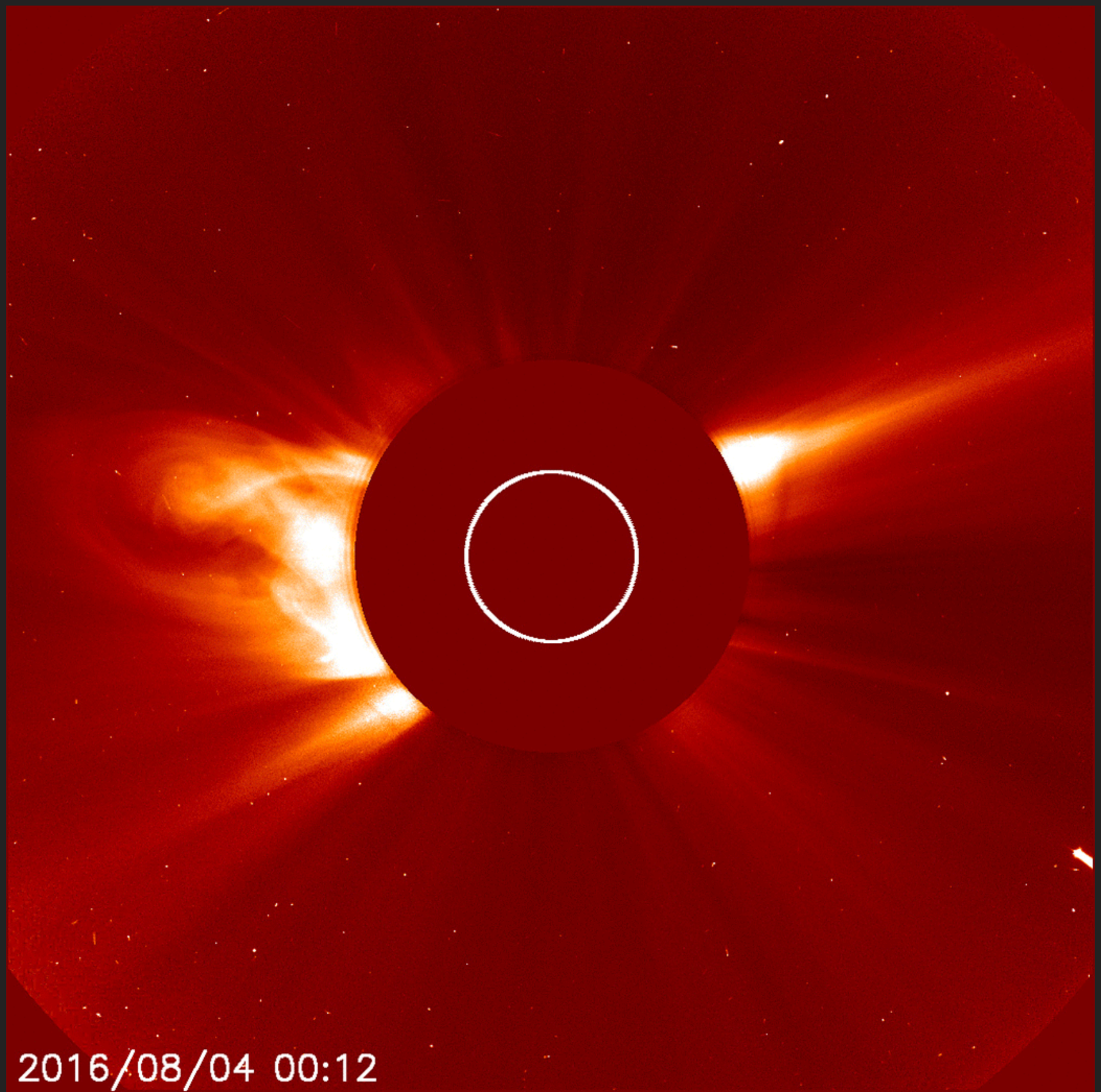
AIA 131 Å
10 million Kelvin
Flaring regions

SUN AT DIFFERENT WAVELENGTHS

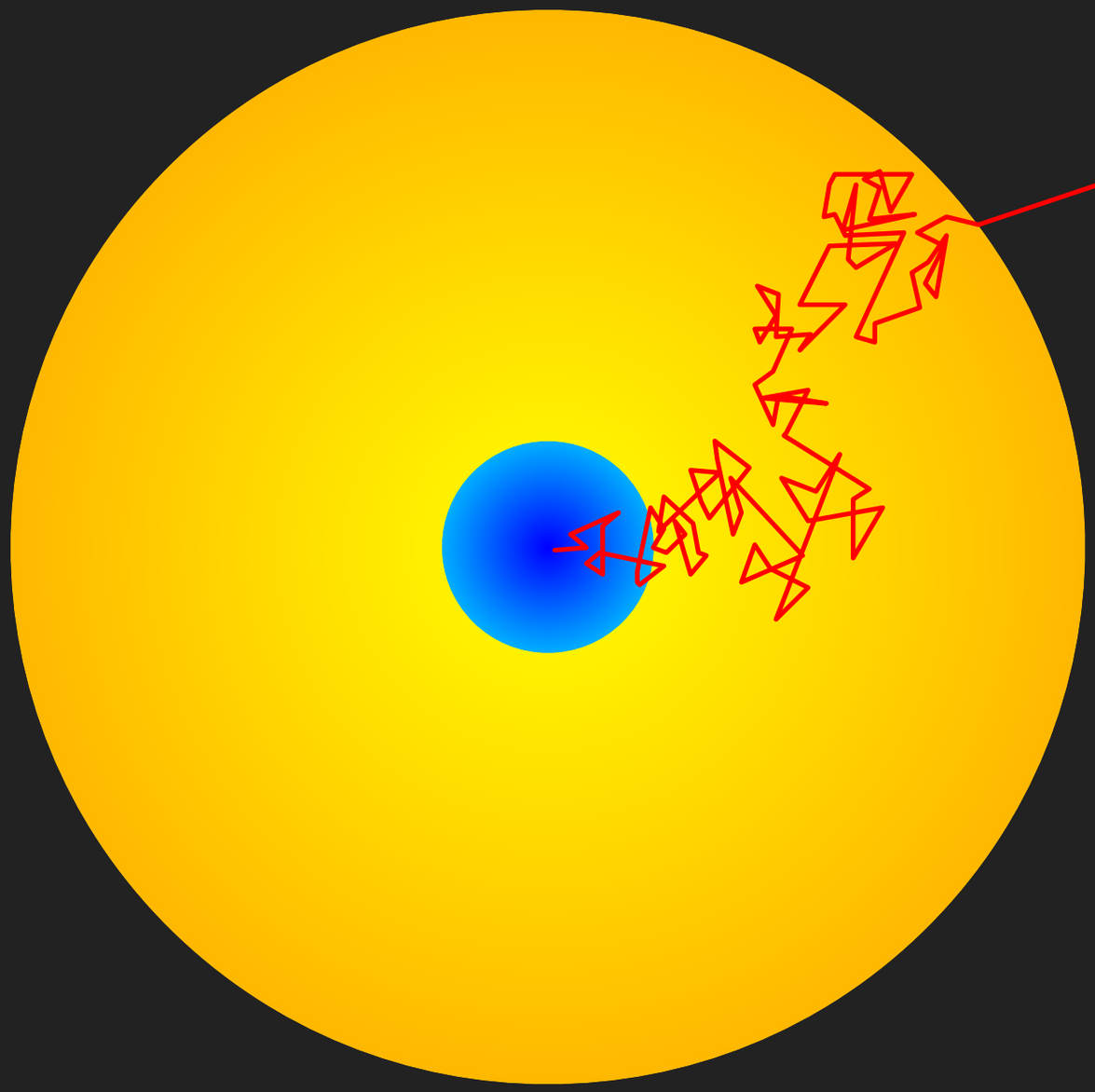


SUN AT DIFFERENT WAVELENGTHS

WHY COMETS DIVE ON THE SUN?



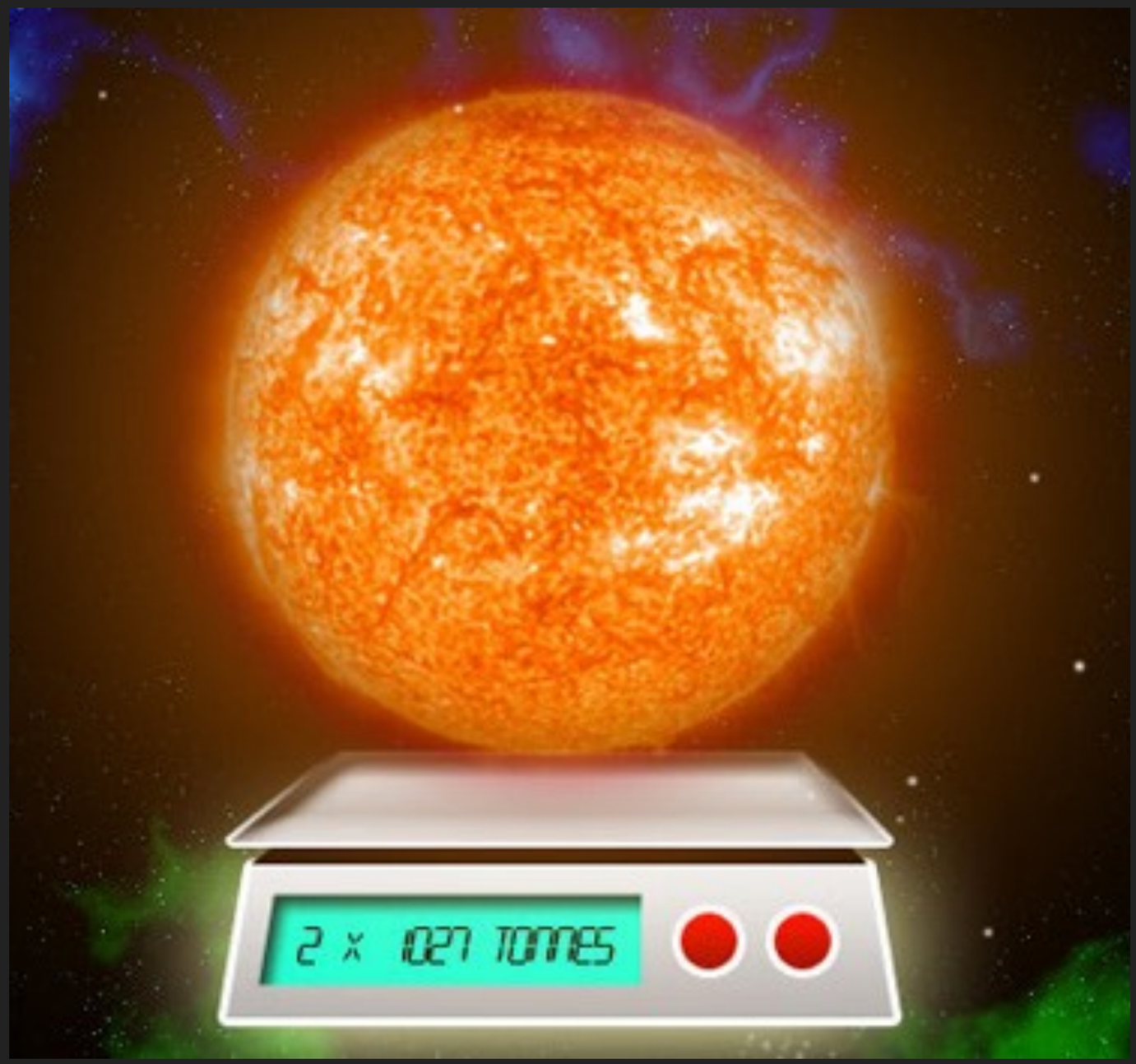
HOW LONG DOES IT TAKE FOR A PHOTON TO REACH US?



- v=x/t -> t= x/ v
- t = 1AU / c
  - 1AU = 149.500.000km
  - c = 300.000 km/sec
- t = 498 sec
  - =498/60 = 8 mins

FACT SHEET

- T≅ 5800K
- d ≅ 149.5x10^{6}km = 1AU
- R ≅700.000 km = $R_{\odot}$
- M ≅2x10^{30}kg = $M_{\odot}$



RESOURCES

- http://www.infobeck.com/articles/2011/5/11/how-does-hydrostatic-equilibrium-work.html
- http://www.est-east.eu
- https://www.swpc.noaa.gov/products/aurora-30-minute-forecast
- https://www.aavso.org/zurich-classification-system-sunspot-groups
- http://cesar.esa.int/upload/201807/the_suns_structure_booklet.pdf
- http://web.tiscali.it/unitronitalia/coronado.html
- https://www.nationalgeographic.org/media/space-weather/