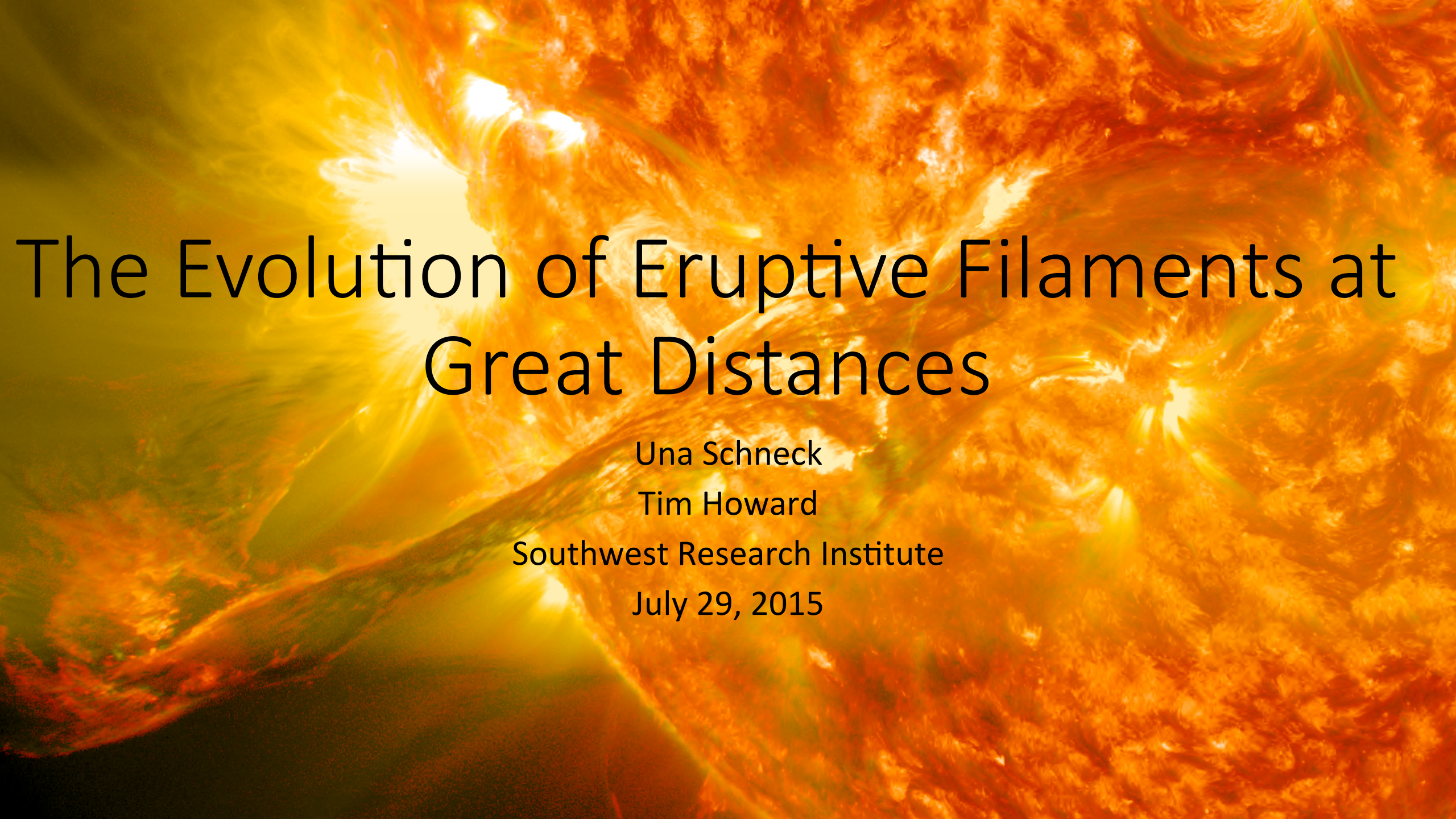


The Evolution of Eruptive Filaments at Great Distances

Una Schneck
Tim Howard
Southwest Research Institute

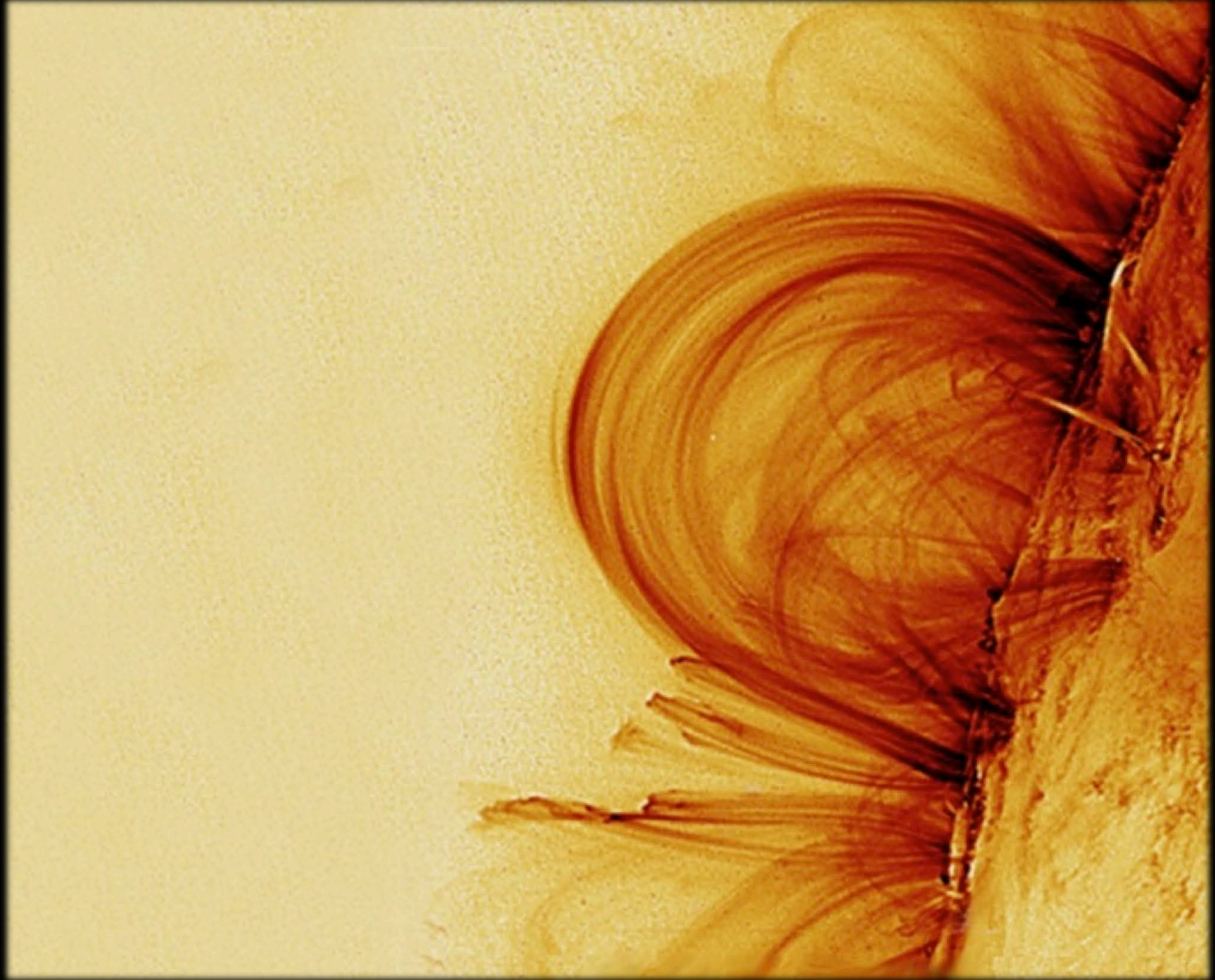
July 29, 2015

Solar corona is the outer portion of the sun

Reaches temperatures over one million kelvin

Sun has a complex magnetic field

Plasma collects on magnetic field lines to form filaments on the surface of the sun



Magnetic fields and plasma can erupt from the corona

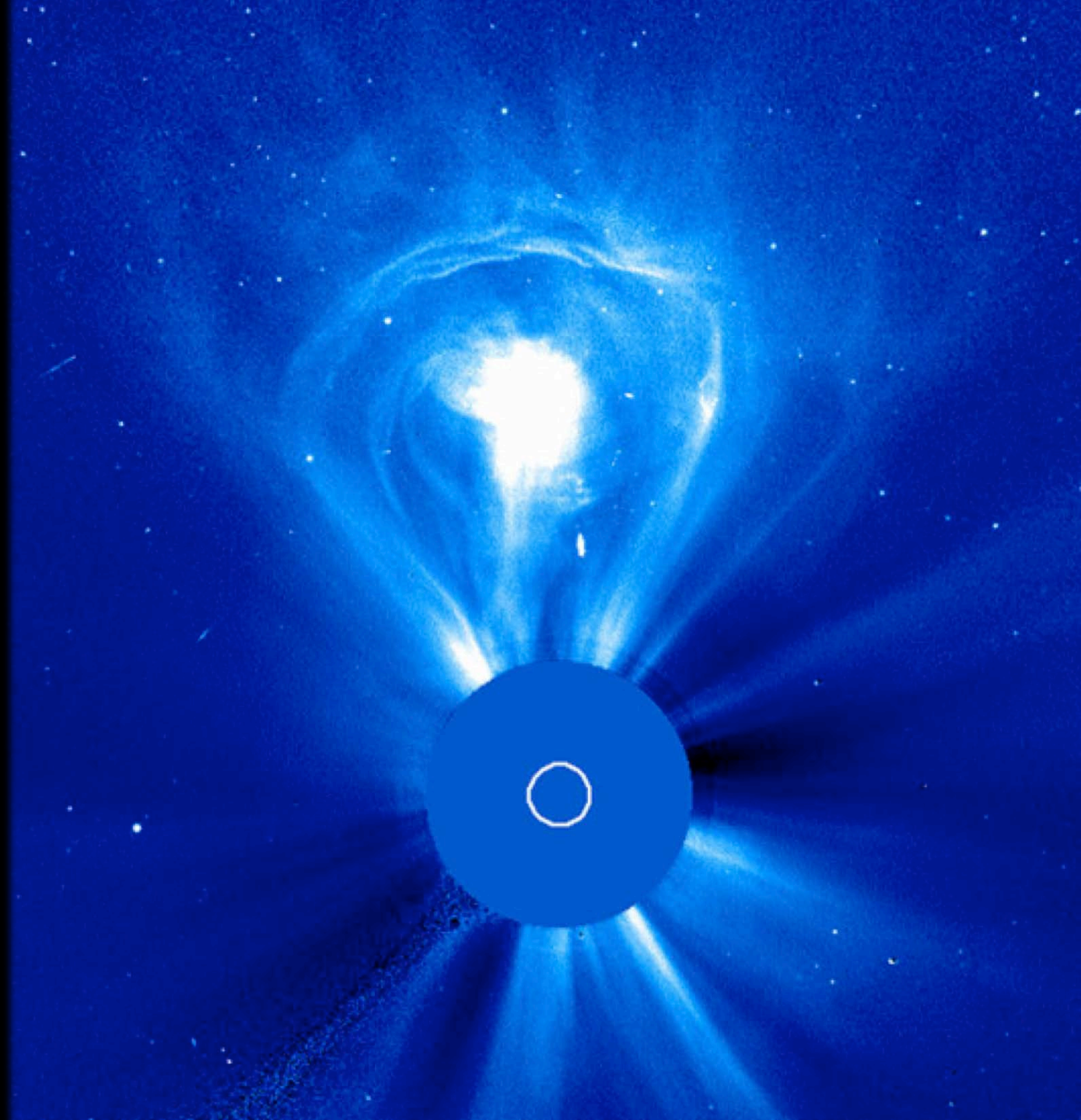
Coronal Mass Ejections (CMEs) have a classic 'lightbulb' shape

Three parts:

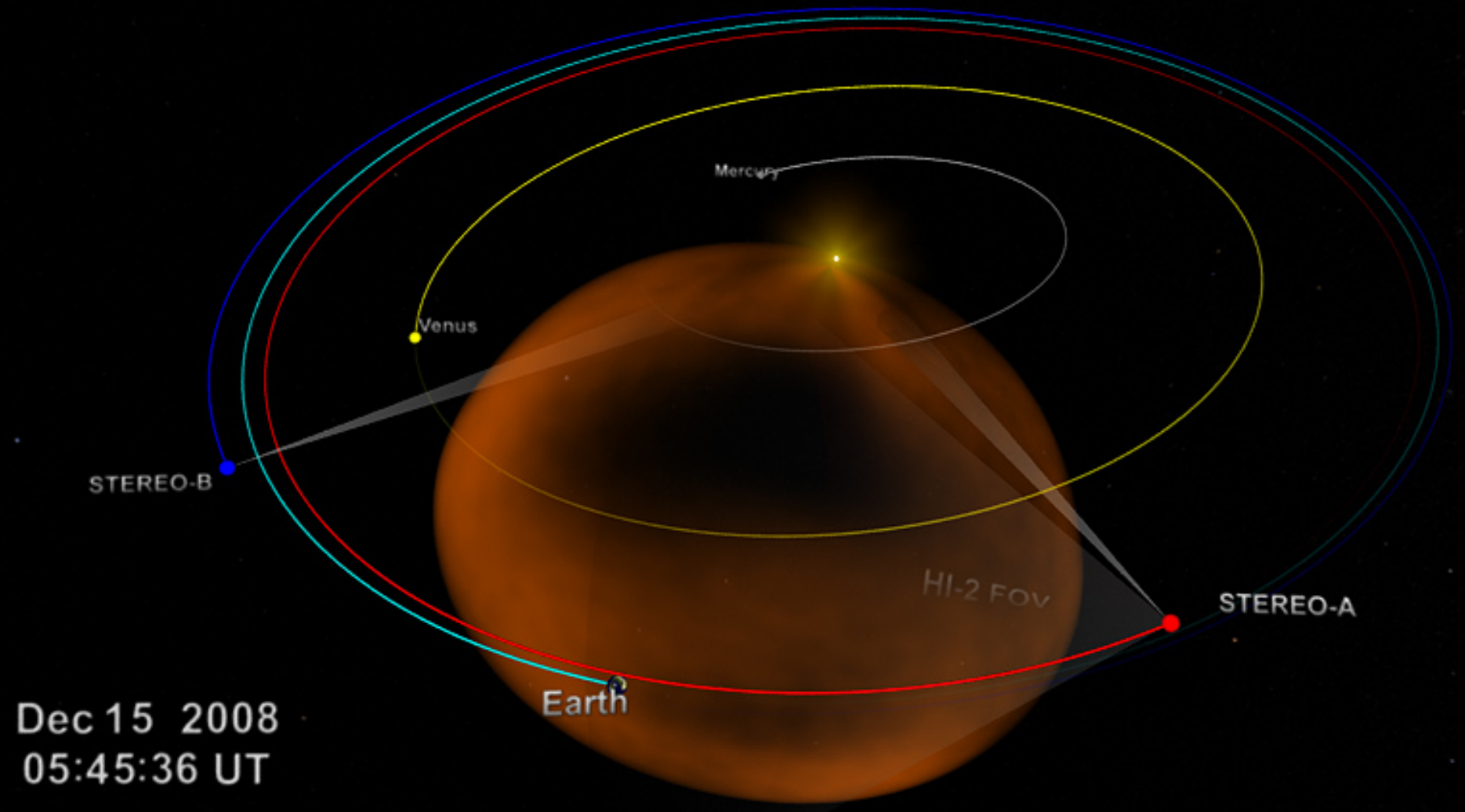
Bright leading edge of plasma

Dark magnetic cavity

Bright, but smaller eruptive filament



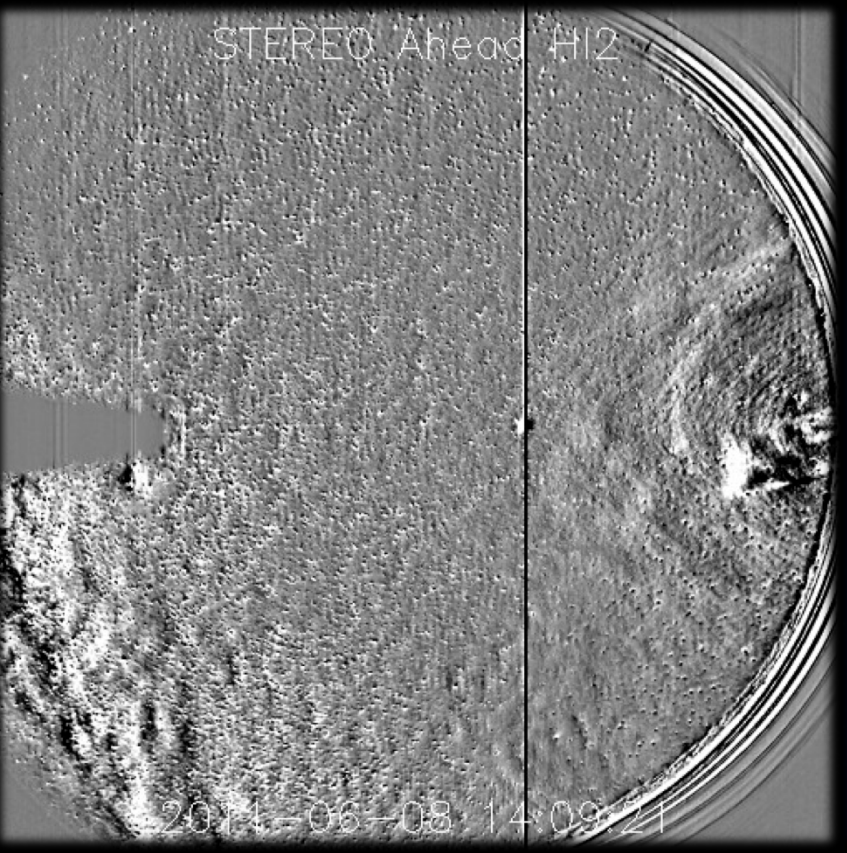
STEREO-A and STEREO-B



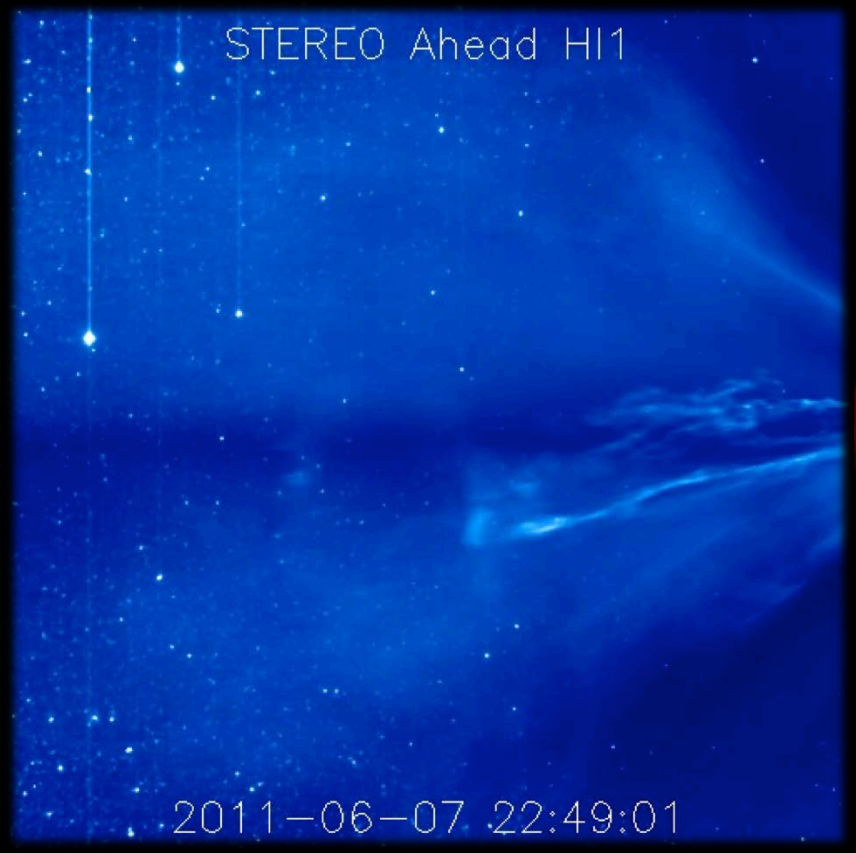
Orbit ahead (A) and behind (B) earth

Constantly monitor the sun

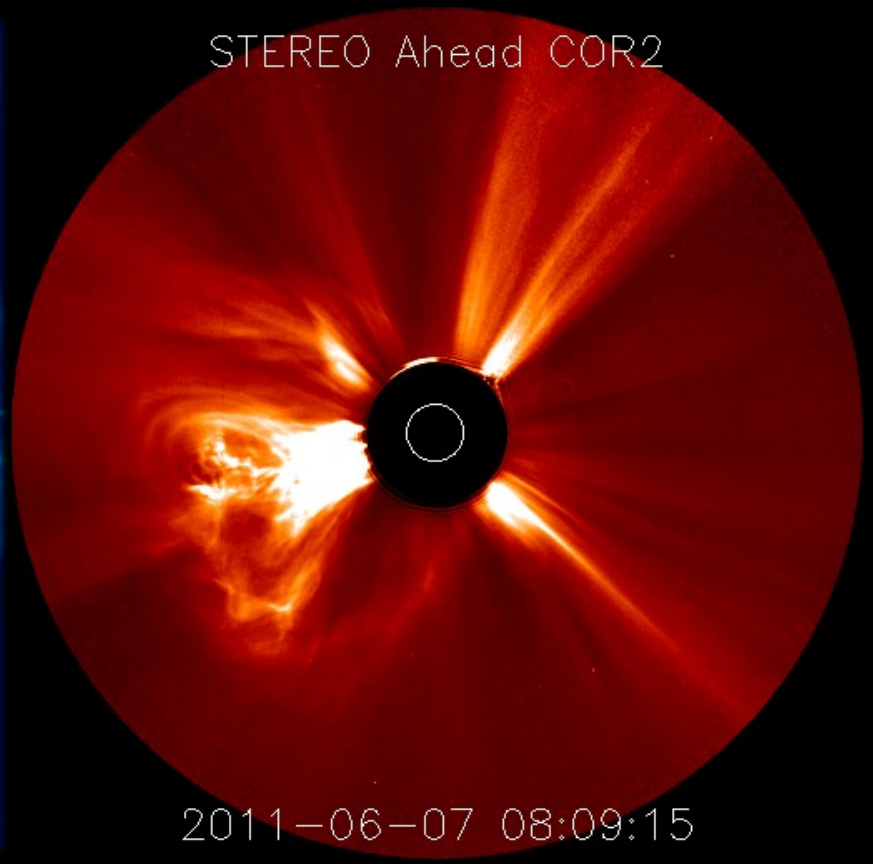
Not to scale



HI-2
<Earth's orbit

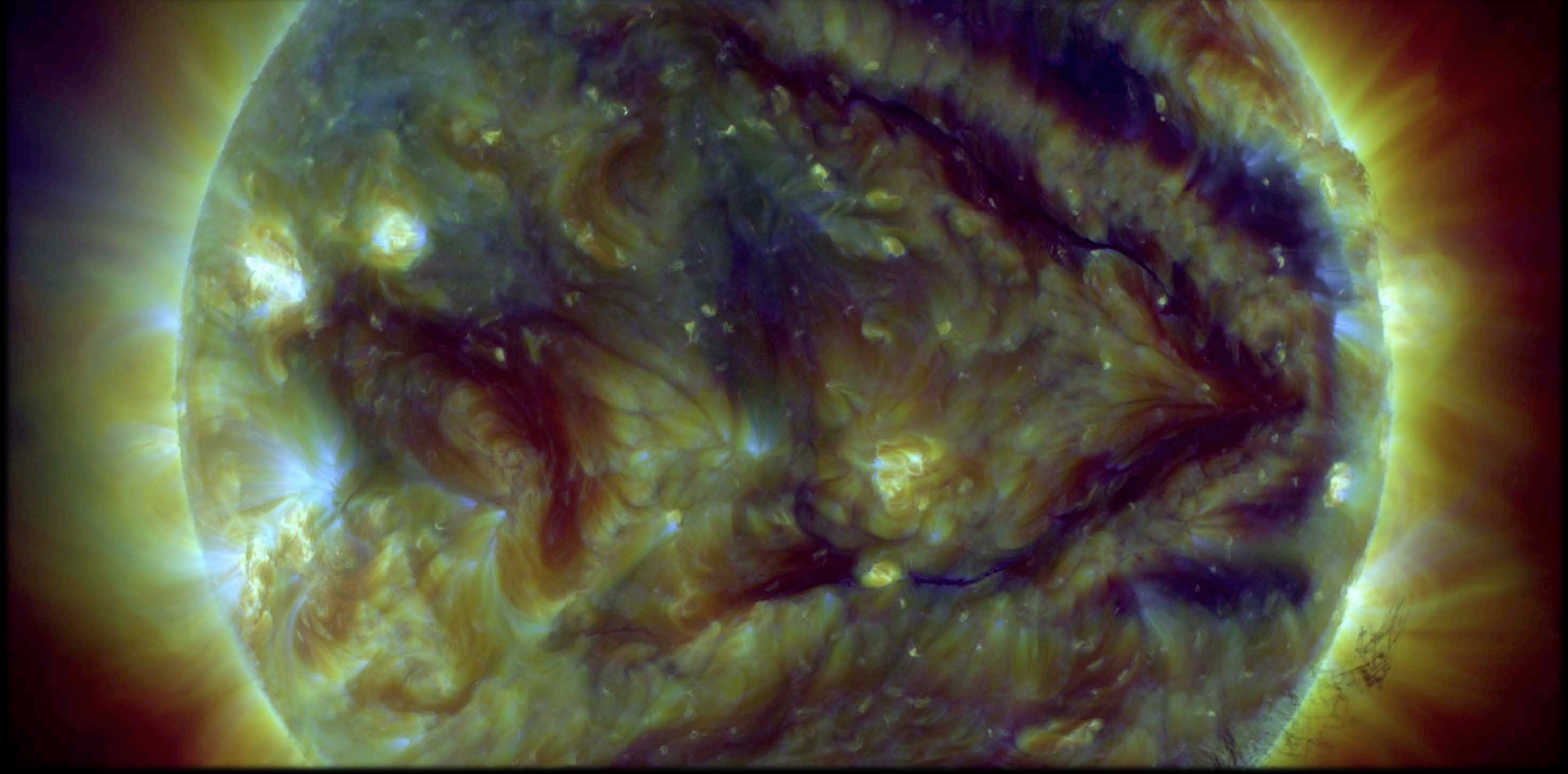


HI-1
~1/3 Earth's orbit



COR-2
~15 solar radii

IMAGING INSTRUMENTS ON STEREO

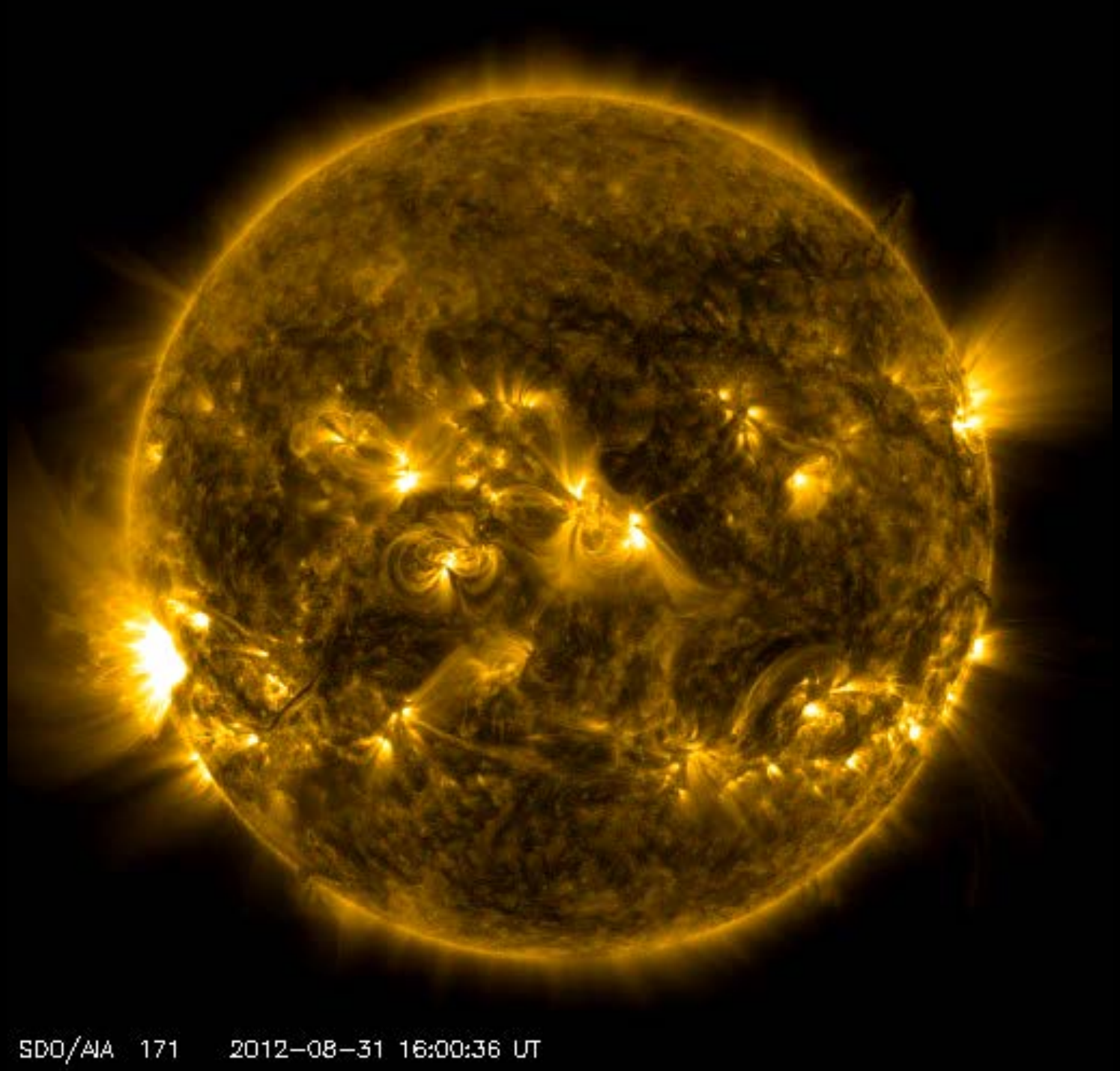


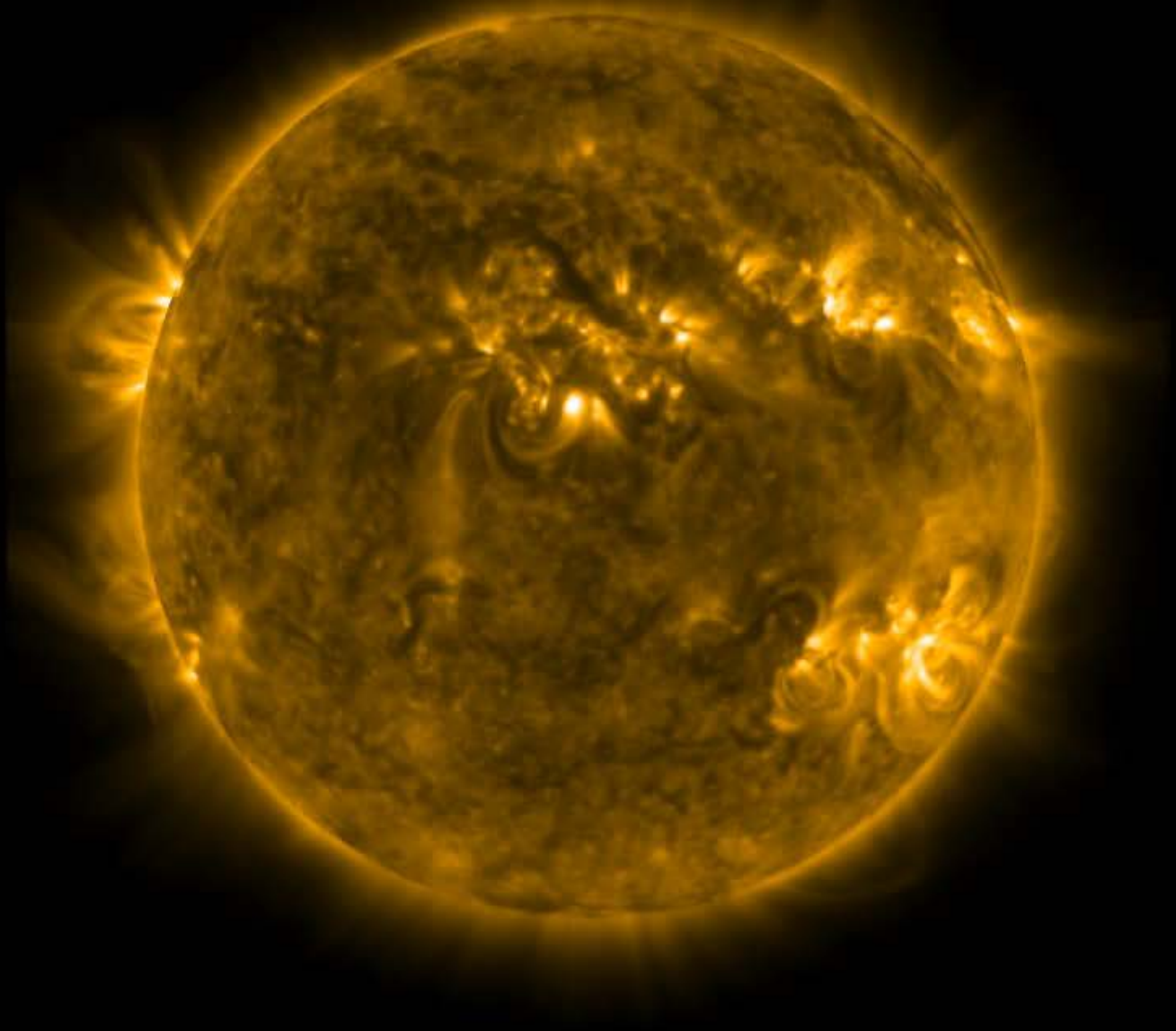
FILAMENTS are cool, dense plasma that collect near the sun's surface

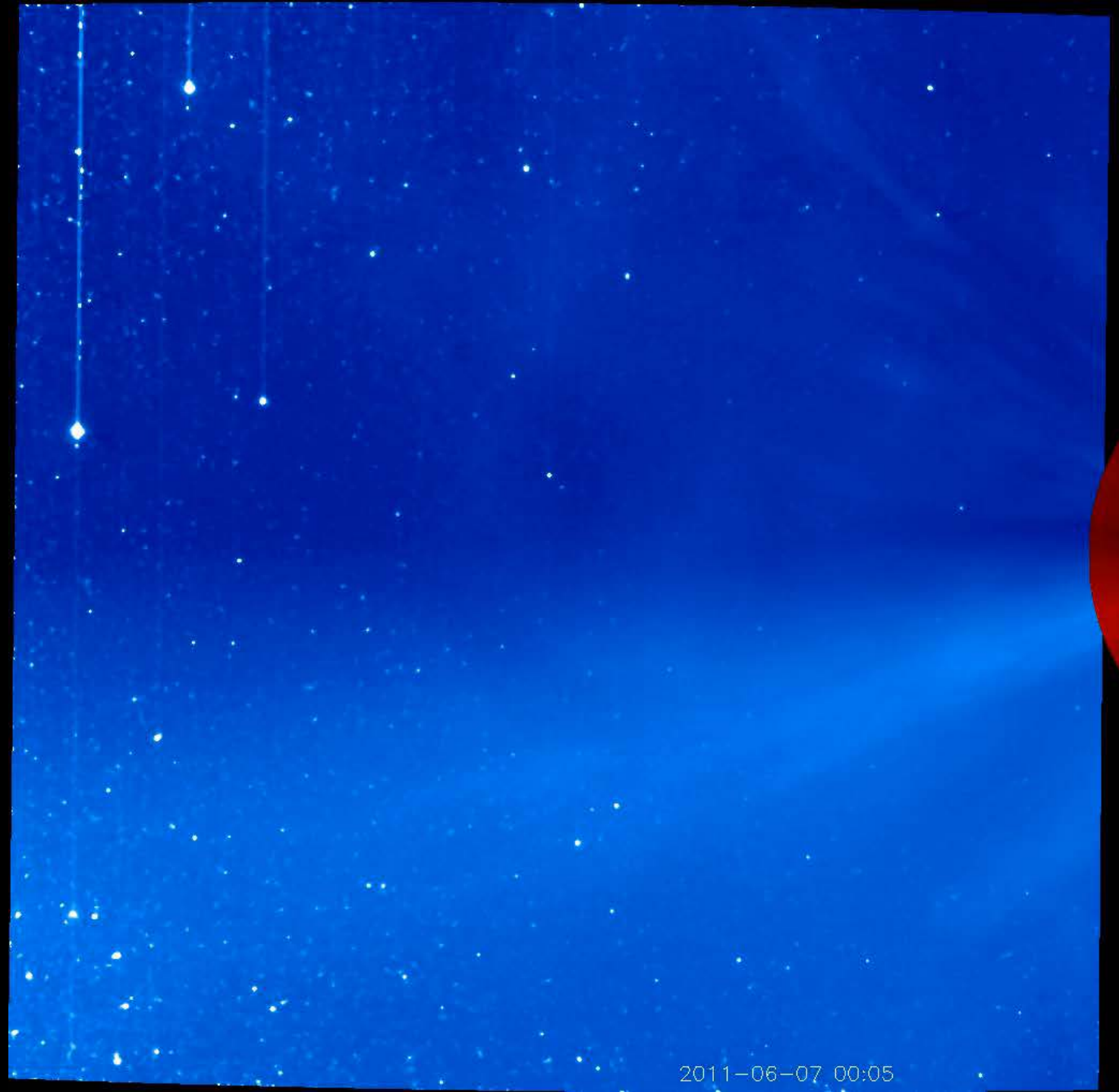
Tells us about local B field environments on surface of the sun

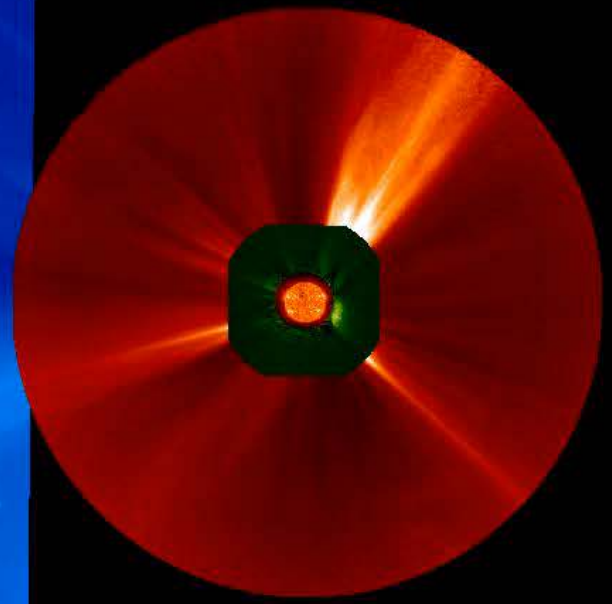
Sometimes filaments erupt from the surface as part of CMEs

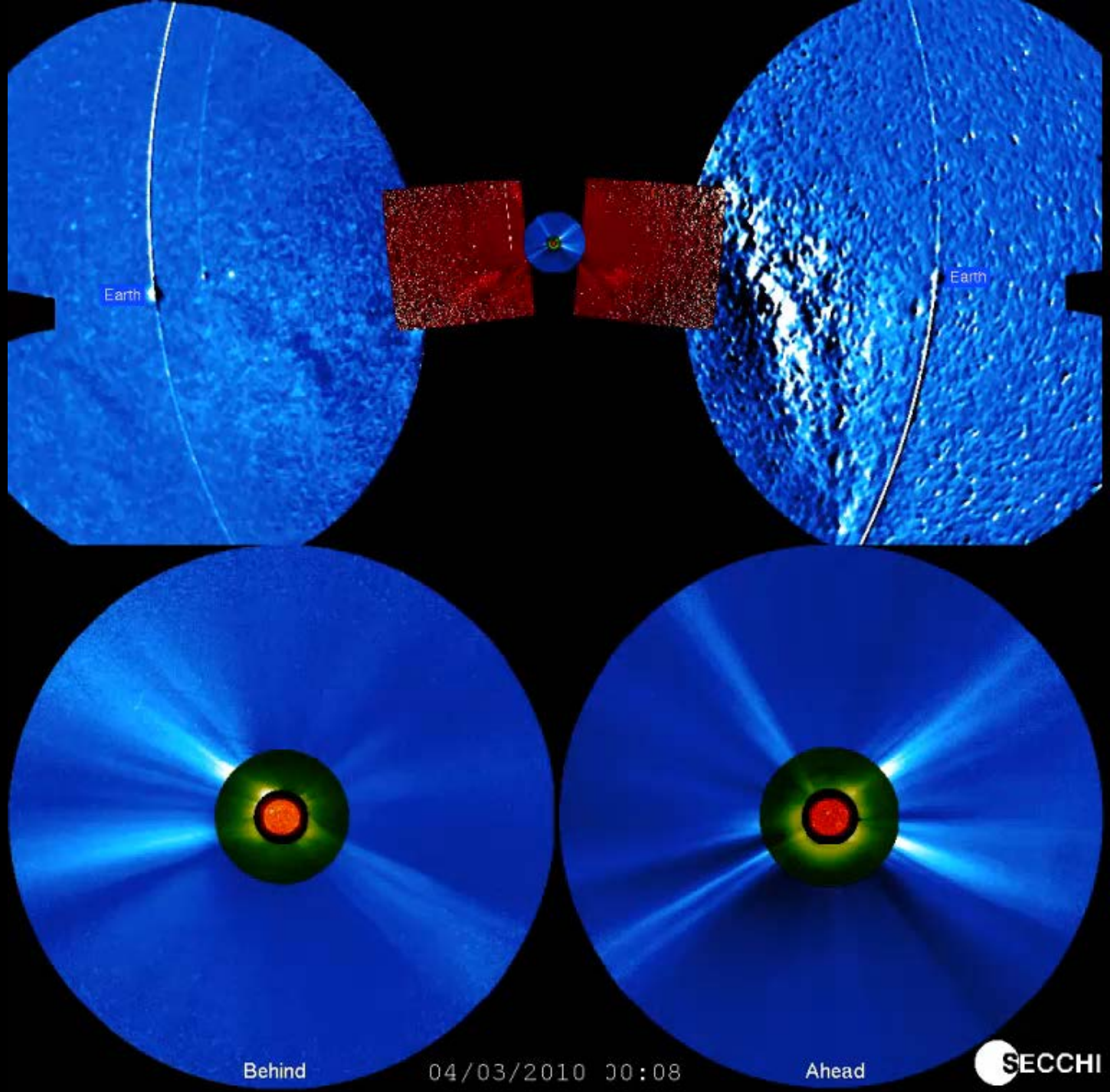
Until this year, we could not track them once they had left the sun





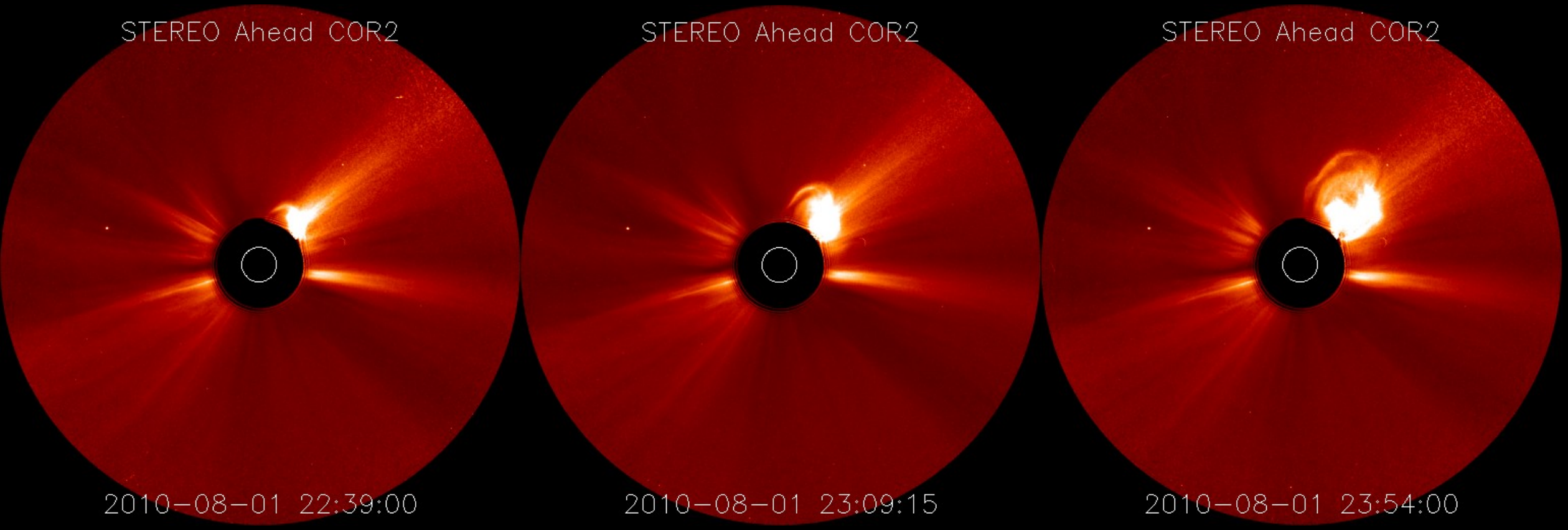

2011-06-07 00:05




Earth
Earth
Behind
04/03/2010 00:08
Ahead
SECCHI

Solar images can only detect OVERALL brightness of object

No information on the type of brightness

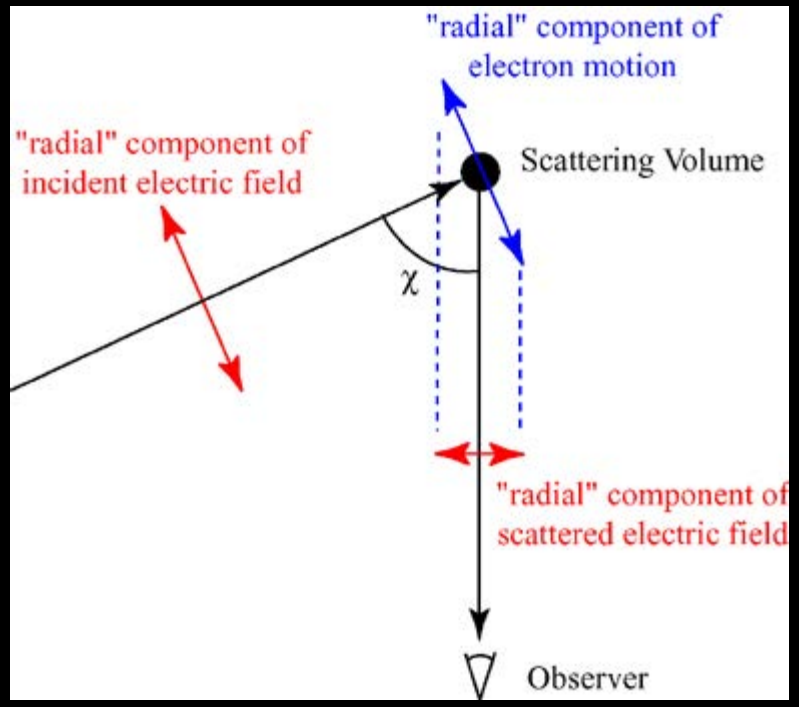


STEREO IMAGES (http://stereo-ssc.nascom.nasa.gov/)

Thomson Scattering is the elastic collision between a photon and a free electron, which produces light

Depends on the amount of free electrons (ionized hydrogen) available

When all the light is Thomson Scattered we can convert the BRIGHTNESS of the event to its MASS

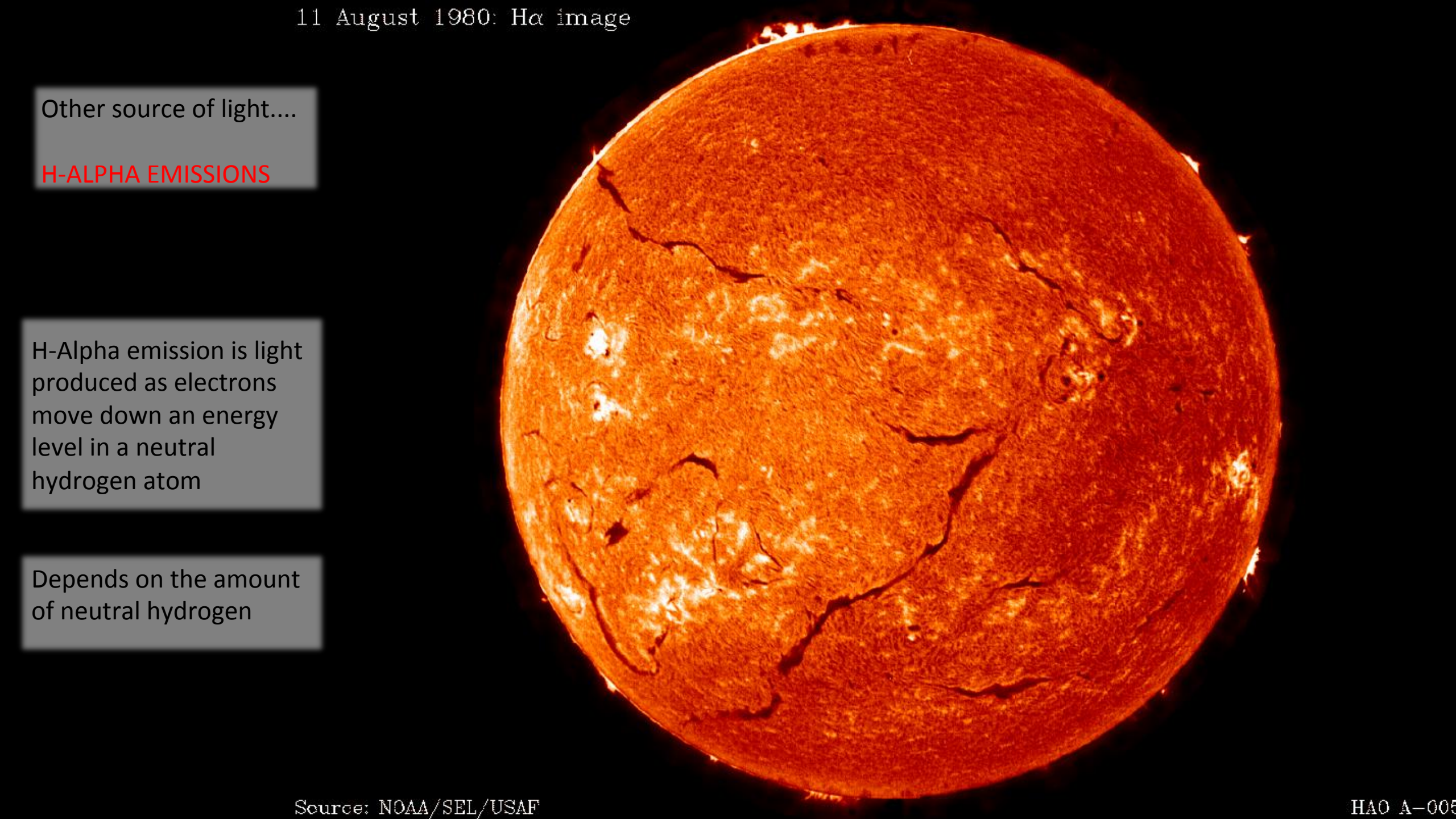


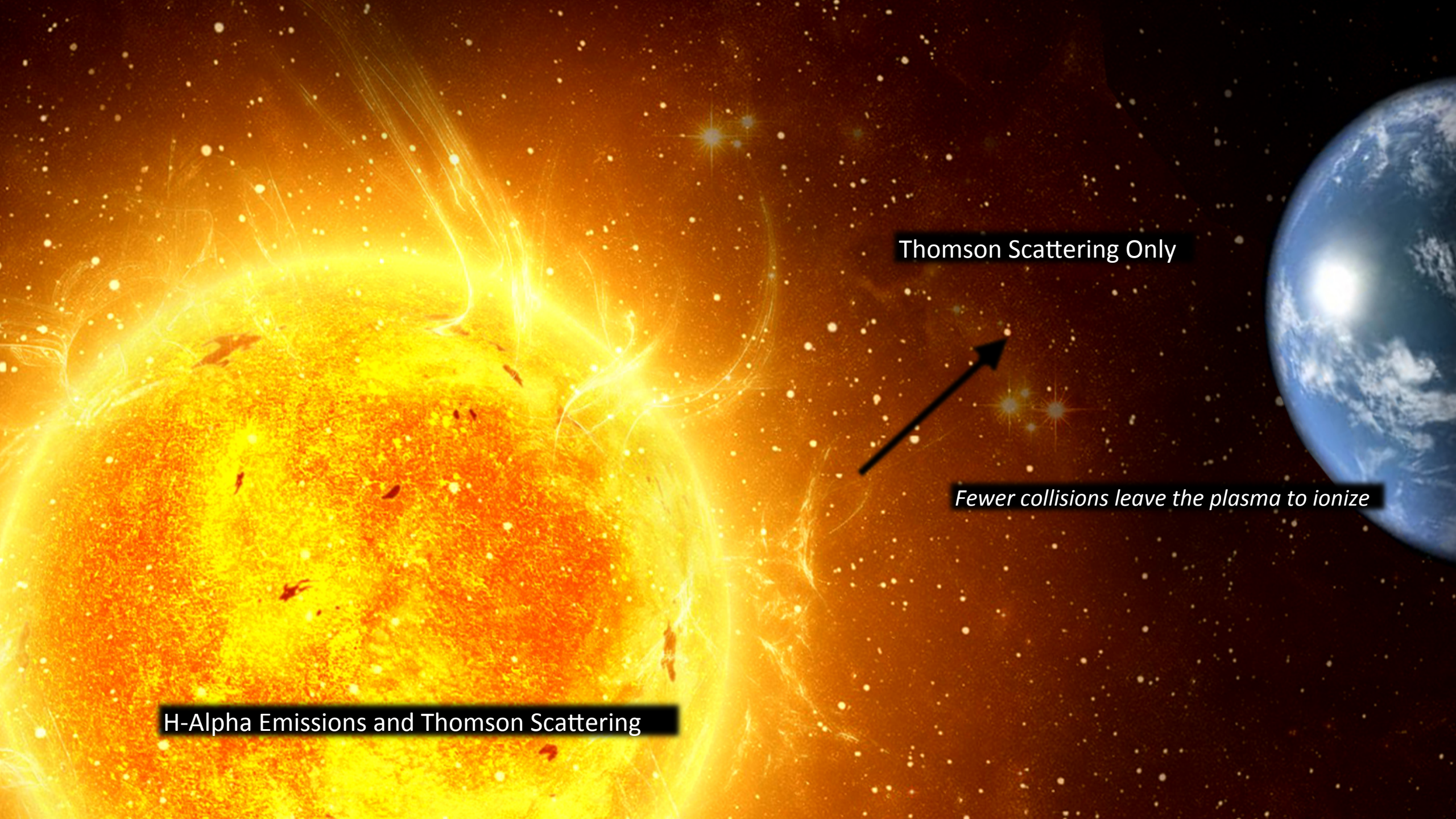
Other source of light....

H-ALPHA EMISSIONS

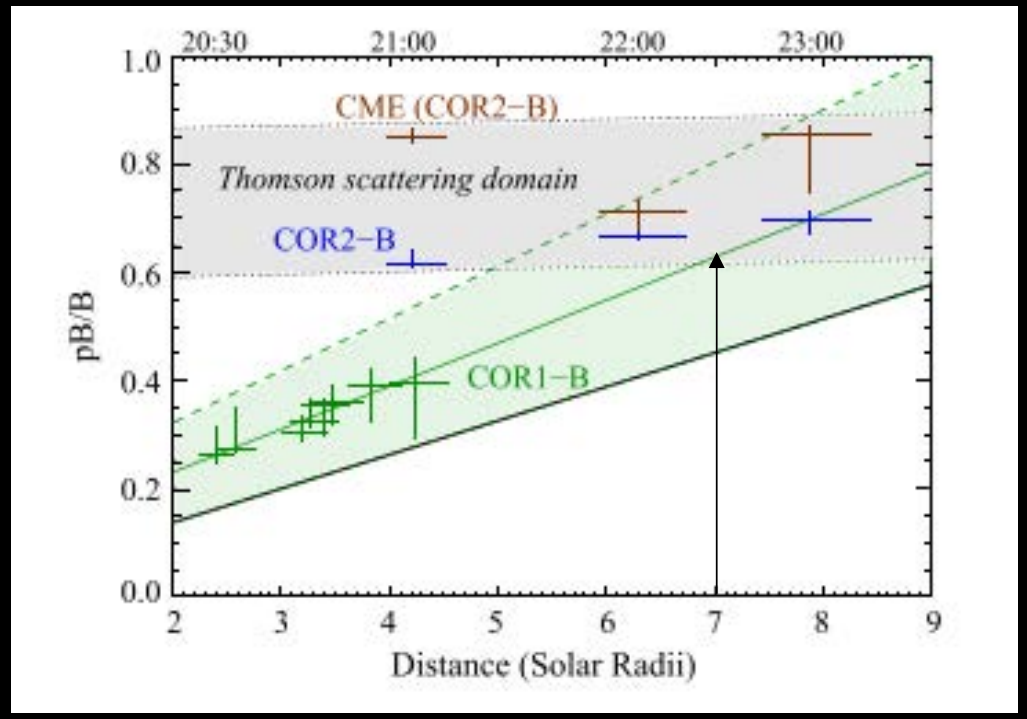
H-Alpha emission is light produced as electrons move down an energy level in a neutral hydrogen atom

Depends on the amount of neutral hydrogen



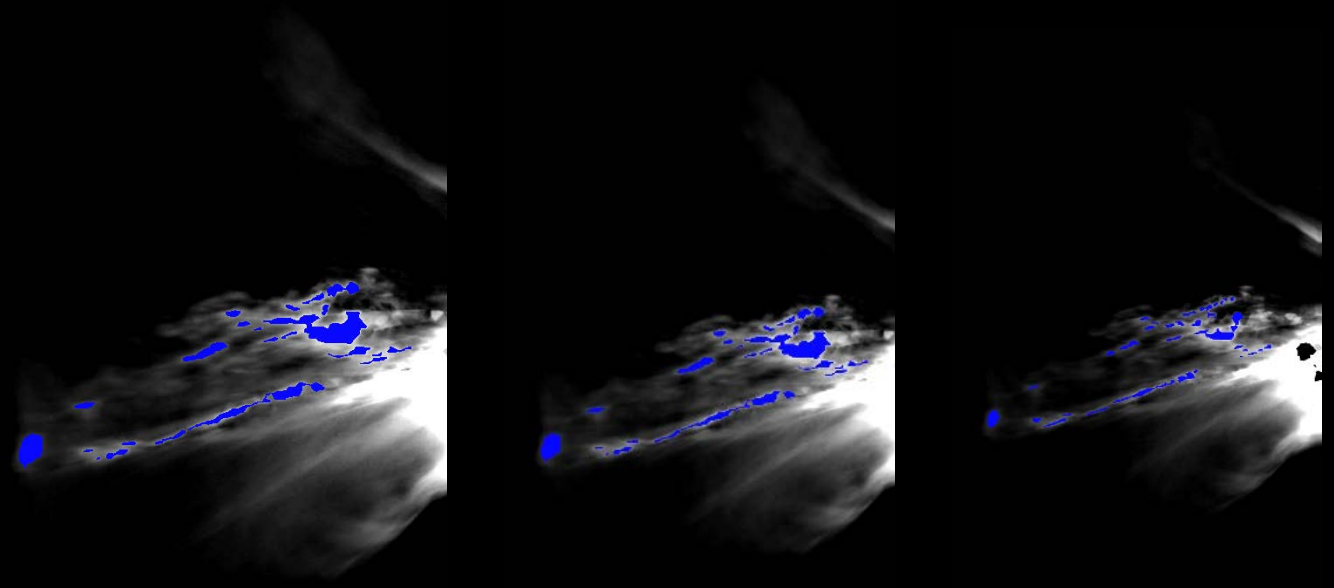

Thomson Scattering Only
Fewer collisions leave the plasma to ionize
H-Alpha Emissions and Thomson Scattering

Thomson Scattering starts to dominate at around
SEVEN SOLAR RADII

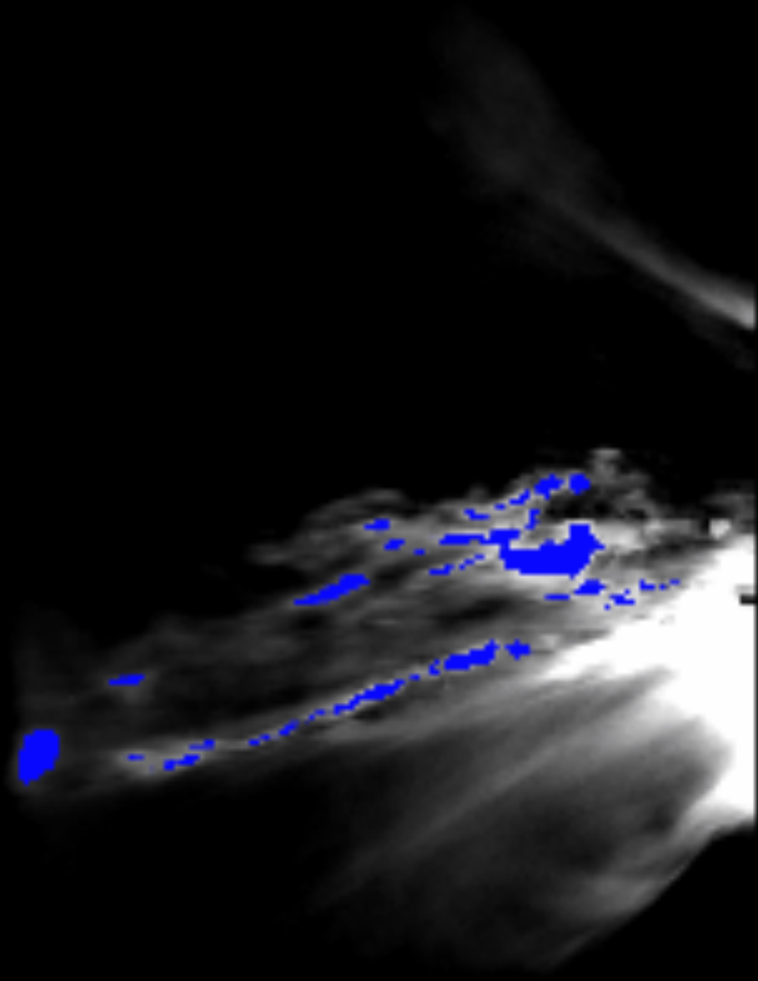


Howard, 2015

I created a program in PDL that converts the brightness of keyed pixels in the heliospheric images from HI1 and HI2 to their associated mass



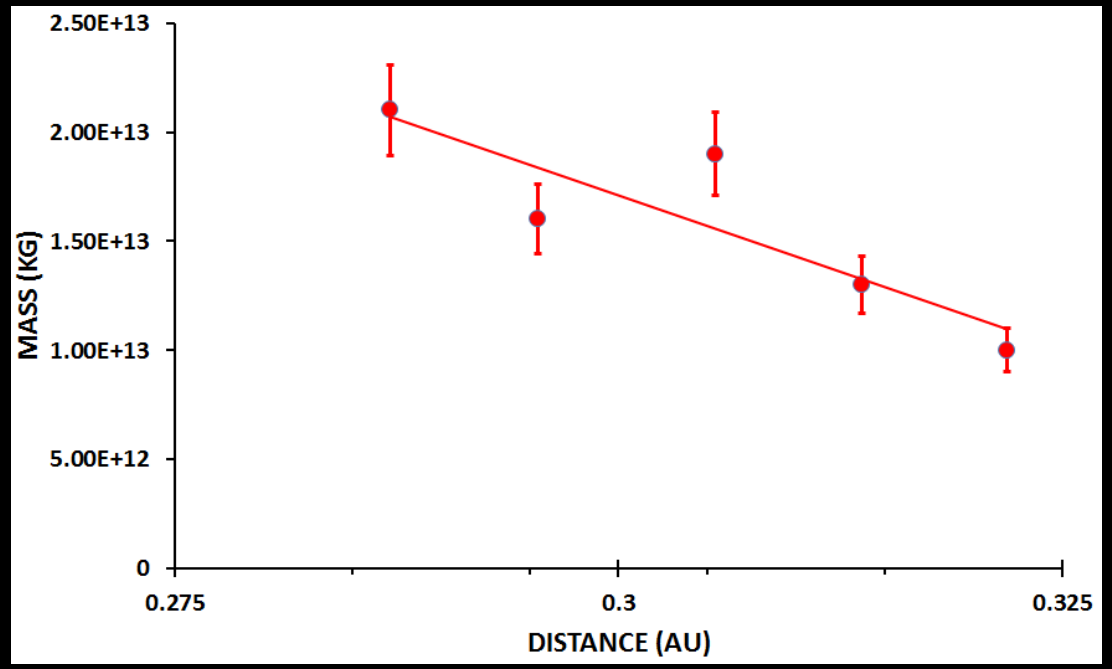
Allows us to track an individual event far out from the sun and analyze how it changes



RESULTS

Mass of the prominence seems to DECREASE with distance from the sun

Unusual because the leading plasma edge of the same CME will GAIN mass as it travels through the surrounding solar wind like a “snow plow”



CONCLUSION

FILAMENTS are cool, dense plasma that collect near the sun's surface

At seven solar radii the brightness of a CME is dominated by Thomson Scattering

Heliospheric images can be analyzed to attain the mass trends of an EFs far from the sun.

We see a gradual decrease in the mass of the prominence as it gets further from the sun.

This is the second measurement beyond COR-2 for eruptive filaments!

Questions?

References:
- “The Thomson Surface, I. Reality and Myth” (Howard & DeForest, 2012)
- “Measuring an Eruptive Prominence at Large Distances from the Sun, I.: Ionization and Early Evolution” (Howard, 2015)
- “Measuring an Eruptive Prominence at Large Distances from the Sun, II : Approaching 1 AU” (Howard, 2015)