



# SOHO

The Solar and Heliospheric  
Observatory



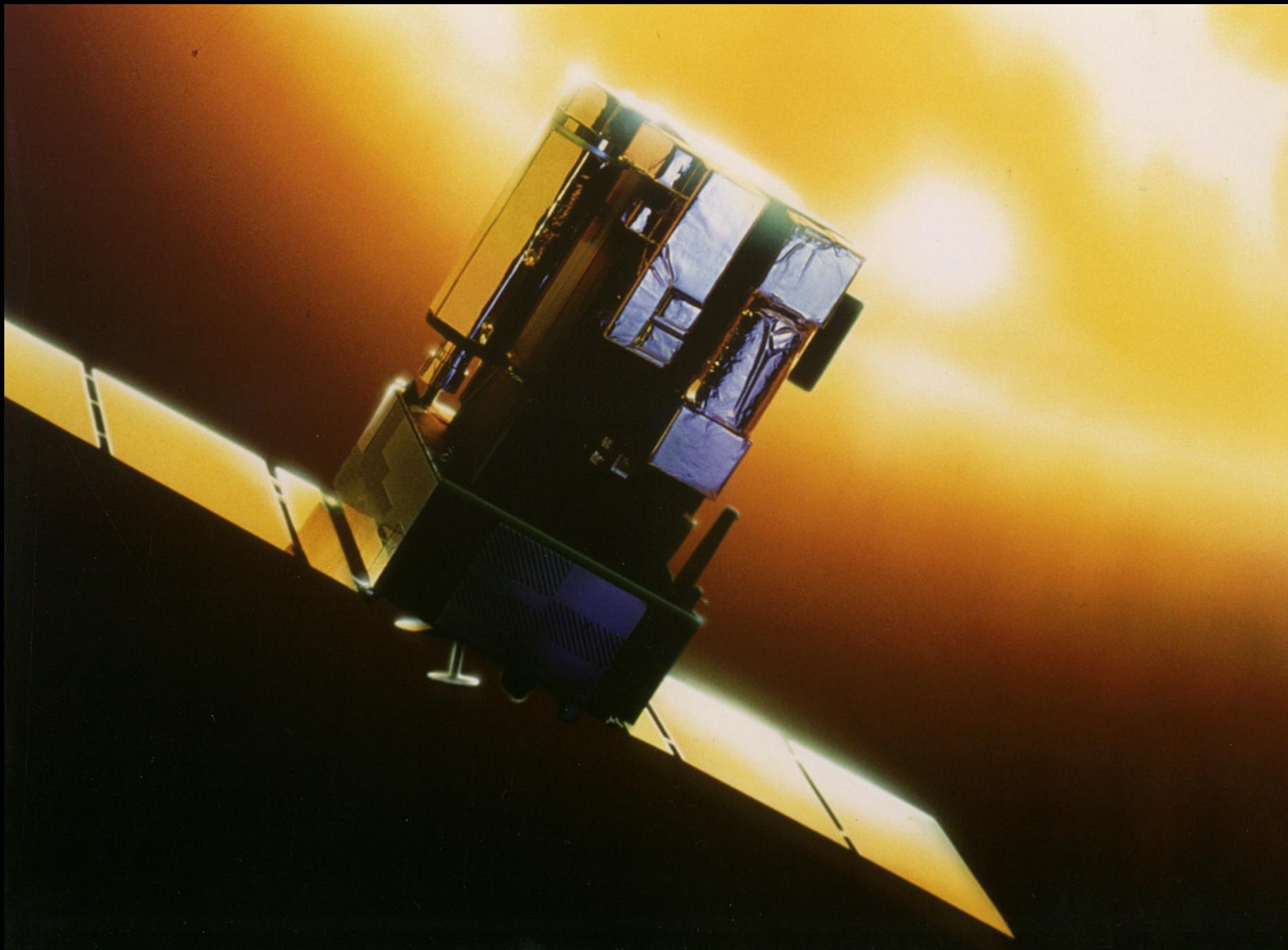
## *New Views of the Sun*



SOHO is a joint mission of international cooperation between ESA and NASA



# An artist's illustration of the SOHO spacecraft





# The SOHO spacecraft under construction and prepared for testing

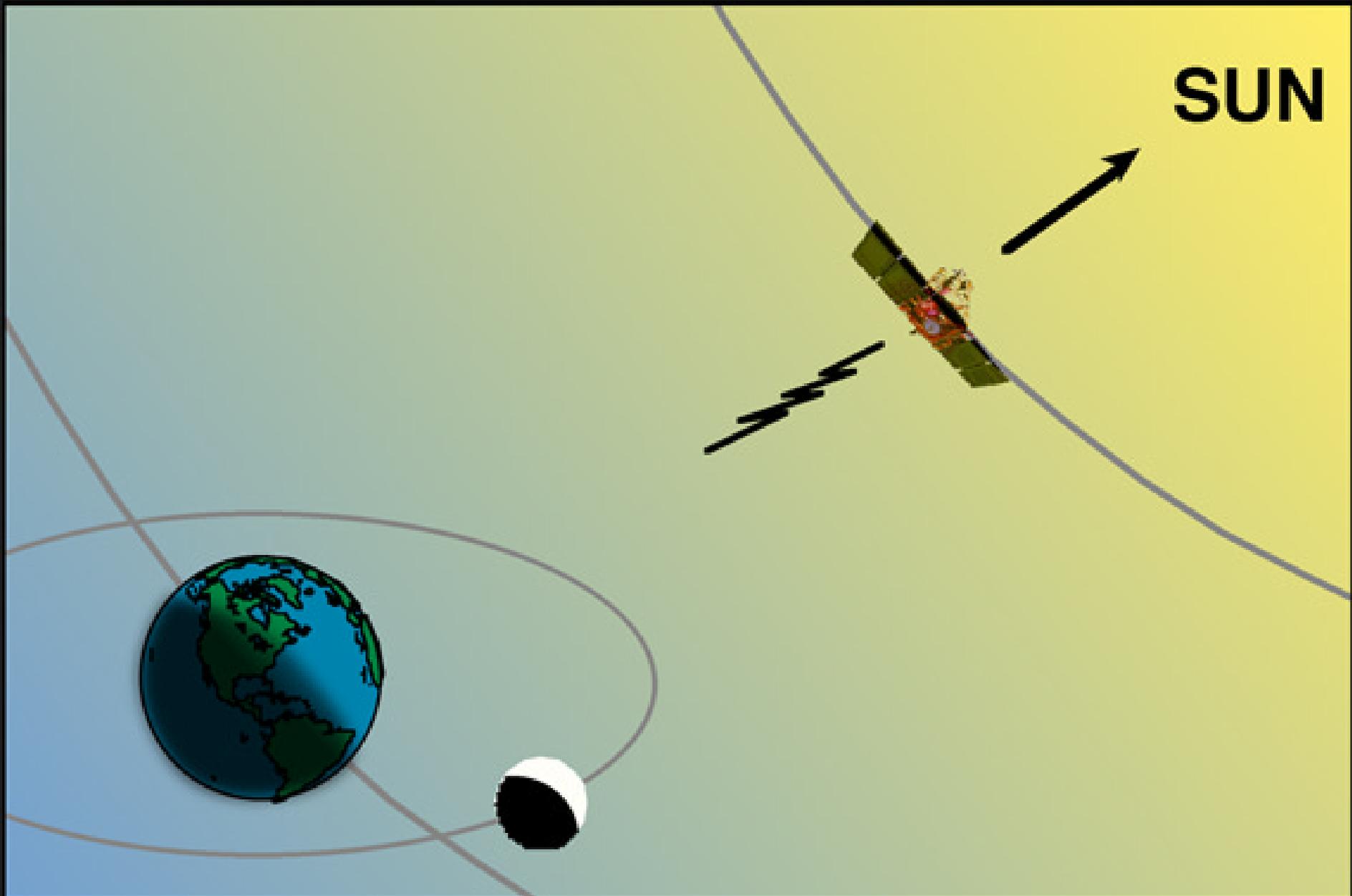


- taller than a school bus
- weighs over 2 tons
- stretches 25 feet with solar panels extended
- launched in late 1995

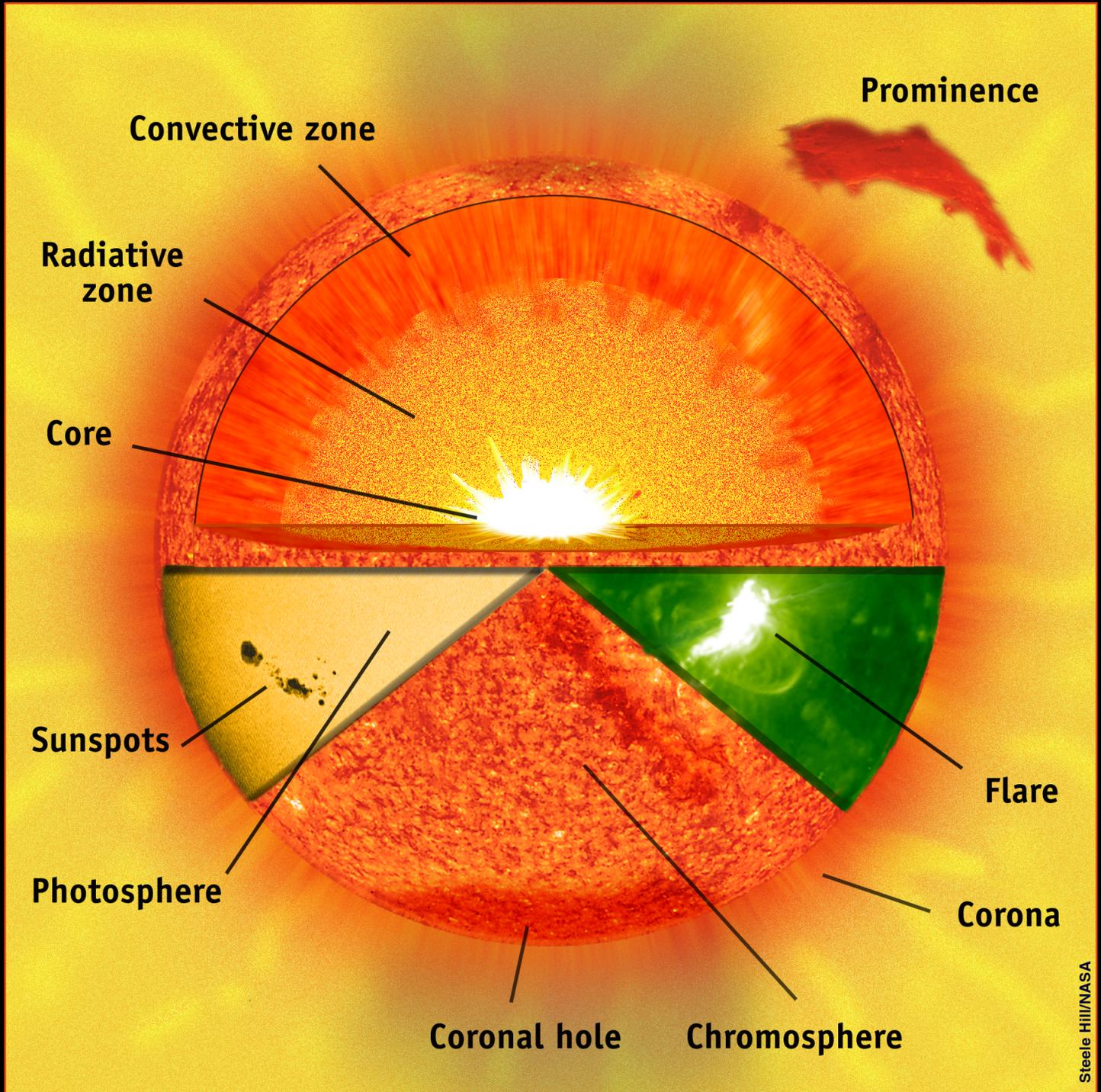




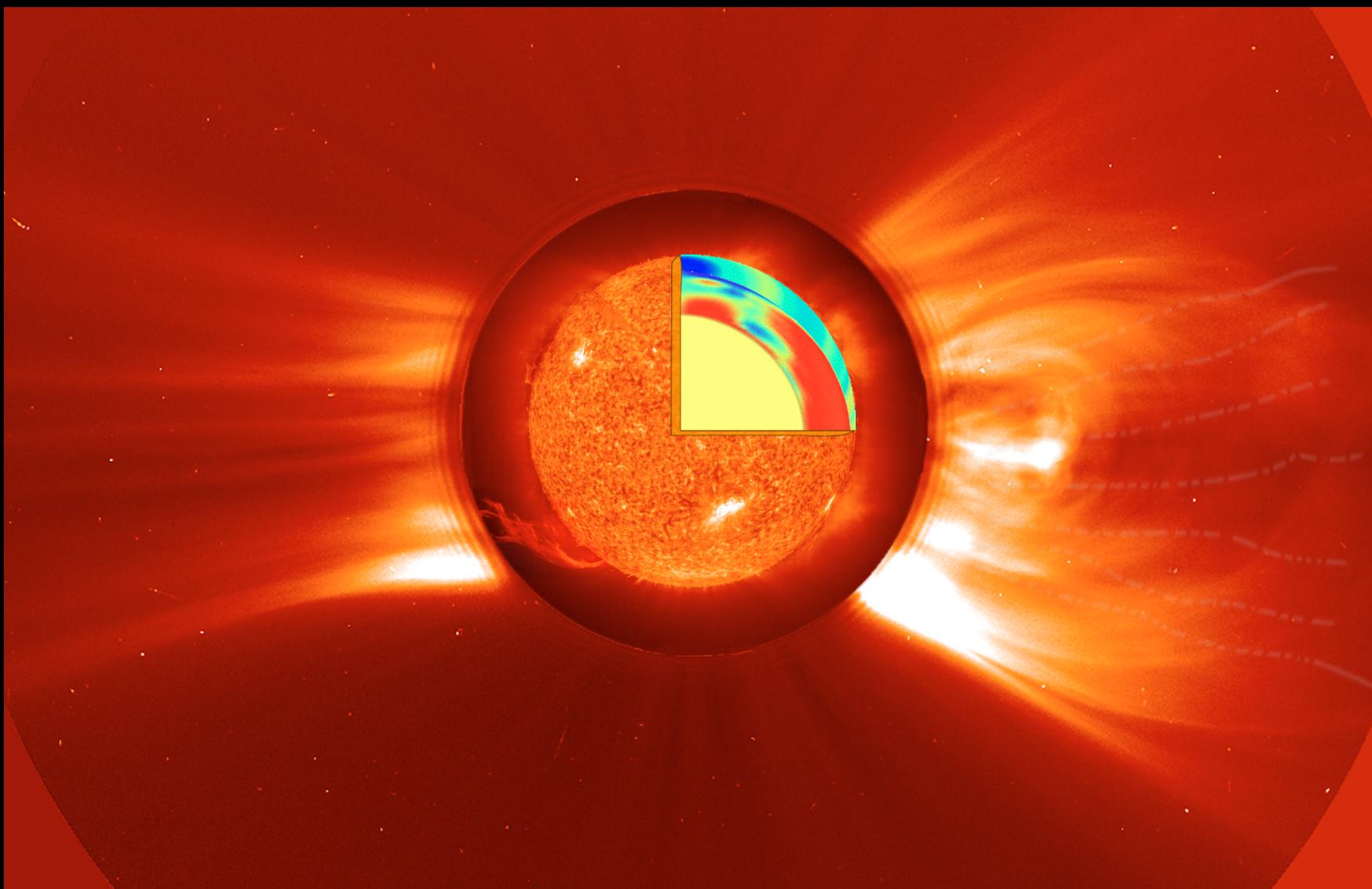
**SOHO maintains an orbit around the Sun, 1.5 million km (a million miles) from Earth at the Lagrangian point (L1)**



# The parts of the Sun

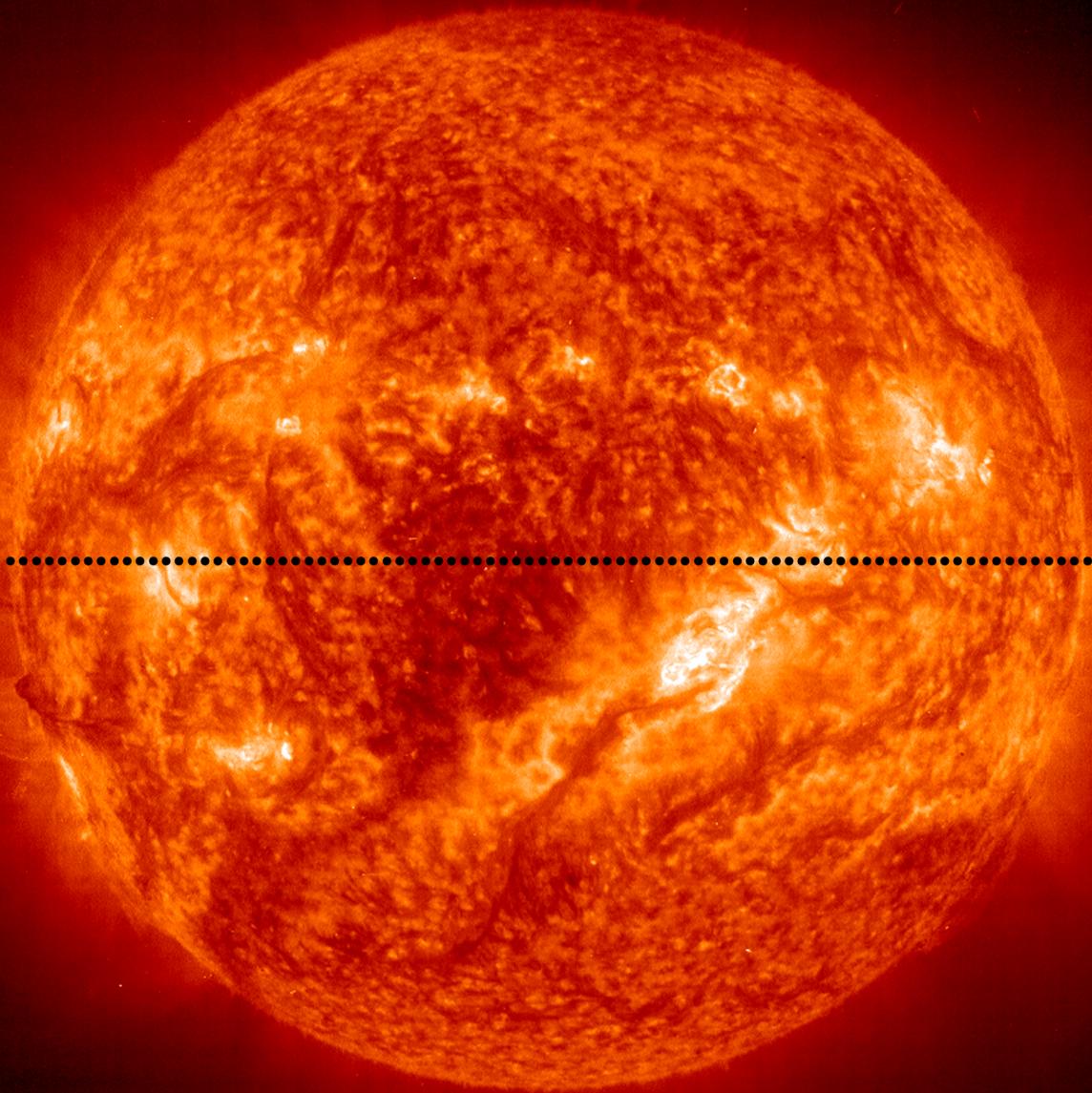


**The three major areas of SOHO's scientific investigations are the solar interior, the corona, and the solar wind**





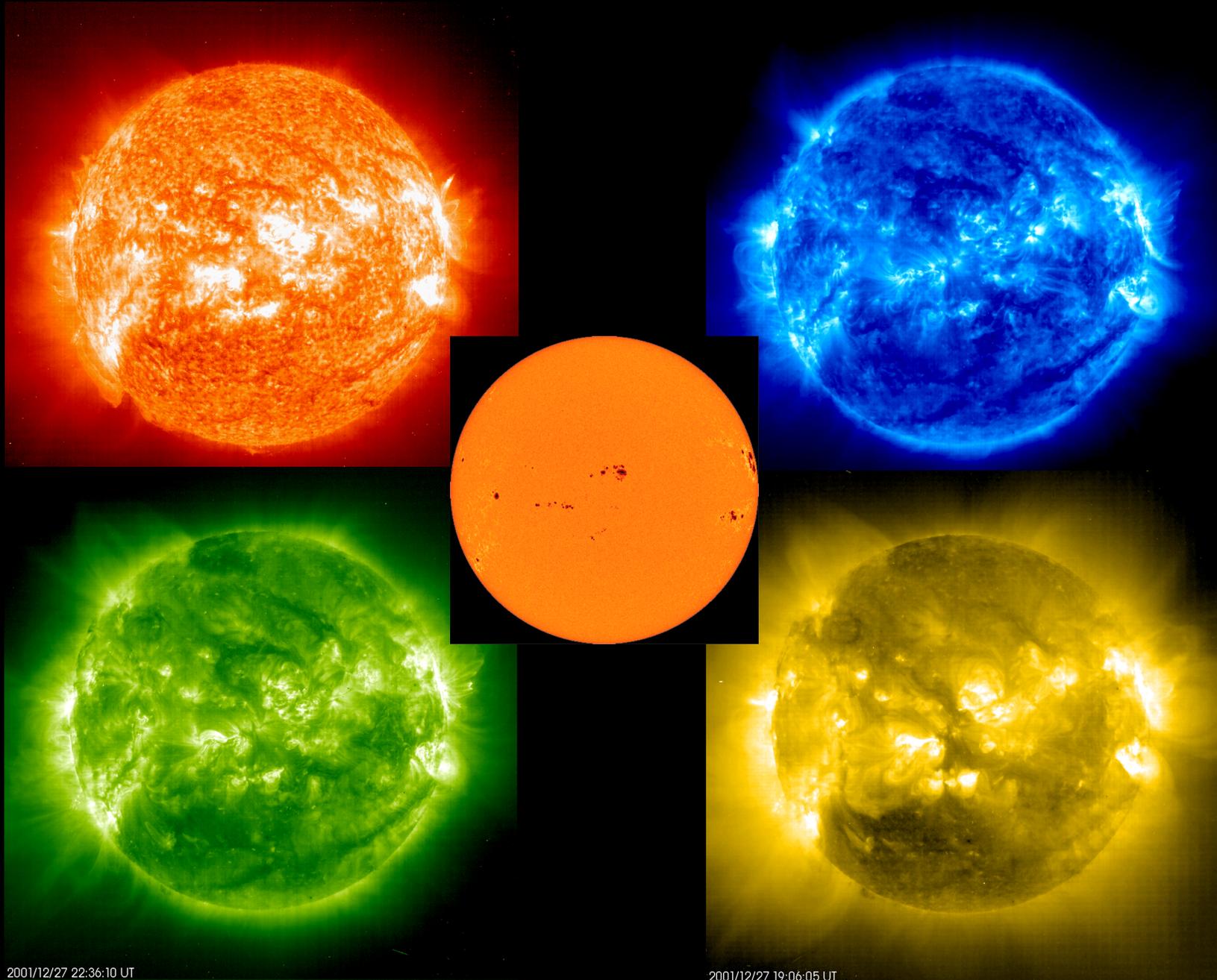
**How big is the Sun? You could fit 108 Earths across the diameter of the Sun. It accounts for 99% of the mass in our solar system.**



The Sun has a diameter of about 1.3 million kilometers (860,000 miles)



# SOHO observes the Sun in four extreme ultraviolet wavelengths as well as in visible light (center)

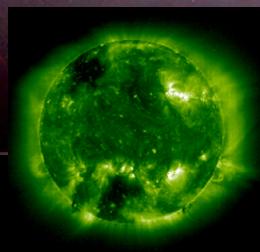
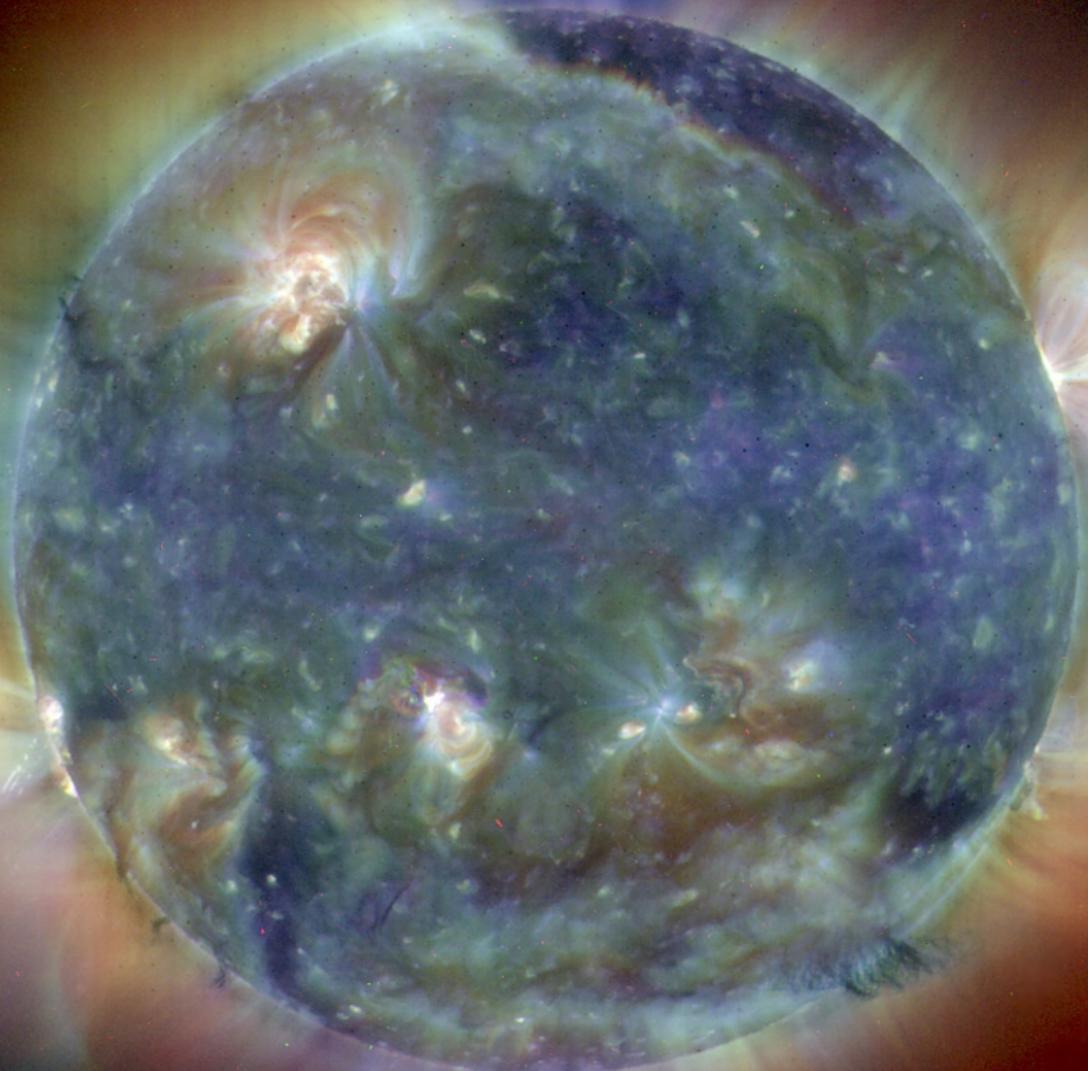


2001/12/27 22:36:10 UT

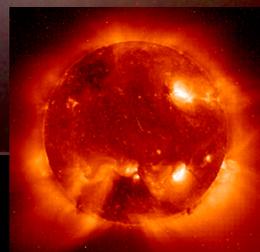
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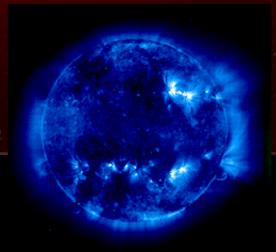
**A composite image of the Sun, combining three different ultraviolet wavelengths, reveals solar features unique to each**



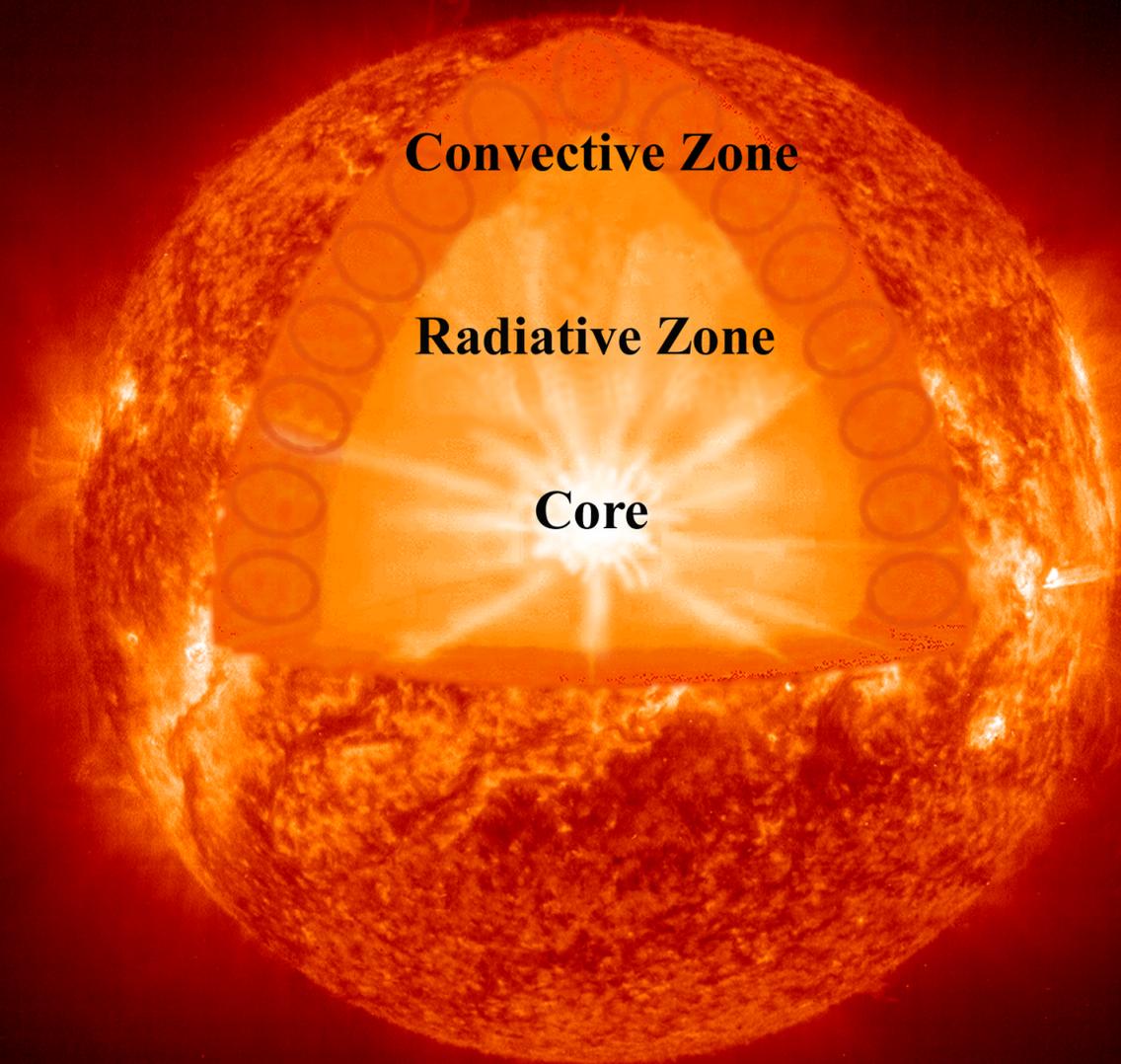
+



+



# The three major interior regions of the Sun's internal structure

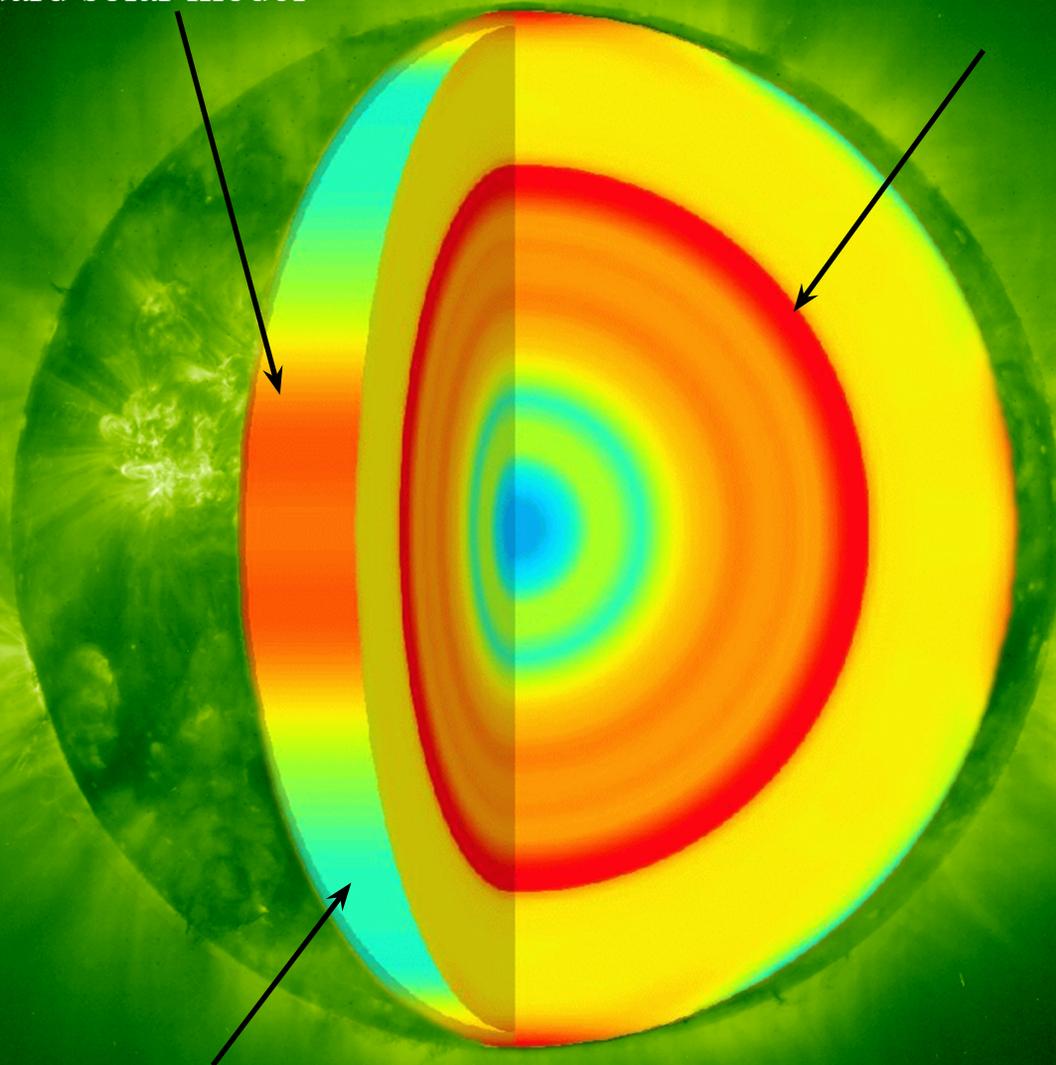




# Using helioseismology, SOHO can see inside the Sun to reveal its structure and interior processes

red = hotter than standard solar model

boundary between convection zone & radiation zone



blue = cooler than standard solar model





**A magnetic observation of the Sun where  
the black and white areas represent north  
and south polarities -- magnetic fields  
drive most solar activity**

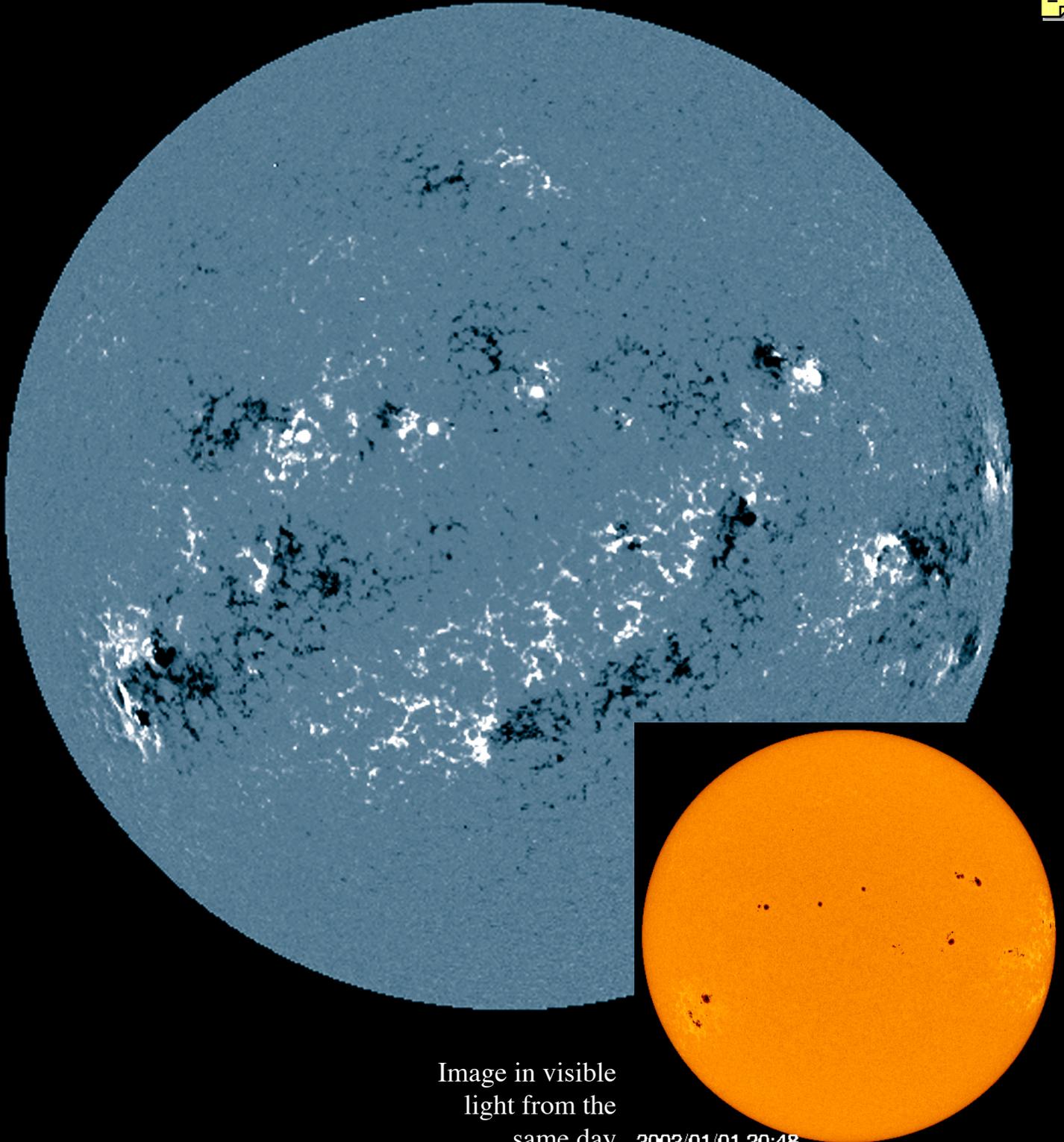
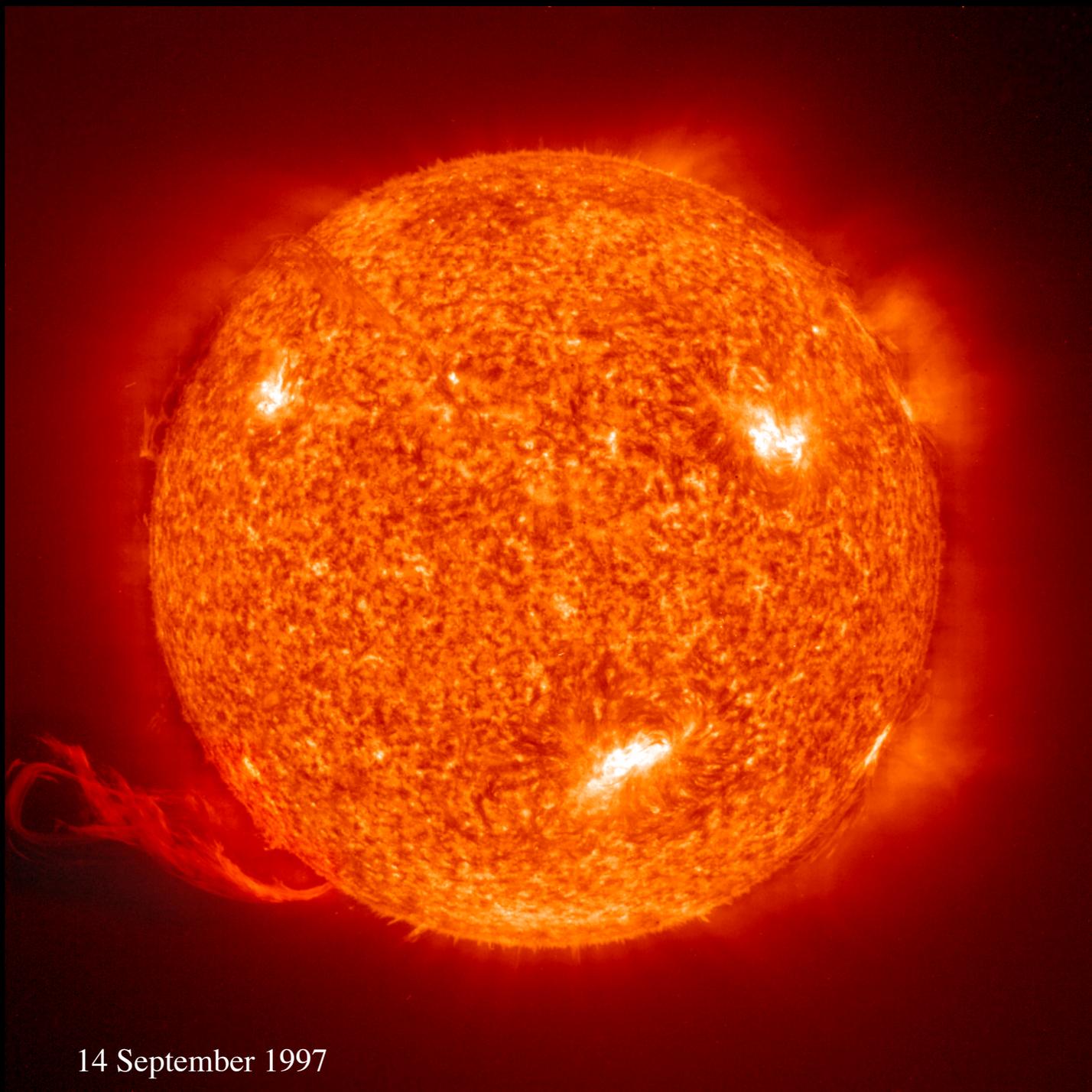


Image in visible  
light from the  
same day 2002/01/01 20:48



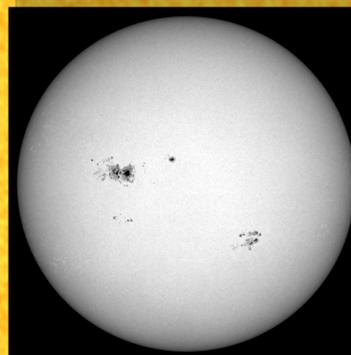
# An eruptive prominence extends from the Sun



14 September 1997

# A very large sunspot group, about 12 times the size of Earth

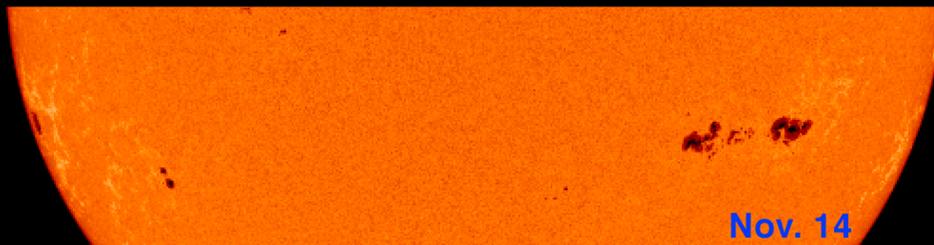
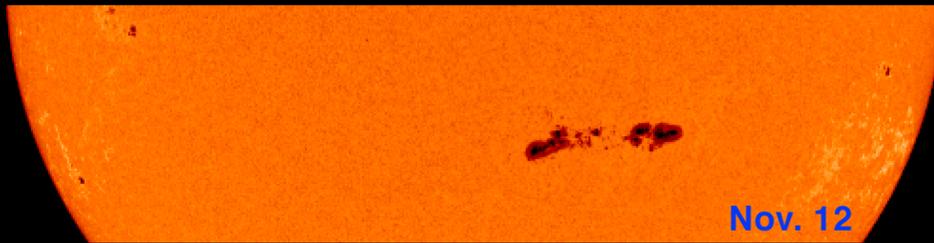
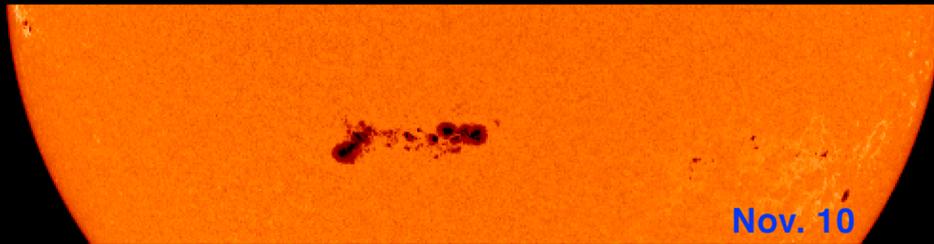
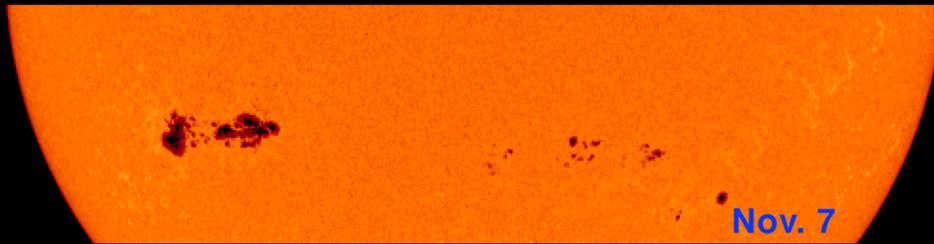
September 23, 2000



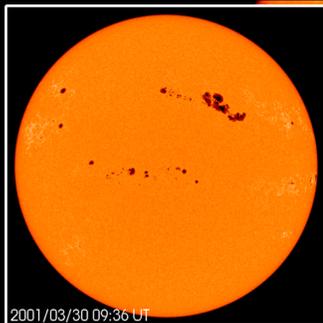
Size of Earth (approx.)



# Sunspots changing over a week



Sunspots rotate with the Sun (every 27 days) and can appear, grow, get smaller or disappear over time. They can last from hours to months.



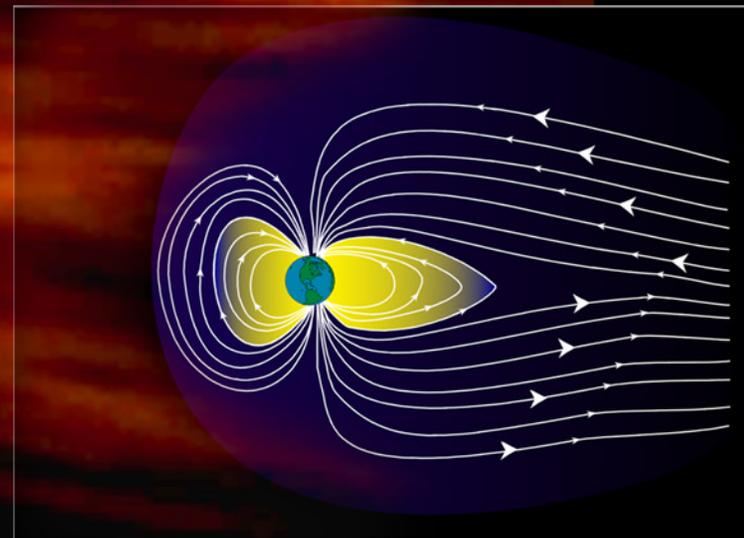
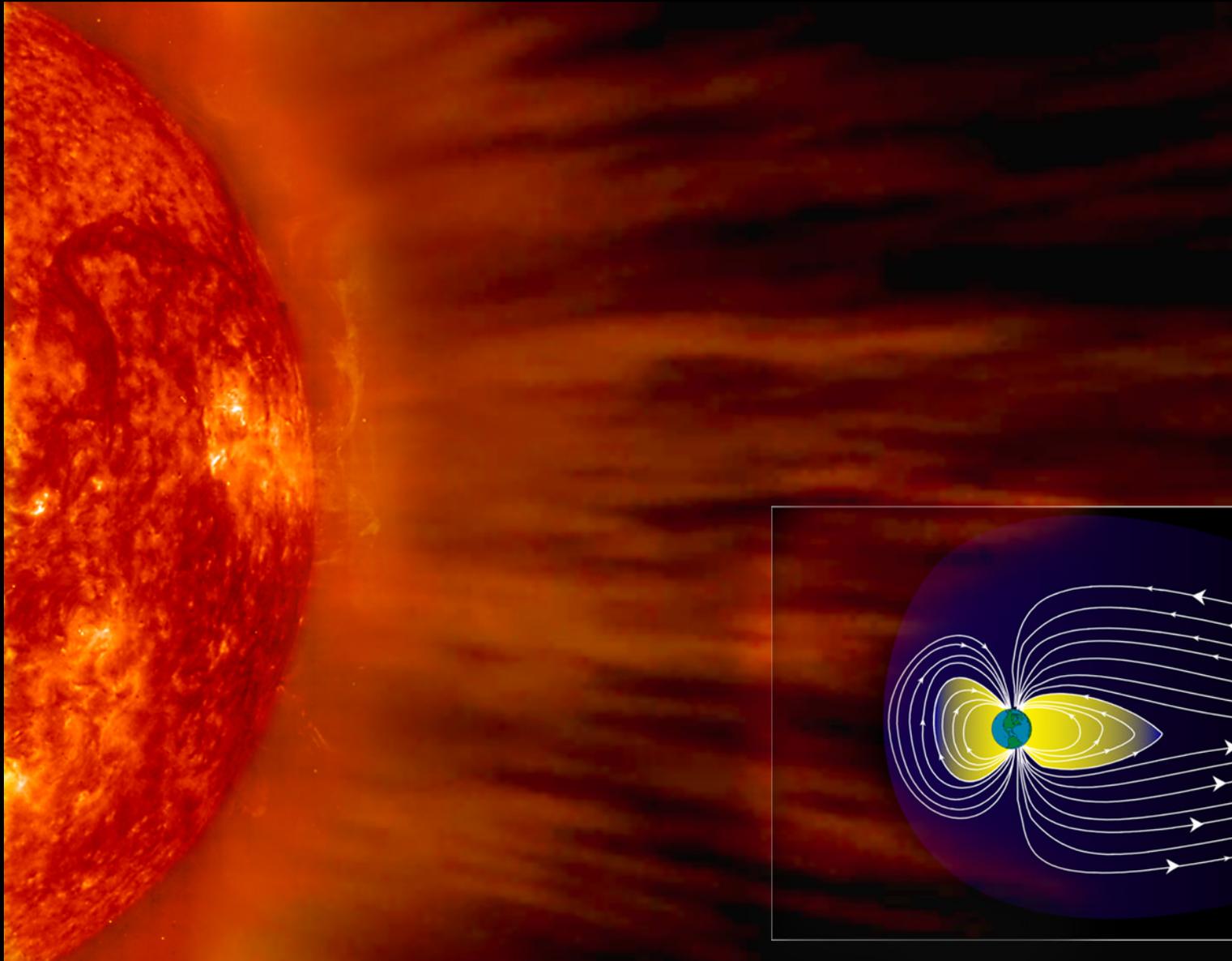
2001/03/30 09:36 UT

Approx. size of Earth → ●

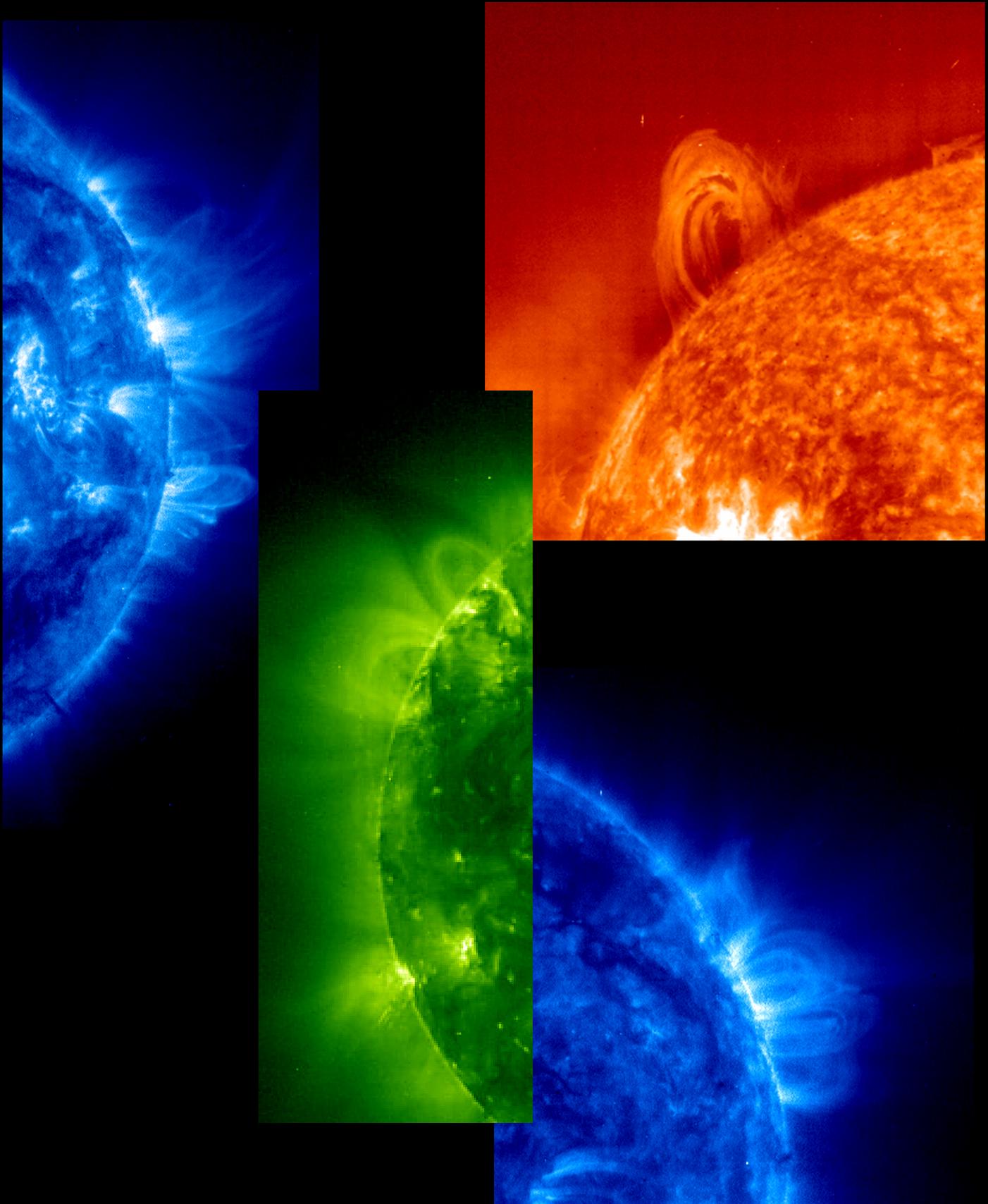
The largest sunspot observed by SOHO was over 13 times the size of Earth



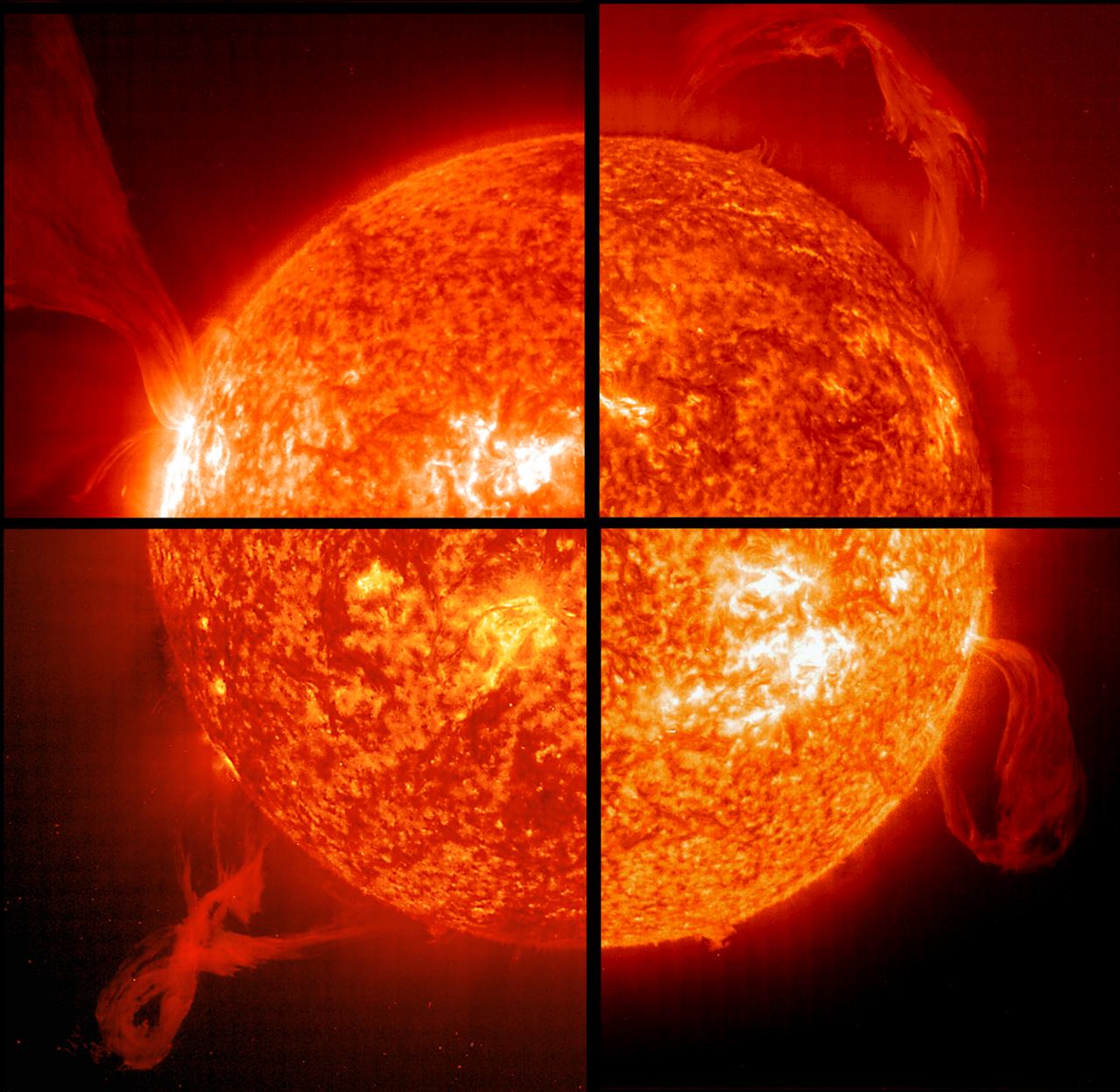
**The solar wind constantly streams particles from the Sun into space, which pushes and shapes Earth's magnetosphere -- the Earth bathes in the Sun's atmosphere**



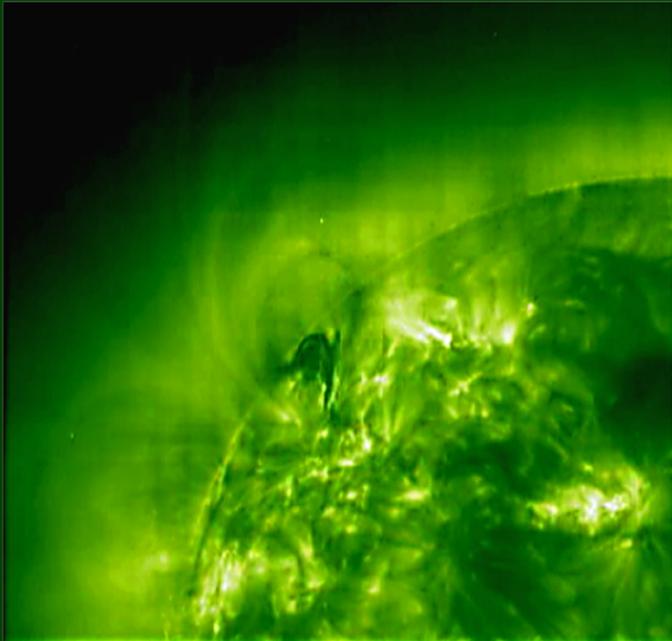
# Magnetic loops are made visible by plasma that follows invisible field lines extending above the surface



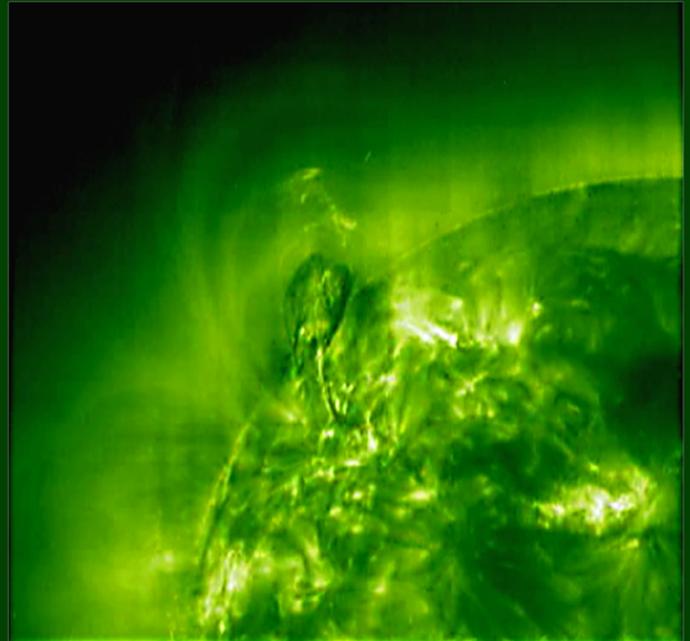
# Large solar prominences, plasma extended along magnetic field lines, sometimes break away



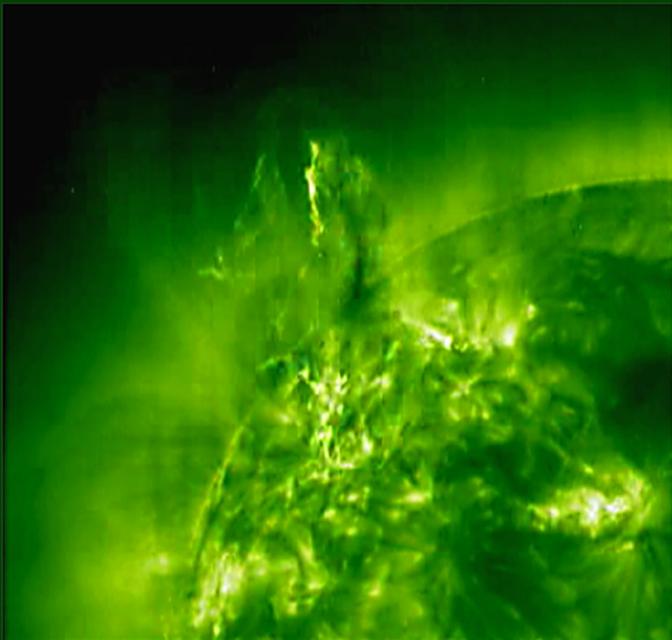
**This close-up of a coronal mass ejection in extreme ultraviolet light shows a mass of particles being blasted into space over a 35-minute period**



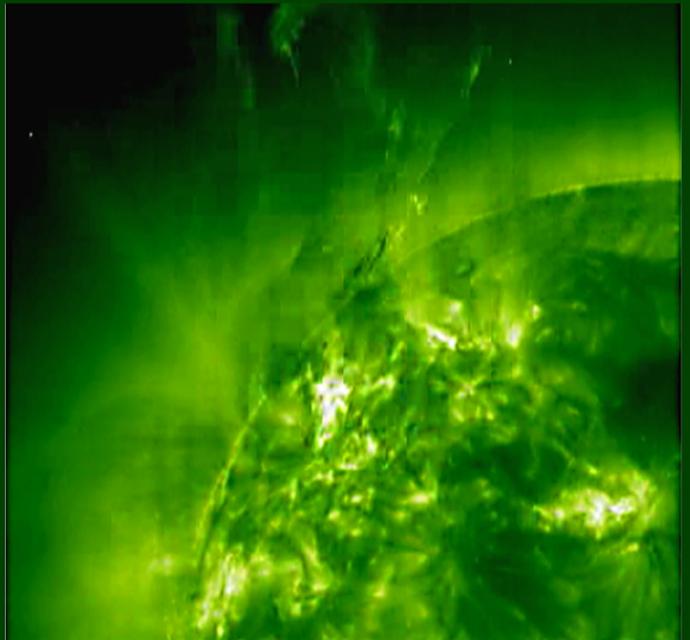
**2/26/00 23:24 UT**



**2/26/00 23:36 UT**



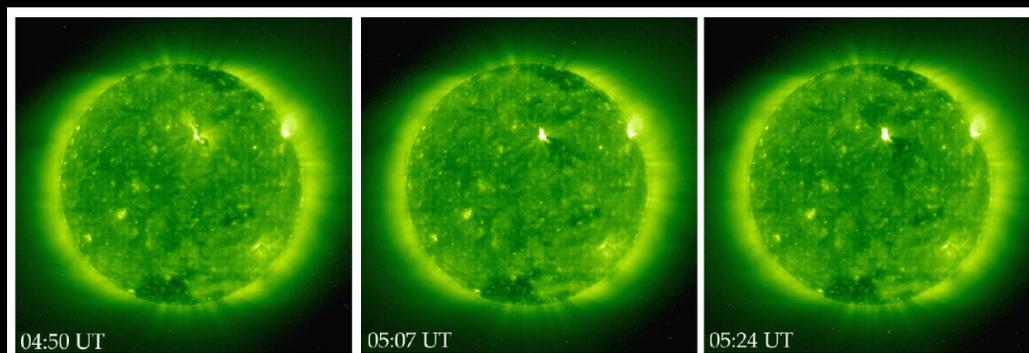
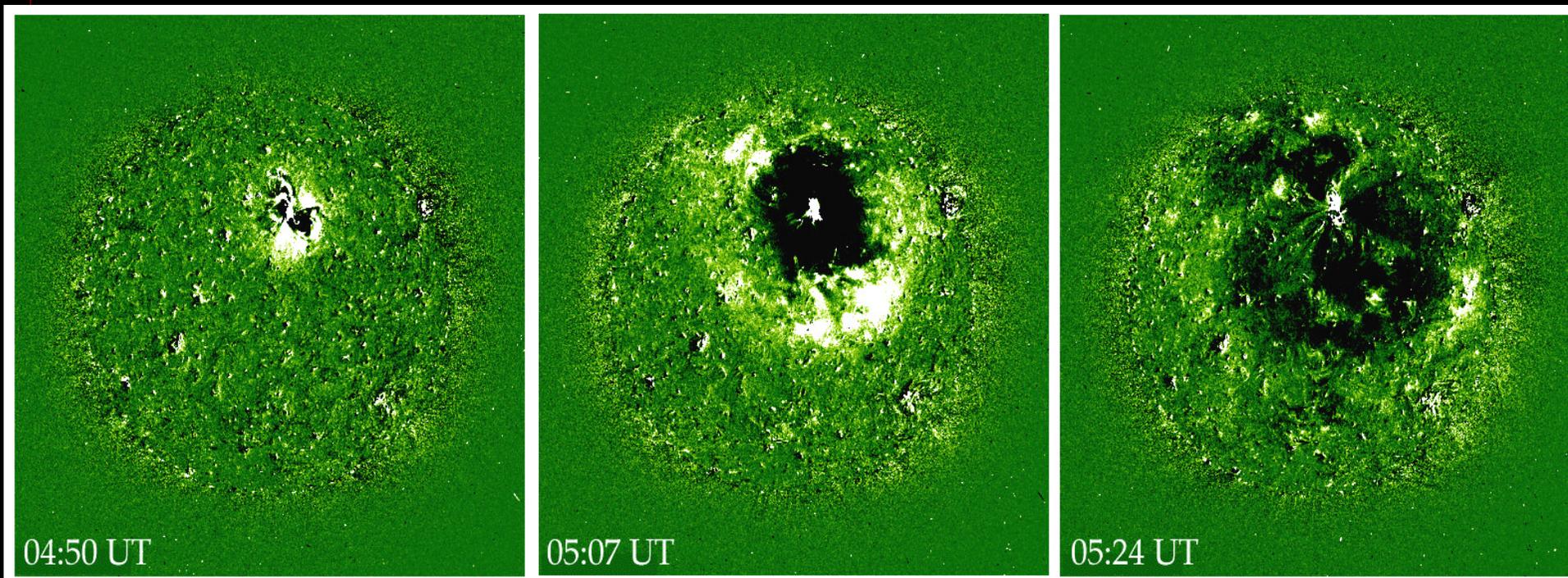
**2/26/00 23:48 UT**



**2/27/00 00:00 UT**



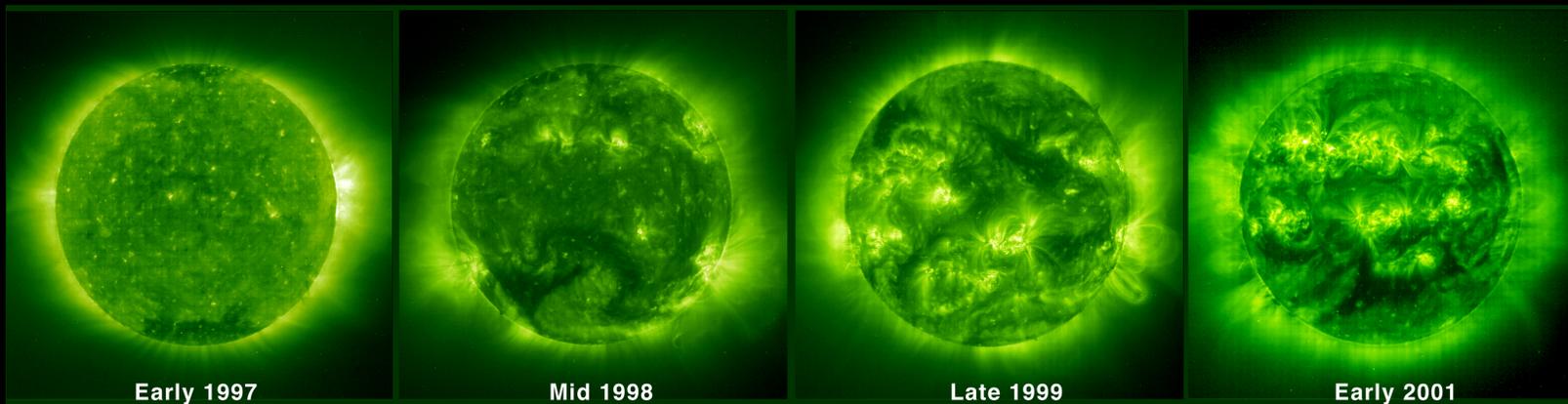
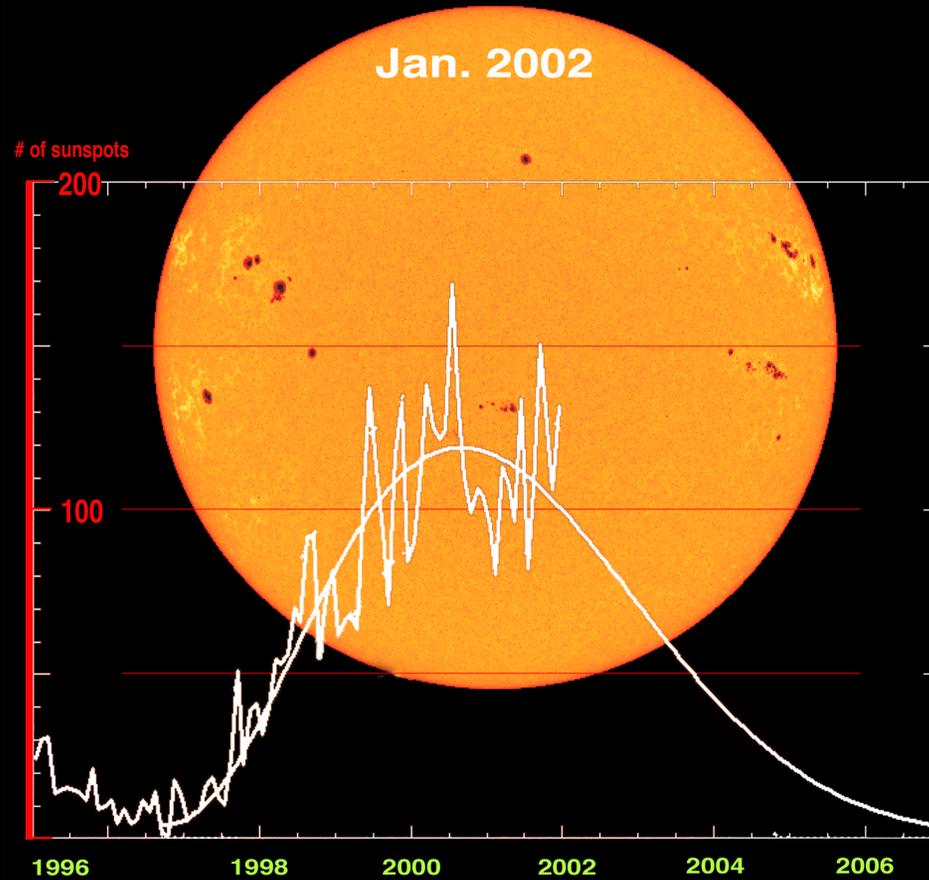
# A special imaging technique highlighting change shows a wave front, driven by a CME, as it expands over much of the Sun's surface



Source of this CME and wave as seen in an ultraviolet image



# The current solar cycle (as measured by sunspot numbers) shows a double-peak of maximum activity

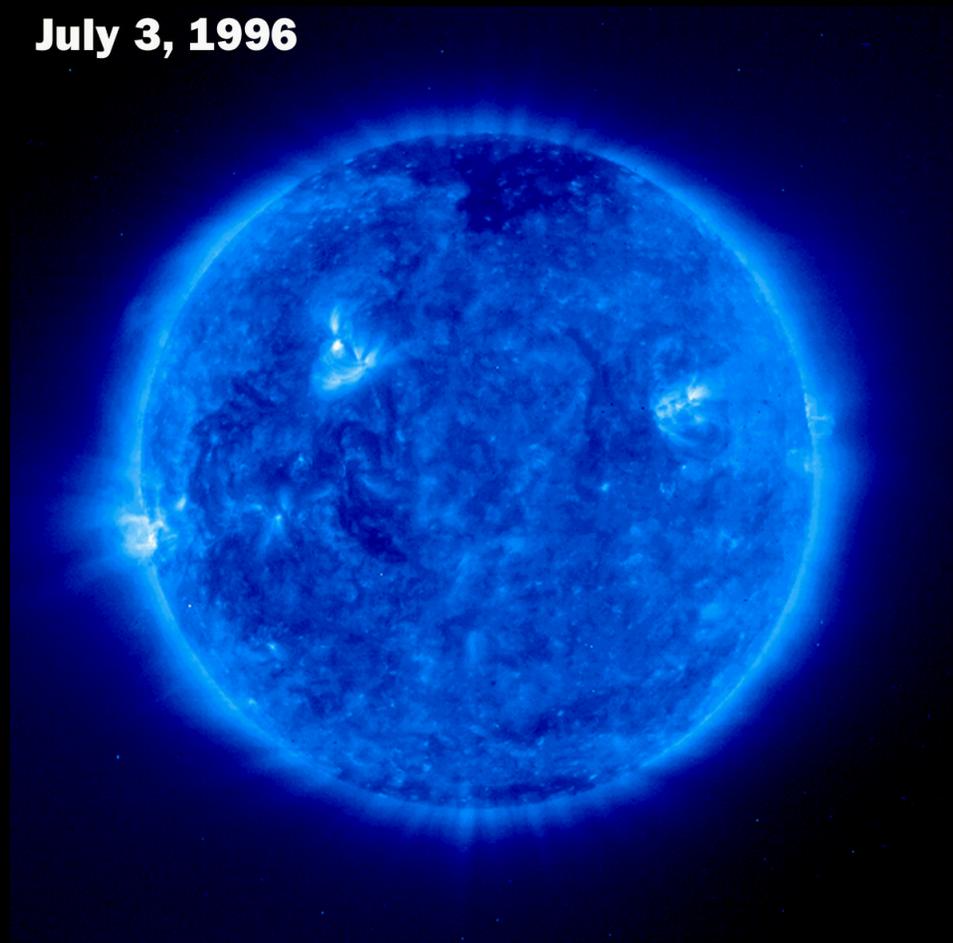




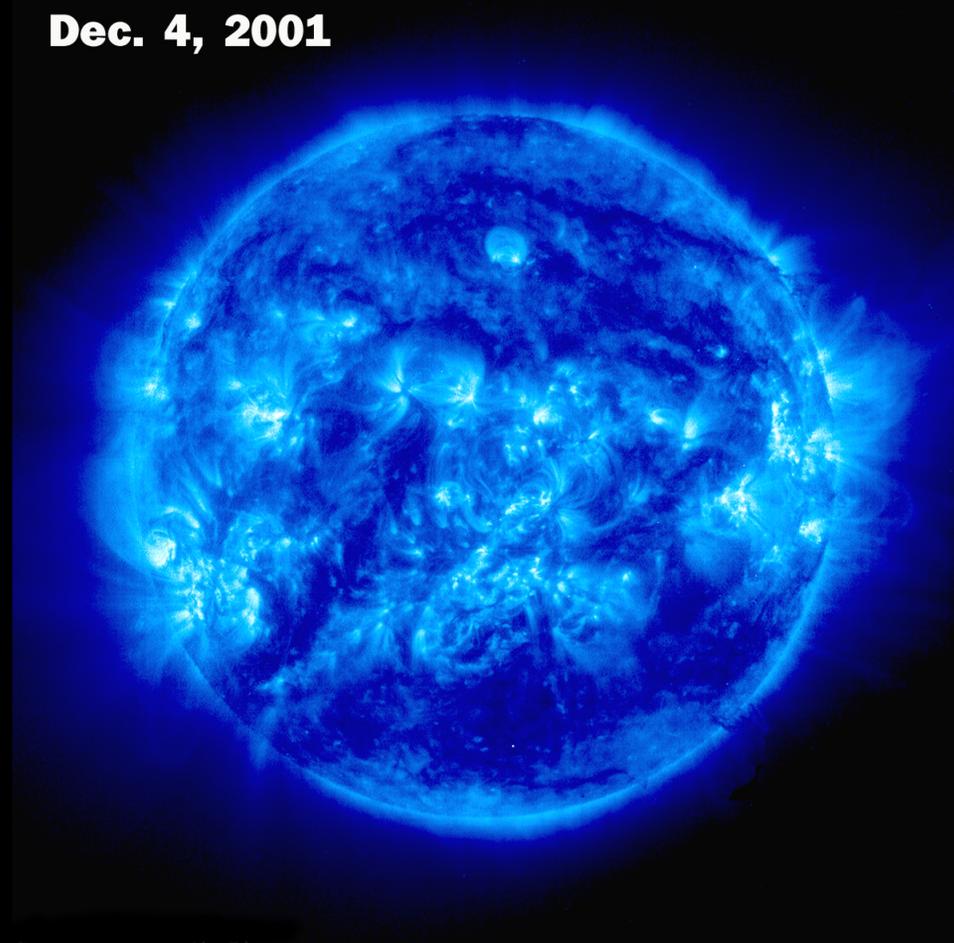
**A comparison of two ultraviolet images over five years apart illustrates how the level of solar activity increases significantly from near solar minimum to near solar maximum**



**July 3, 1996**



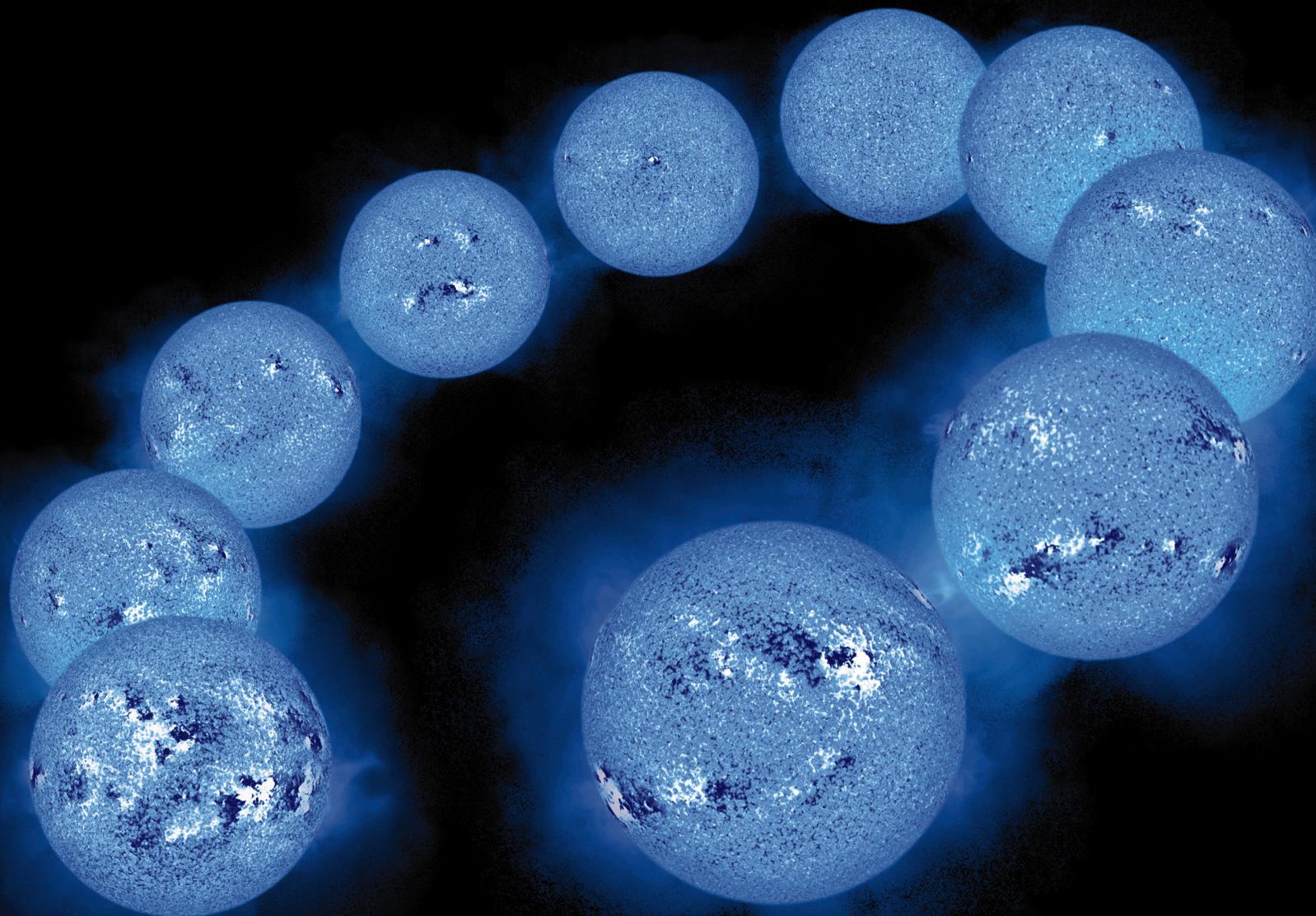
**Dec. 4, 2001**



(Note: the bright areas represent more intense magnetic activity)

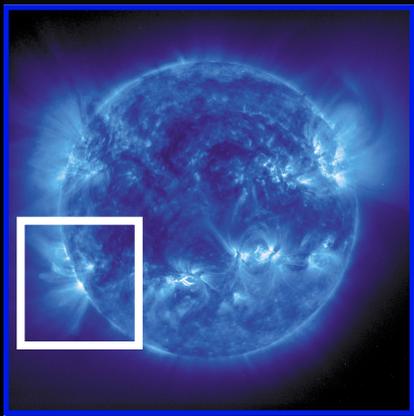
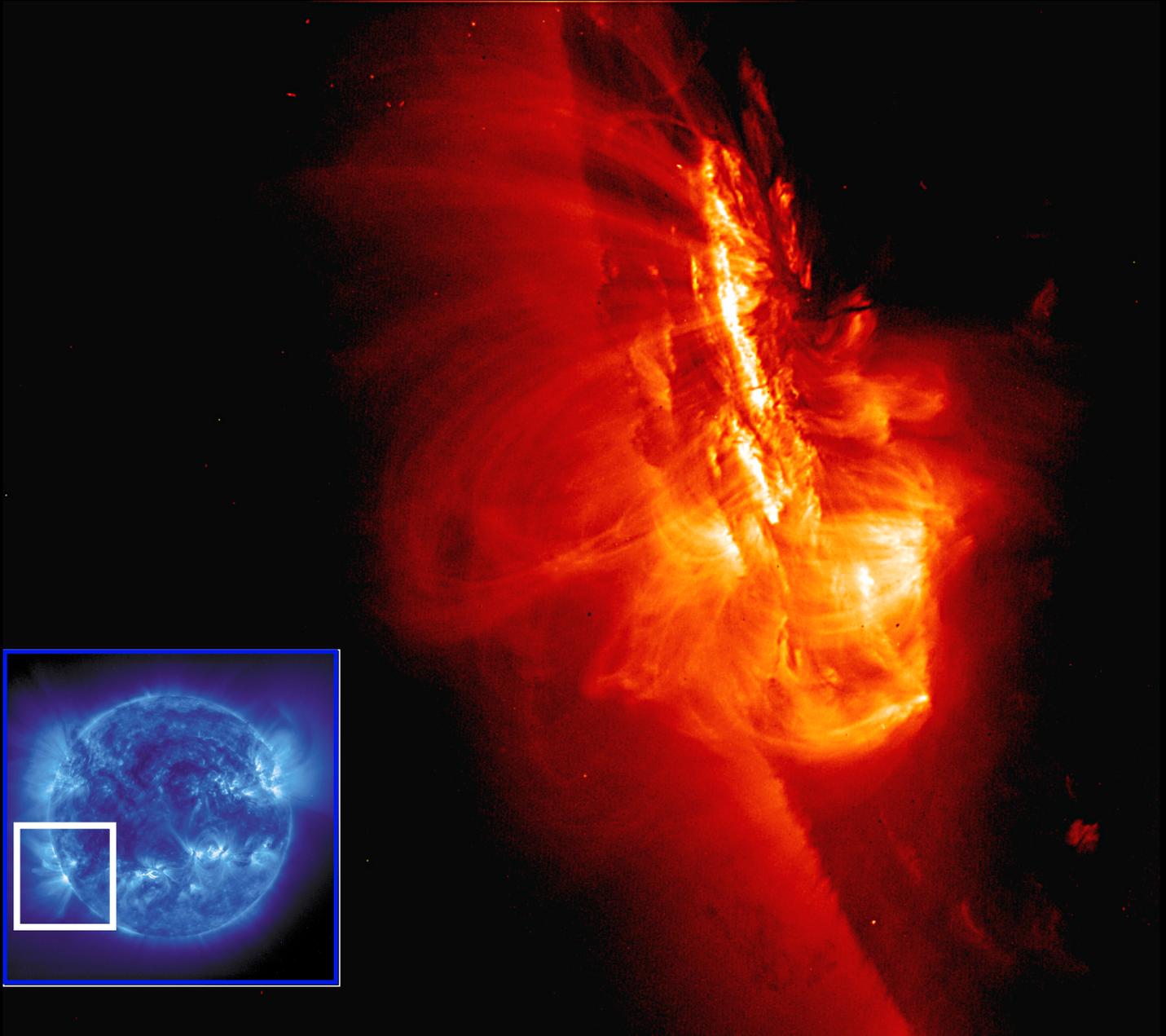


# The magnetic changes in the Sun seen over a complete solar cycle, 1991-2001





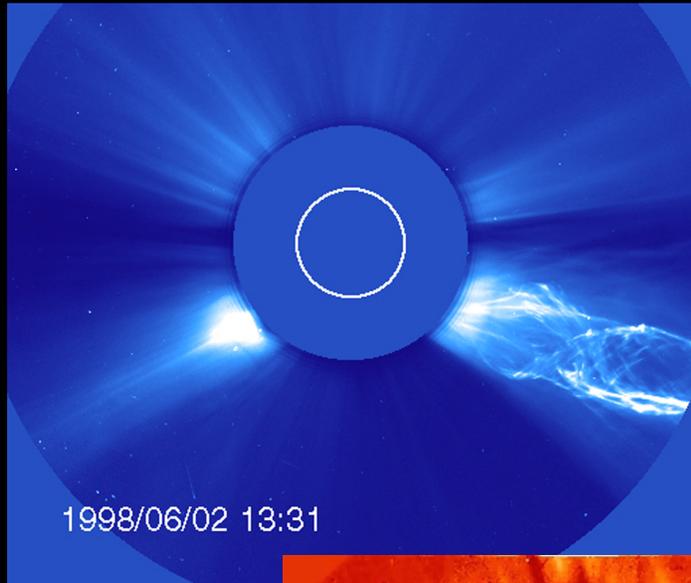
**This detailed close-up of an active region shows multiple magnetic loops arcing above it**



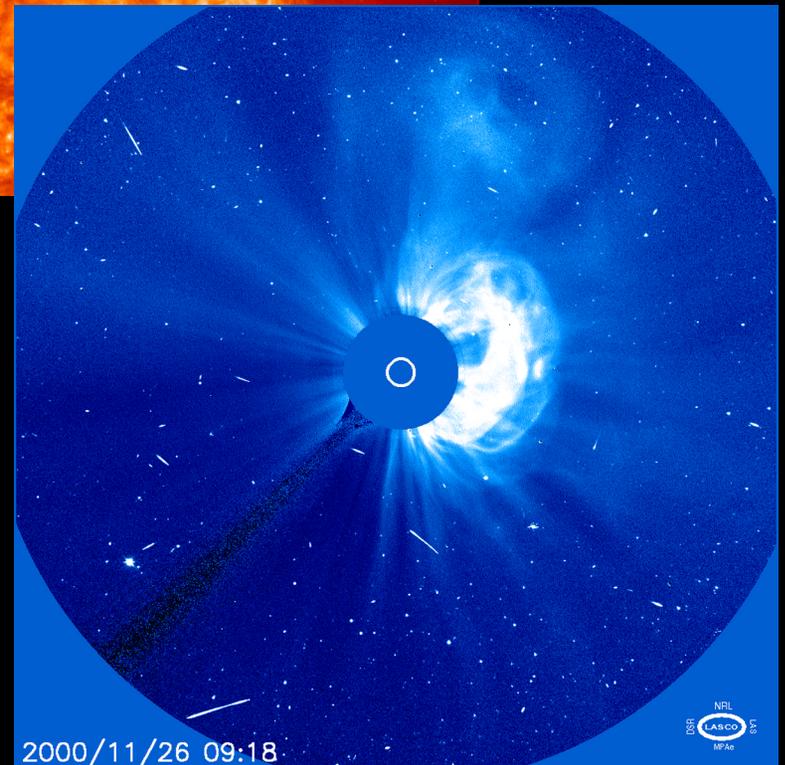
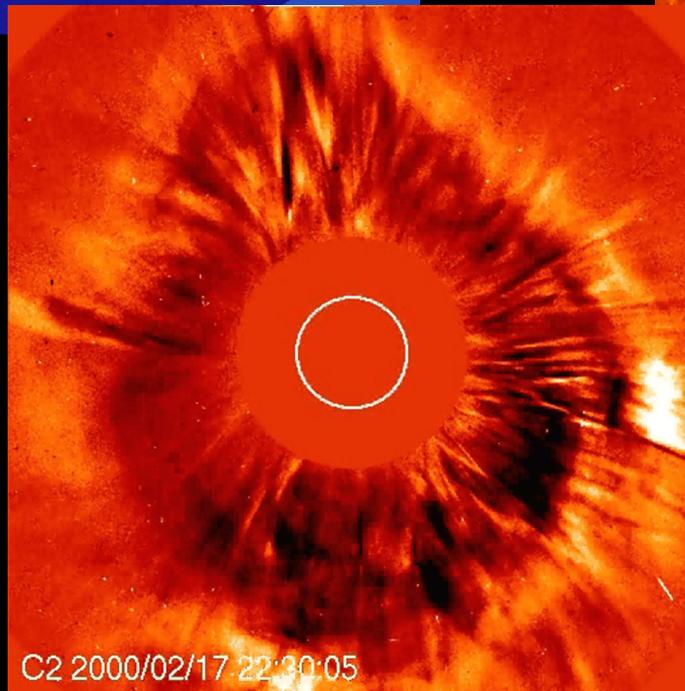
*Image: Courtesy of NASA's TRACE (Transition Region and Coronal Explorer) spacecraft*



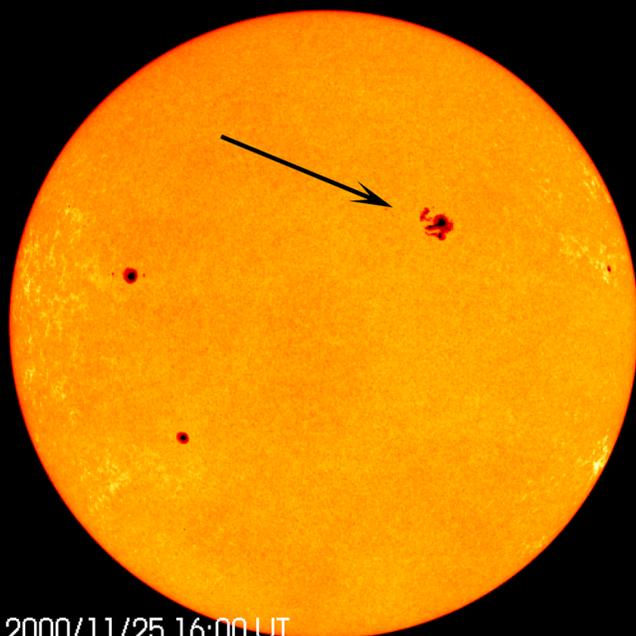
# Coronal mass ejections are huge explosions that send out billions of tons of matter at millions of km per hour



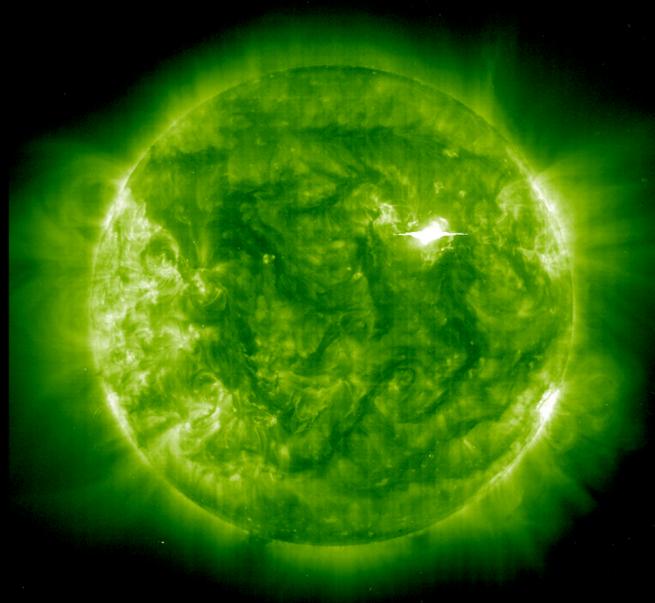
Note: In all but the upper right image, the Sun is blocked out by an occulting disk and the white outline indicates the size of the Sun.



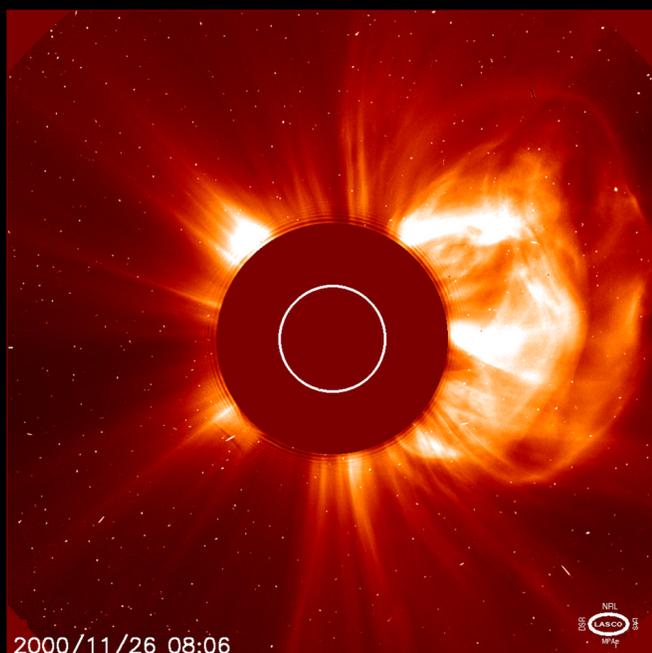
# A flare and coronal mass ejection are shown from their initial active region source to the expanding CME cloud



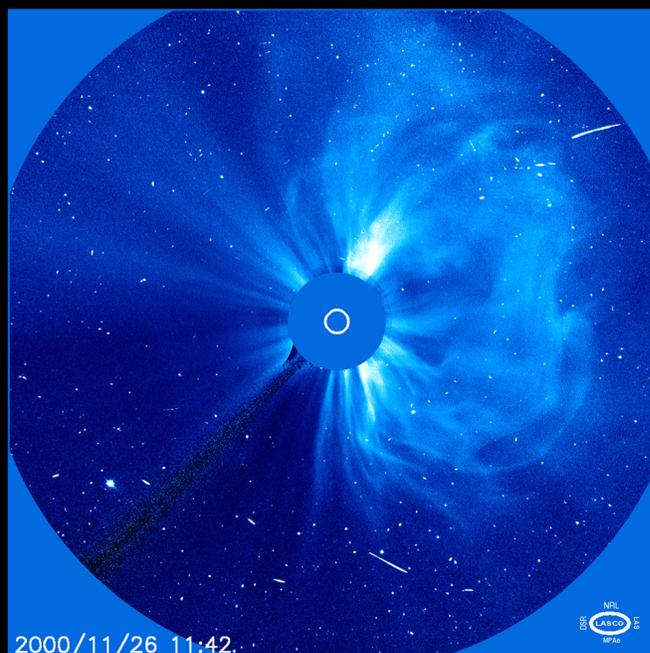
2000/11/25 16:00 UT



2000/11/25 18:48



2000/11/26 08:06

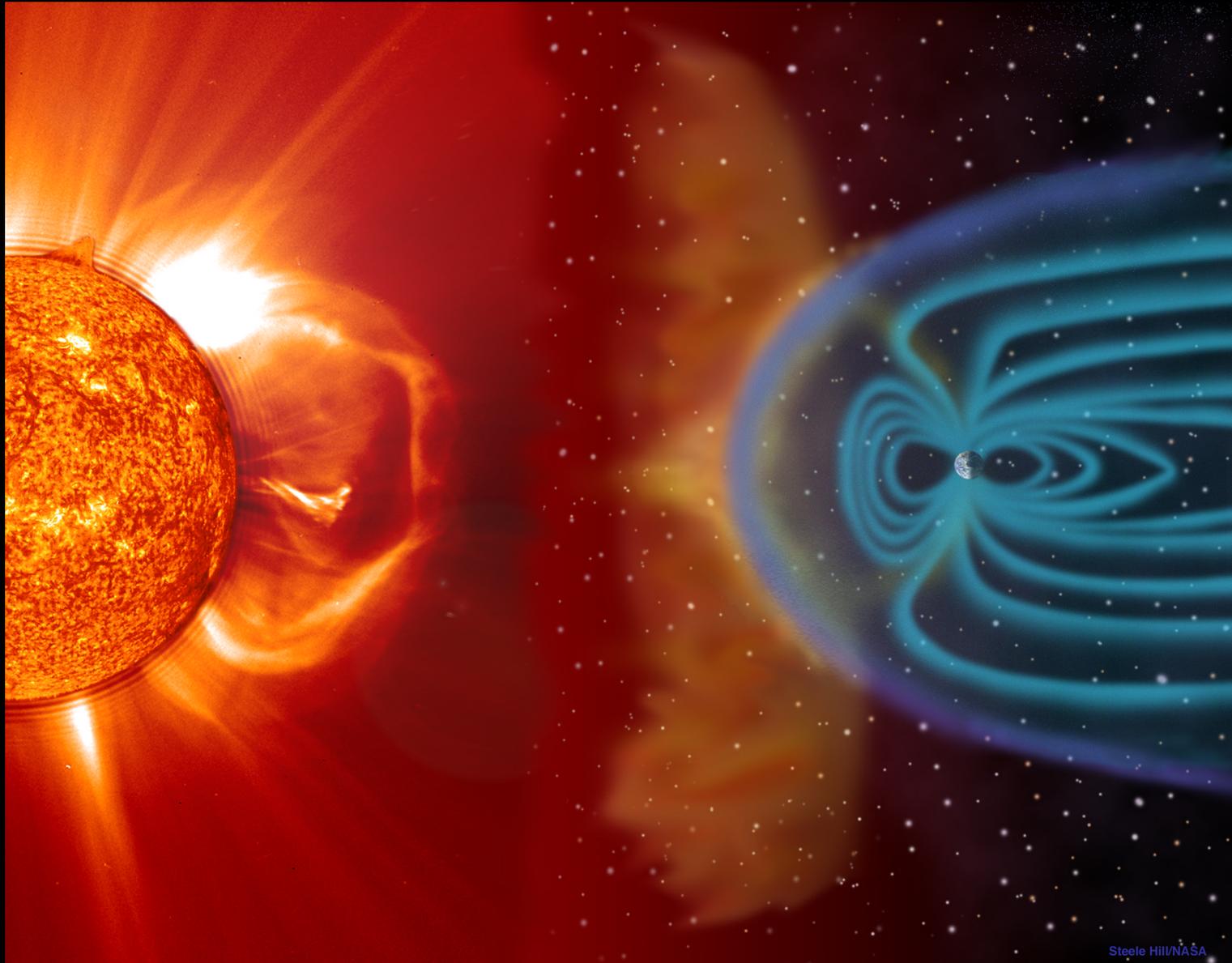


2000/11/26 11:42

The white speckles in the last 2 images are protons hitting SOHO



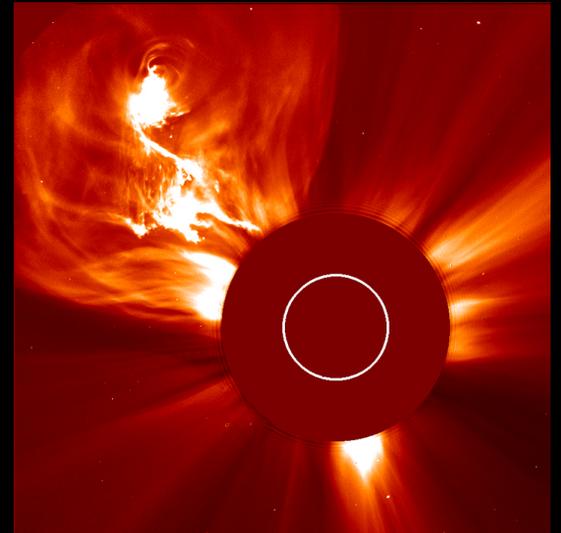
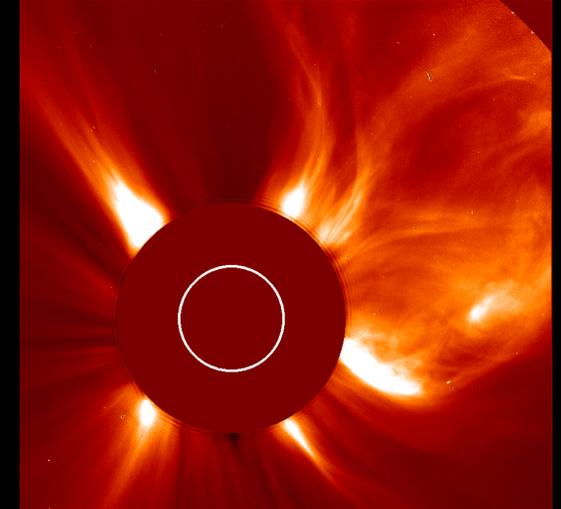
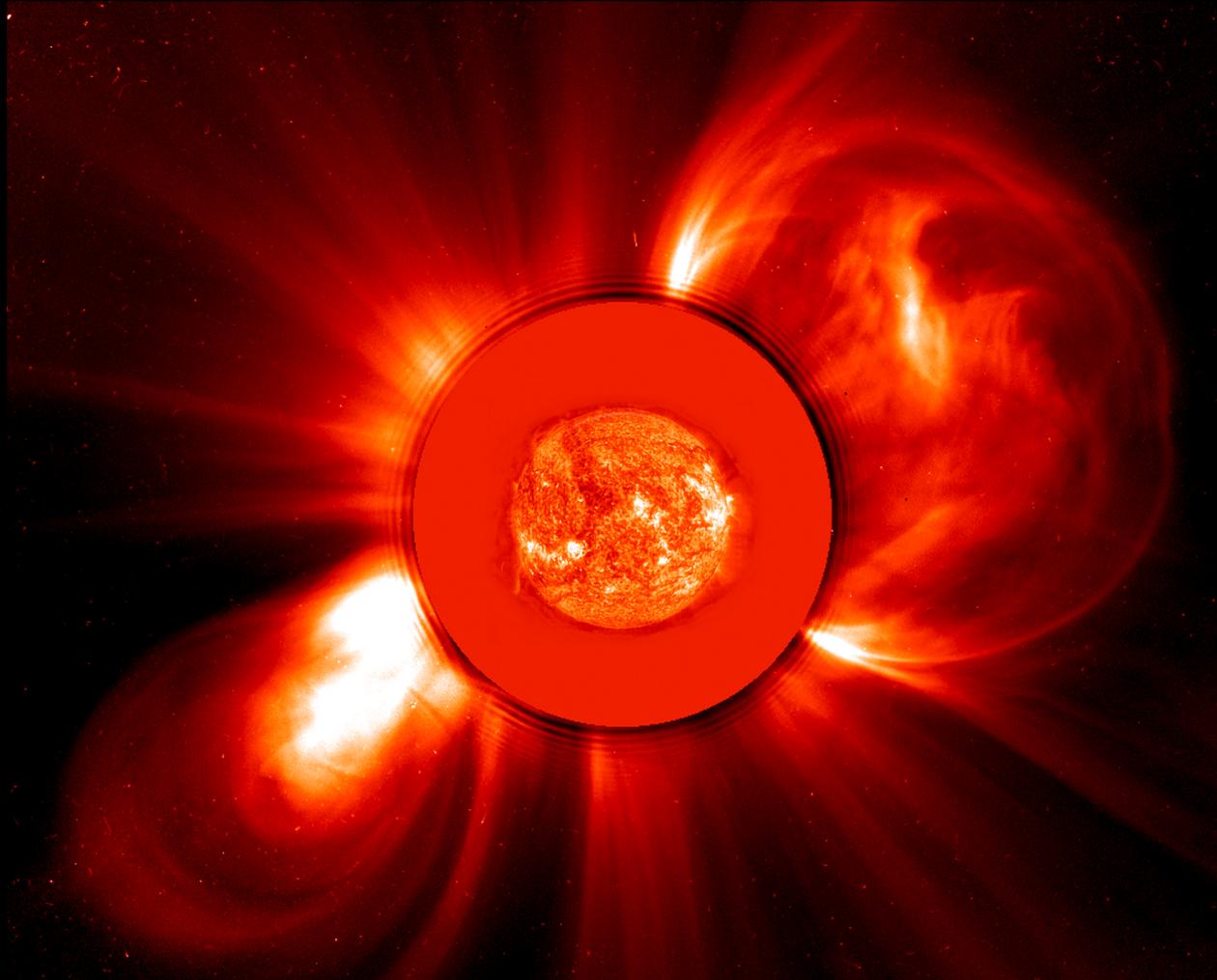
**After a CME blasts from the Sun towards Earth, a cloud of charged particles impacts our magnetosphere in 2 - 4 days. Thus, the Earth is electrically connected to the Sun.**



Note: The distance and size of the Sun to earth is not to scale



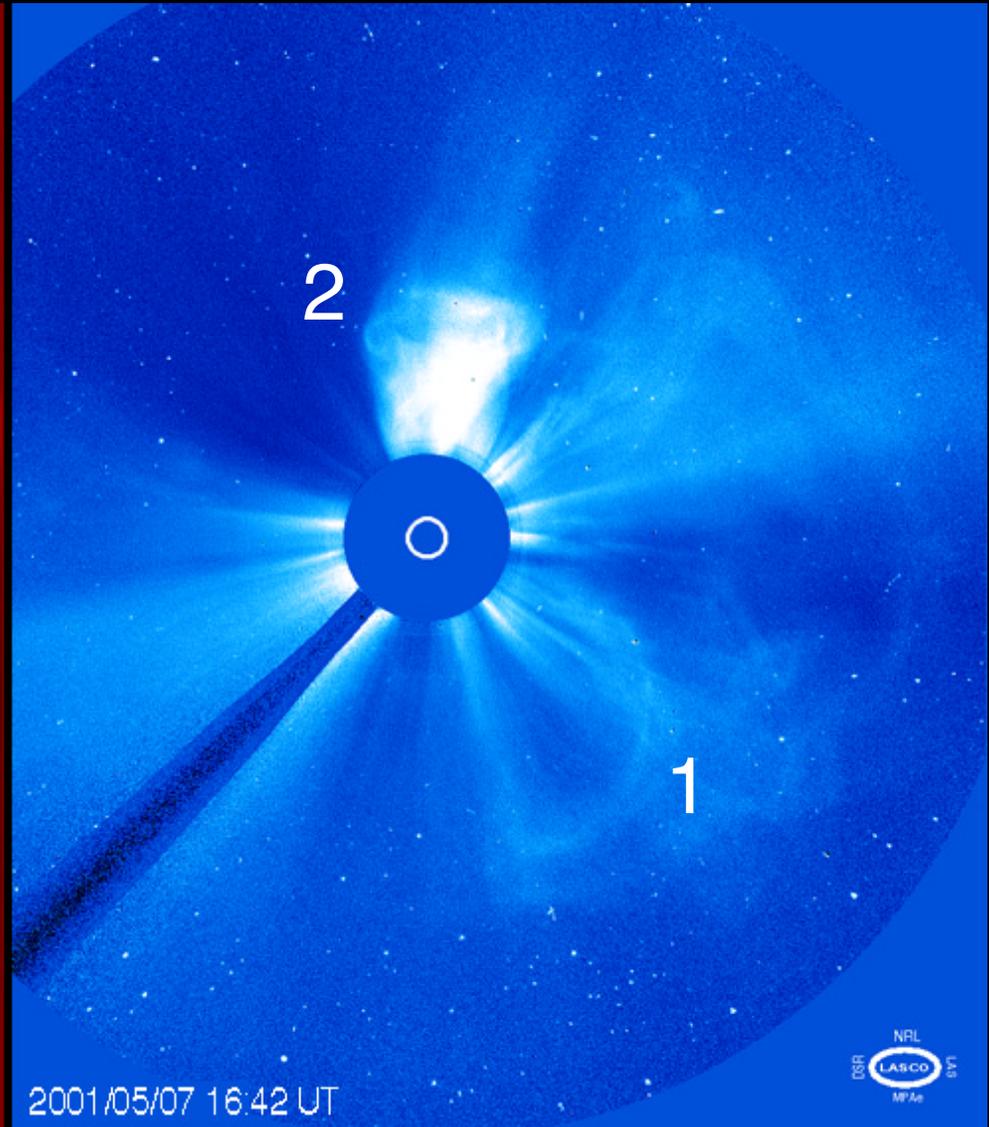
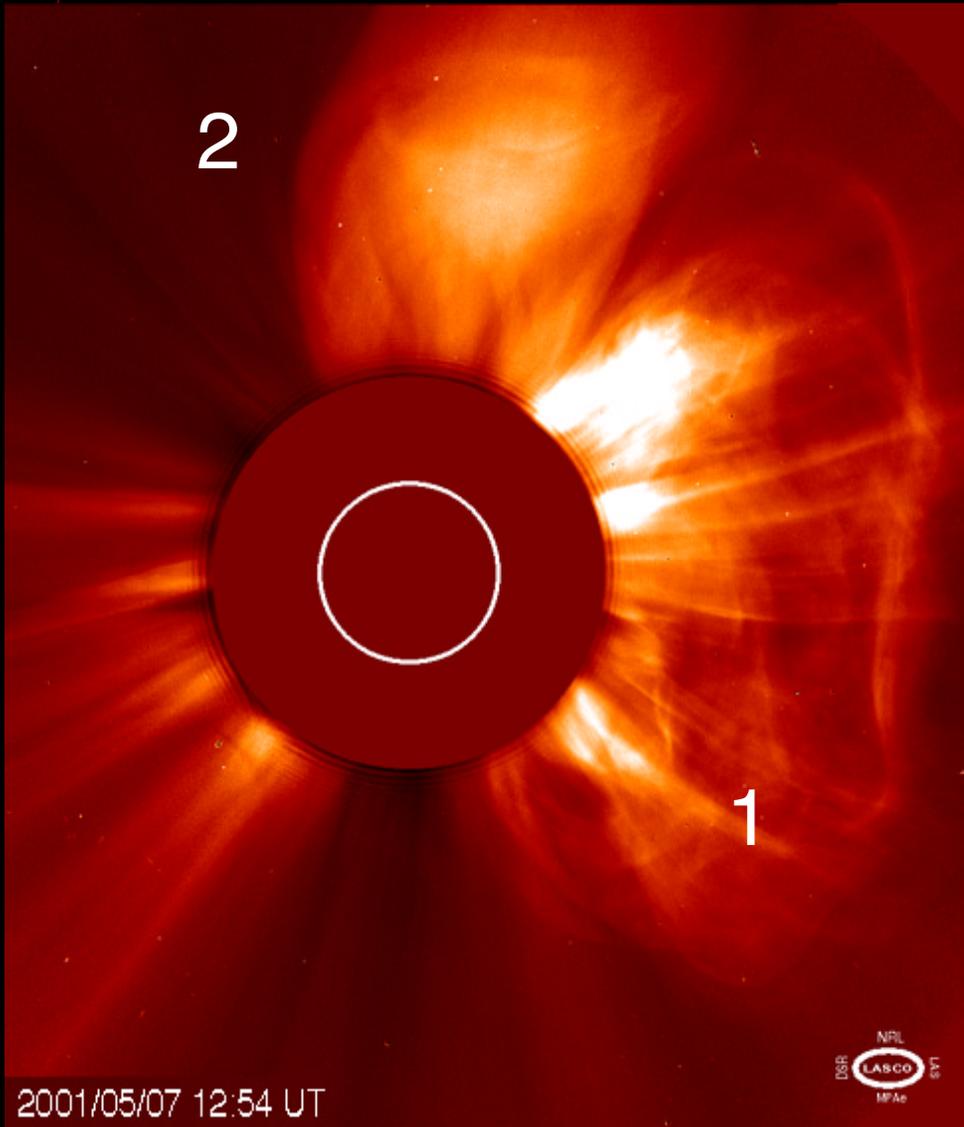
# A double CME blasts particles out in opposite directions, one just minutes after the other



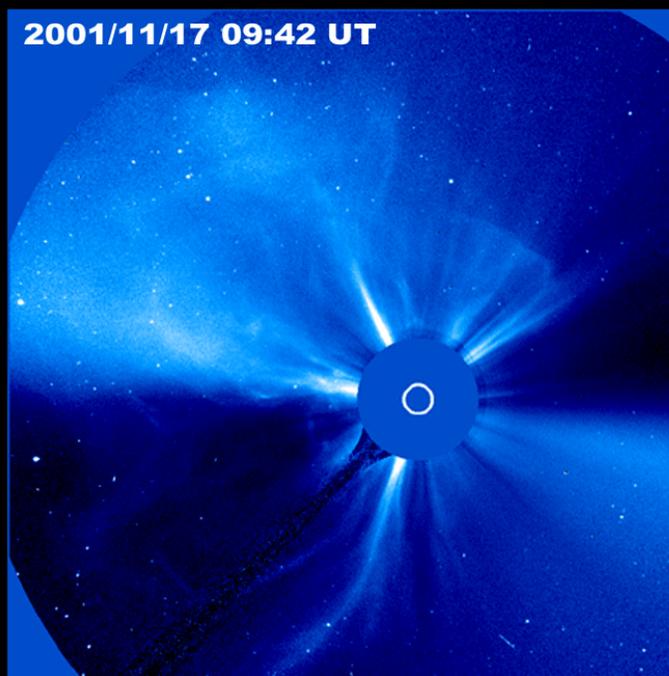
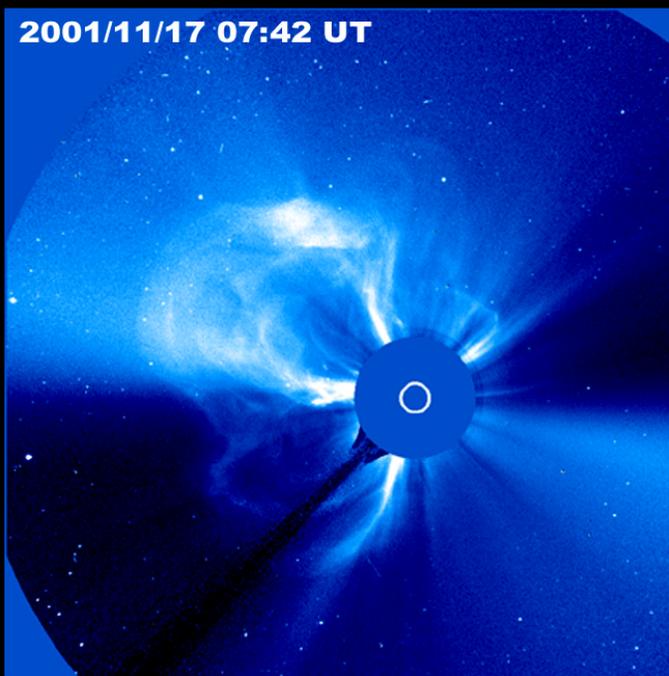
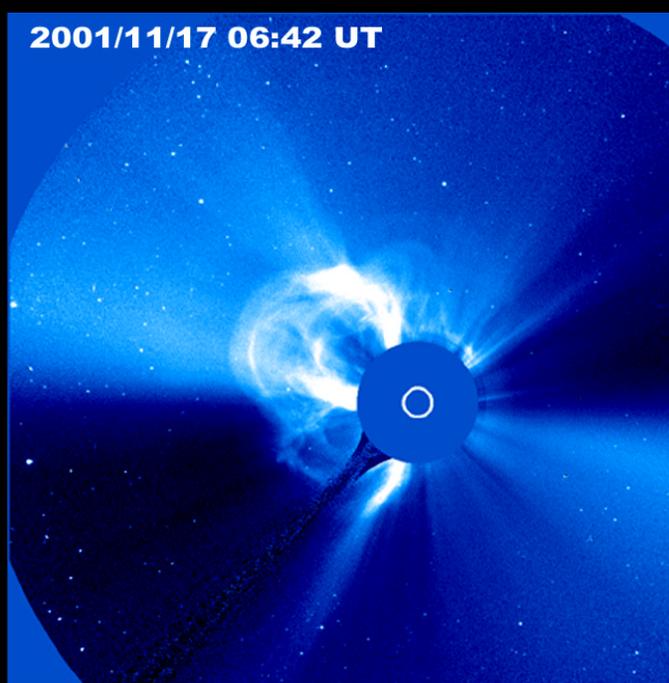
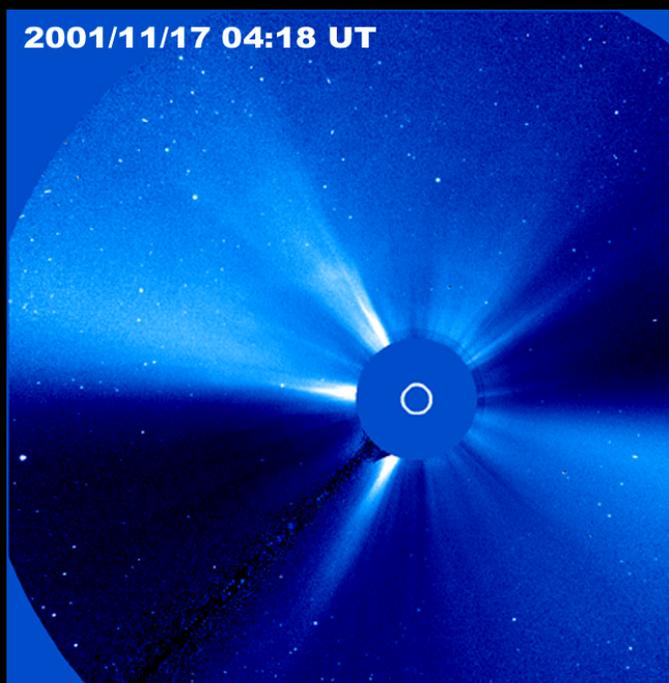
Note: An ultraviolet image of the Sun has been superimposed on the image's occulting disk to show the Sun



# Two coronal mass ejections (CMEs) almost at the same time, an uncommon event

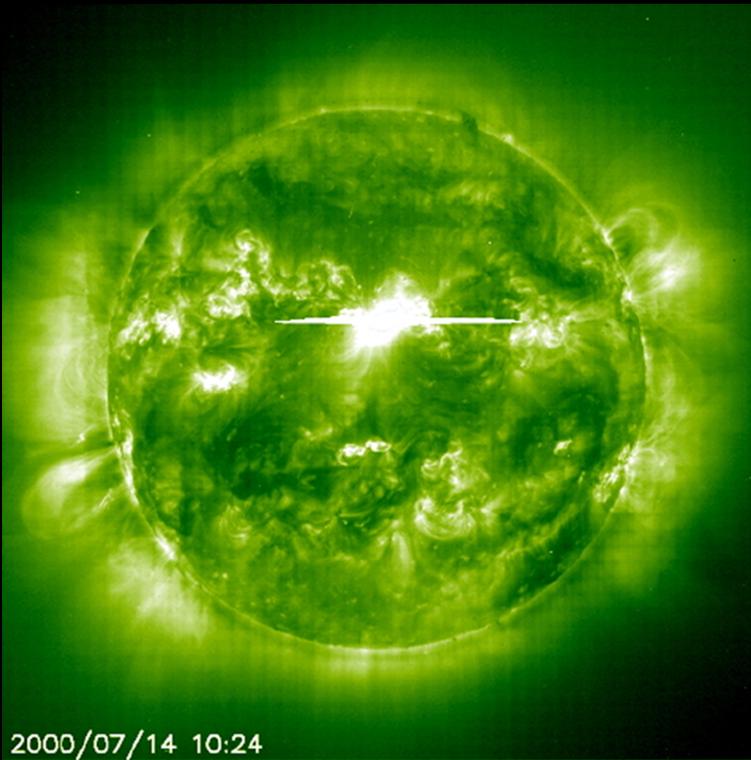


# A CME cloud expanding over a four hour period as viewed by the LASCO C3 instrument



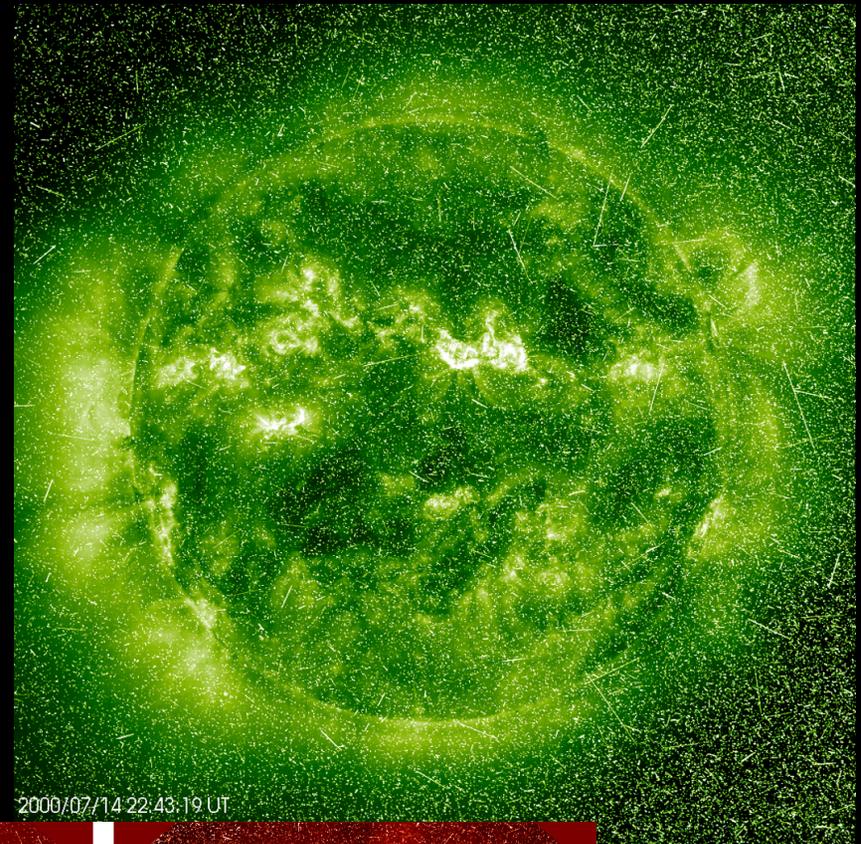


# A strong solar flare triggers the largest particle storm of this solar cycle near solar maximum

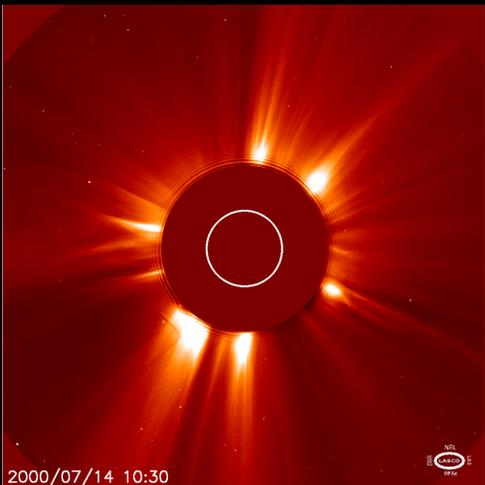


2000/07/14 10:24

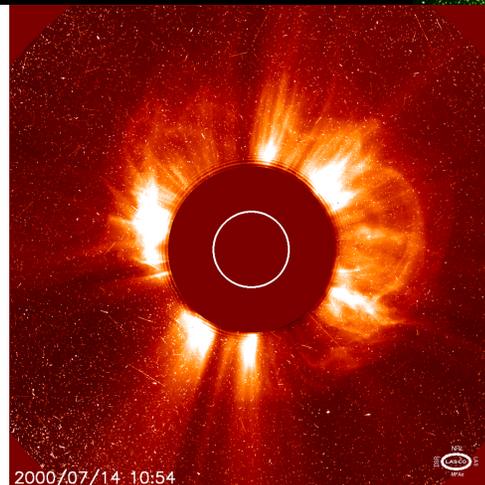
A powerful flare flashes . . .



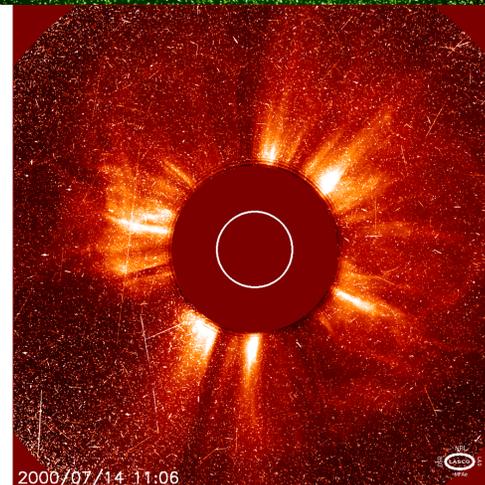
2000/07/14 22:43:19 UT



2000/07/14 10:30



2000/07/14 10:54



2000/07/14 11:06

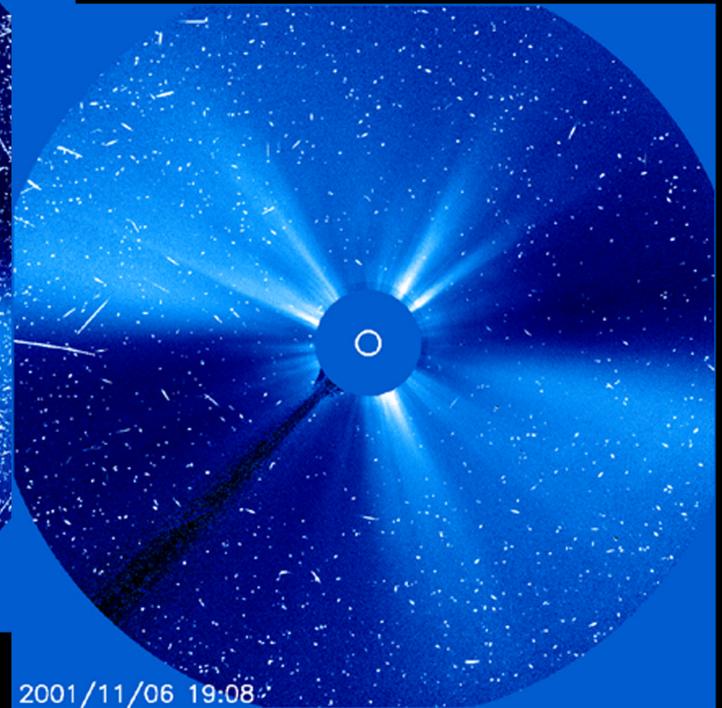
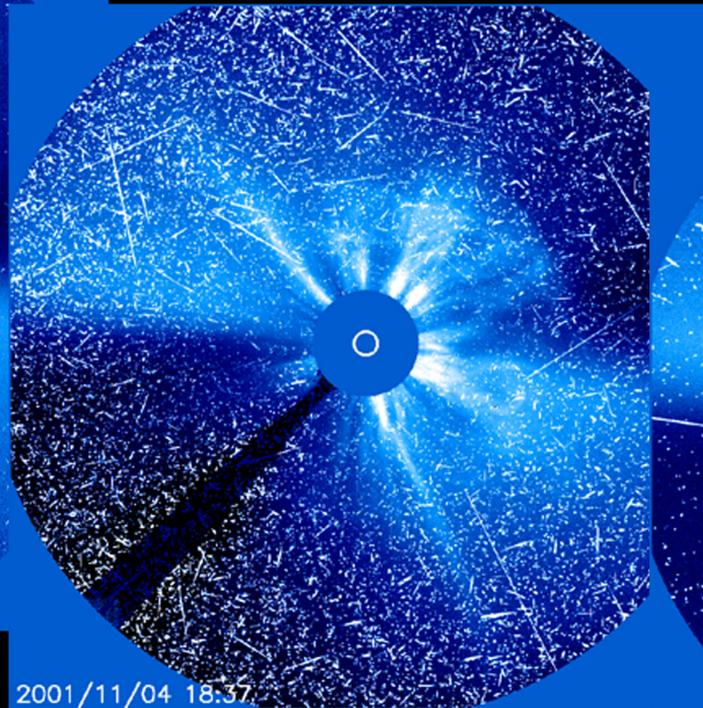
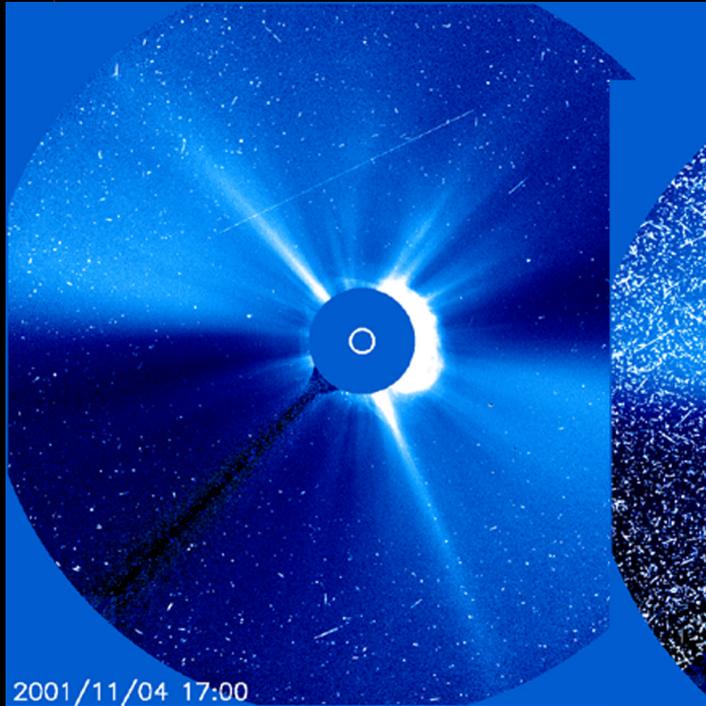
and hours (even days) later high-energy protons were still smacking SOHO

Protons unleashed by the flare begin striking SOHO in minutes



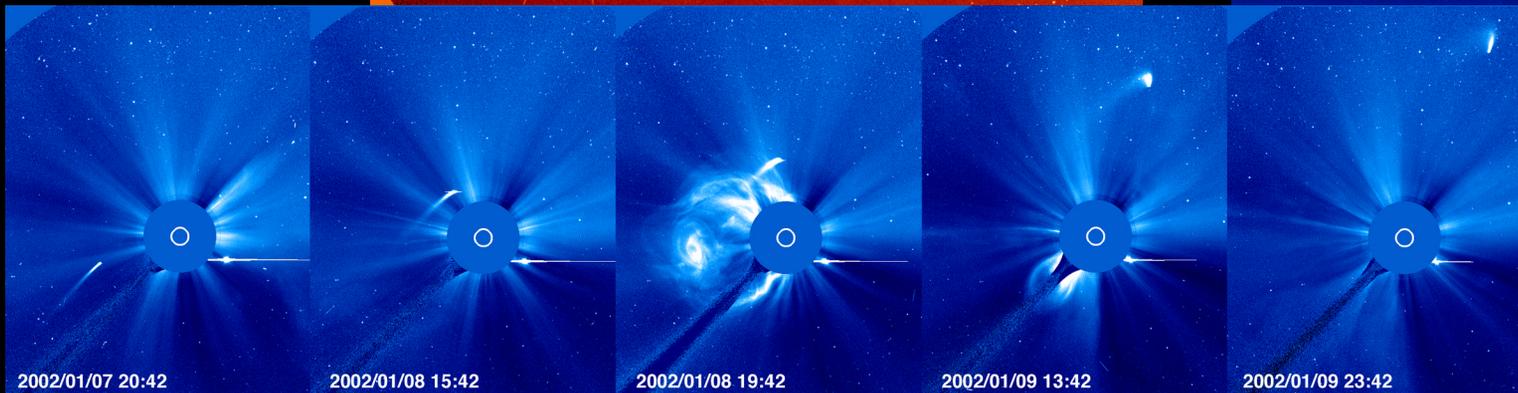
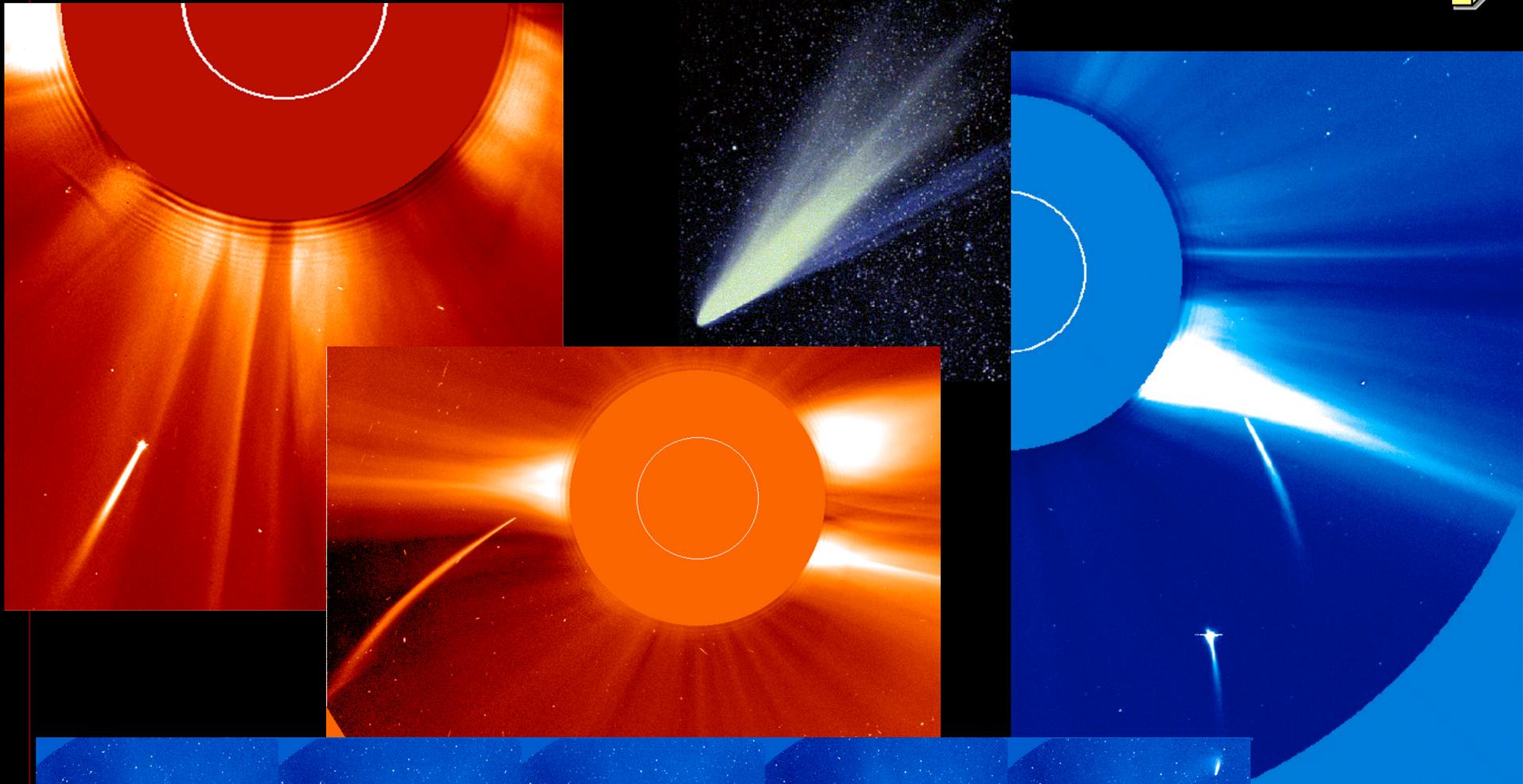
# A high-energy proton event associated with a CME

(Note that the protons are still hitting the spacecraft two days later)



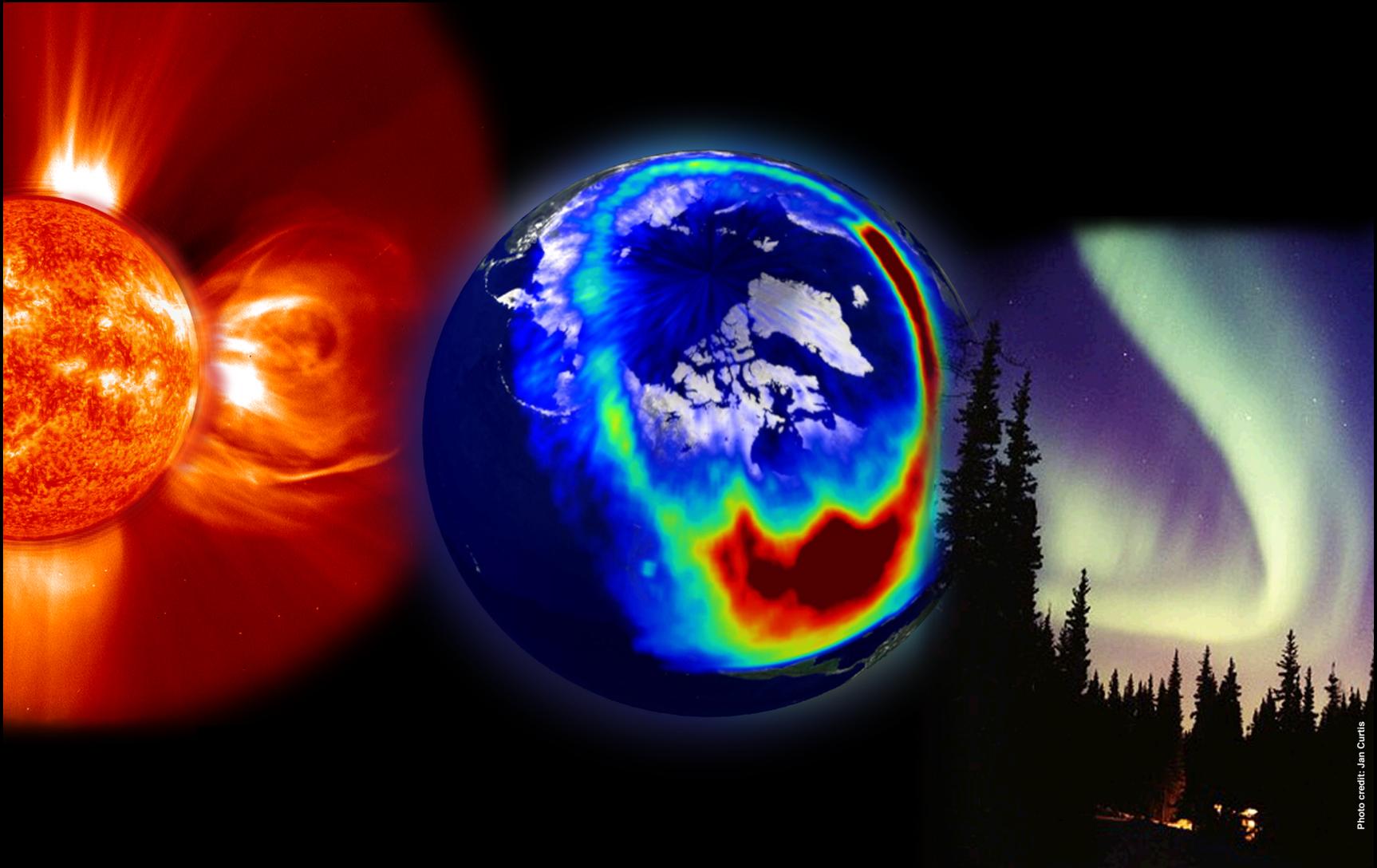


# SOHO has discovered over 400 sungrazing comets streaking near and sometimes into the Sun





# The three principal “visual” elements of space weather: solar storm, charged particles impacting Earth, and aurora





# Some of the effects of "space weather" caused by the Sun

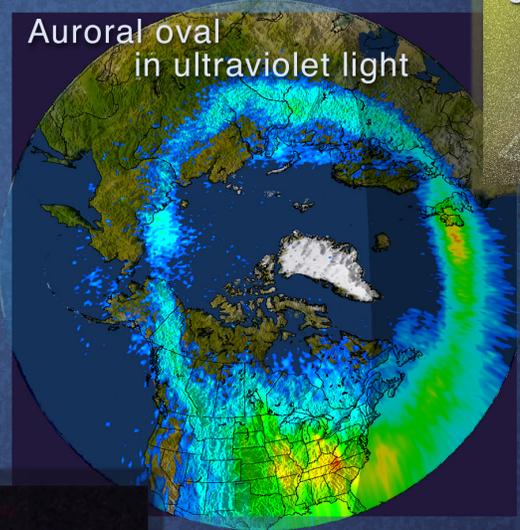
Radiation threat for astronauts



Spacecraft damaged or orbit changed



Auroral oval in ultraviolet light



Aurora viewed from space shuttle



Electrical equipment destroyed by power surges



Aurora from Earth (taken in Canada)

Credit: Michel Tournay



## SOHO: major science results so far

- First images of a star's convection zone and the subsurface structure of sunspots
- Discovery of a “magnetic carpet” on the solar surface
- First measurements of how the slow and fast solar wind accelerates
- Discovered new technique for imaging the far side of the Sun
- Most detailed view to date of the dynamics in the outer solar atmosphere
- Most spectacular images and movies of coronal mass ejections
- Most comprehensive archive of images and data on the Sun which will continue to grow and serve as a treasure for future research



# Visit the SOHO web site to learn more about the Sun and the SOHO mission: [soho.nascom.nasa.gov](http://soho.nascom.nasa.gov) or [soho.estec.esa.nl](http://soho.estec.esa.nl)

September 10, 2001 19:11:34 UT - Mission Day: 2110 - DOY : 253

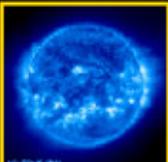
**SOHO 5th Year Anniversary**  
**HOT SHOTS: The Solar Genome**

# SOHO

## EXPLORING THE SUN

esa NASA

SOHO is a project of international cooperation between [ESA](#) and [NASA](#)  
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**THE SUN NOW**  


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Instruments

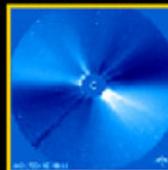
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Operations

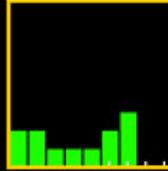
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**SUNSPOTS**  


**SPACE WEATHER**  


**Estimated Kp**  


**SOLAR WIND**  
Speed:  
278 km/s  
Density:  
12.9 p/cm<sup>3</sup>

- Daily images and movies
- Weekly Pick
- Best of SOHO images and movies
- Educational lesson plans/resources
- Latest news articles
- Free screen saver
- Downloadable SOHO paper model
- Slide set
- Links
- Ask Dr. SOHO
- Hot Shots