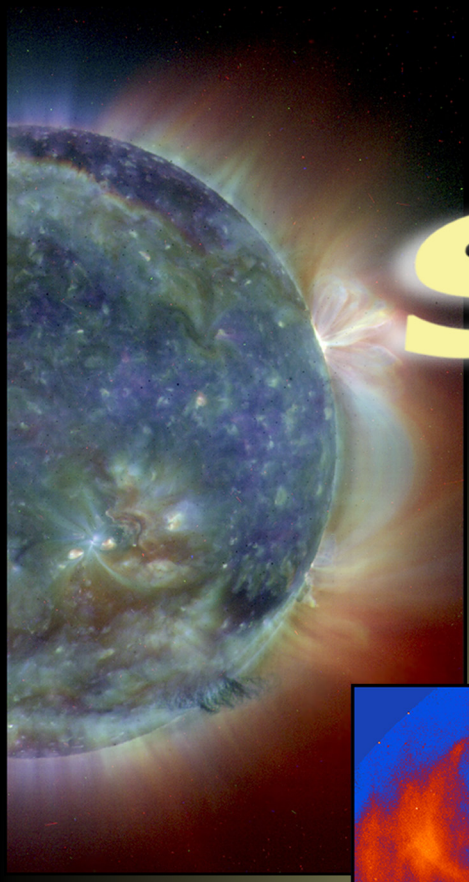
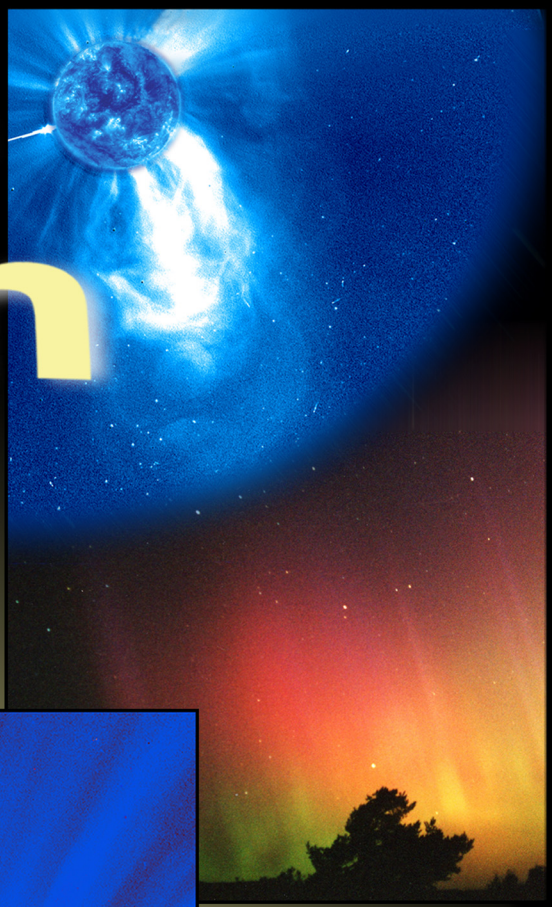
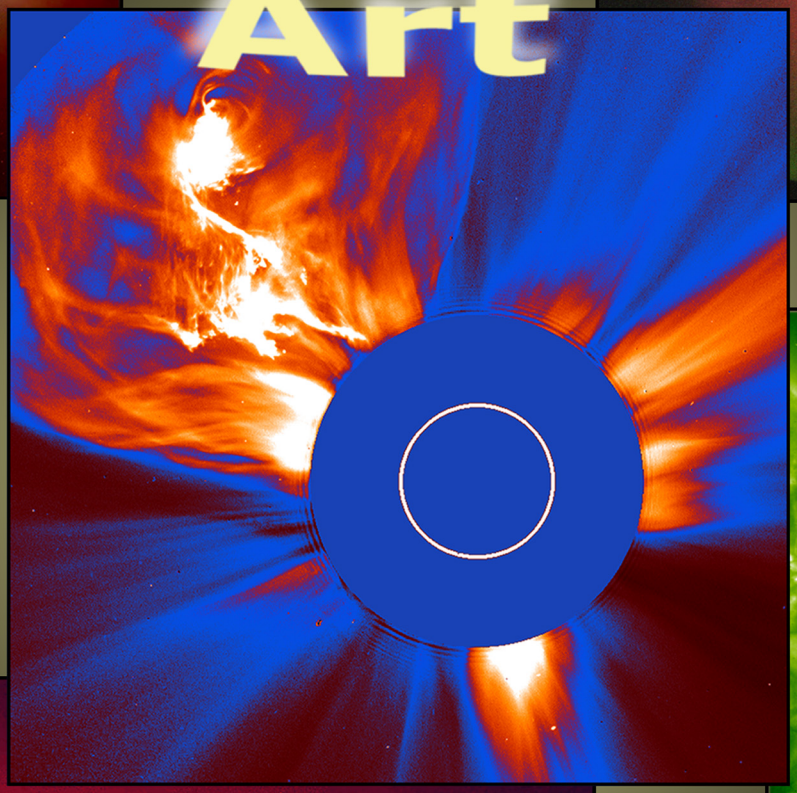
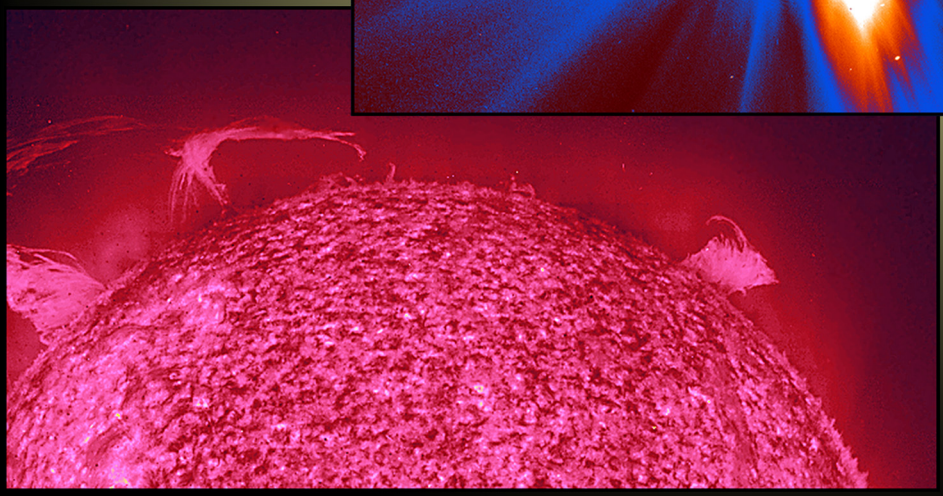
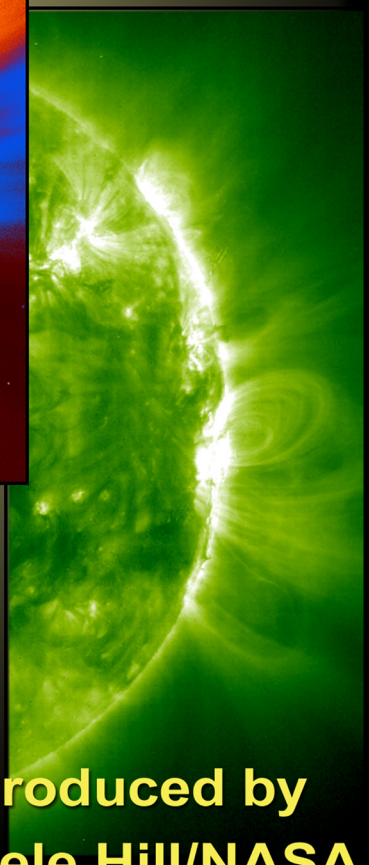
# The Sun as Art











Produced by
Steele Hill/NASA

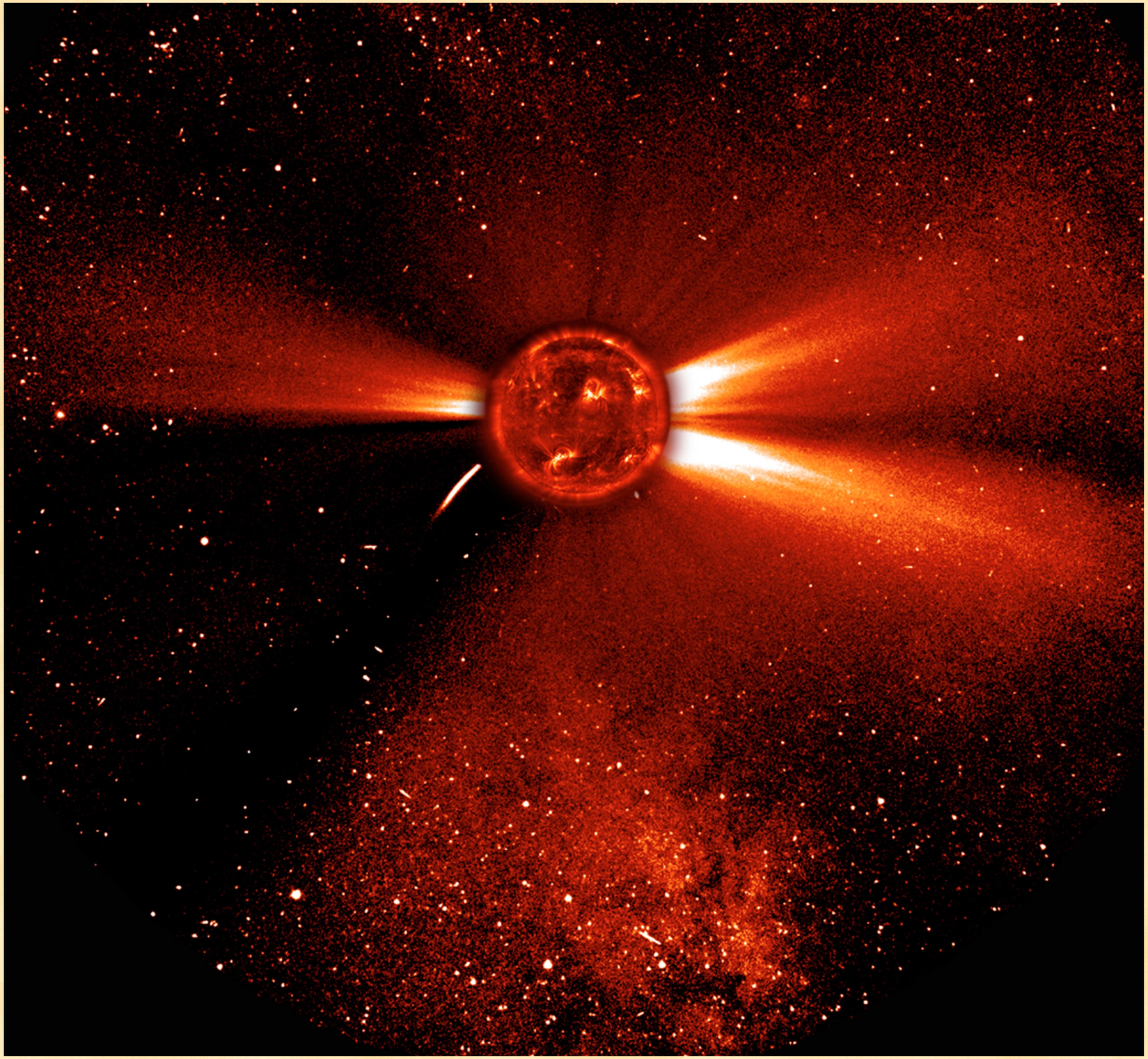
# The Sun as Art

This show presents a new way of looking at the Sun, made possible by advances in imaging technology and sophisticated spacecraft engineering. Its goal is to entertain while generating a renewed interest in the Sun, a star that is generally taken for granted as a plain round ball of fiery gas that changes very little. The images will show otherwise. They are based, in all instances, on images captured by the SOHO (Solar and Heliospheric Observatory) and TRACE (Transition Region and Coronal Explorer) since 1996. Both missions are managed at NASA's Goddard Space Flight Center in Greenbelt, MD. New programs to study further the Sun-Earth system (Living with a Star and Solar Terrestrial Probes) are already underway.

We hope that visitors are surprised with the range of colors, shapes and striking beauty that our observations of the Sun have captured and learn something of the science and techniques involved in its study. Many images are presented with no manipulation at all; in some, only color tables are altered; in the most inventive, pieces were cut and moved around. (Only in the image called "The Sun-Earth Connection" is anything drawn by hand.) May you come away with a sense of the variety and wonder of the Sun and a keen sense that art and science are not always so far apart as we believe.

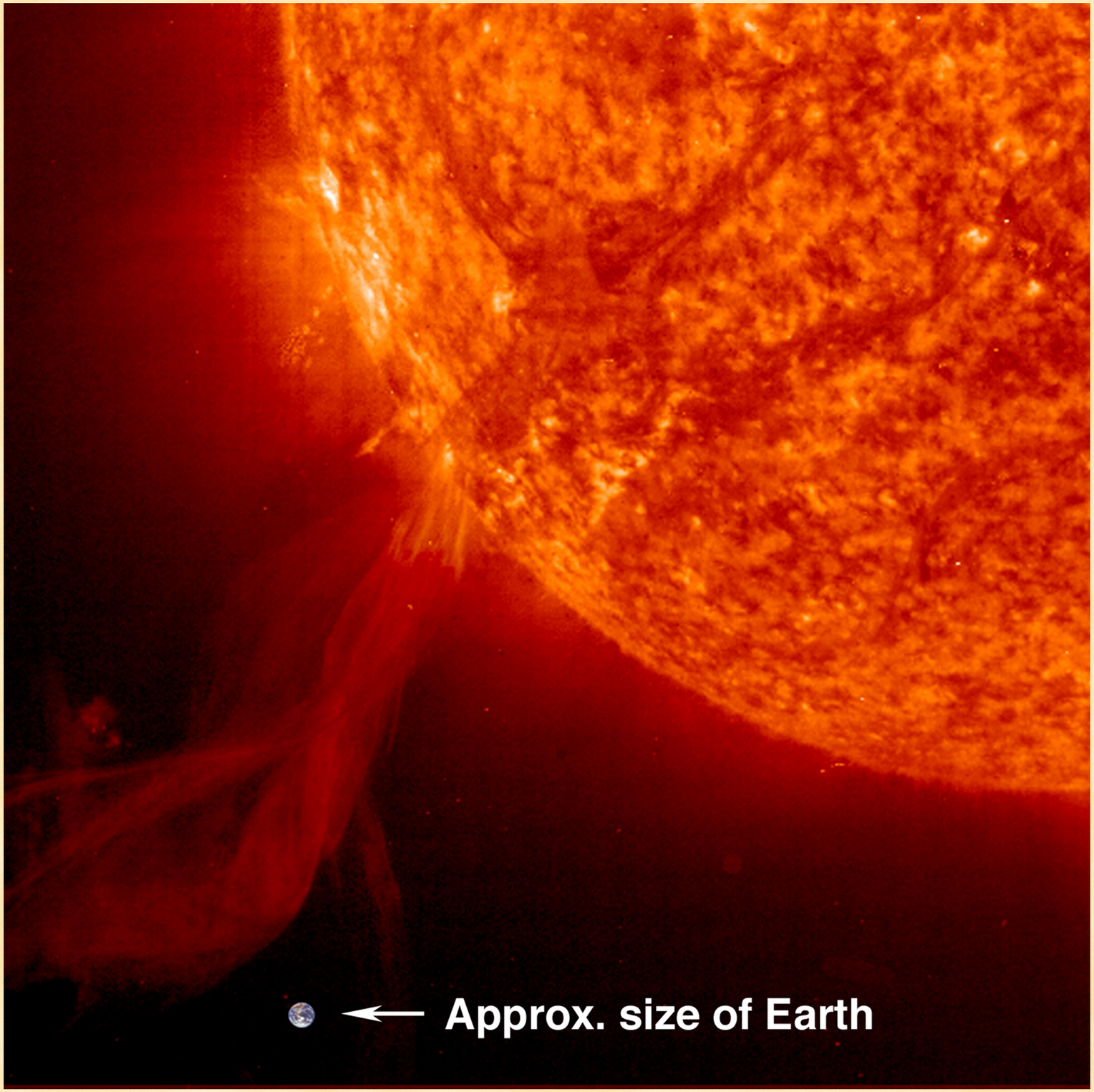
# One star among many

Our Sun, a star, is just one among billions in our galaxy alone. The Sun (in extreme ultraviolet light) is superimposed on a wide view of the sky around the Sun. With the bright Sun itself eclipsed by an occulting disk, the star field beyond it comes into view. One can also see bright plumes of solar wind and streamers emerging on both sides. Note the sun-grazing comet (the white streak to the Sun's lower left) is heading right for the Sun where it will be consumed.



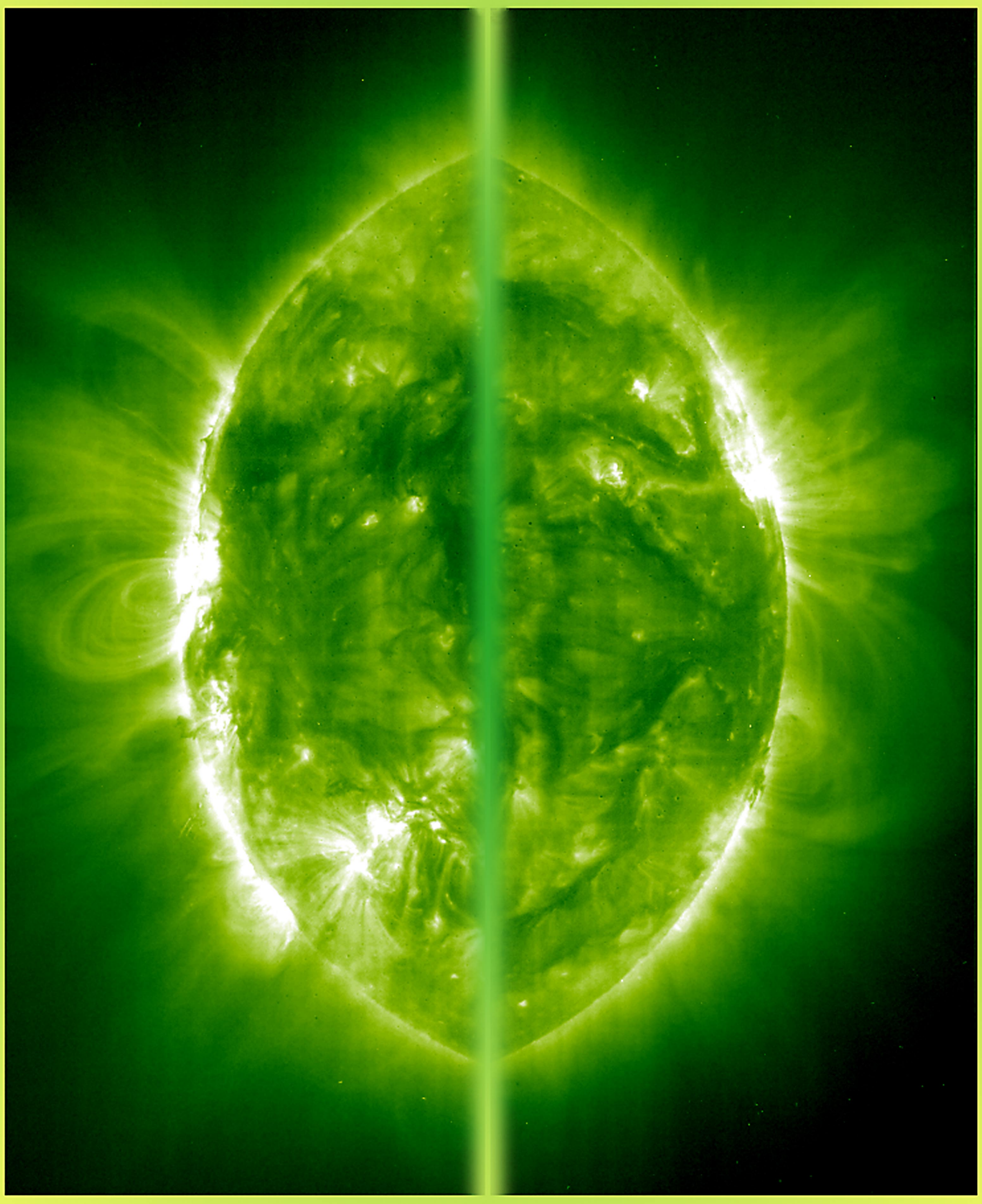
# Twisting prominence extending from the Sun

Prominences are huge clouds of relatively cool dense plasma suspended in the Sun's hot, thin corona. At times, they can erupt, propelled by magnetic forces out from the Sun's atmosphere. Ultraviolet emission in this wavelength (ions of helium at 304Å) shows the upper chromosphere at a temperature of about 60,000 degrees C. To get a fair sense of the prominence's size, an image of Earth has been added.



## “TRACE”ing the loops

These tightly coiled loops taken in profile along the Sun’s edge in ultraviolet light by NASA’s TRACE spacecraft are commonly seen just after a coronal mass ejection. They consist of solar particles racing along and being controlled by magnetic field lines which would otherwise be invisible.

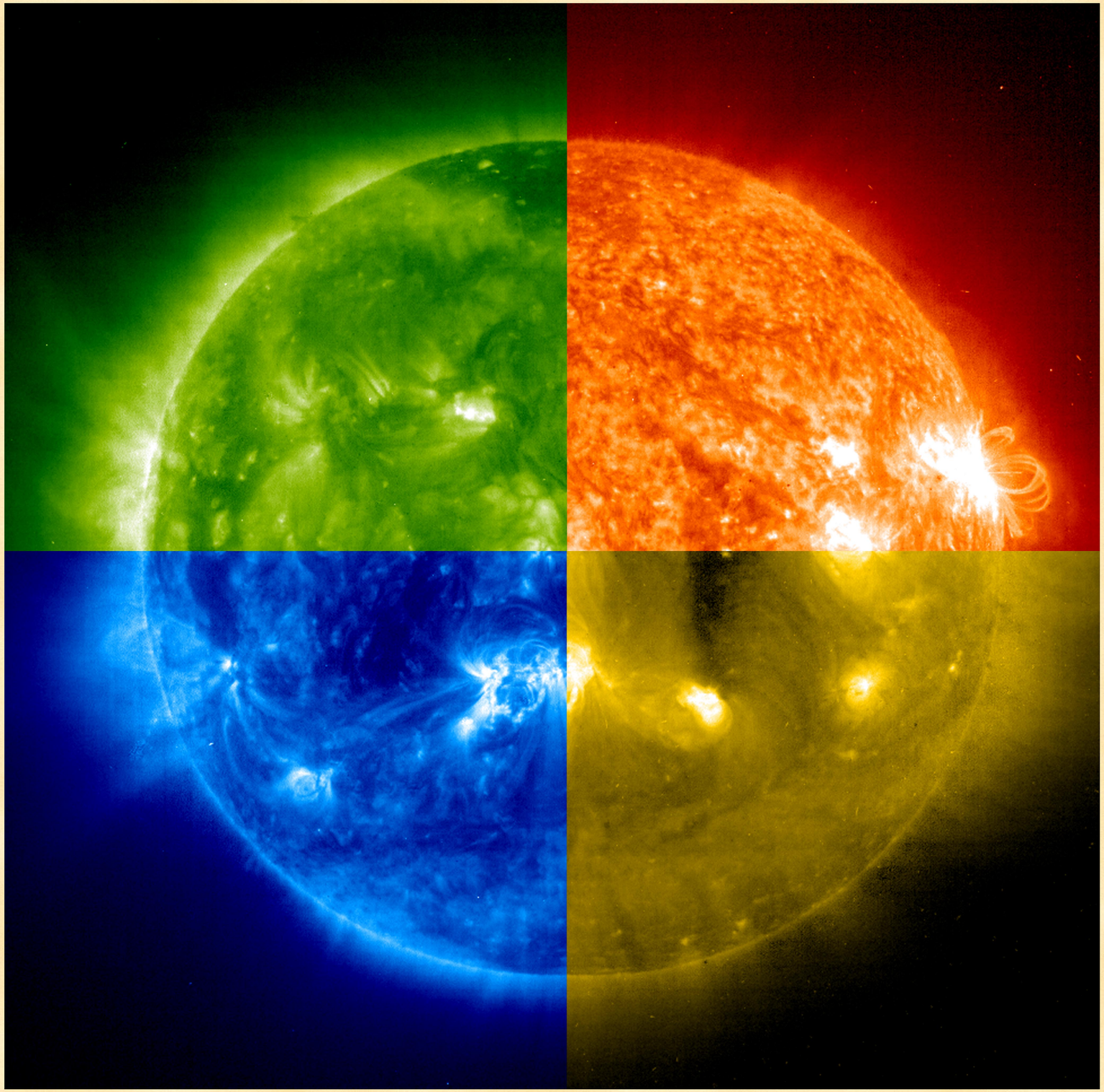


## It's all in the loops

As observed in extreme ultraviolet light, the lower corona is a cauldron of charged plasma being shaped by twisting magnetic field lines into coils of magnetic loops rising from out of the Sun. These are two unusually busy sides of the same image, with just the middle part taken out. These looping features in the lower corona are quite common, though the Sun here was quite active as it was near its maximum of activity (October 18, 2000) in the Sun's 11-year solar cycle.  The temperature of iron ions seen here is about 1.5 million degrees C.

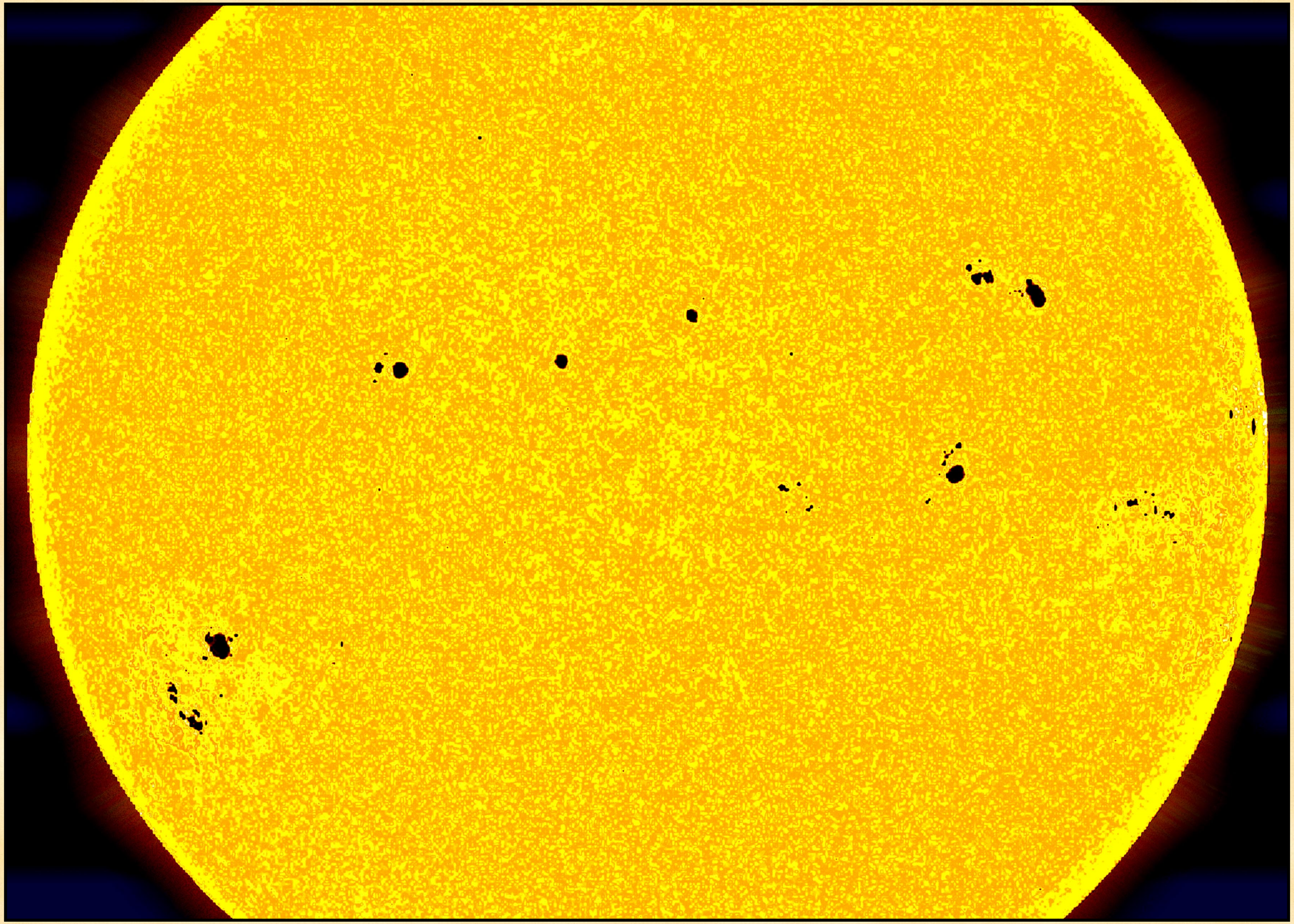
# Your choice of wavelengths

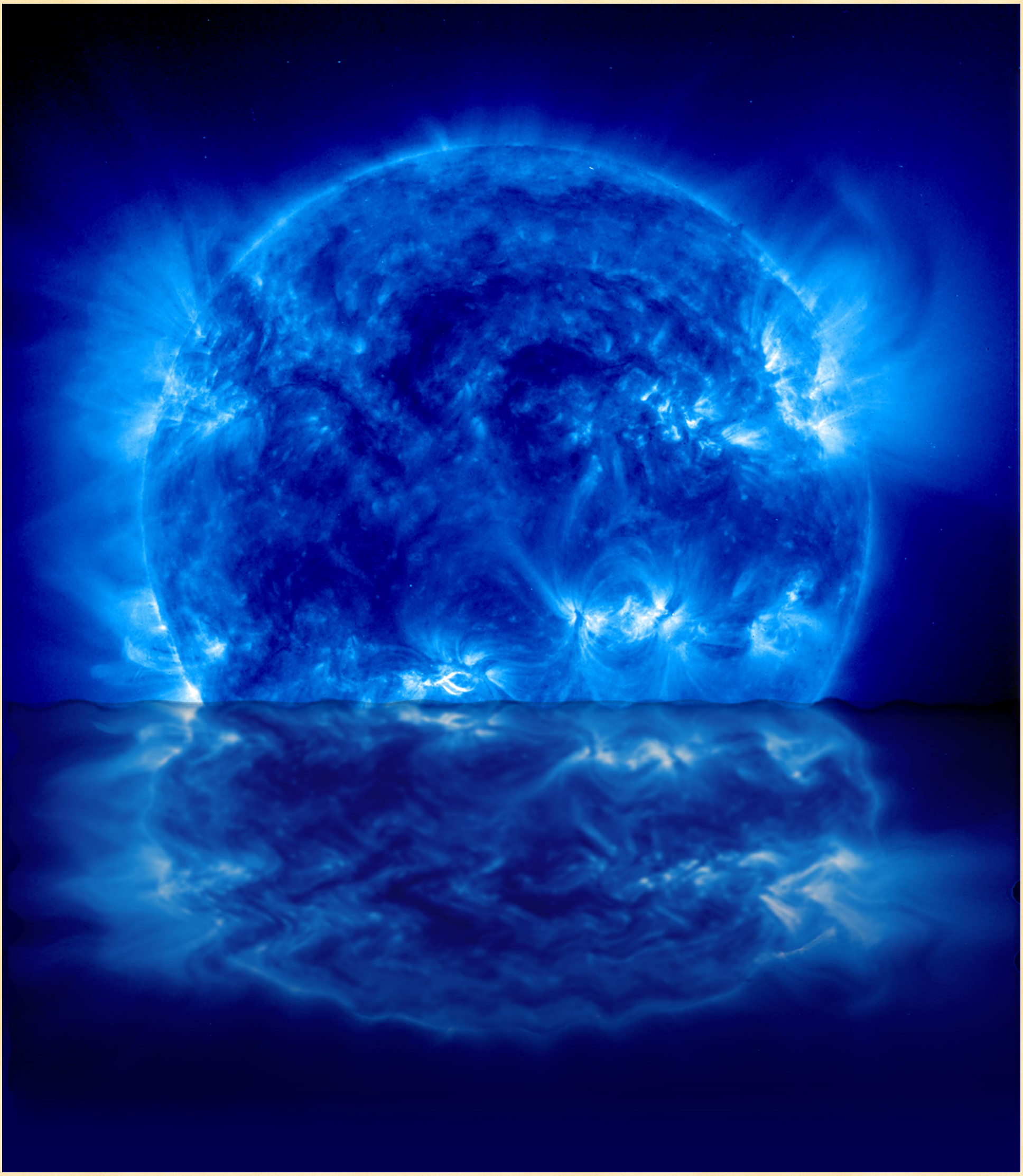
Images of the Sun in four quadrants all taken about the same time in June 2003 by SOHO's four extreme ultraviolet imagers. Each imager captures a different wavelength at different levels and temperatures of the Sun's corona – and each reveals different features. In all cases, though, brighter areas mean higher density of material; darker means less density. All the colors are false colors for quick identity of the wavelength being imaged.



## Smooth surface? Not.

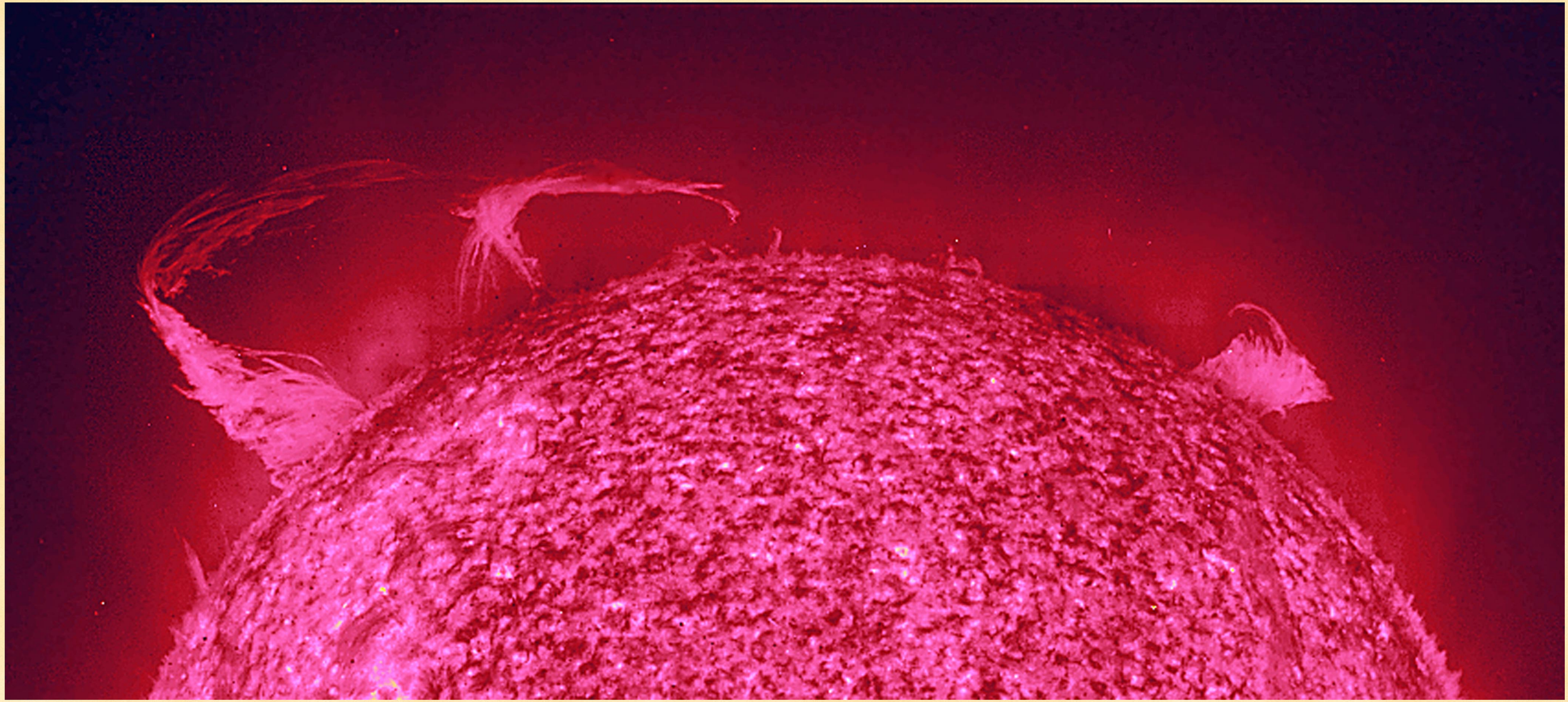
This “visible” light image of the solar surface shows a number of sunspots, quite common on the Sun. These are darker areas of intense magnetic activity. The sunspots are darker because they are cooler (about 4000 vs. 6000 degrees C. for the rest of the surface). The uneven, granulated texture of the surface is created by the churning motions of smaller cells all over the Sun.  Sunspots were first scientifically observed and recorded almost 400 years ago by Galileo.





## Blue bayou sunrise

If one were to observe the Sun rising over a bayou or ocean in extreme ultraviolet light and apply a blue filter, it might look something like this. This EIT 171 image from 1999 shows an active Sun with magnetic field lines and active regions wildly connecting and reconnecting over its surface. Yet, the subtle tones of blue suggest a watery fluidity nevertheless.

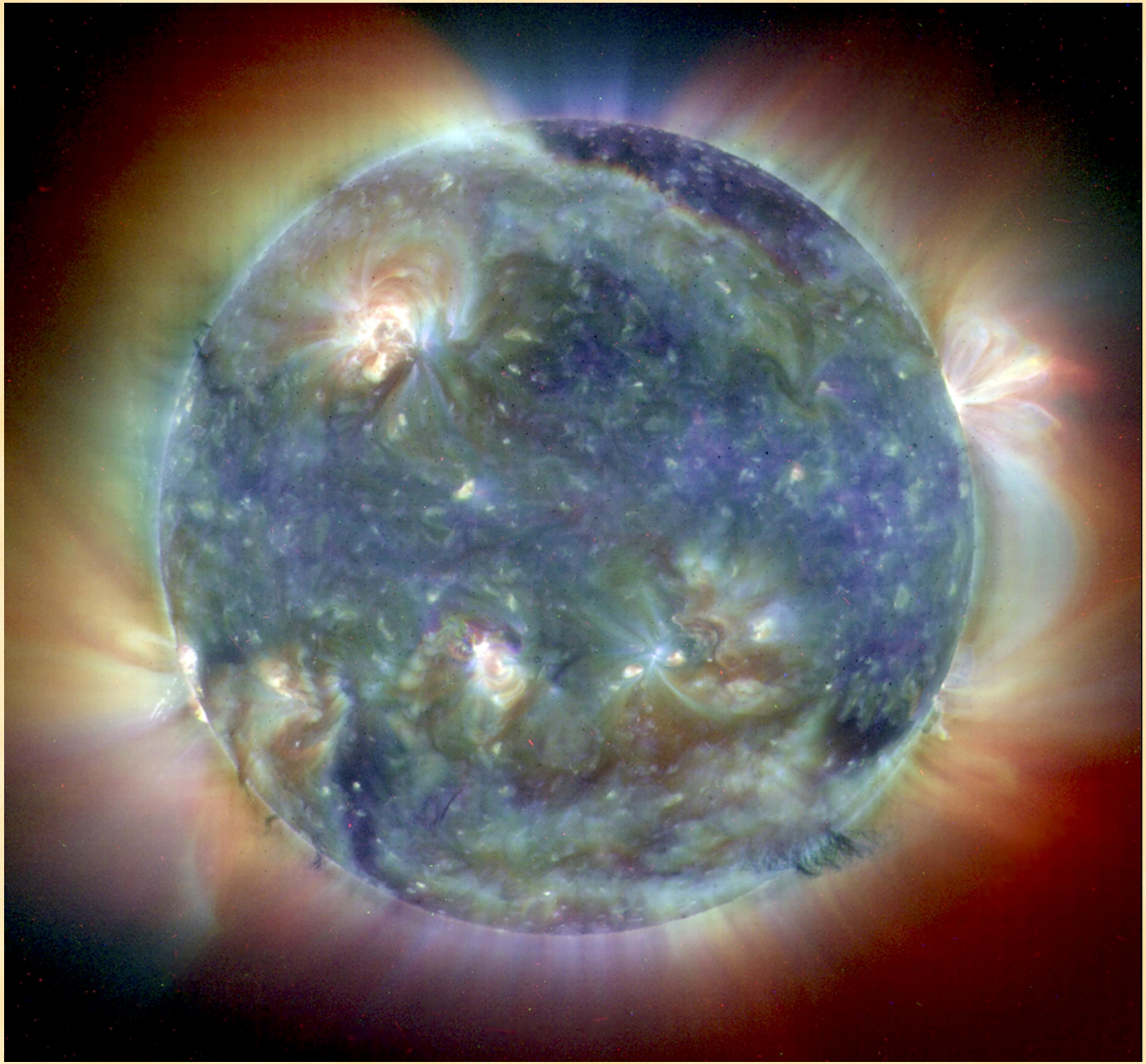


## Hooked prominences

An Extreme ultraviolet Imaging Telescope (EIT) 304Å image of a pair of similarly shaped prominences (left side) and other, smaller one (right side) from 11 January 1998. Material in the He II line shown here is at temperatures of 60,000 to 80,000K. These prominences consist of plasma that is spiralling around magnetic field lines which extend above the Sun's surface. Sometimes, they break away entirely. The length of the prominences seen here extend many times the size of Earth.

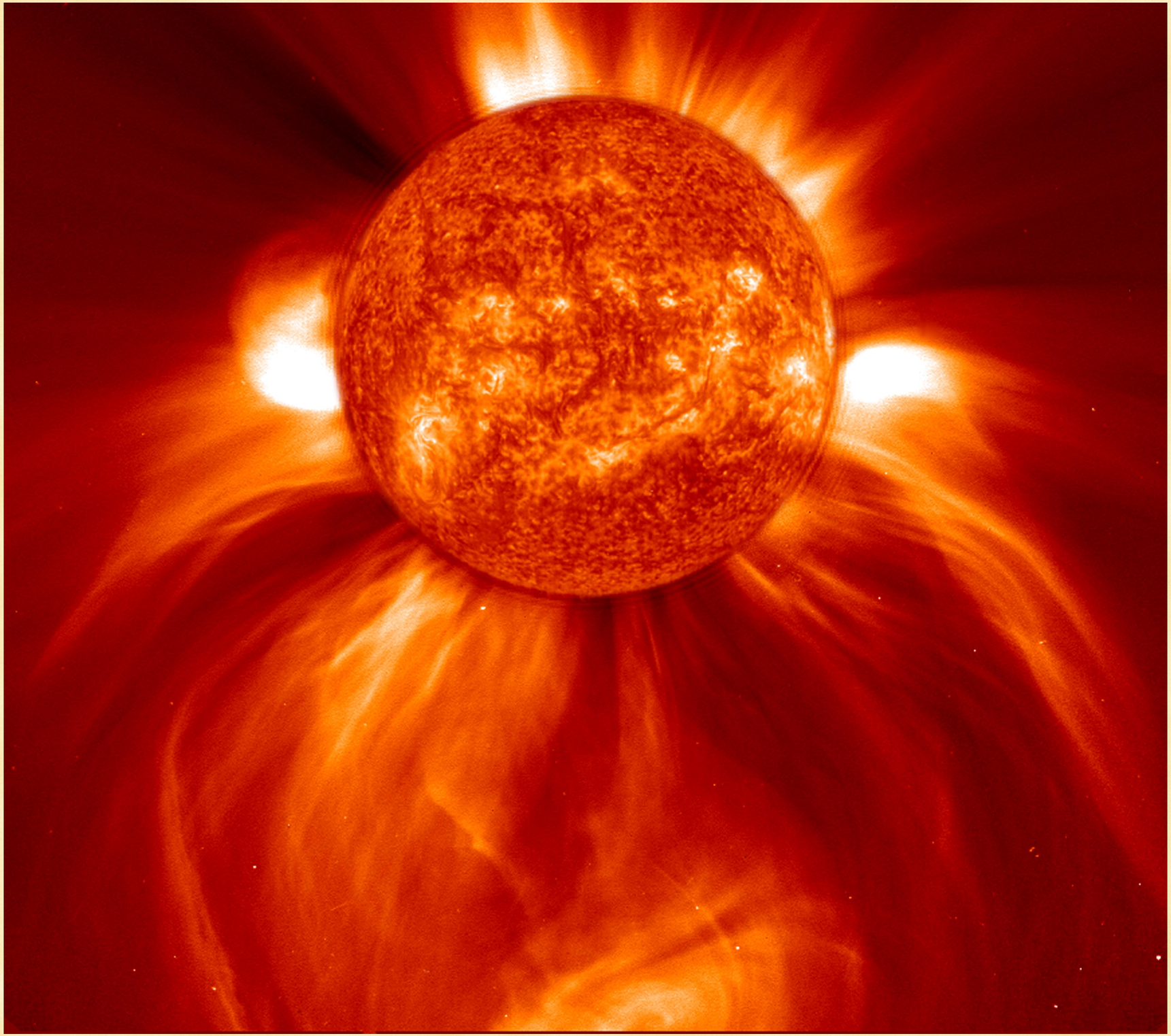
# The marbled Sun

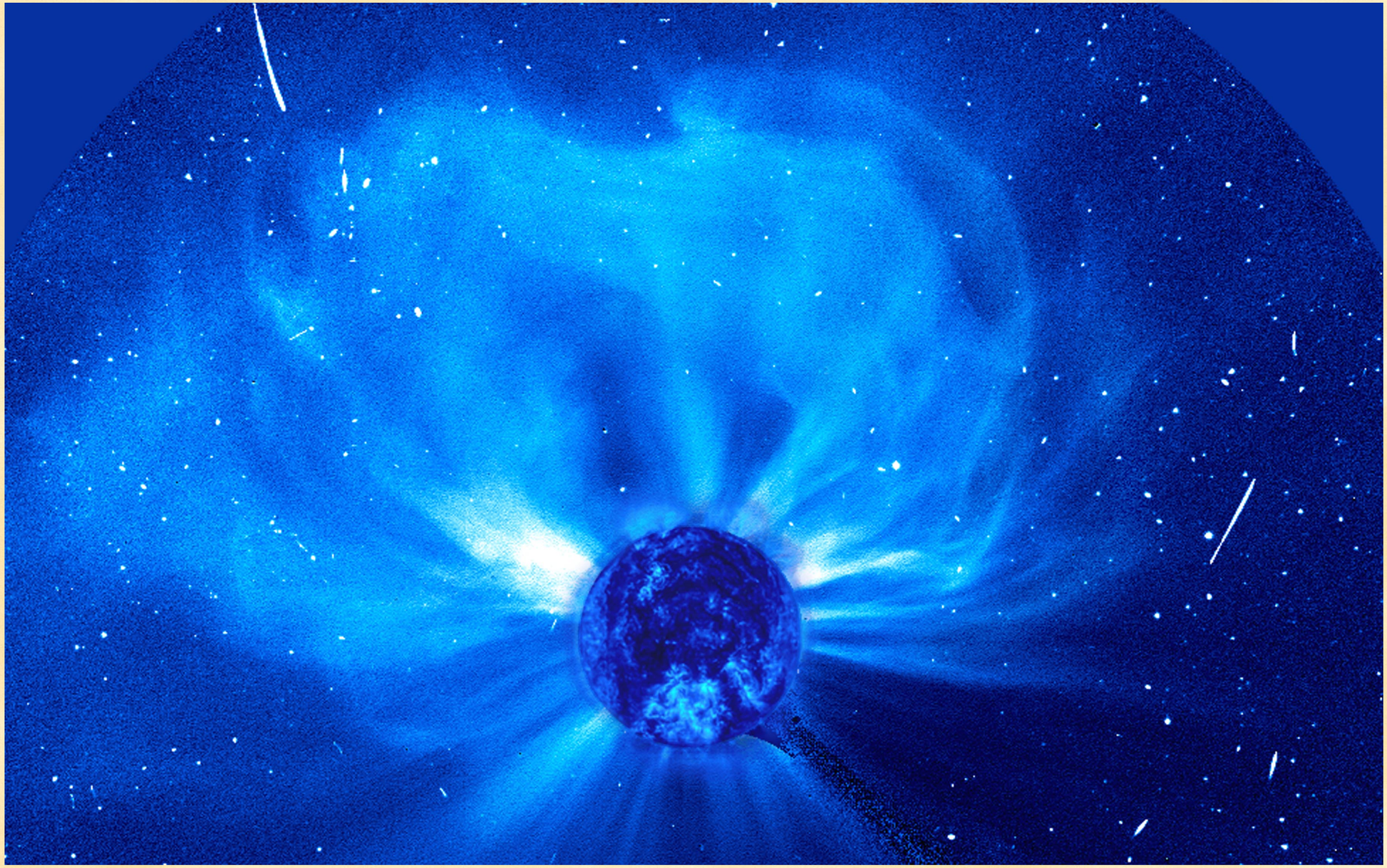
The extreme ultraviolet images (from different imagers) come to Earth from the SOHO spacecraft in black and white. Then they are consistently color coded for easy identification. For this May 1998 image, the nearly simultaneous images from three different ultraviolet imagers were each given a color code (red, yellow and blue) and digitally merged into one. The colorful result revealed features that no one of the instruments could capture.



# A billowing, brilliant Sun

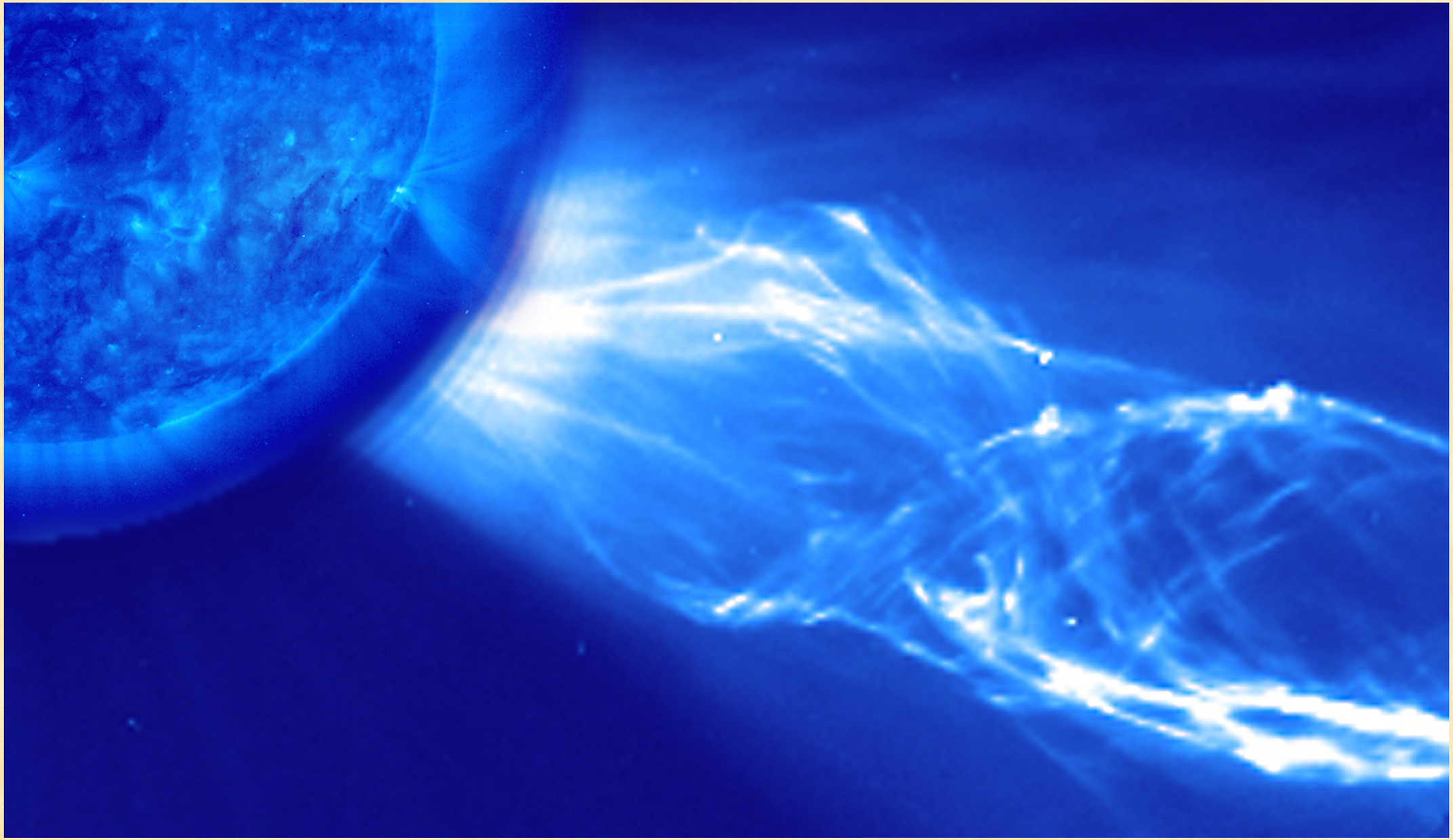
An extreme ultraviolet image from one day was enlarged and superimposed on the larger background image so that it filled the occulting disk for effect. This LASCO C2 background image shows a widely spreading coronal mass ejection (CME) as it blasts more than a *billion* tons of matter out into space at *millions* of kilometers per hour. The image was turned 90 degrees so that the blast seems to be pointing down.





## Solar Storming

This coronal mass ejection from 26 November 2000 is blasting *billions* of tons of matter at *millions* of kilometers per hour. An ultraviolet image of the Sun (same day) has been enlarged and superimposed on the LASCO instrument's occulting disk. Colors have been slightly altered, but nothing else has been added. The large white speckles and longer streaks are high-energy protons hitting the SOHO imager after being blasted at nearly the speed of light by the solar storm. This was a big one!

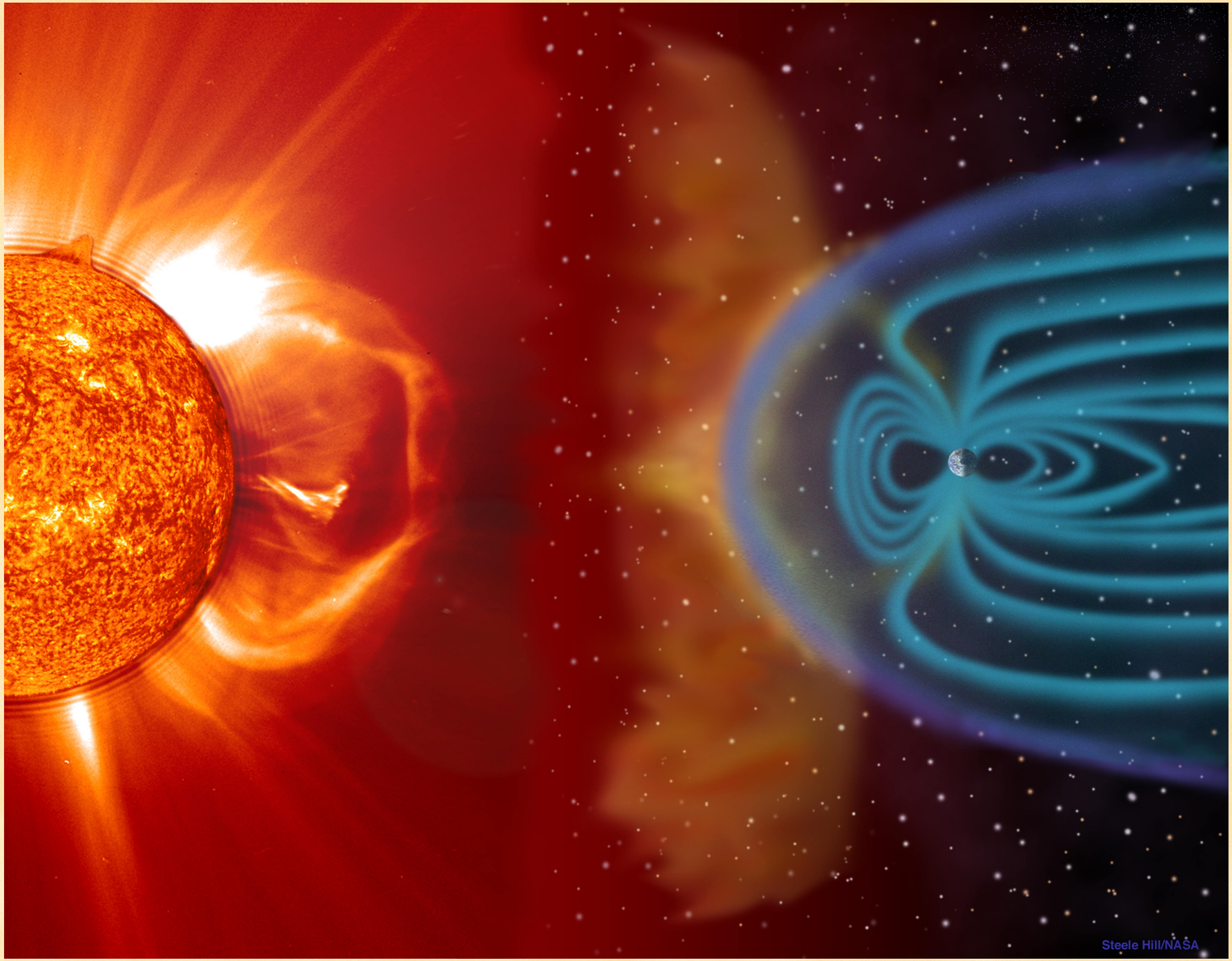


## Helical, twisting coronal mass ejection

A close-up of the filaments in this 1998 coronal mass ejection surprised scientists by exhibiting distinct twisting as they roared away from the Sun in a tightly controlled pattern.  The image of the corona in visible light was taken by the LASCO C2 instrument. An ultraviolet Sun in blue was superimposed in the upper left corner in place of the instrument's occulting disk.

# The Sun-Earth Connection

This illustration shows a CME blasting off the Sun's surface in the direction of Earth. The left portion is composed of an extreme ultraviolet image superimposed on a coronagraph. Two to four days later, the CME cloud is shown striking and beginning to be mostly deflected around the Earth's magnetosphere. The magnetic cloud of plasma can extend to 30 million miles wide by the time it reaches Earth. The blue paths emanating from the Earth's poles represent some of its magnetic field lines. These storms, which occur frequently, can disrupt communication and navigational equipment, damage satellites, and even cause blackouts.

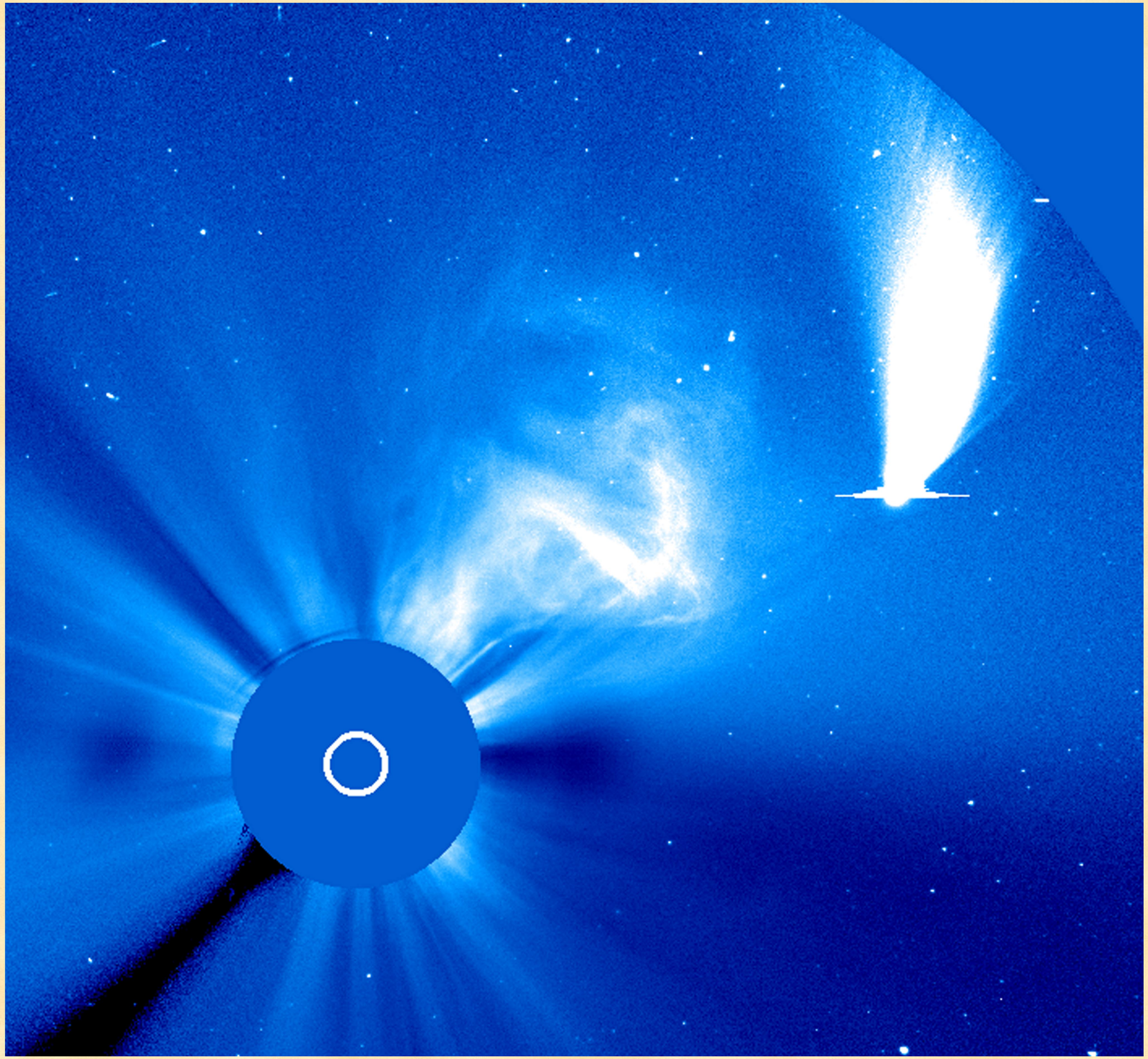


## From there to here

This colorful juxtaposition of a coronal mass ejection that, when headed towards Earth, generates many of the beautiful aurora that we see by injecting energy from the Sun into our magnetosphere.  Despite many myths, theories, and efforts to figure it out, scientists did not know what caused the aurora until about a hundred years ago!

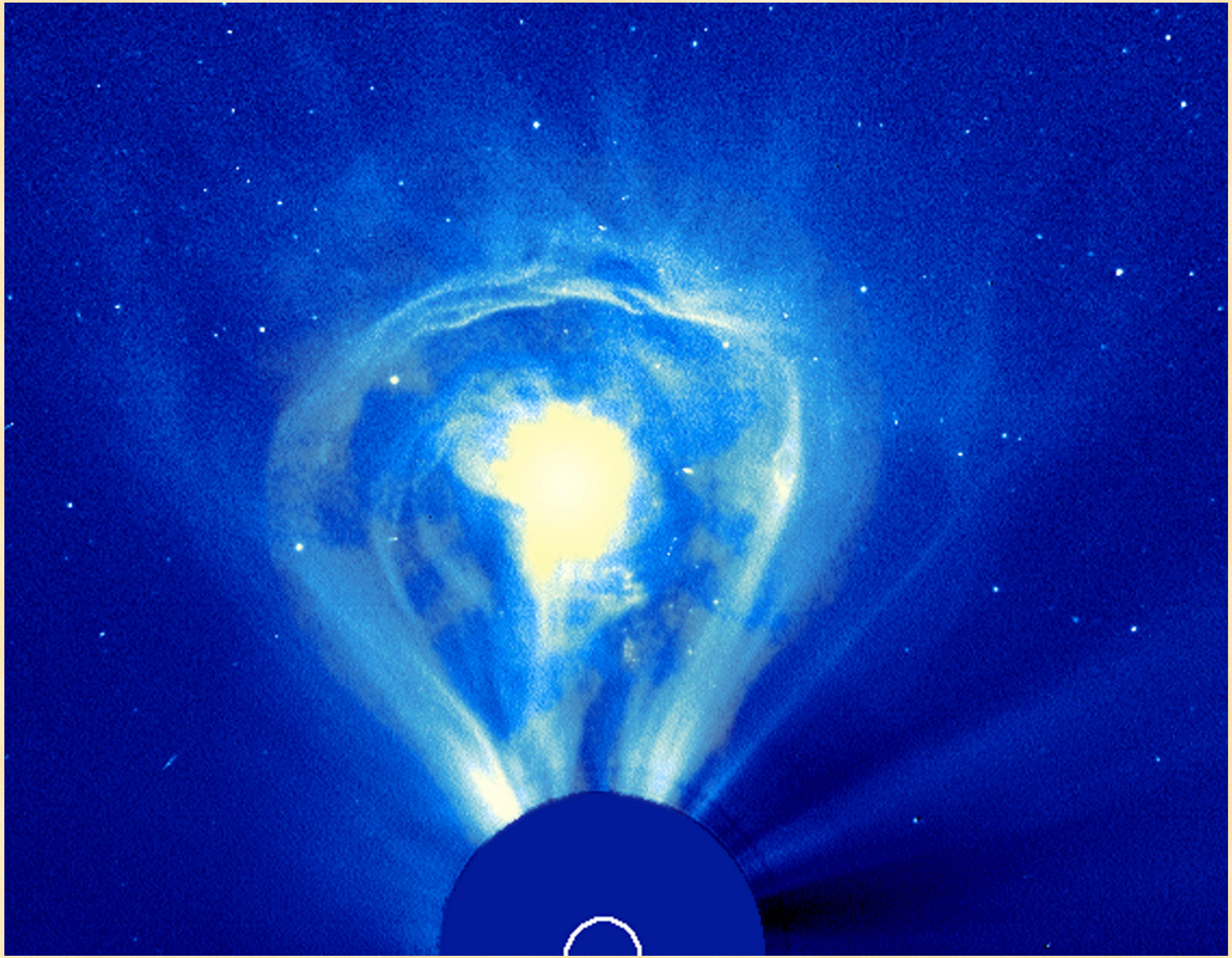
# A Diving Comet NEAT

The very bright Comet NEAT is nearing its closest approach to the Sun at the same time that a coronal mass ejection is caught blasting particles into space. The Sun's large gravitational field provides the central force for comet orbits. Comets themselves are long-tailed messengers of ice and dust, often from the outer Solar System that fall through the inner solar system, before heading back into the celestial reaches. LASCO is a spectacular comet-observing tool (over 600 discovered) because of its combination of high sensitivity and large field of view.



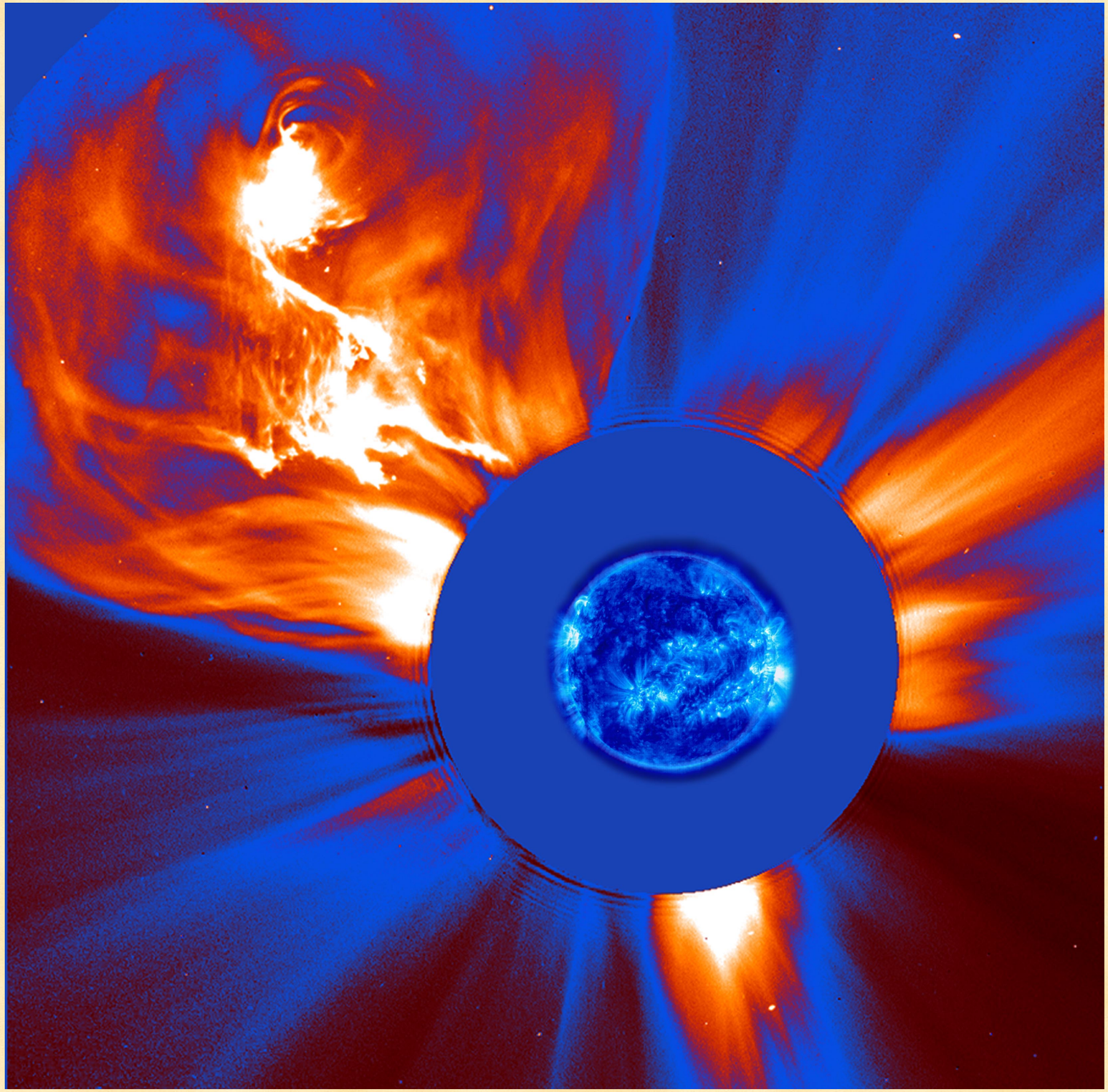
## The Sun has a great idea!

Yes, we all know that the Sun provides light during the day, but the irony of this is not what we were expecting. A large coronal mass ejection on 27 February 2000 blasted out directly above the Sun into an instantly recognizable, incandescent light-bulb. Just some yellow tones were added to the center to embellish the impression.



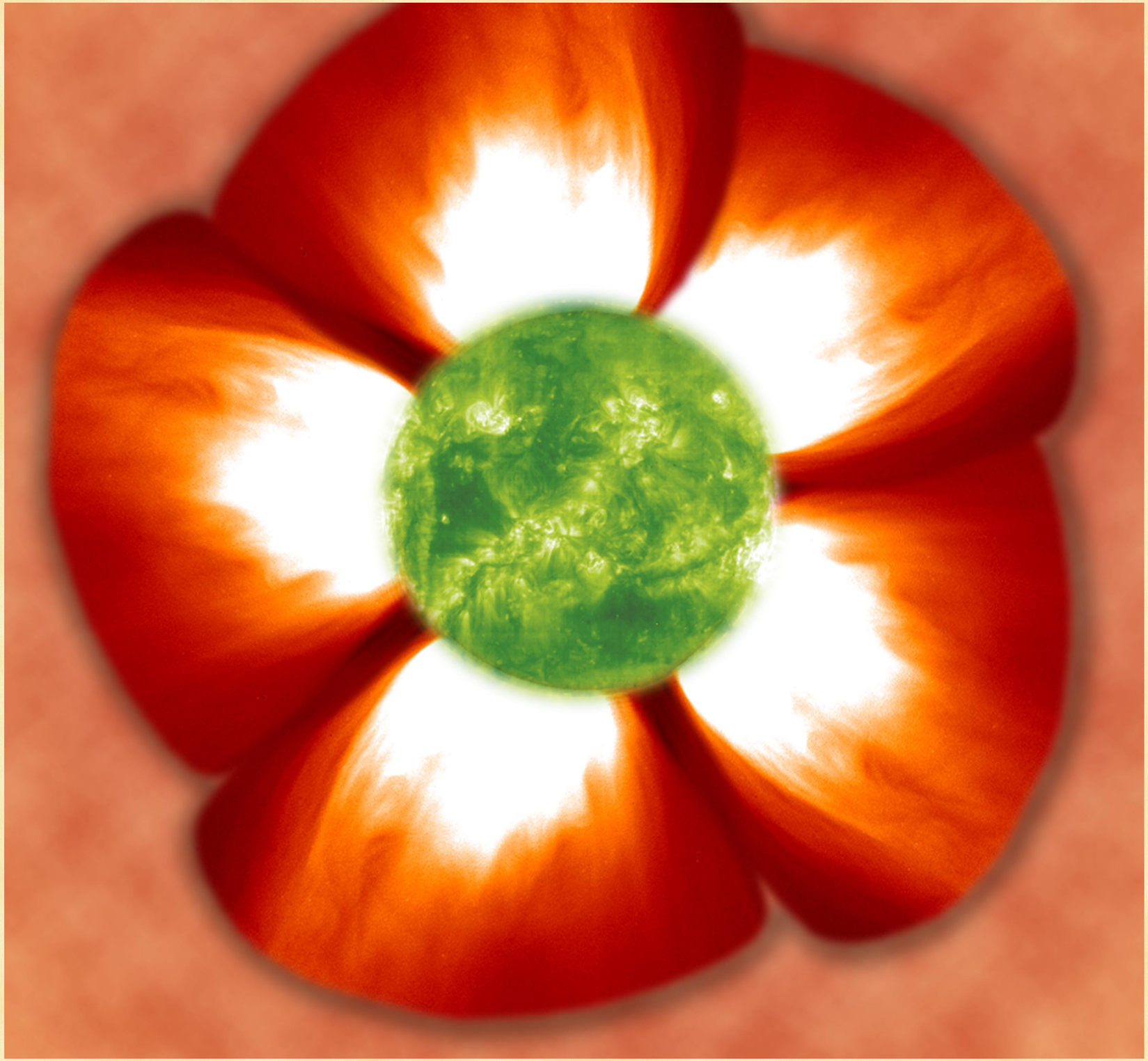
# Fire-Breather

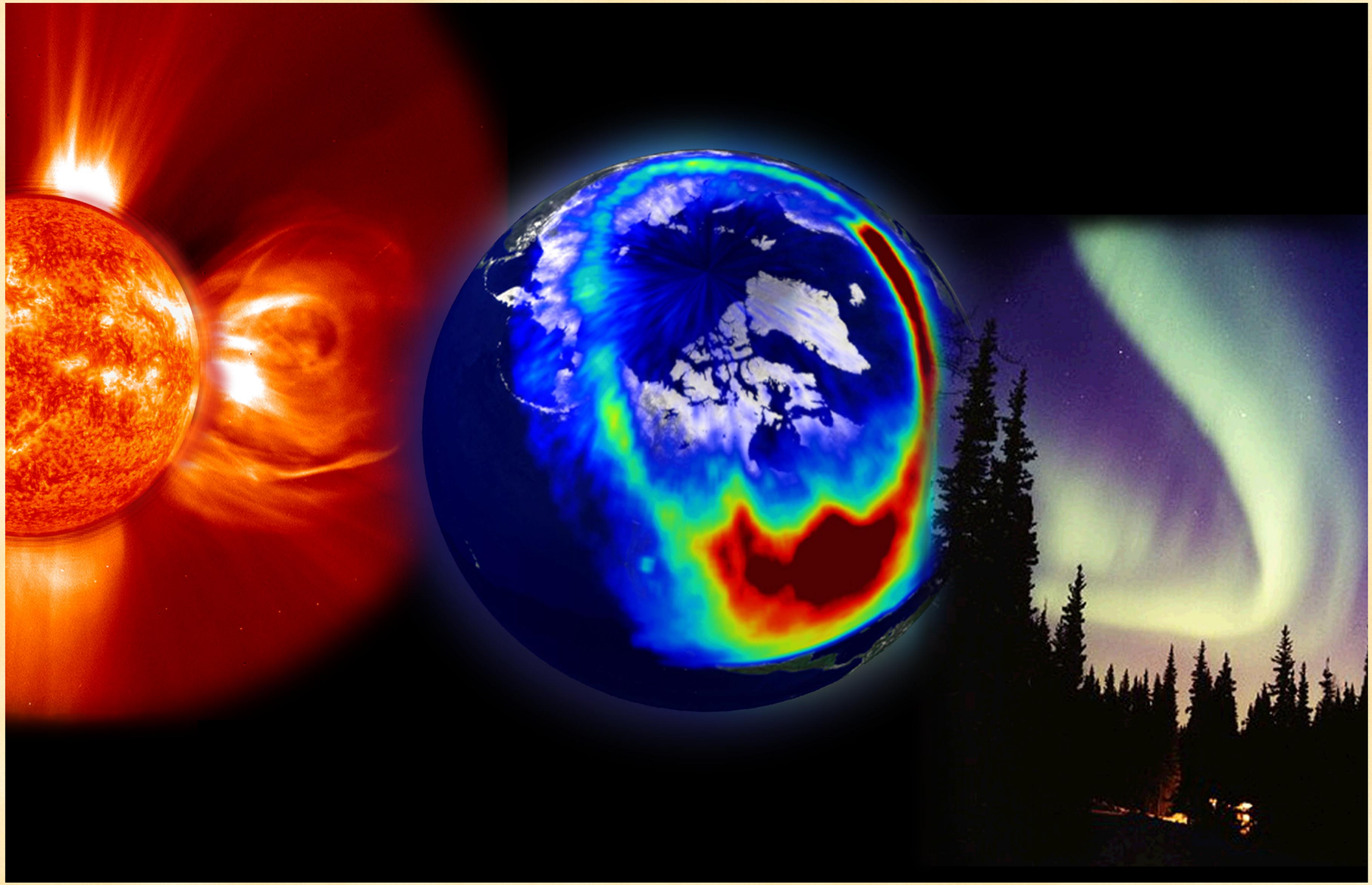
An especially complex and large coronal mass ejection on 4 January 2002 made even seasoned solar physicists gasp with awe. The LASCO C2 instrument observes the particles blasting into the corona. Areas of white indicate the greatest intensity of matter; the reds somewhat less; blues, even less. An extreme ultraviolet image of the Sun was superimposed on image to show the size and active regions of the Sun this day.



# “Sun-flower” petals

There was something about the bright coronal mass ejection (cropped but un-retouched) on 27 February 2002 that suggested the splash of color found in a flower petal, especially when copied into a circular pattern. Add an extreme ultraviolet image of the Sun (same day) as the centerpiece and it suggests a recreation of oneness in the universe. The English poet William Blake expressed it as “all the world in a grain of sand.”



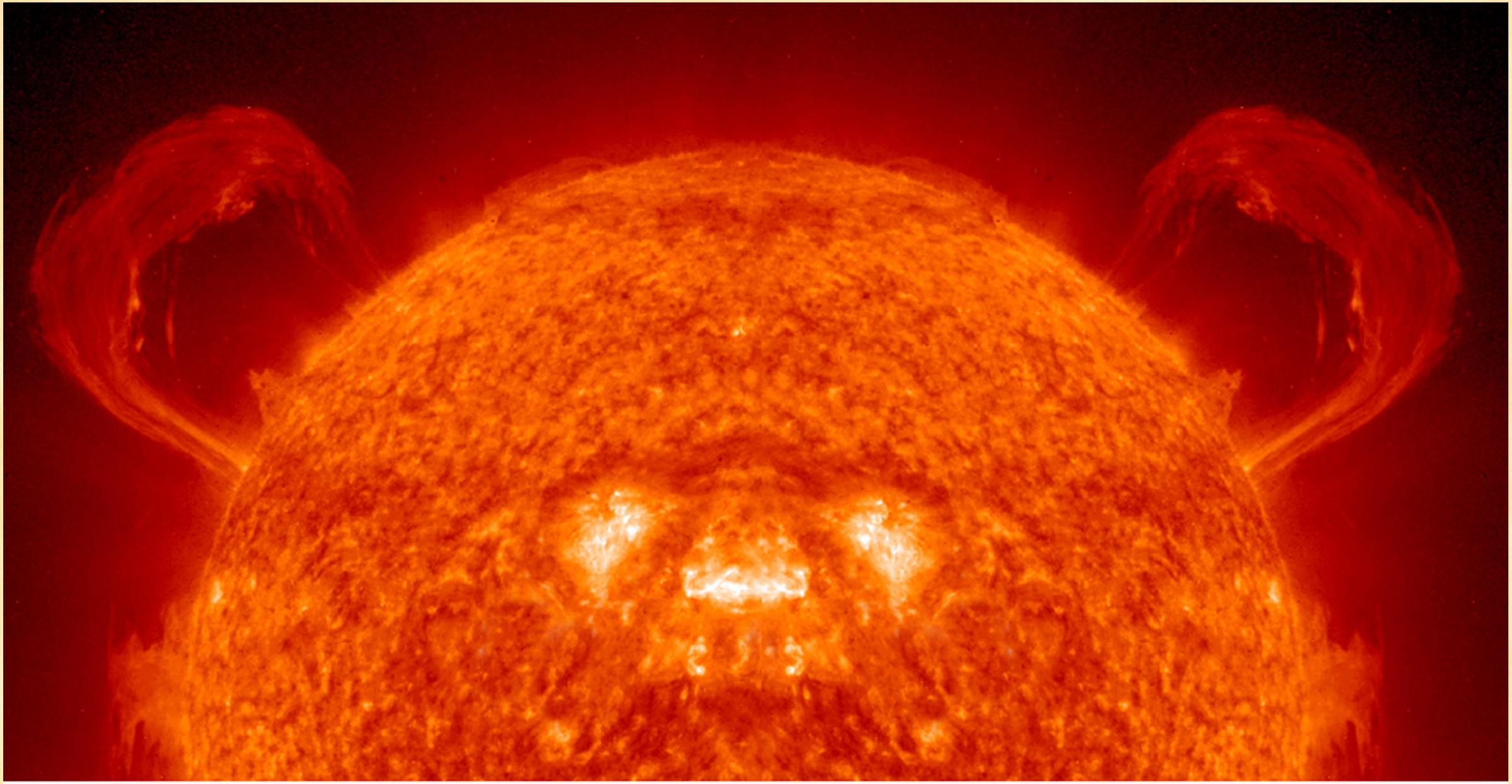


## Visual elements of space weather

This composite image presents the three most visible elements of space weather: a storm from the Sun, aurora as seen from space, and aurora as seen from the Earth. The solar storm is a corona mass ejection (CME) composite from EIT 304Å superimposed on a LASCO C2 image, both from SOHO. The middle image from Polar's VIS imager shows charged particles as they spread down across the U.S. during a major solar storm event on July 14, 2000, the largest in ten years. Lastly, Jan Curtis took this image of an aurora display in Alaska, the visible evidence of space weather that we see here on Earth.

## Stonehenge and the Sun

A large coronal mass ejection forms the dramatic backdrop in this fanciful juxtaposition of a SOHO image and sunset silhouetting the stones at Stonehenge, in England. The occulting disk, which blocks out the Sun so the instrument can observe activity in the corona, has been replaced with a sunset image. Stonehenge, a mammoth stone and timber structure that dates back over 2700 years, was constructed over hundreds of years. It is speculated that the builders of Stonehenge oriented some of the stone structure to mark certain astronomical events, including equinoxes, which provides the logical linkage for these two images.



## Sunny the Bear

We've all heard of the man in the moon, right? So, using a dramatic solar image of an eruptive prominence that seemed ear-like, this illustrator took it from there. With a flipped copy of the image and by judiciously moving an active region or two, voilà. Here's looking at you, kid! (He thinks he's hot stuff!)