



ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
Εθνικόν και Καποδιστριακόν
Πανεπιστήμιον Αθηνών

Ηλιακή Φυσική

Ενότητα 6: Μέθοδοι και όργανα παρατήρησης

Ξενοφών Δ. Μουσάς
Σχολή Θετικών Επιστημών
Τμήμα Φυσικής



ΕΘΝΙΚΟ ΚΑΙ ΚΑΠΟΔΙΣΤΡΙΑΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
ΤΜΗΜΑ ΦΥΣΙΚΗΣ
ΕΡΓΑΣΤΗΡΙΟ ΑΣΤΡΟΦΥΣΙΚΗΣ

Παρατηρήσεις του Ηλίου

Ε. Μουσάς

xmoussas@phys.uoa.gr

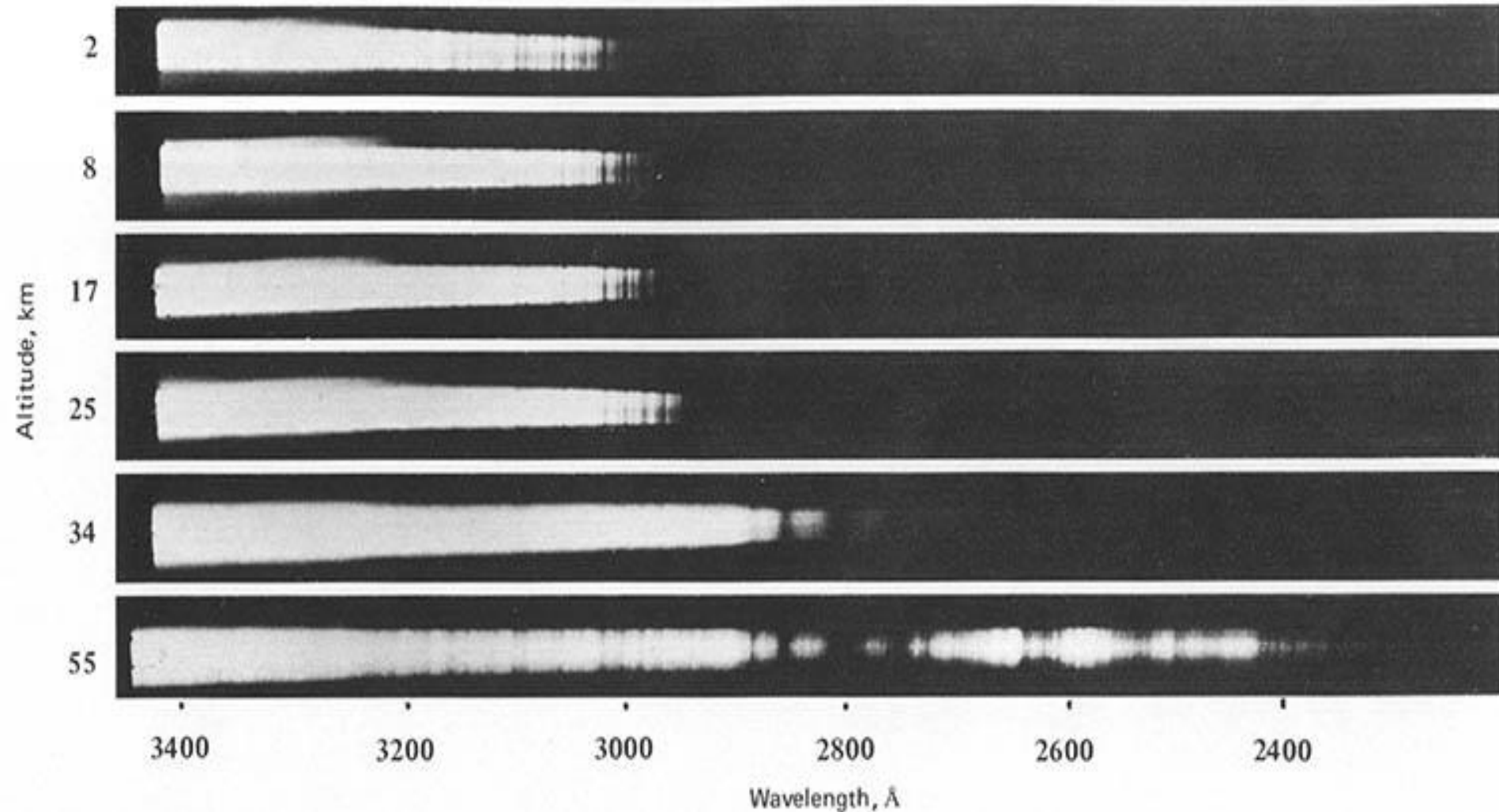
Αθήνα, 2013

Ευχαριστίες

Ιδιαίτερες Ευχαριστίες οφείλονται στη NASA, ESA, ESO, NOAO/NSO/Kitt Peak FTS/AURA/NSF

στους Ερευνητές και λοιπούς συντελεστές των επιγείων τηλεσκοπίων και διαστημικών πειραμάτων, στην κυρία Παν. Πρέκα Παπαδήμα, στους κυρίους Αλ. Χείλαρη, Αθ. Κοντογεώργο, Παν. Τσιτσιπή, Πάνο Παπασπύρου για τις ενδιαφέρουσες συζητήσεις, σε αυτούς που μας έδωσαν μετρήσεις ή συμβουλές, στην Wikipedia για πολλές πολύτιμες εικόνες που προσφέρονται χωρίς δικαιώματα χρήσης και συνεπώς είναι πολύτιμες σε κάθε δάσκαλο.

Ηλιακό φάσμα (NOAO)
NOAO/NSO/Kitt Peak
FTS/AURA/NSF



FIRST PHOTOGRAPHS OF THE ULTRAVIOLET SPECTRUM OF THE SUN, made from a V-2 rocket on October 10, 1946, under the direction of Richard L. Tousey of the U.S. Naval Research Laboratory. A sequence of exposures shows how more and more of the ultraviolet radiation of the Sun is recorded as the rocket rises in altitude from 2 to 55 km above sea level. SP-402 A New Sun: The Solar Results From Skylab, by John A. Eddy

Τηλεσκόπιο

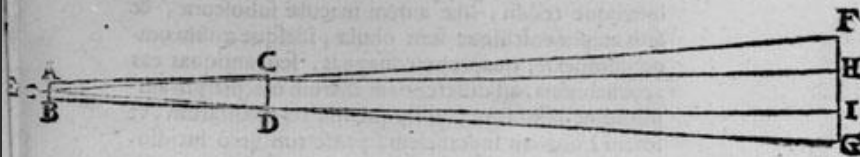
Από τη Βικιπαίδεια, την ελεύθερη εγκυκλοπαίδεια

Τηλεσκόπιο λέγεται το οπτικό όργανο εκείνο δια του οποίου αυξάνεται το φαινόμενο μέγεθος αντικειμένων που βρίσκονται μακριά.

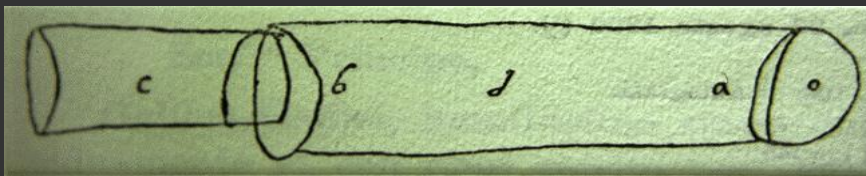
Συγκεκριμένα είναι μία οπτική διάταξη για τη συλλογή και εστίαση της ηλεκτρομαγνητικής ακτινοβολίας, μέσω της οποίας επιχειρείται η παρατήρηση μακρινών αντικειμένων και κυρίως ουράνιων σωμάτων. Το τηλεσκόπιο αποτελεί το κύριο αστρονομικό όργανο.

RECENS HABITAE. 7

Spicillis ferantur secundum lineas refractas ECH.
 EDI. coarctantur enim, & qui prius liberi ad FG.
 Obiectum dirigebantur, partem tantummodo HI. cō-



prehendent: accepta deinde ratione distantiae BH. ad
 lineam HI. per tabulam sinuum reperietur quantitas
 anguli in oculo ex obiecto HI. constituti, quem mi-
 nuta quaedam tantum continere comperiemus. Quod
 si Specillo CD. bracteas, aliàs maioribus, aliàs verò mi-



telescopio
 του Γαλιλαίου

SIDEREVS
 NVNCIVS *R-2-27*

MAGNA, LONGEQVE ADMIRABILIA
 Spectacula pandens, suspiciendaque proponens
 vnicuique, praesertim verò

PHILOSOPHIS, atq; ASTRONOMIS, qua à
 GALILEO GALILEO
 PATRITIO FLORENTINO

Patavini Gymnasij Publico Mathematico

PERSPICILLI

Nuper à se reperti beneficio sunt observata in LVNÆ, ÆFACIÆ, FIXIS IN
 NVMERIS, LACTEO CIRCVLO, STELLIS NEBVLOSIS,

Apprime verò in

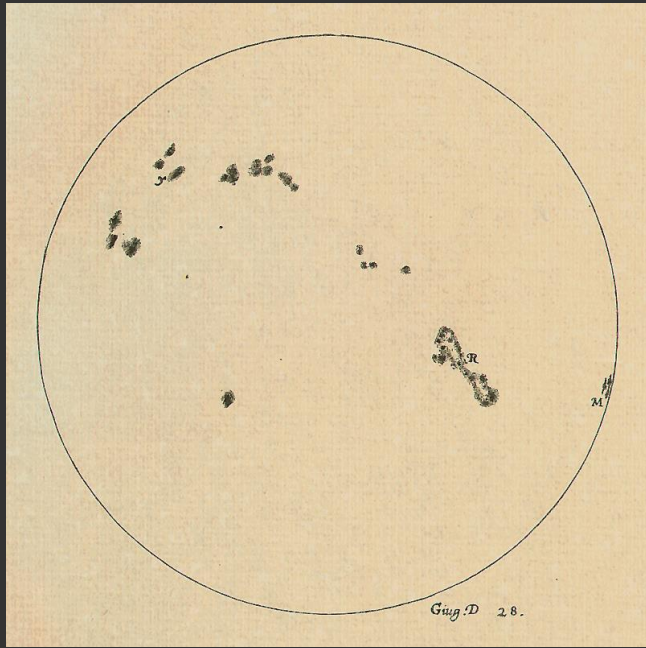
QVATVOR PLANETIS

Circa IOVIS Stellam disparibus intervallis, atque periodis, celeri-
 tate mirabili circumvolutis; quos, nemini in hanc vsque
 diem cognitos, nouissimè Author depræ-
 hendit primus; atque

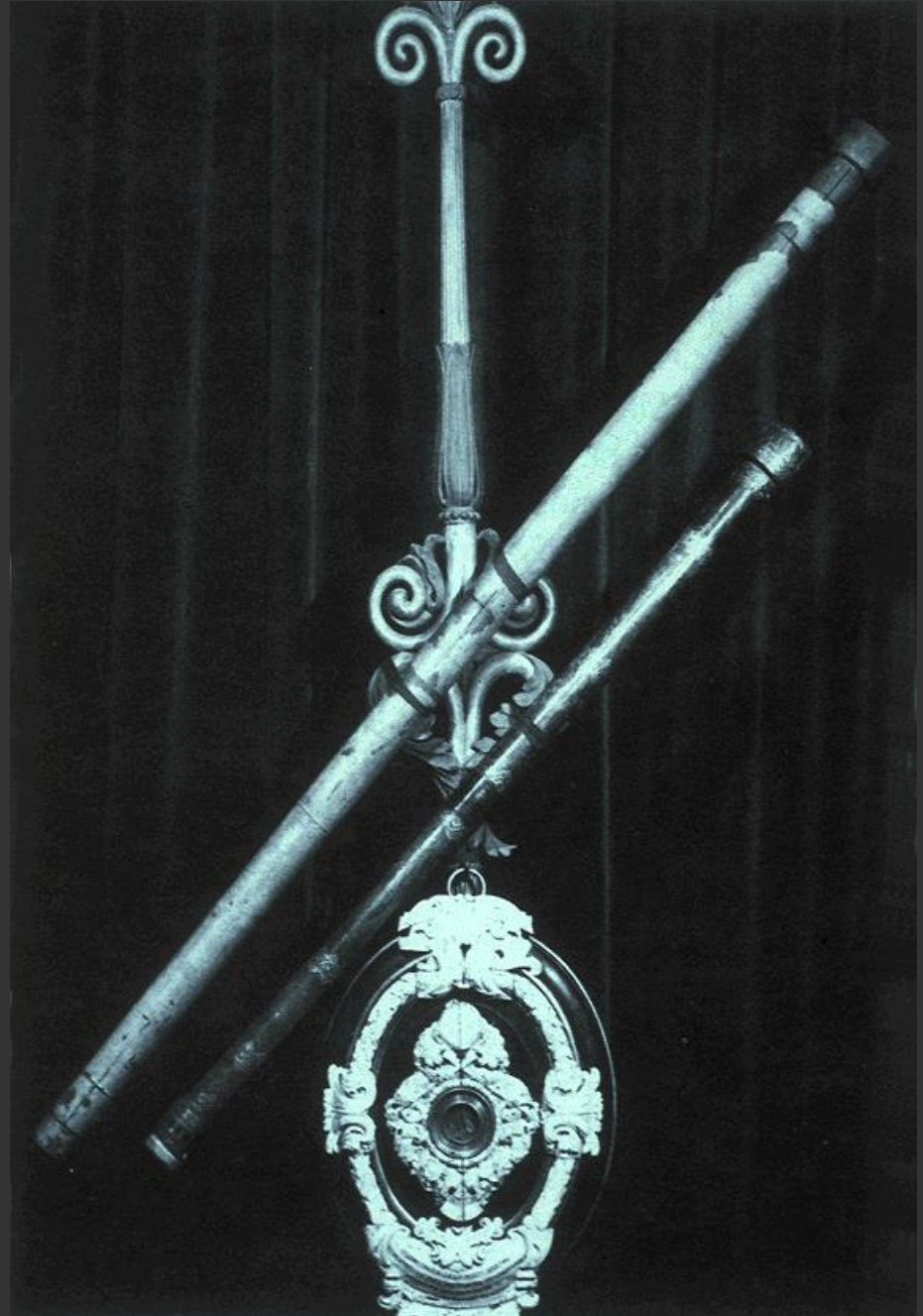
MEDICEA SIDERA
 NVNCVPANDOS DECREVIT.



VENETIIS, Apud Thomam Baglionum. M DC X.
 Superiorum Permissu, & Privilegio.



*telescopio
και κηλίδες
ΤΟΥ
Γαλιλαίου*

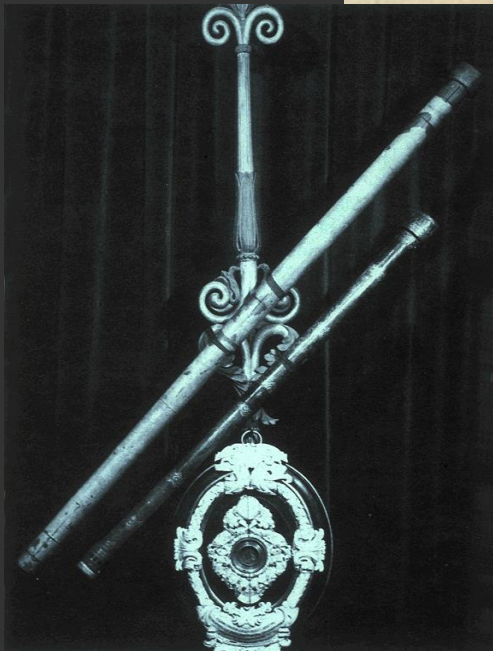




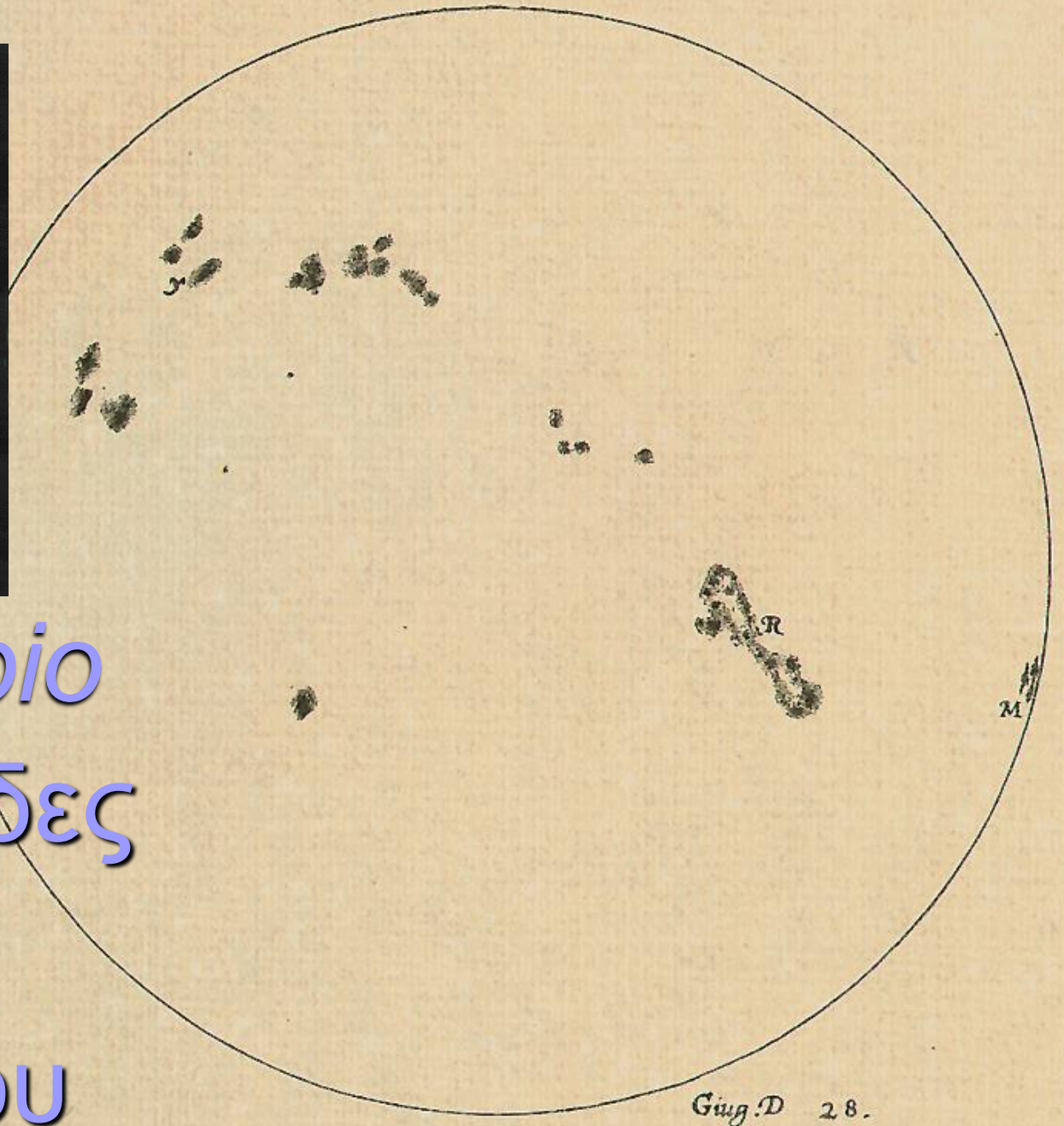
*telescopio
του Γαλιλαίου*

η λέξη *telescopio*
πλάστηκε το 1611 από τον
Πρίγκηπα Φεντερίκο
Τσέζι, ιδρυτή και πρόεδρο
της Ακαδημίας των
Λύγκων, ιταλικής
επιστημονικής ακαδημίας,
της οποίας ο Γαλιλαίος
ήταν μέλος.

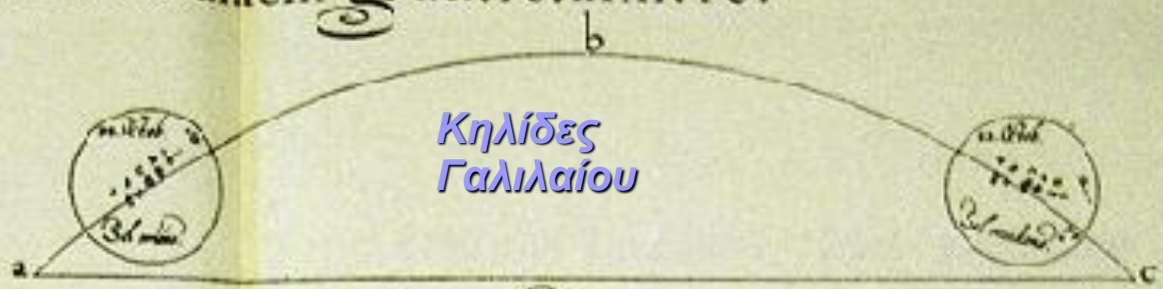
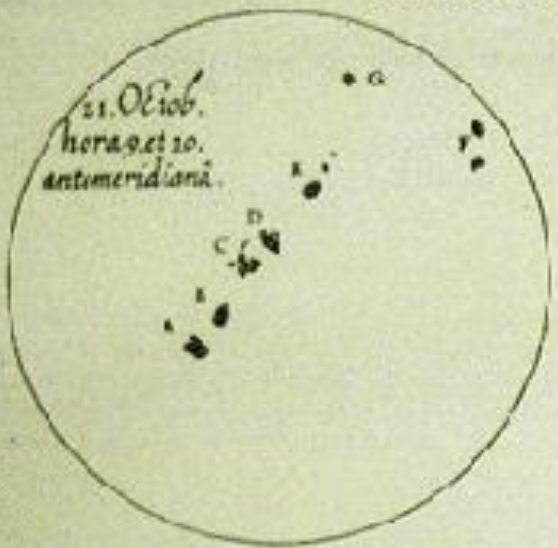




telescopio
και κηλίδες
ΤΟΥ
Γαλιλαίου



MACVLAE IN SOLE APPARENTES, OBSERVATAE anno 1611. ad latitudinem grad. 48. min. 40.



Κηλίδες
Γαλιλαίου

a c, horizon. a b c, arcus solis diurnus. Sol oriens ex parte a, maculas exhibet quas videt, occidens vero c, easdem ratione primj motus, non nihil inuariat. Et hanc matutinam vespertinamq; mutationem, omnes maculae quocidie subeunt. Quid semel exhibuisse et monstrasse, sufficiat.

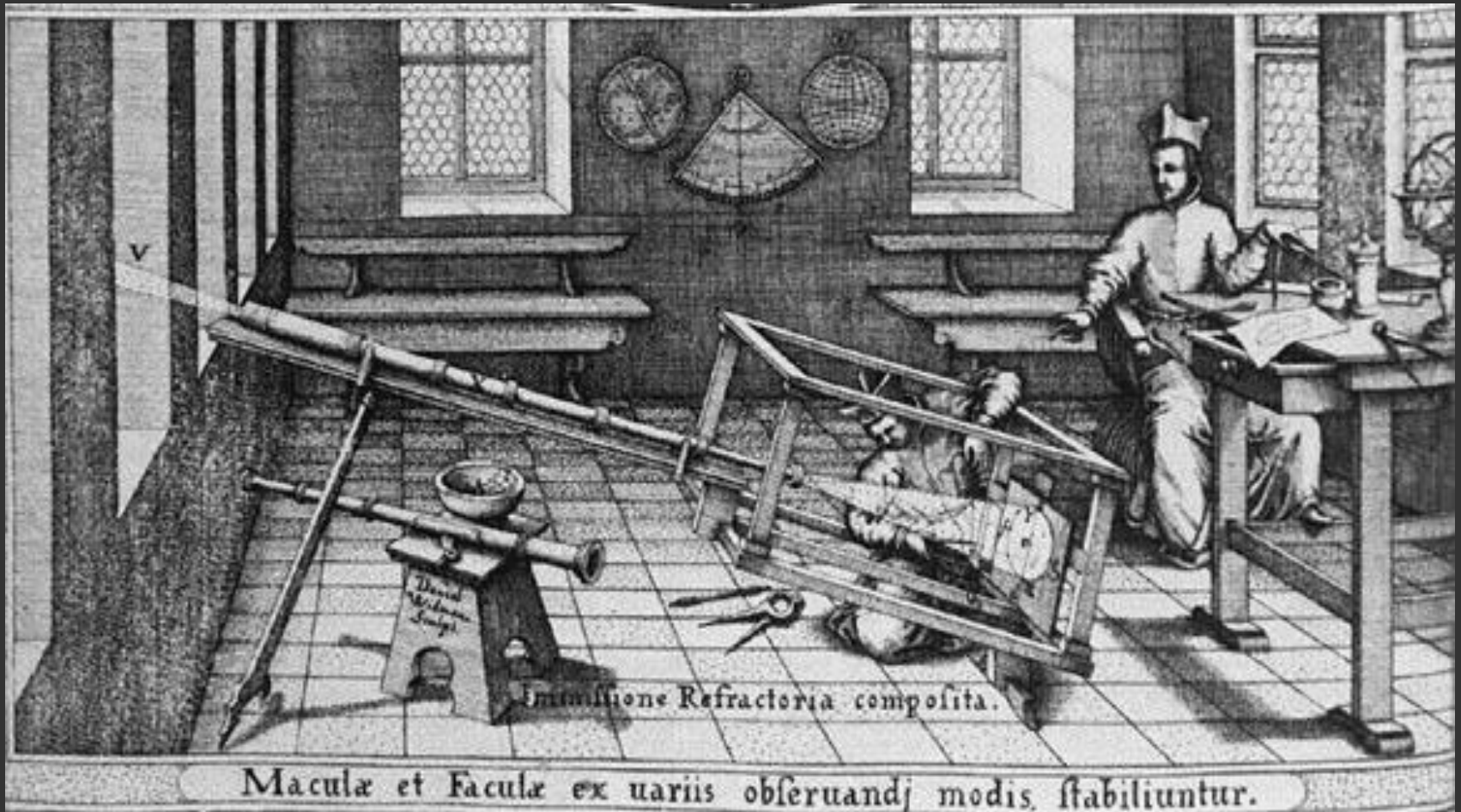


Macula I sunt
veluti conspicua,
proprie notabilis
hinc inde reliquis
magis distincta.

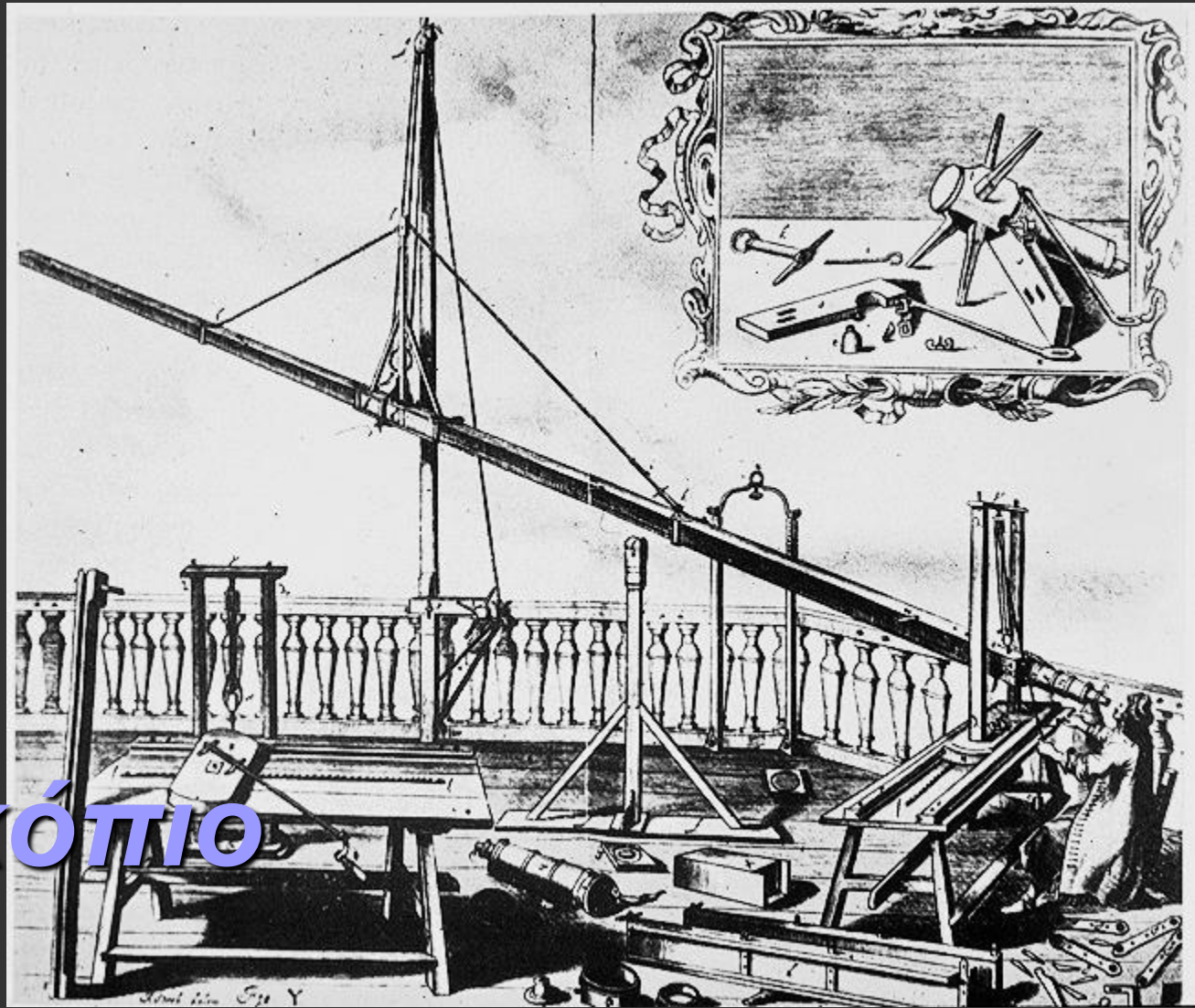
Macula M, est
hinc vixit in aequum
magis, nulliq;
prima magnitudine
sideri fixo cedit.

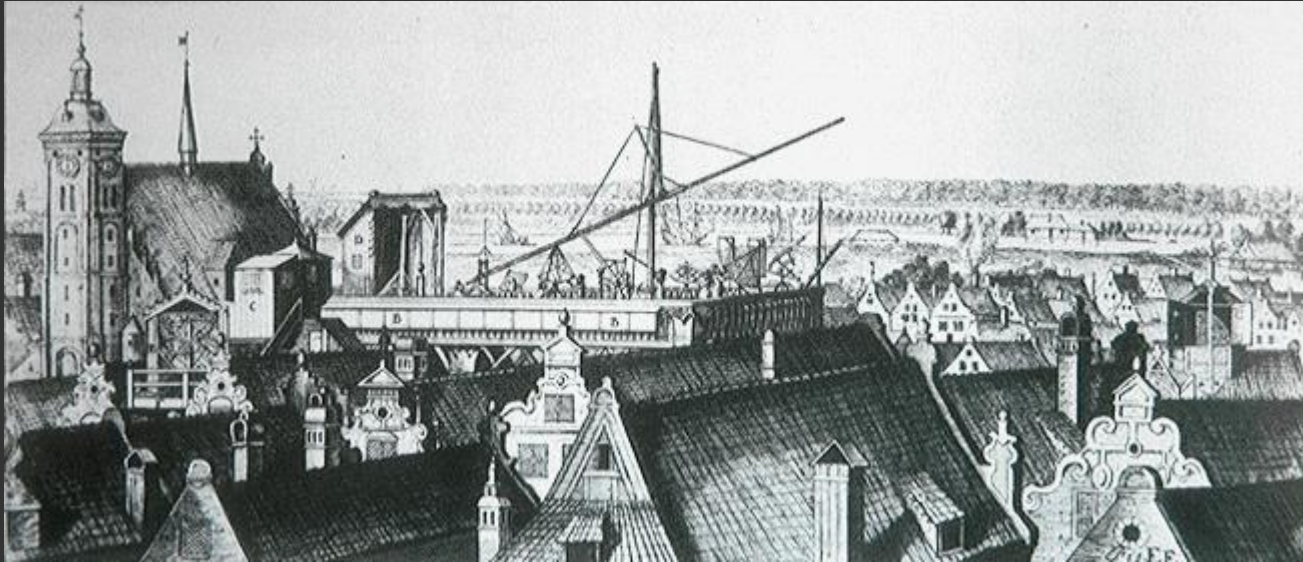
Figura que
habet similitudinem
signi X, et
cetera.

Μέθοδος προβολής

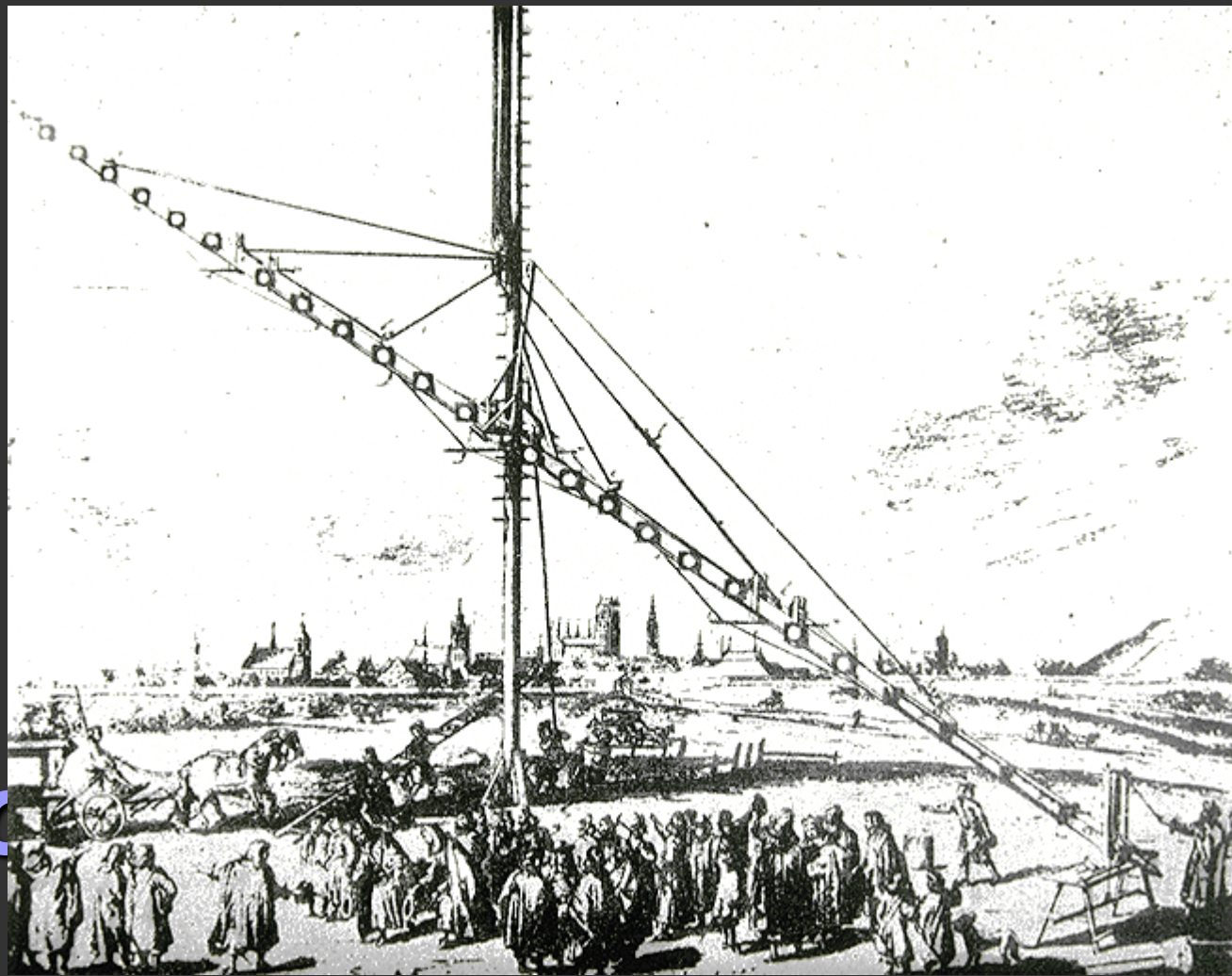


**Τηλεσκόπιο
του
Χεβέλιου (140 πόδια)**





***Τηλεσκόπιο
ΤΟΥ
Χεβέλιου (140 πόδια)***



*Τηλεσκοπ
του
Χεβέλιου Machina
Coelestis, 1673*

GEDANI.
 Anno era Christiana, 1643.
 Curfus Maculorum, à 22 Mayj ad 31 eiusdem.

Ηλιακές κηλίδες

ΤΟΥ

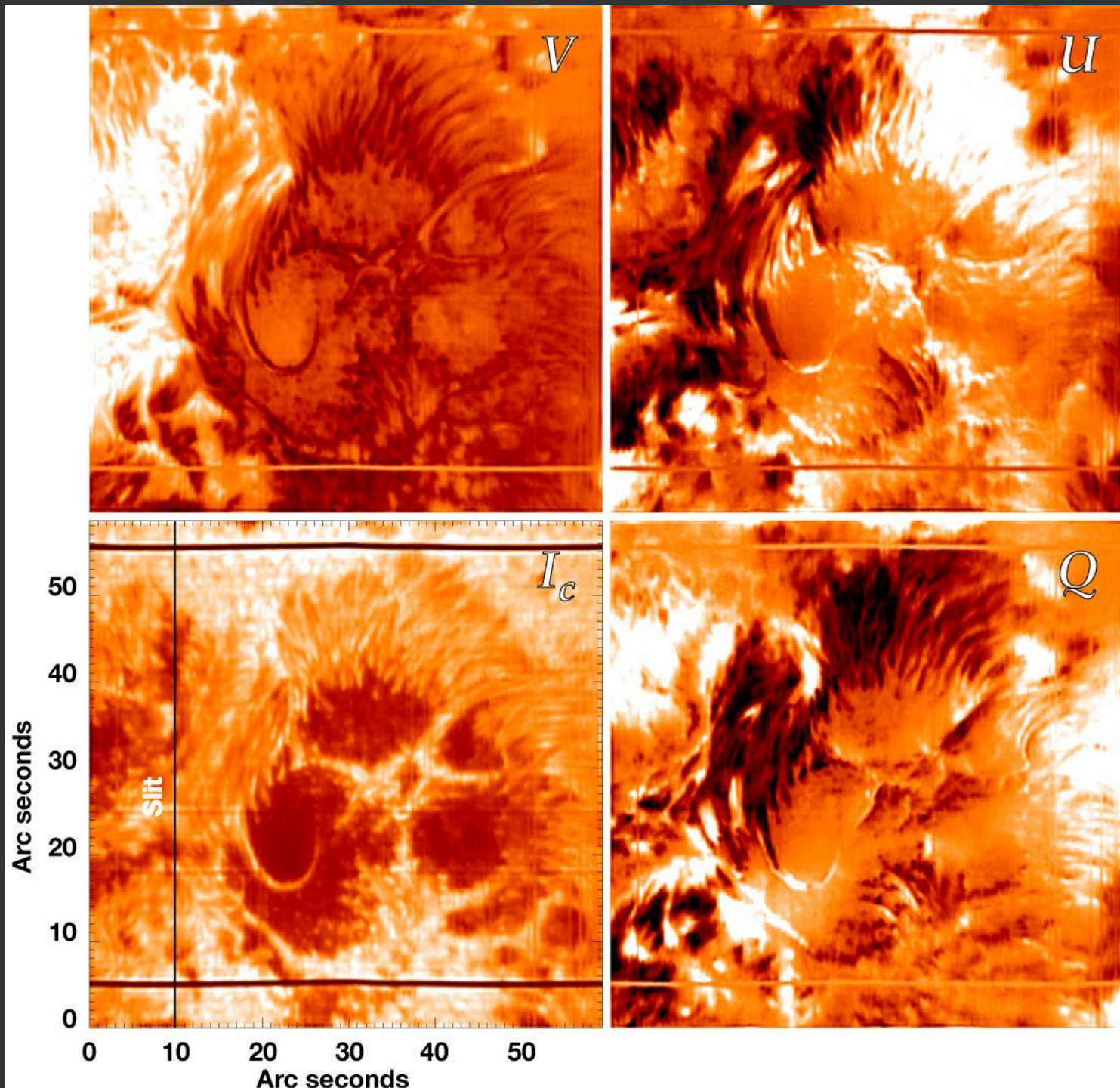
Χεβέλιου 22 με 31 Μαΐου
 1643 στο Danzig.



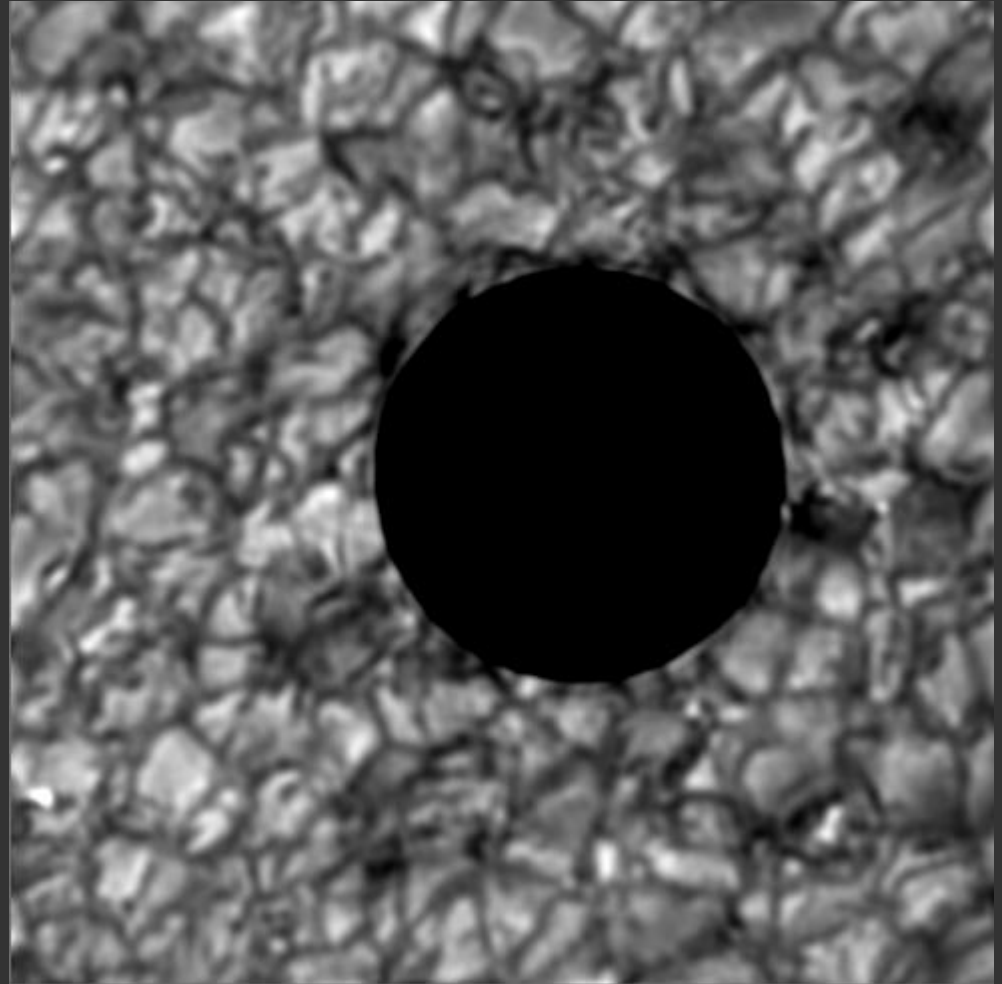
**Τηλεσκόπιο
του
Νεύτωνος
(Newton's reflecting
telescope, 1671)**

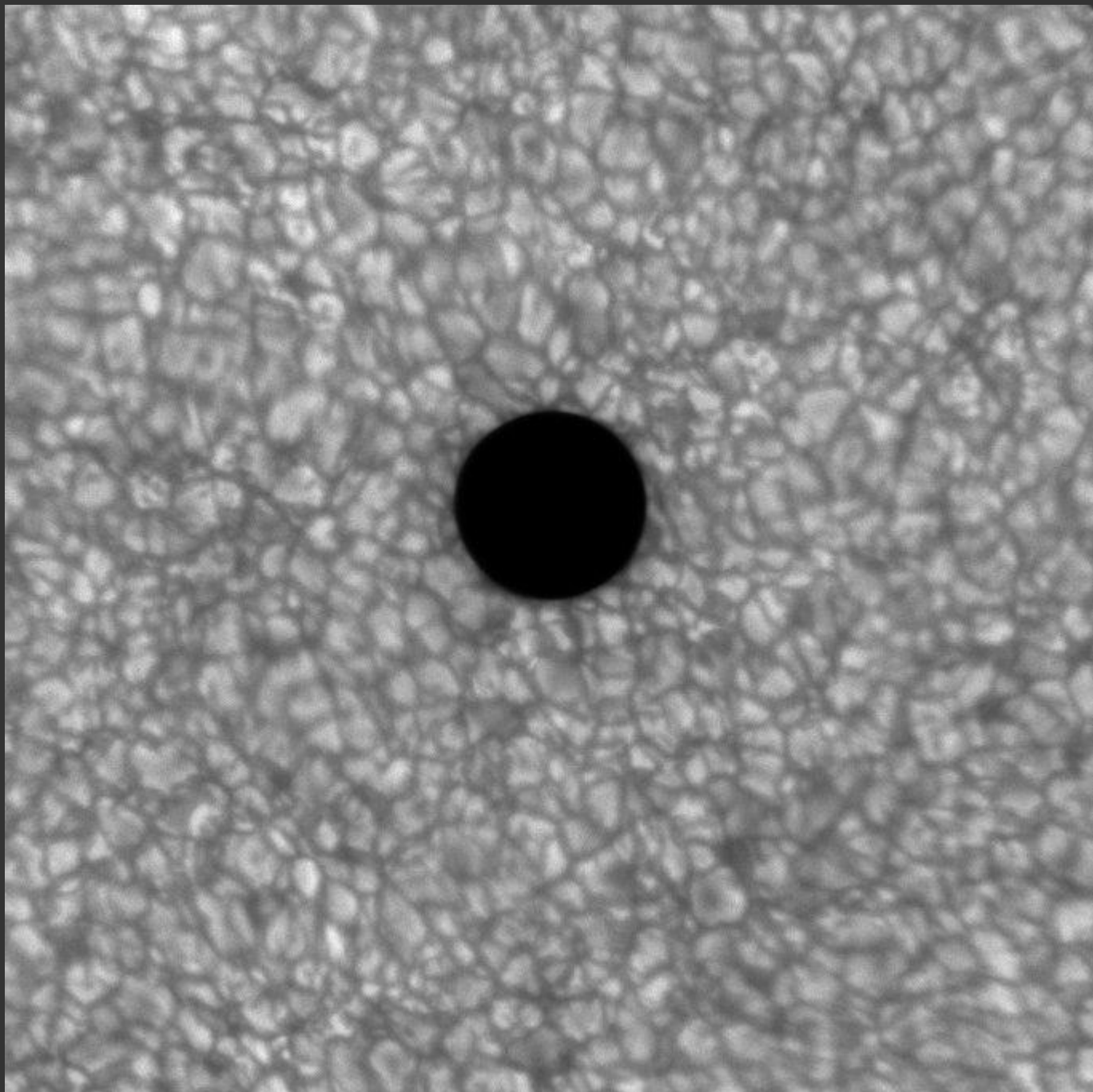






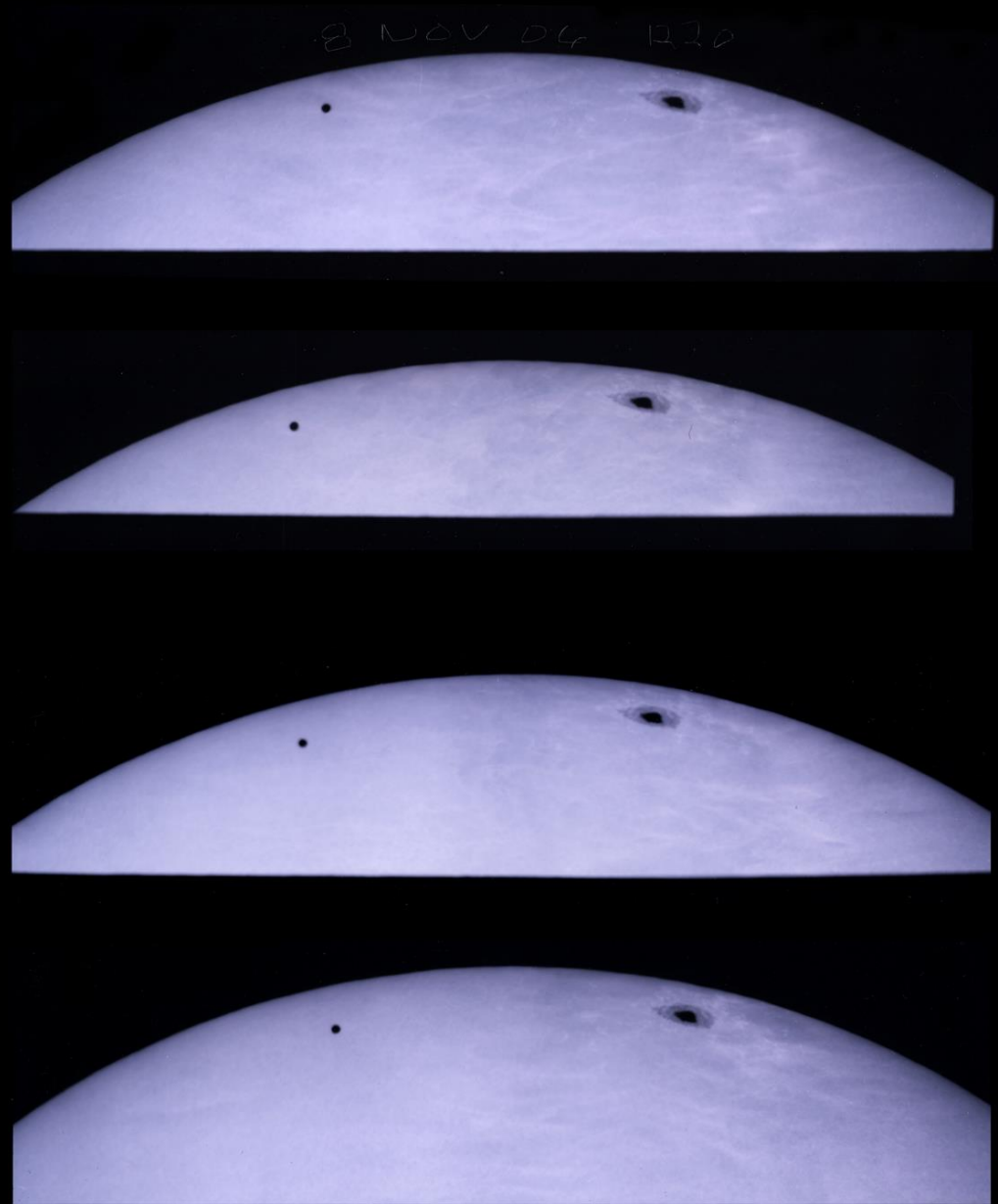
Speckle reconstructed G-band (430nm) image of Mercury. Field of view is 25 arcseconds. Image obtained using the Portable Occultation, Eclipse, and Transit System (POETS), courtesy of S. Souza, B. Babcock, and J. Pasachoff.





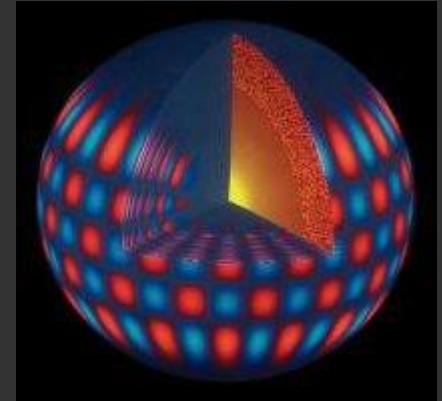
Με μικρότερο τηλεσκόπιο

Mercury Transit—8 November 2006



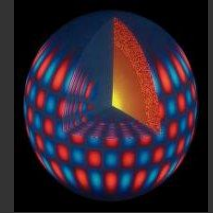
NSO/GONG

General Information



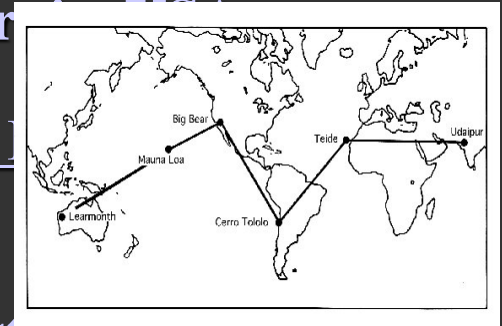
The Global Oscillation Network Group (GONG) is a community-based program to conduct a detailed study of solar internal structure and dynamics using helioseismology. In order to exploit this new technique, GONG has developed a six-station network of extremely sensitive, and stable velocity imagers located around the Earth to obtain nearly continuous observations of the Sun's "five-minute" oscillations, or pulsations.

NSO/GONG

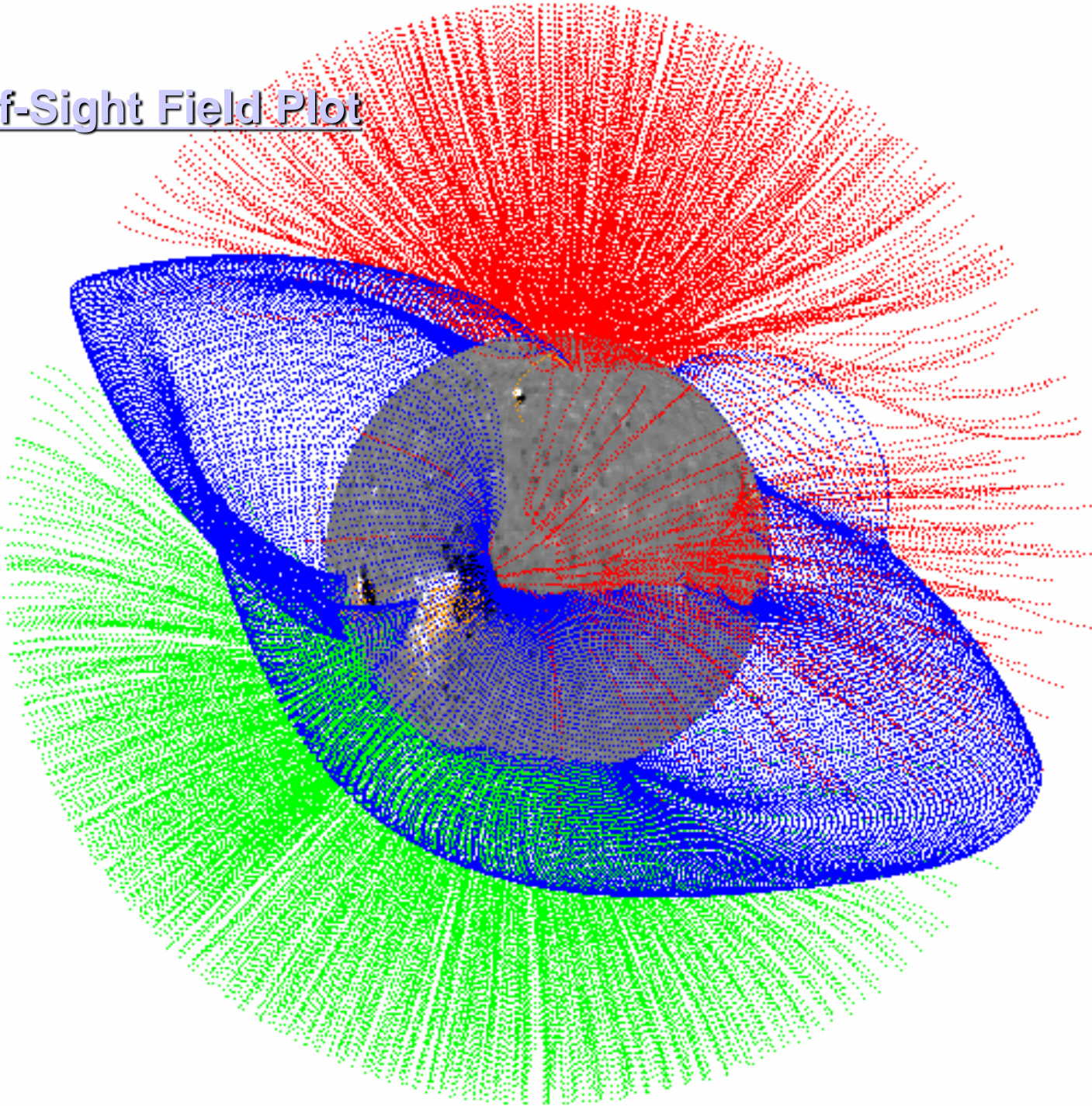


The six sites comprising the GONG Network are:

- The Big Bear Solar Observatory in California, USA.
- The High Altitude Observatory at Mauna Loa in Hawaii, USA.
- The Learmonth Solar Observatory in Western Australia.
- The Udaipur Solar Observatory in India.
- The Observatorio del Teide in the Canary Islands.
- The Cerro Tololo Interamerican Observatory in Chile.



Line-Of-Sight Field Plot



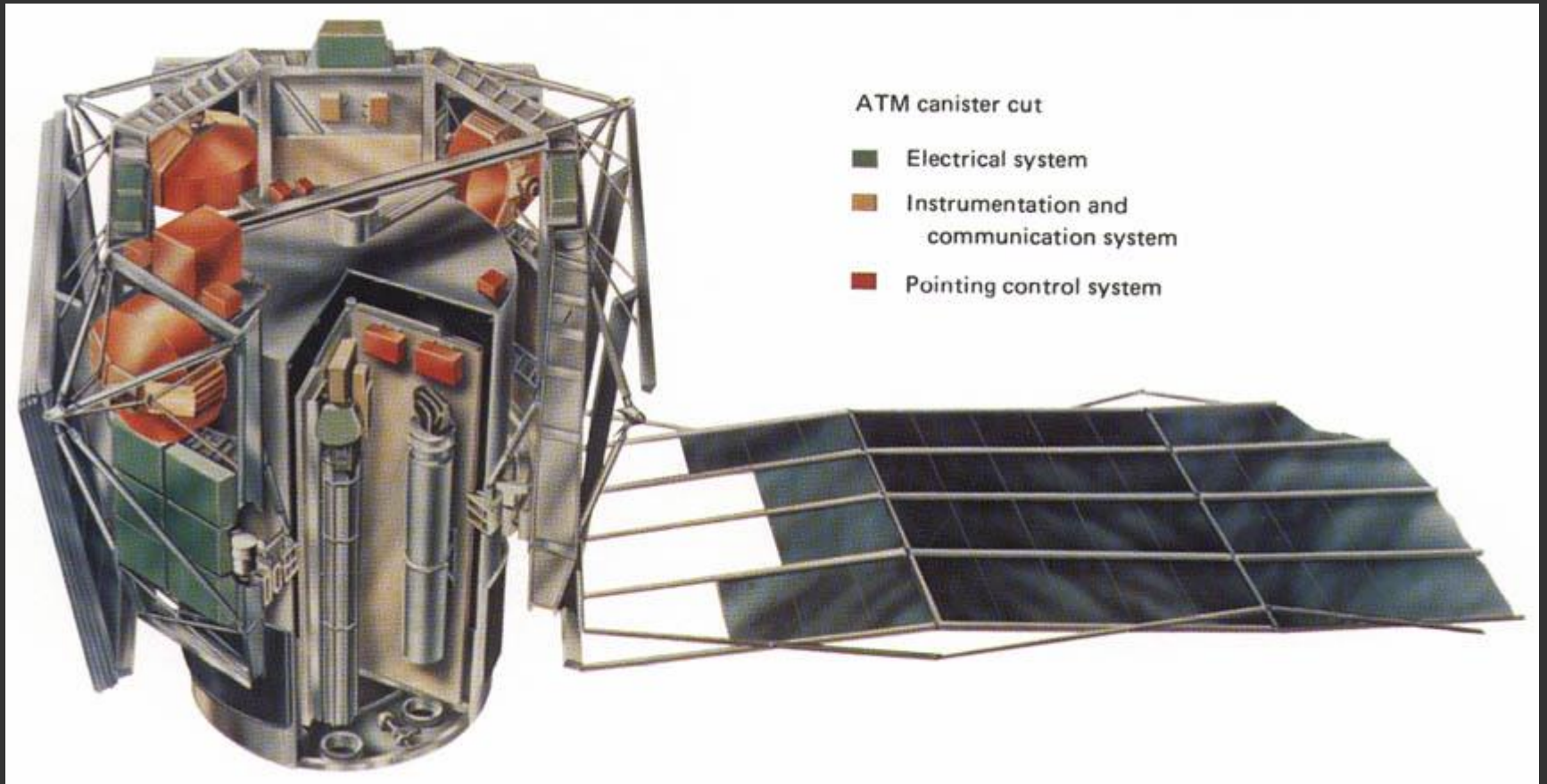
Skylab



Skylab



Skylab, The Apollo Telescope Mount, οκτώ όργανα



Skylab, το Apollo Telescope Mount, οκτώ όργανα

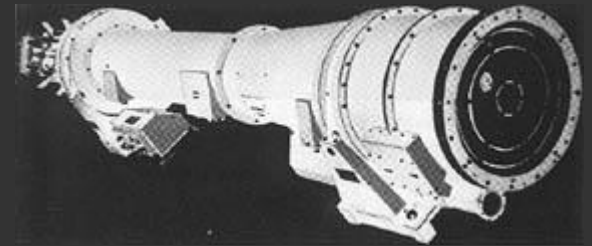


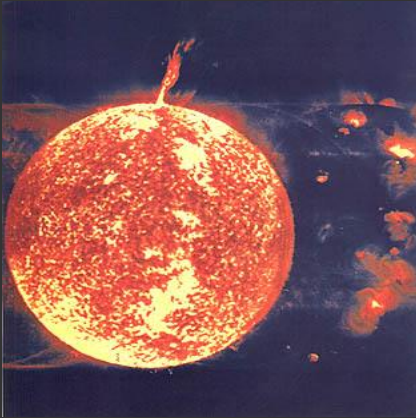
X-Ray Instruments

Instrument	IVOTITOUTO	Wavelength covered, Å	Solar region observed
.			
X-ray telescope:			
S-054	American Science & Engineering, Cambridge, Mass.	2 to 60	Corona (1 to 1.5 solar radii)
S-056	Marshall Space Flight Center, Huntsville, Ala.	6 to 33	Low corona
	Aerospace Corp., El Segundo, Calif.		
X-ray and extreme ultraviolet camera (S-020)	U.S. Naval Research Laboratory, Washington, D.C.	10 to 200	Chromosphere, transition region, and low corona

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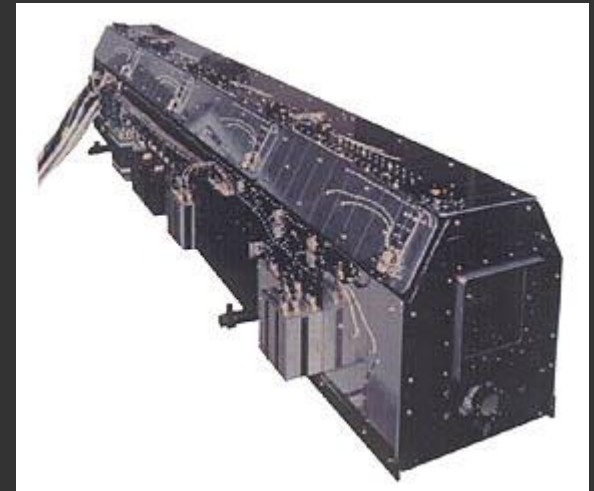




Instrument	Sponsor	Wavelength covered, Å	Solar region observed
Extreme ultraviolet spectroheliograph (S-082A)	U.S. Naval Research Laboratory, Washington, D.C.	150 to 615	Chromosphere, transition region, and low corona
Ultraviolet spectroheliometer (S-055)	Harvard College Observatory, Cambridge, Mass.	300 to 1400	Chromosphere, transition region, and low corona
Ultraviolet spectrograph (S-082B)	U.S. Naval Research Laboratory, Washington, D.C.	970 to 3940	Chromosphere, transition region, and low corona

Ultraviolet Instruments

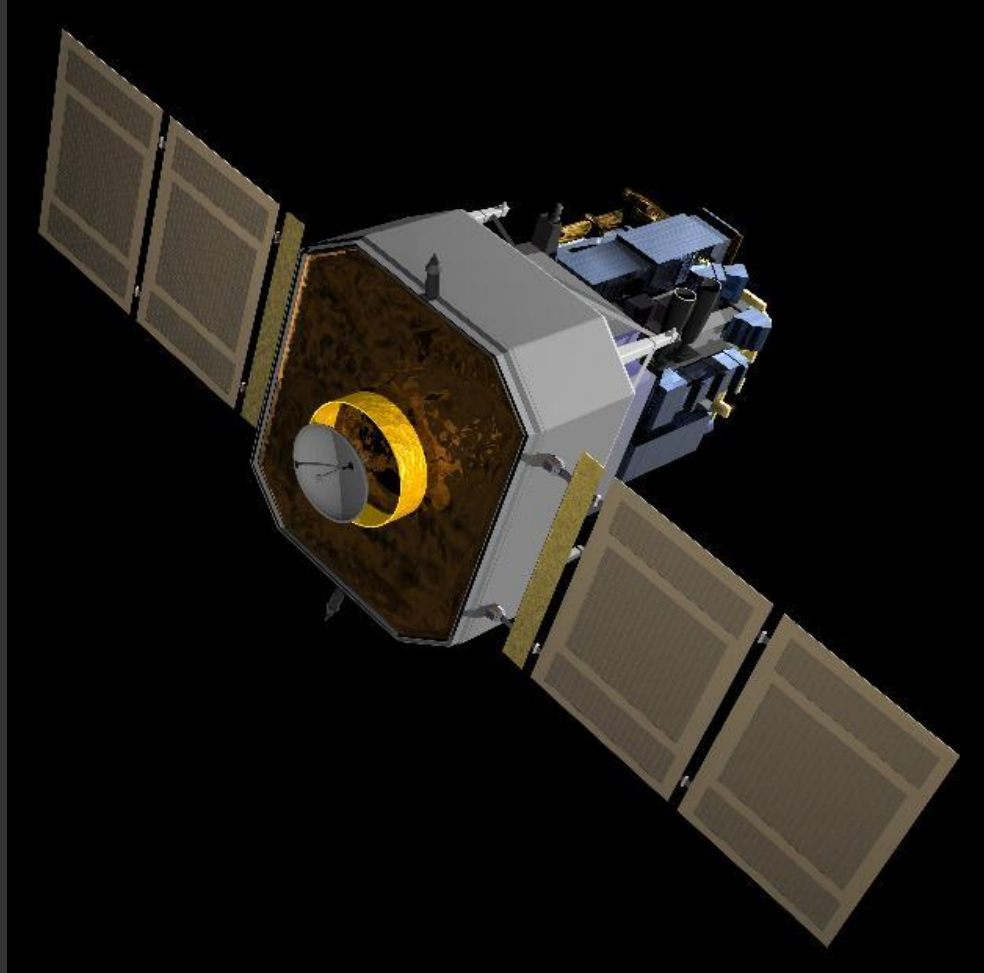
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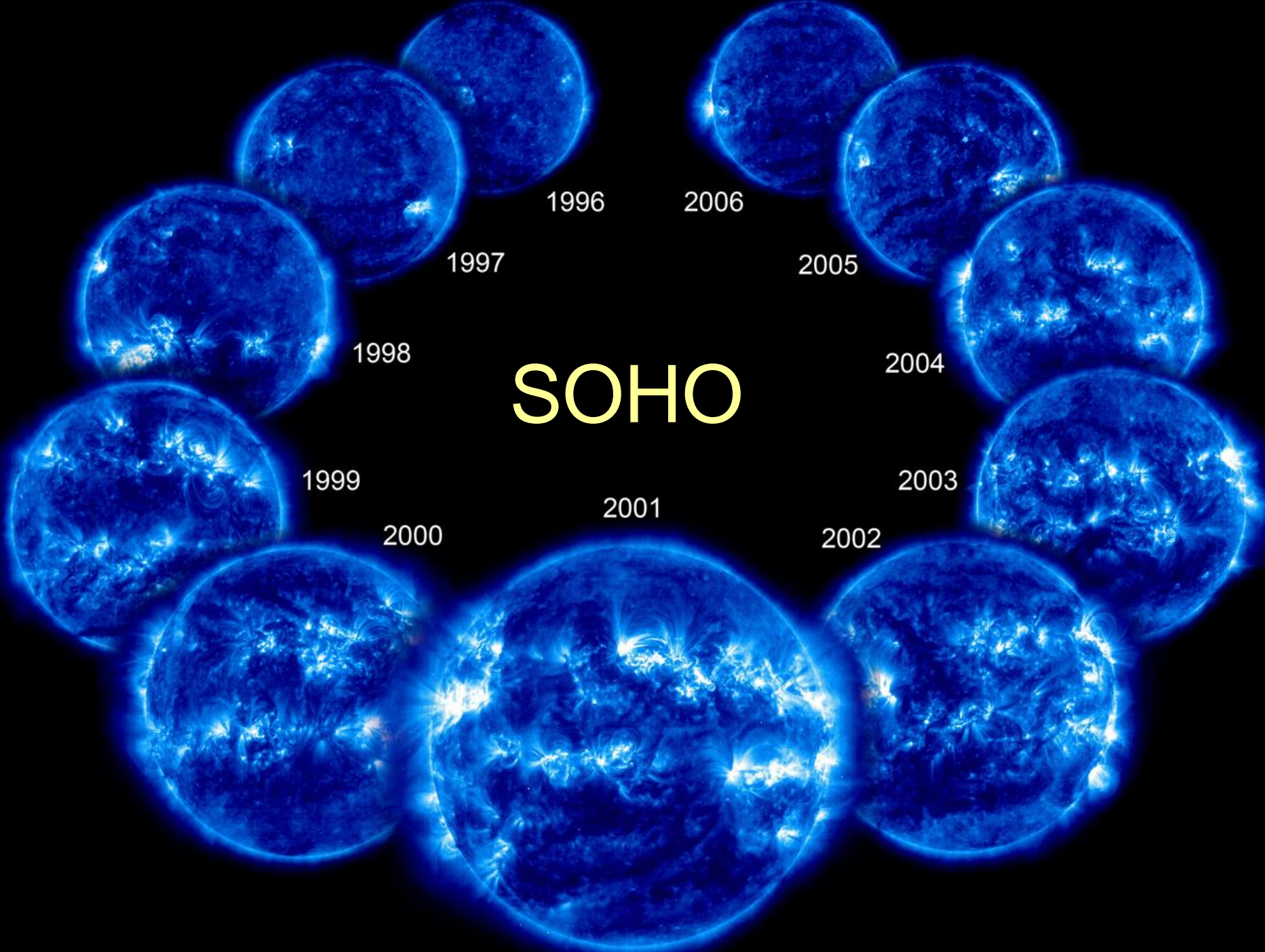
SOHO Mission

SOHO, the Solar & Heliospheric Observatory, is a project of international collaboration between ESA and NASA to study the Sun from its deep core to the outer corona and the solar wind.

SOHO was launched on December 2, 1995. The SOHO spacecraft was built in Europe by an industry team led by prime contractor Matra Marconi Space (now EADS Astrium) under overall management by ESA. The twelve instruments on board SOHO were provided by European and American scientists. Nine of the international instrument consortia are led by European Principal Investigators (PI's), three by PI's from the US. Large engineering teams and more than 200 co-investigators from many institutions supported the PI's in the development of the instruments and in the preparation of their operations and data analysis. NASA was responsible for the launch and is now responsible for mission operations. Large radio dishes around the world which form NASA's Deep Space Network are used for data downlink and commanding. Mission control is based at Goddard Space Flight Center in Maryland.







SOHO

1996

2006

1997

2005

1998

2004

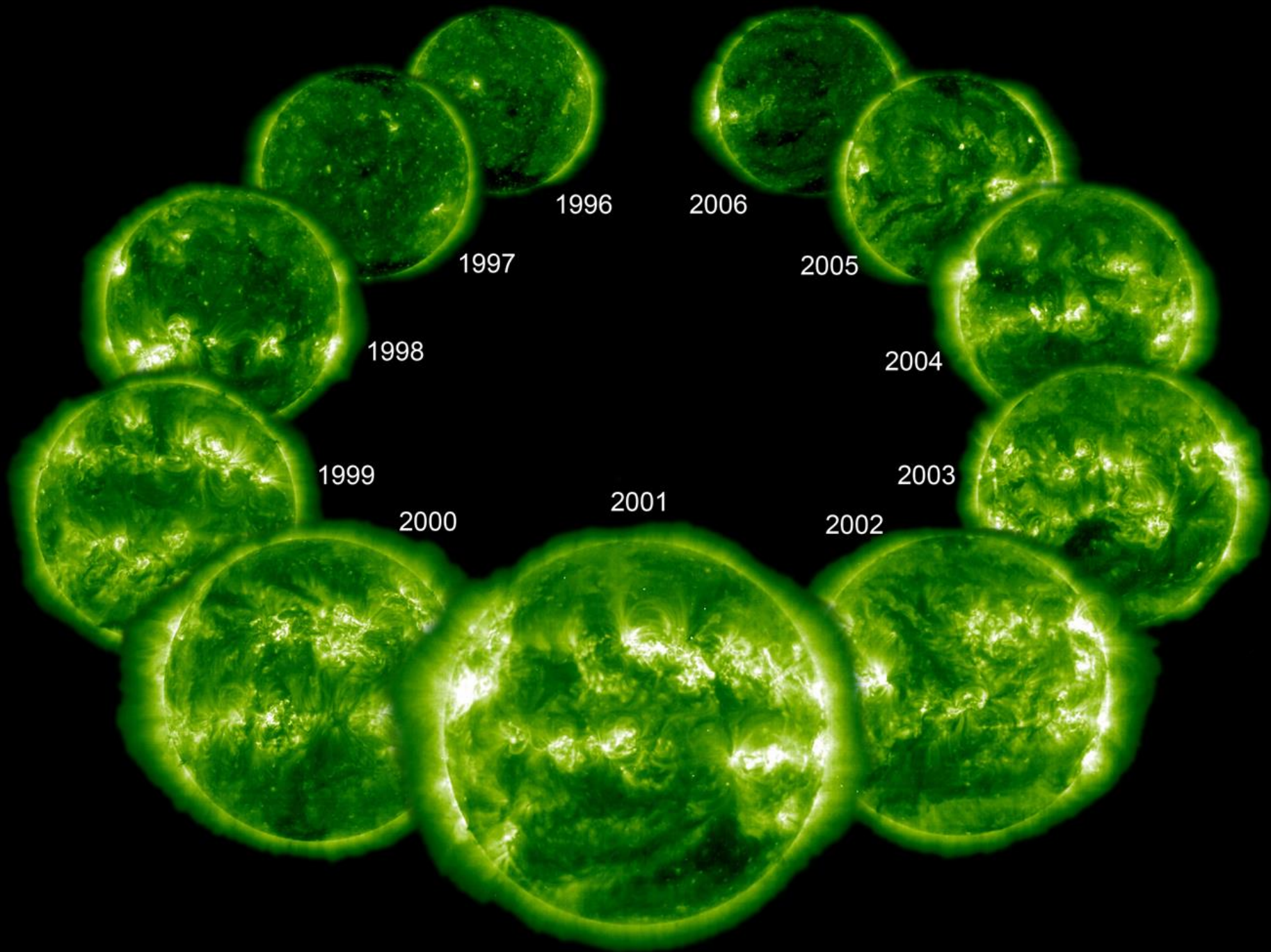
1999

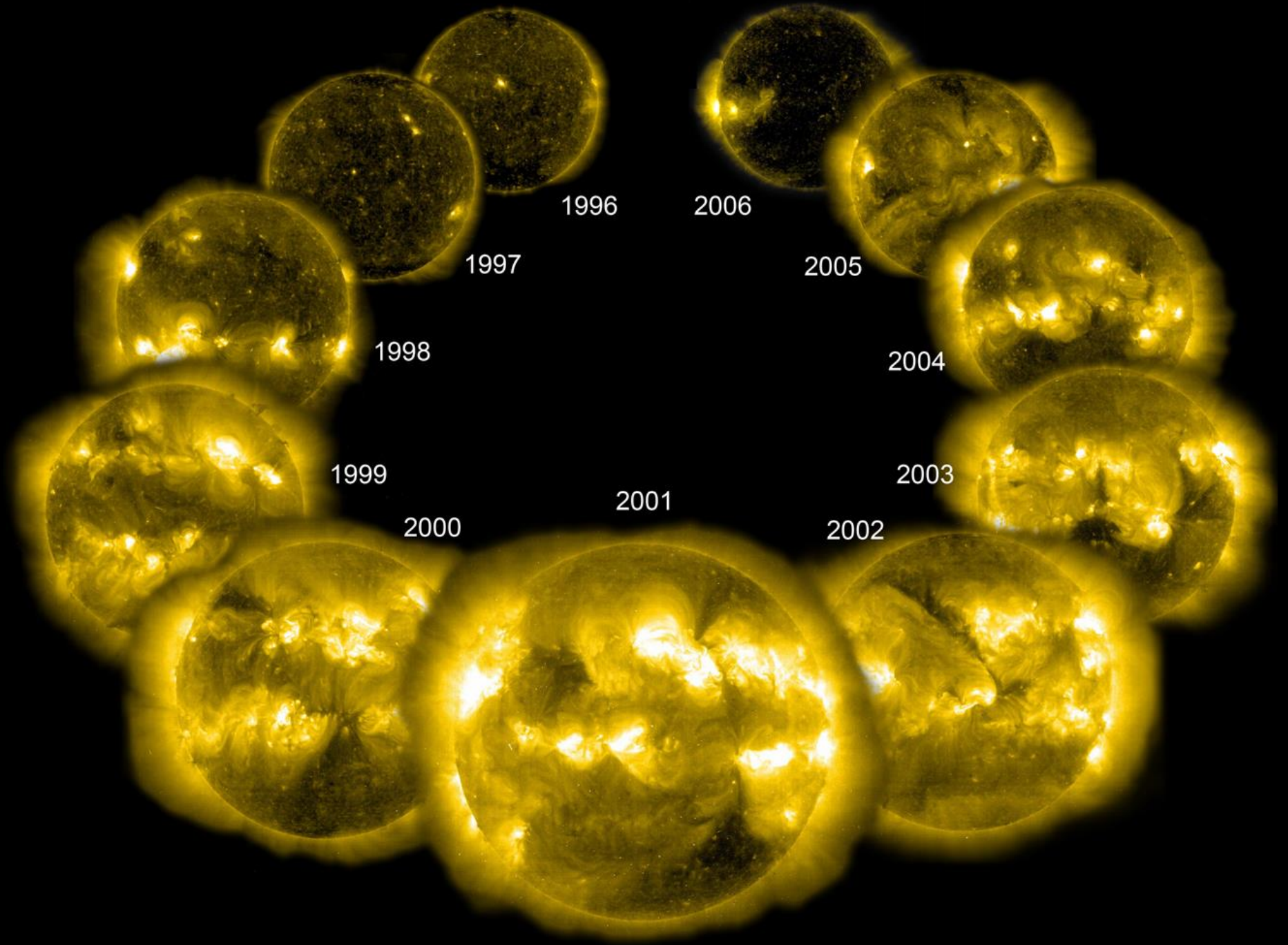
2003

2000

2001

2002





1996

2006

1997

2005

1998

2004

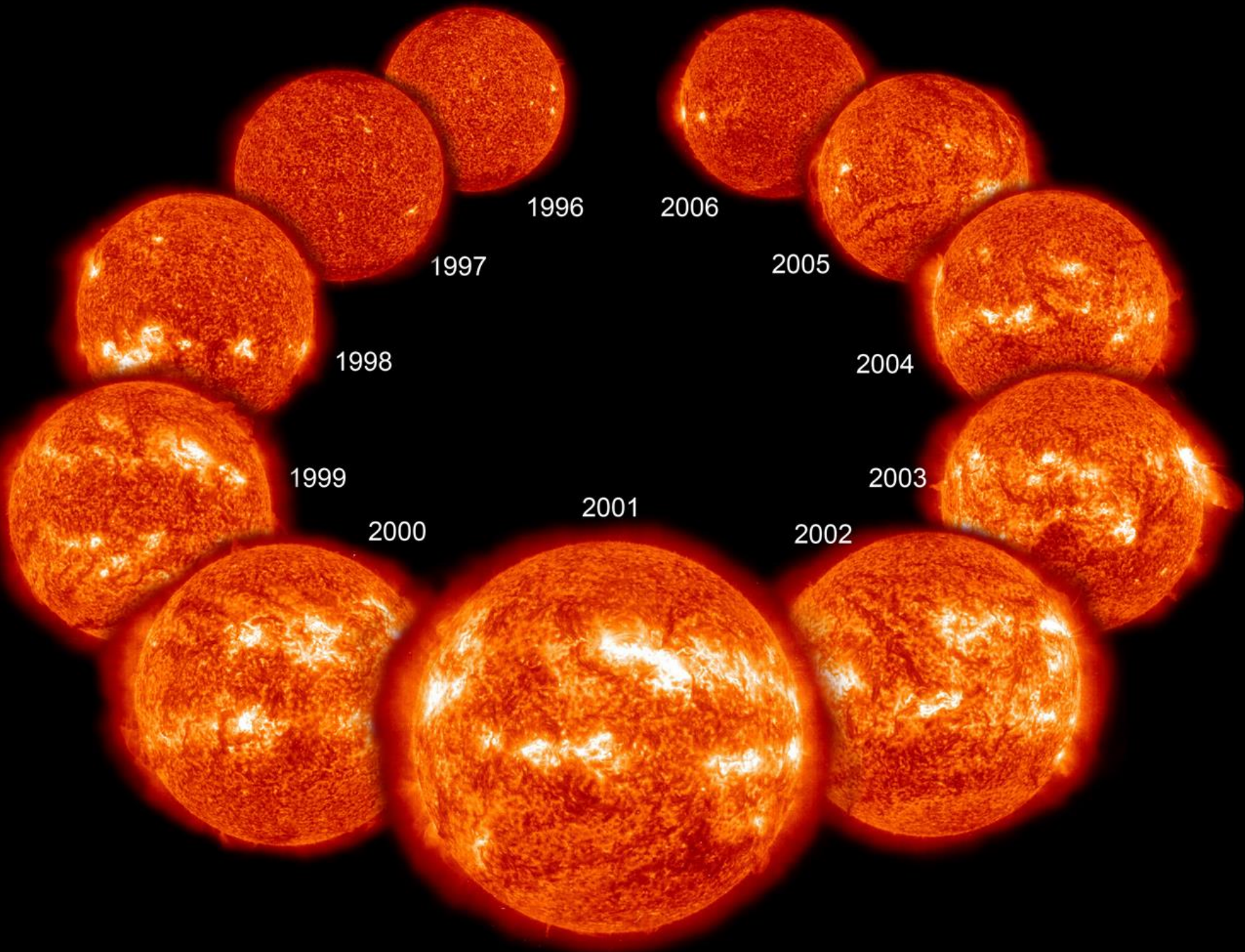
1999

2003

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2001

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1996

2006

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2003

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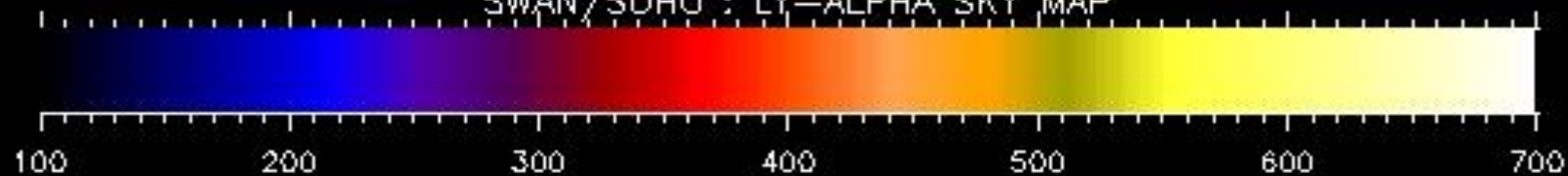
2001

2002

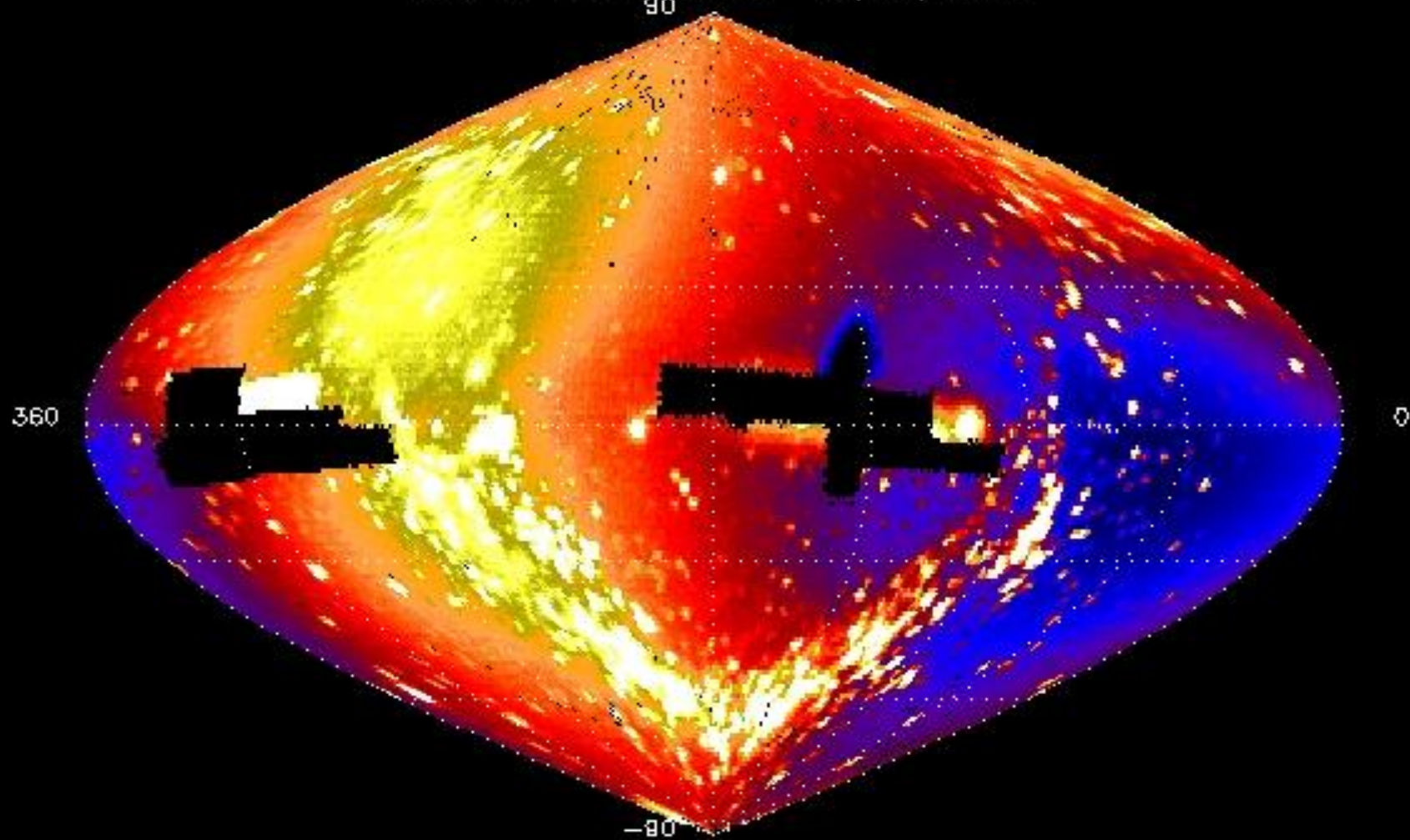
SOHO Instruments

- * CDS (Coronal Diagnostic Spectrometer)
- * CDS from Rutherford Appleton Laboratory, United Kingdom
- * CELIAS (Charge, Element, and Isotope Analysis System)
- * CELIAS from the Universitat Bern, in Switzerland
- * COSTEP (Comprehensive Suprathermal and Energetic Particle Analyzer)
- * COSTEP from the University of Kiel, Germany (in German)
- * EIT (Extreme ultraviolet Imaging Telescope)
- * EIT from the NASA/Goddard Space Flight Center, USA
- * ERNE (Energetic and Relativistic Nuclei and Electron experiment)
- * ERNE from the University of Turku, Finland
- * GOLF (Global Oscillations at Low Frequencies)
- * GOLF from the Institut d'Astrophysique Spatiale, France
- * LASCO (Large Angle and Spectrometric Coronagraph)
- * LASCO from the Naval Research Laboratory, USA
- * LASCO from the Max Planck Institute for Solar System Research, Germany
- * MDI (Michelson Doppler Imager)
- * MDI from the Stanford University, USA
- * SUMER (Solar Ultraviolet Measurements of Emitted Radiation)
- * SUMER from the Max Planck Institute for Solar System Research, Germany
- * SWAN (Solar Wind Anisotropies)
- * SWAN from the FMI, Finland.
- * SWAN from the Service d'Aeronomie, France
- * UVCS (Ultraviolet Coronagraph Spectrometer)
- * UVCS from the Harvard-Smithsonian Center for Astrophysics, USA
- * VIRGO (Variability of Solar Irradiance and Gravity Oscillations)
- * VIRGO from the Institut d'Astrophysique Spatiale, France

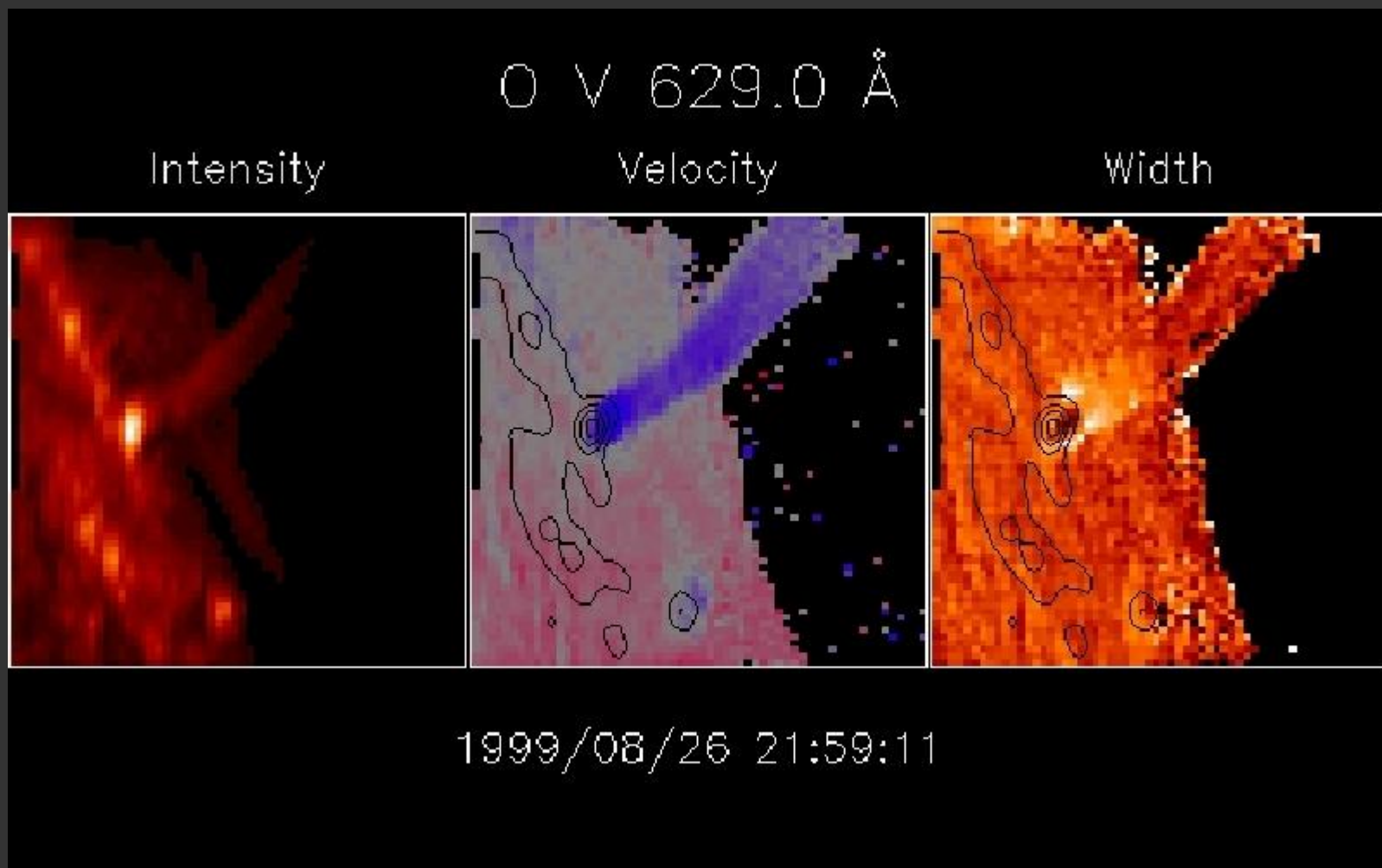
SWAN/SDHO : LY-ALPHA SKY MAP

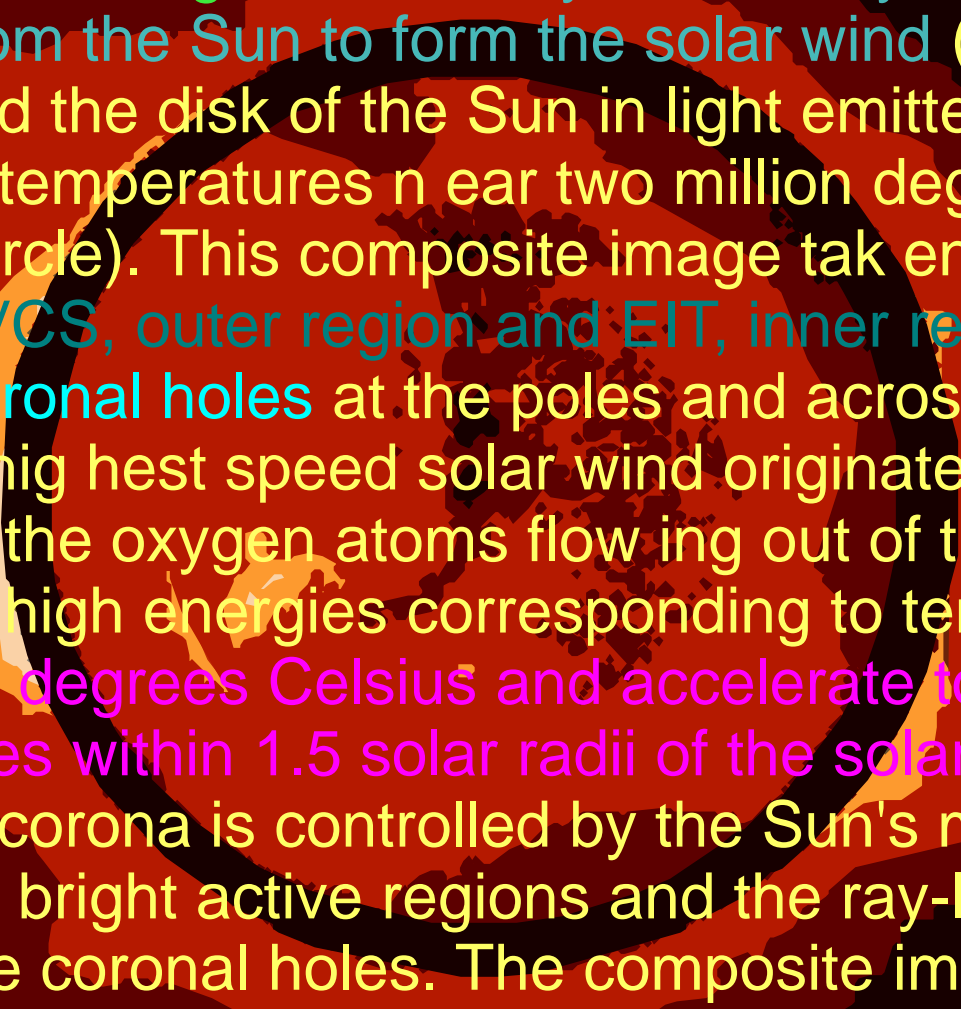


ECLIPTIC COORDINATES: 02/02/1996
90

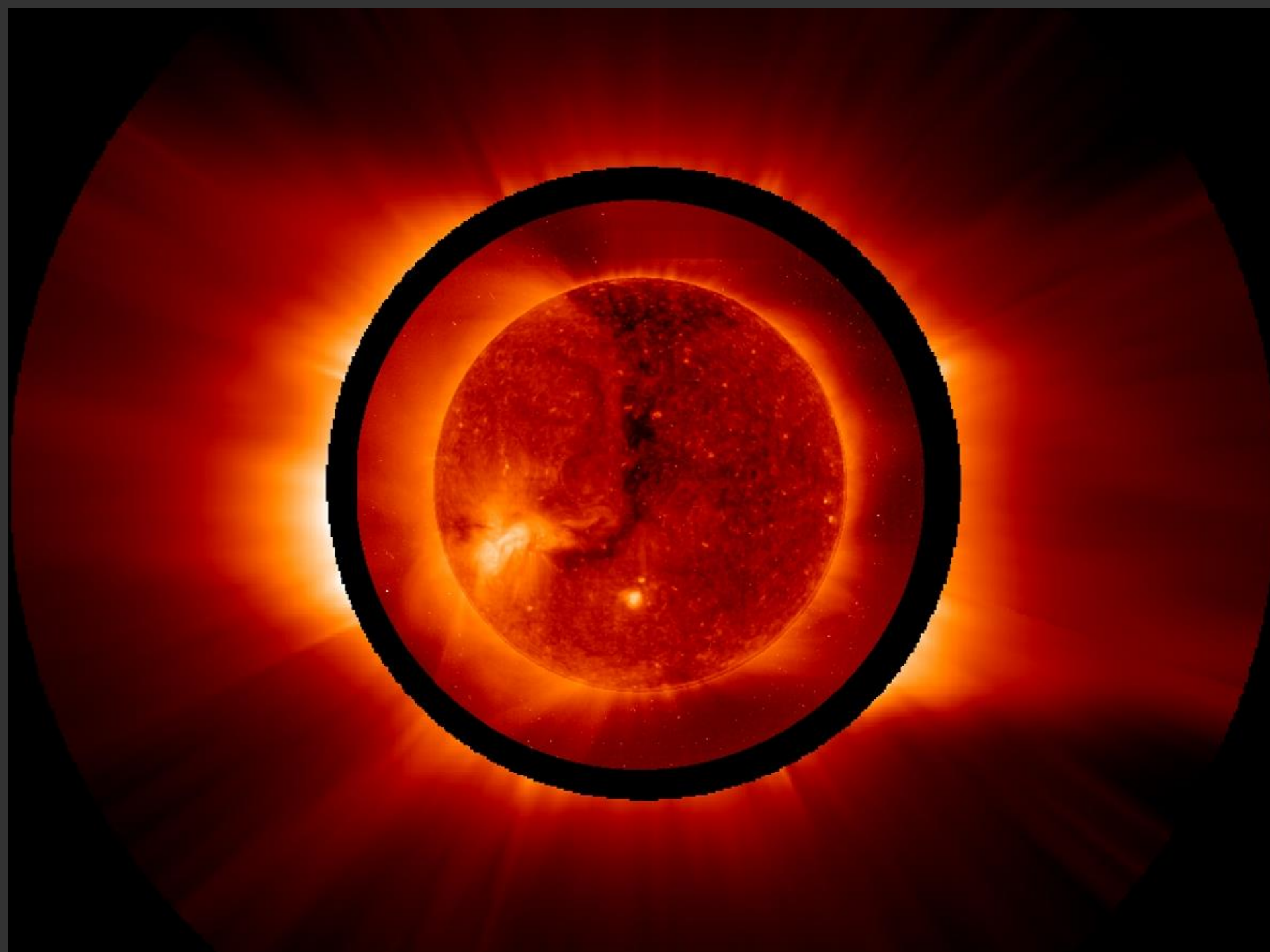


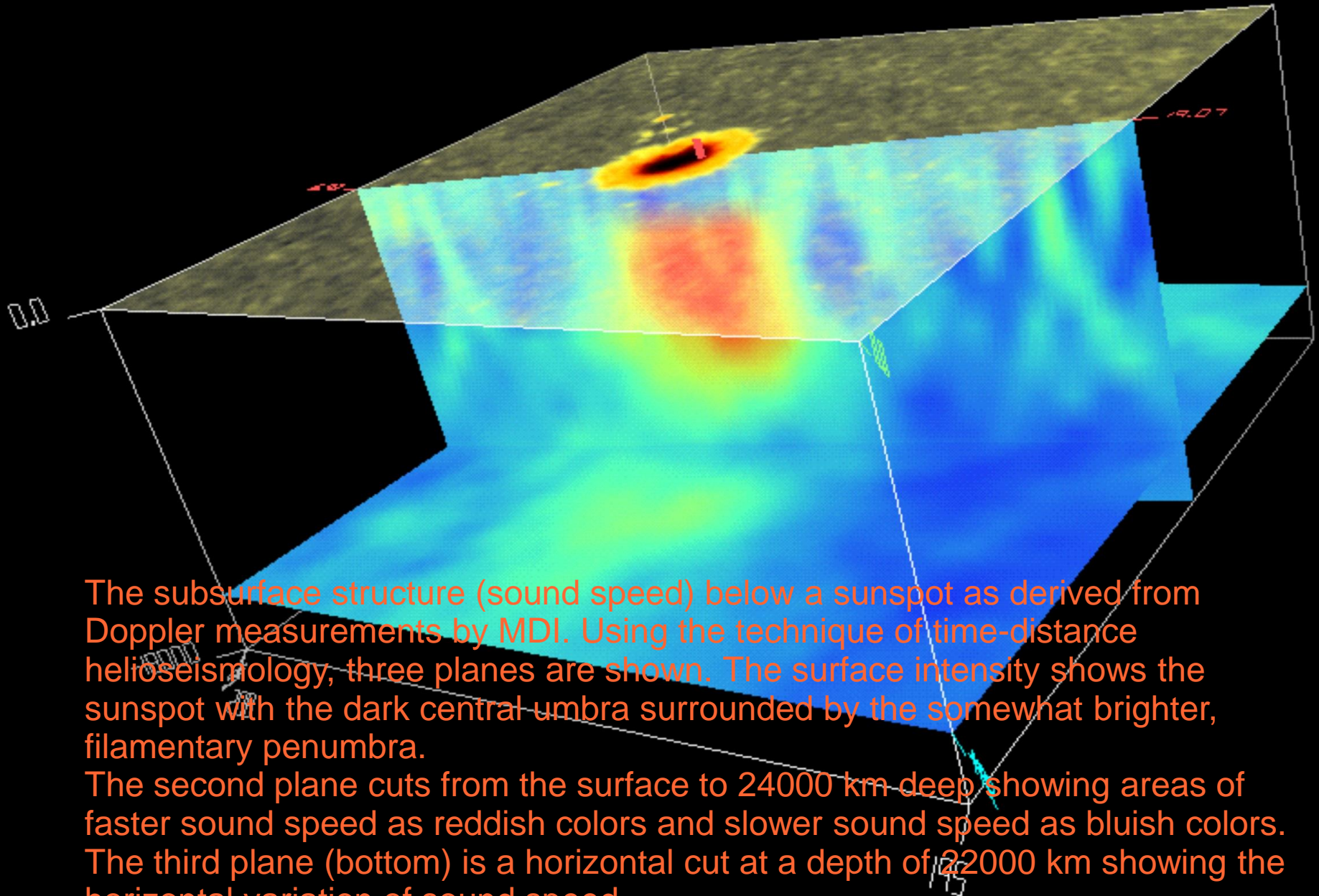
An eruption seen over the limb in the extreme-ultraviolet emission line of Oxygen V at 630 Angstroms. This CDS image shows material streaming back at high velocity onto the disk after the eruption. The left image shows intensity, while the middle and right show the Doppler velocity and width respectively. The blue color of the middle image represents material moving at greater than 200 kilometers per second toward the Sun. In the right image, the unresolved motions represented by the Doppler width reach as high as 300 kilometers per second.



A composite image of the Sun's outer atmosphere. The central part shows the solar disk, which is a bright, textured orange-red circle. Surrounding the disk is the solar corona, a more diffuse, lighter orange-red region. Two black circles are overlaid on the image: a smaller one centered on the solar disk, and a larger one that encompasses the entire visible solar structure. The text is overlaid on the image in various colors: yellow, green, blue, and purple.

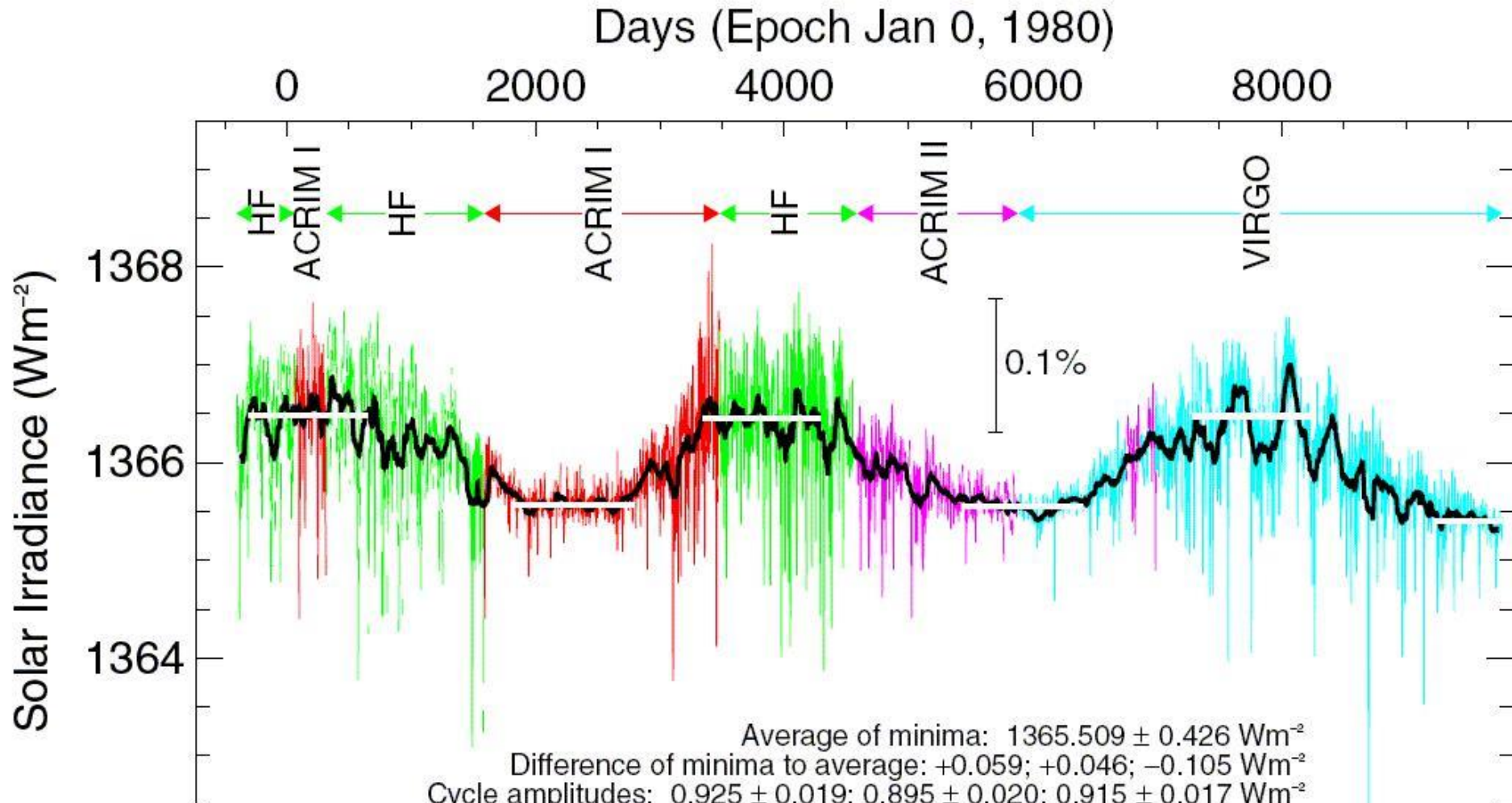
UVCS/EIT composite image. The Sun's outer atmosphere as it appears in ultraviolet light emitted by electrically charged oxygen flowing away from the Sun to form the solar wind (region outside black circle), and the disk of the Sun in light emitted by electrically charged iron at temperatures near two million degrees Celsius (region inside circle). This composite image taken by two instruments (UVCS, outer region and EIT, inner region) shows dark areas called coronal holes at the poles and across the disk of the Sun where the highest speed solar wind originates. UVCS has discovered that the oxygen atoms flowing out of these regions have extremely high energies corresponding to temperatures of over 200 million degrees Celsius and accelerate to supersonic outflow velocities within 1.5 solar radii of the solar surface. The structure of the corona is controlled by the Sun's magnetic field which forms the bright active regions and the ray-like structures originating in the coronal holes. The composite image allows one to trace these structures from the base of the corona to millions above the solar surface

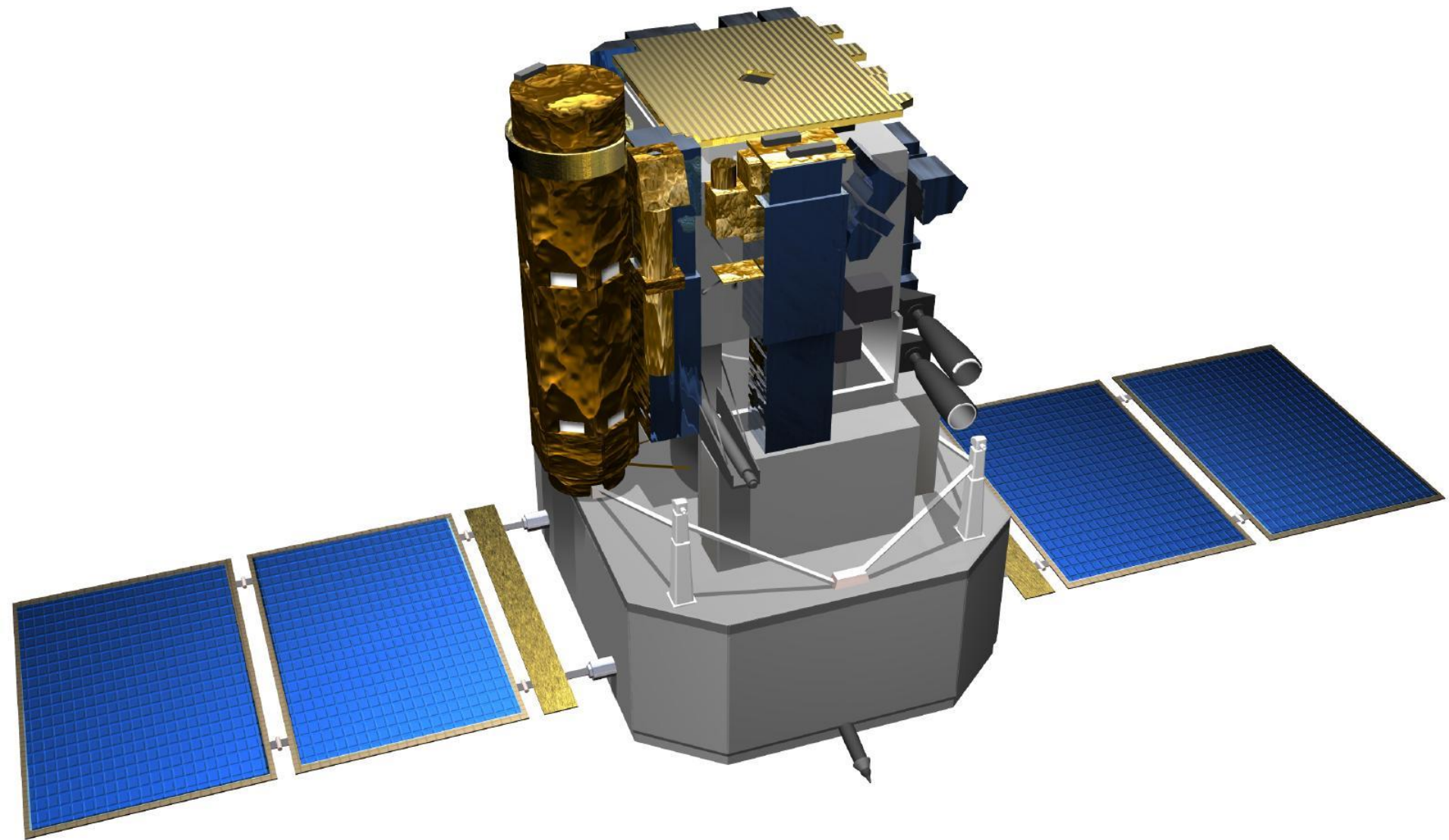


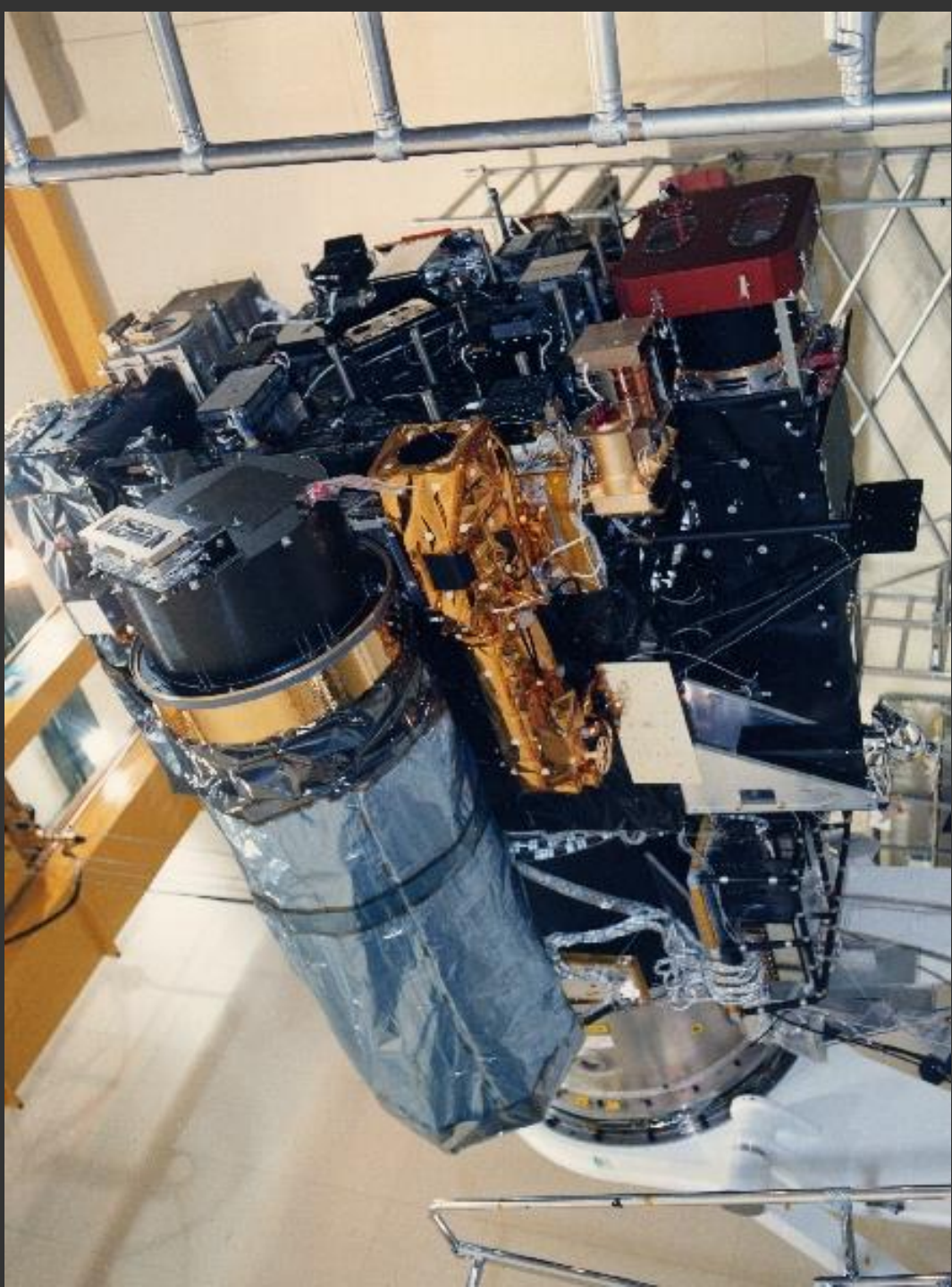


The subsurface structure (sound speed) below a sunspot as derived from Doppler measurements by MDI. Using the technique of time-distance helioseismology, three planes are shown. The surface intensity shows the sunspot with the dark central umbra surrounded by the somewhat brighter, filamentary penumbra. The second plane cuts from the surface to 24000 km deep showing areas of faster sound speed as reddish colors and slower sound speed as bluish colors. The third plane (bottom) is a horizontal cut at a depth of 22000 km showing the horizontal variation of sound speed.

Two and a half solar cycles of Total Solar Irradiance (TSI), also called 'solar constant'. This composite, compiled by the VIRGO team at the Physikalisch-Meteorologisches Observatorium / World Radiation Center Davos, Switzerland, shows TSI as daily values plotted in different colors for the different originating experiments. The difference between the minima values is also indicated, together with amplitudes of the three cycles.

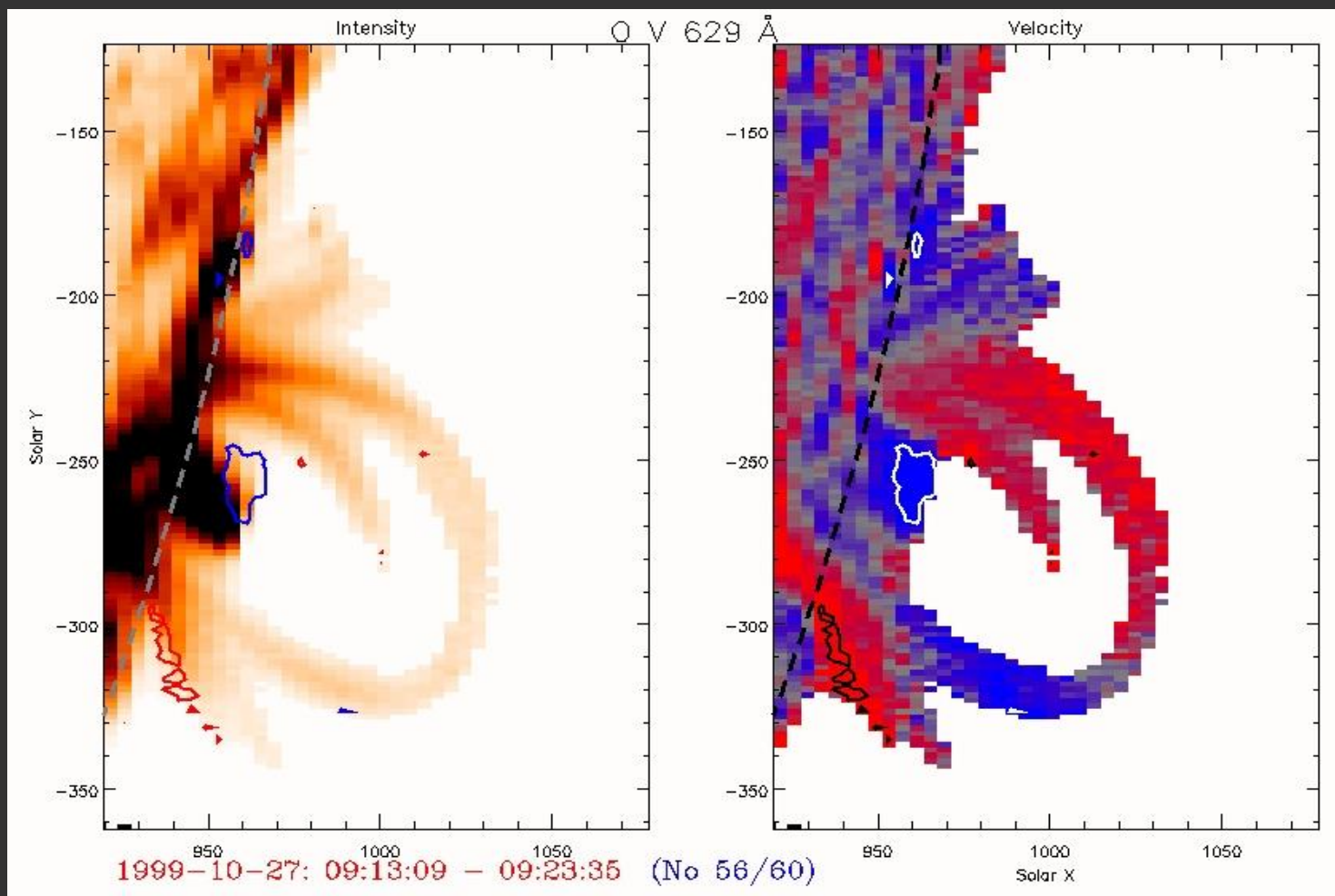


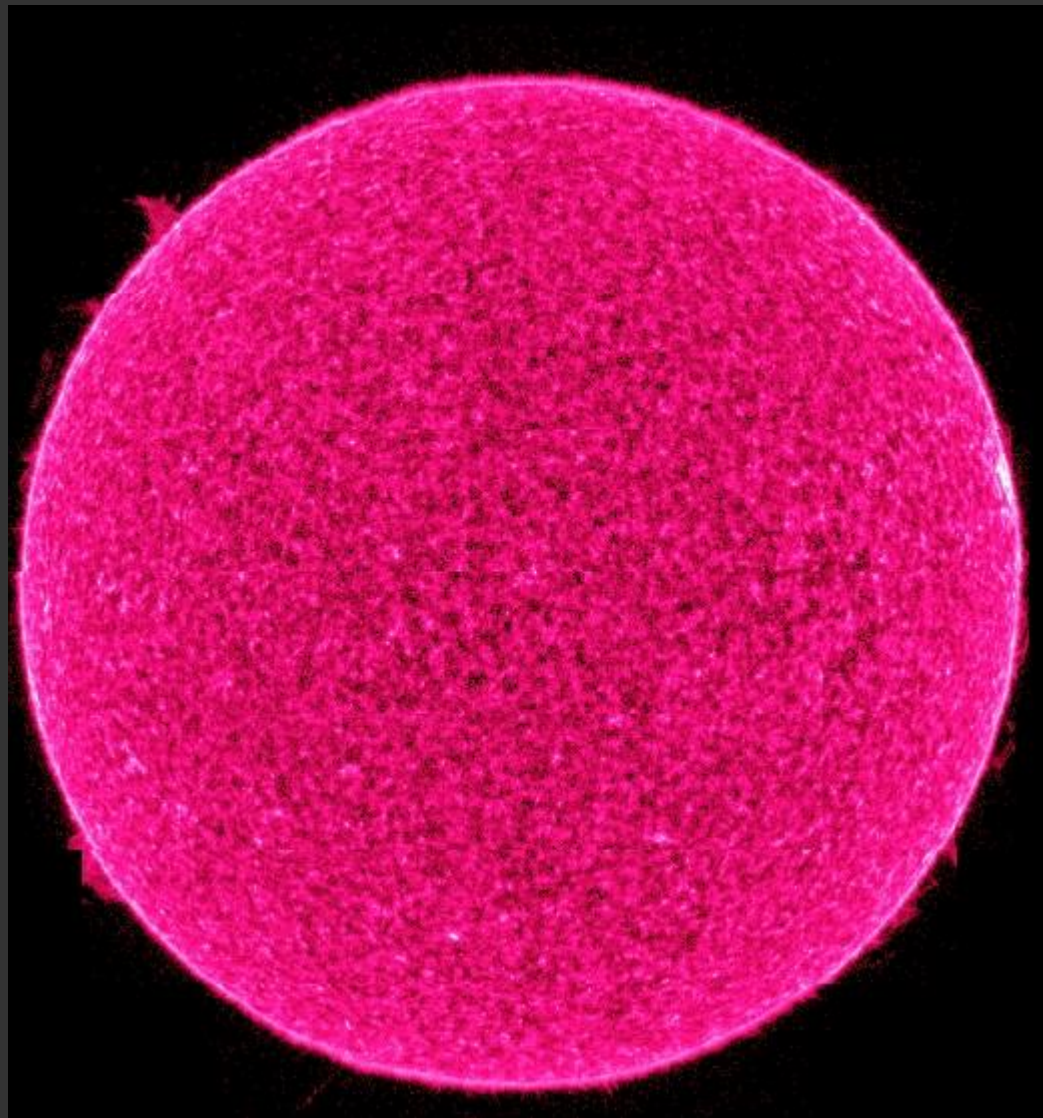




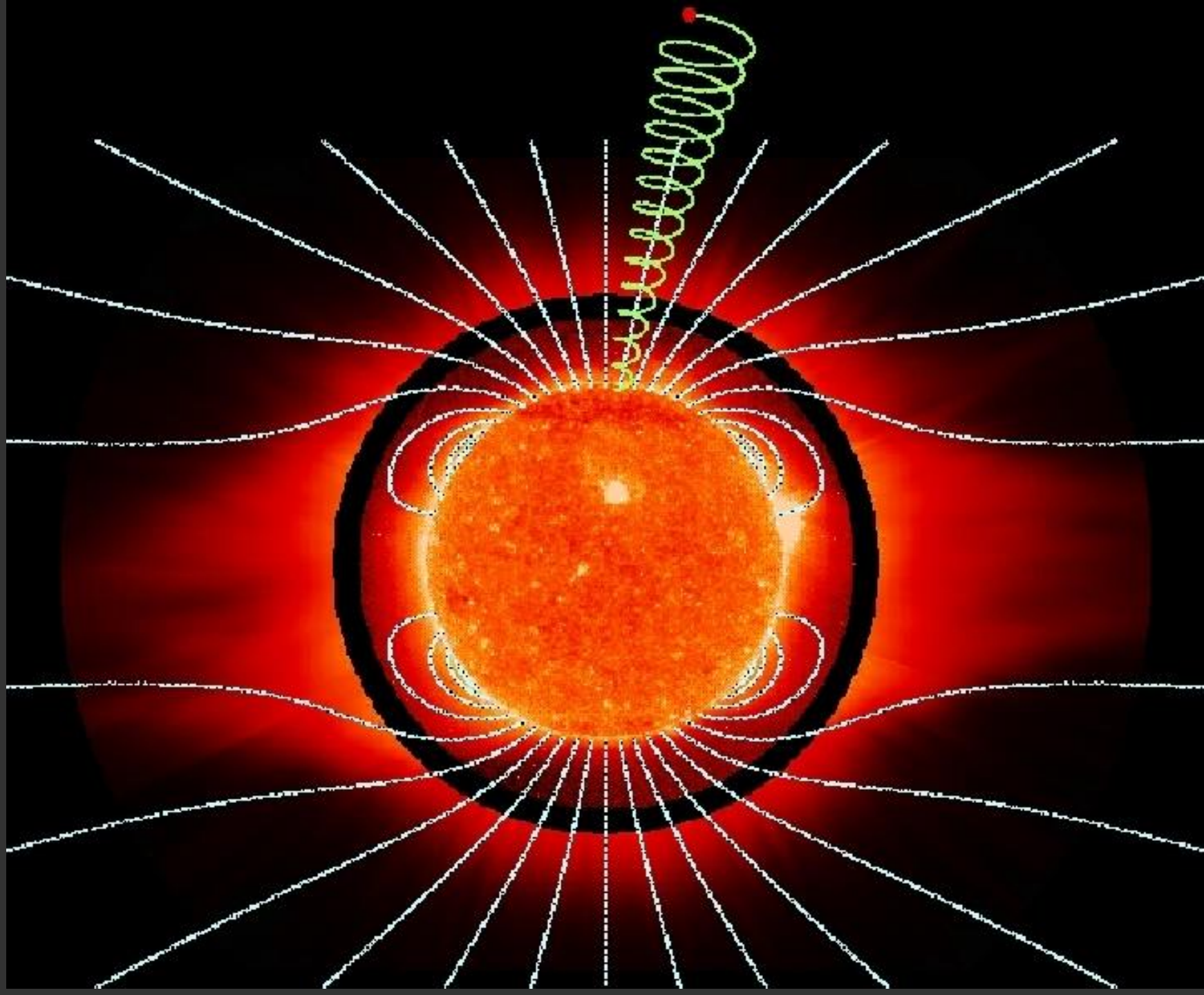


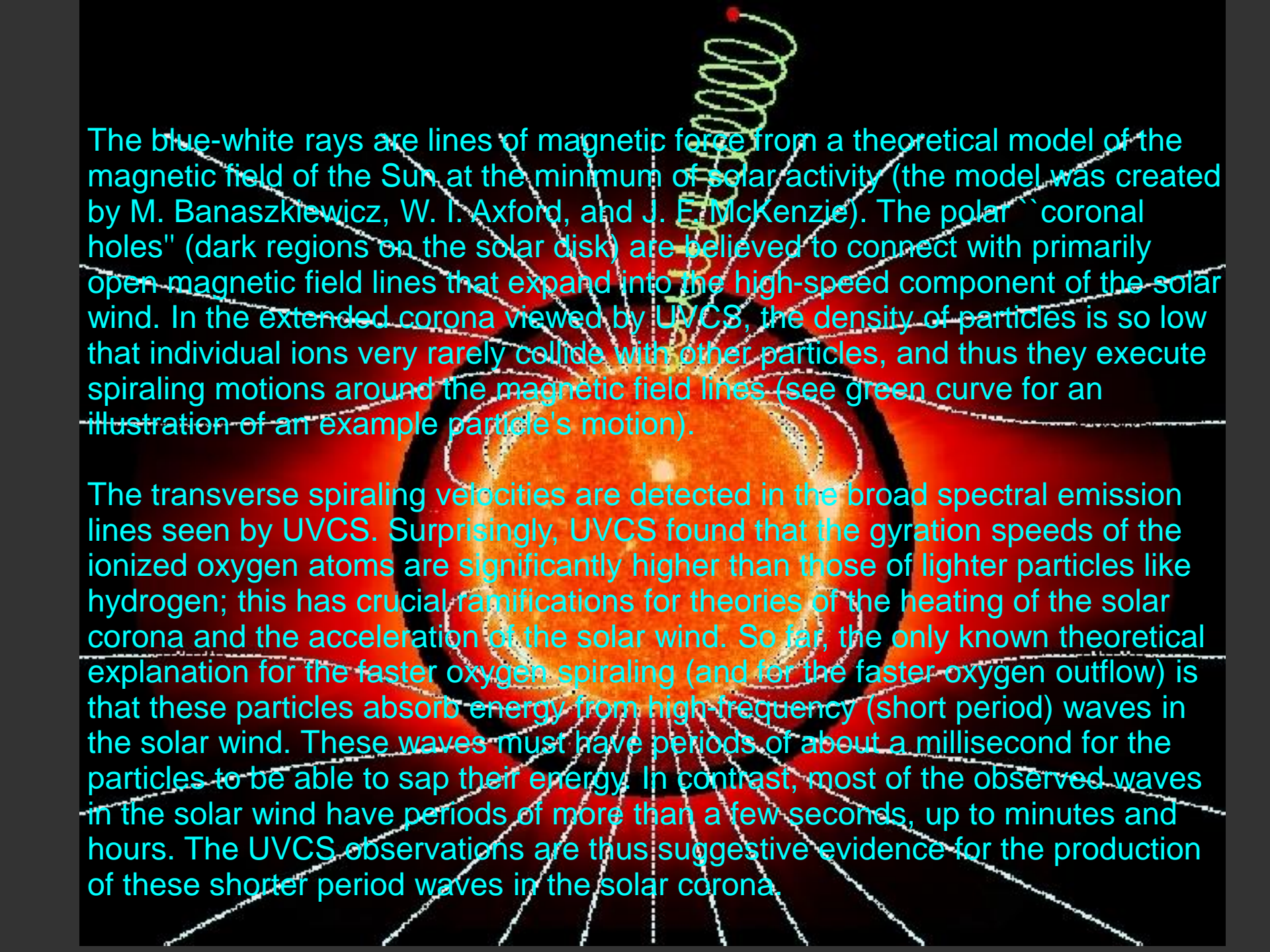
Observing the Sun with a spectrometer like CDS one can derive the intensity and velocity distribution of the O V 629 \AA line formed at approximately 230 000 K in AR8737. Pixels with Doppler shifts corresponding to a velocity greater than 40 km/s is fully red/blue. Contours outline areas with velocities exceeding 50 km/s. The velocities are calculated relative to the part of the solar disk (to the left) that is within the field of view.





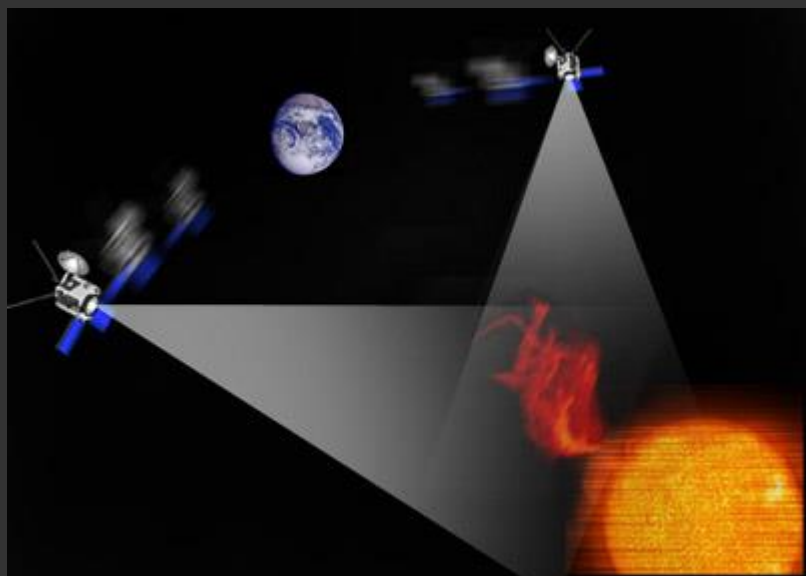
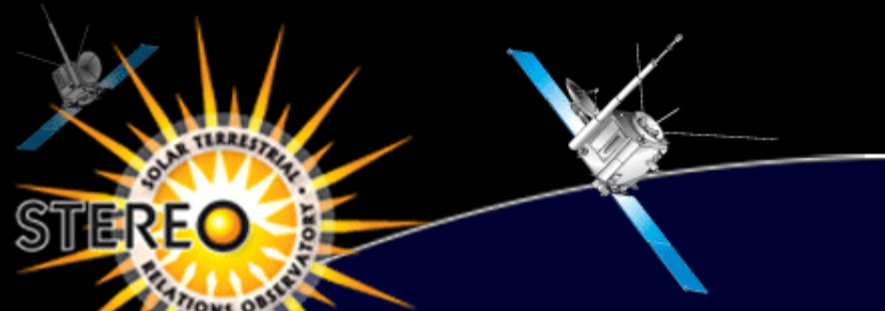
The Sun in C IV 1548 A as observed by SUMER on 4-5 February 1996. The picture was put together from eight horizontal raster scans across the Sun, altogether 7406 exposures, each lasting 15 seconds. The picture is shown in bins of 4x4 pixels, one pixel being approx. 1 arcsec.

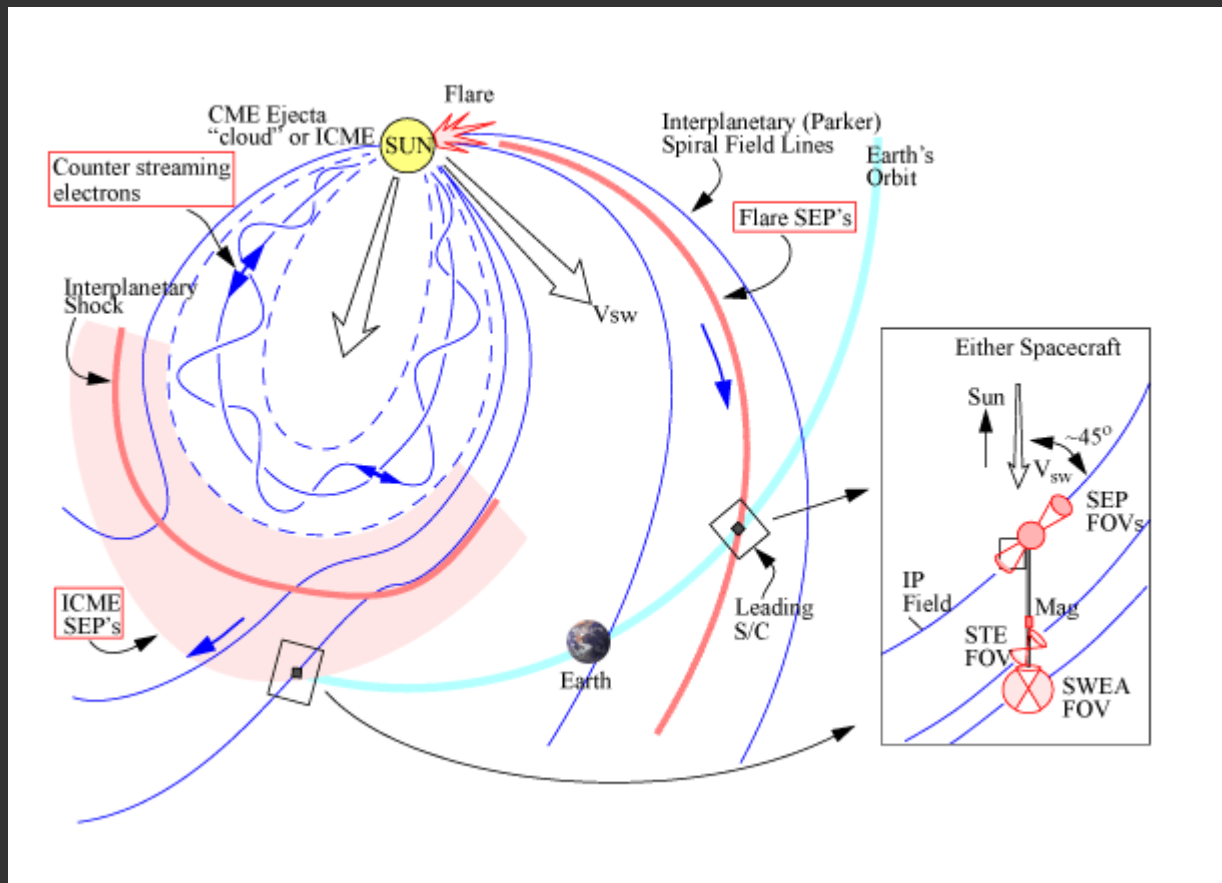




The blue-white rays are lines of magnetic force from a theoretical model of the magnetic field of the Sun at the minimum of solar activity (the model was created by M. Banaszkiewicz, W. I. Axford, and J. E. McKenzie). The polar "coronal holes" (dark regions on the solar disk) are believed to connect with primarily open magnetic field lines that expand into the high-speed component of the solar wind. In the extended corona viewed by UVCS, the density of particles is so low that individual ions very rarely collide with other particles, and thus they execute spiraling motions around the magnetic field lines (see green curve for an illustration of an example particle's motion).

The transverse spiraling velocities are detected in the broad spectral emission lines seen by UVCS. Surprisingly, UVCS found that the gyration speeds of the ionized oxygen atoms are significantly higher than those of lighter particles like hydrogen; this has crucial ramifications for theories of the heating of the solar corona and the acceleration of the solar wind. So far, the only known theoretical explanation for the faster oxygen spiraling (and for the faster oxygen outflow) is that these particles absorb energy from high-frequency (short period) waves in the solar wind. These waves must have periods of about a millisecond for the particles to be able to sap their energy. In contrast, most of the observed waves in the solar wind have periods of more than a few seconds, up to minutes and hours. The UVCS observations are thus suggestive evidence for the production of these shorter period waves in the solar corona.

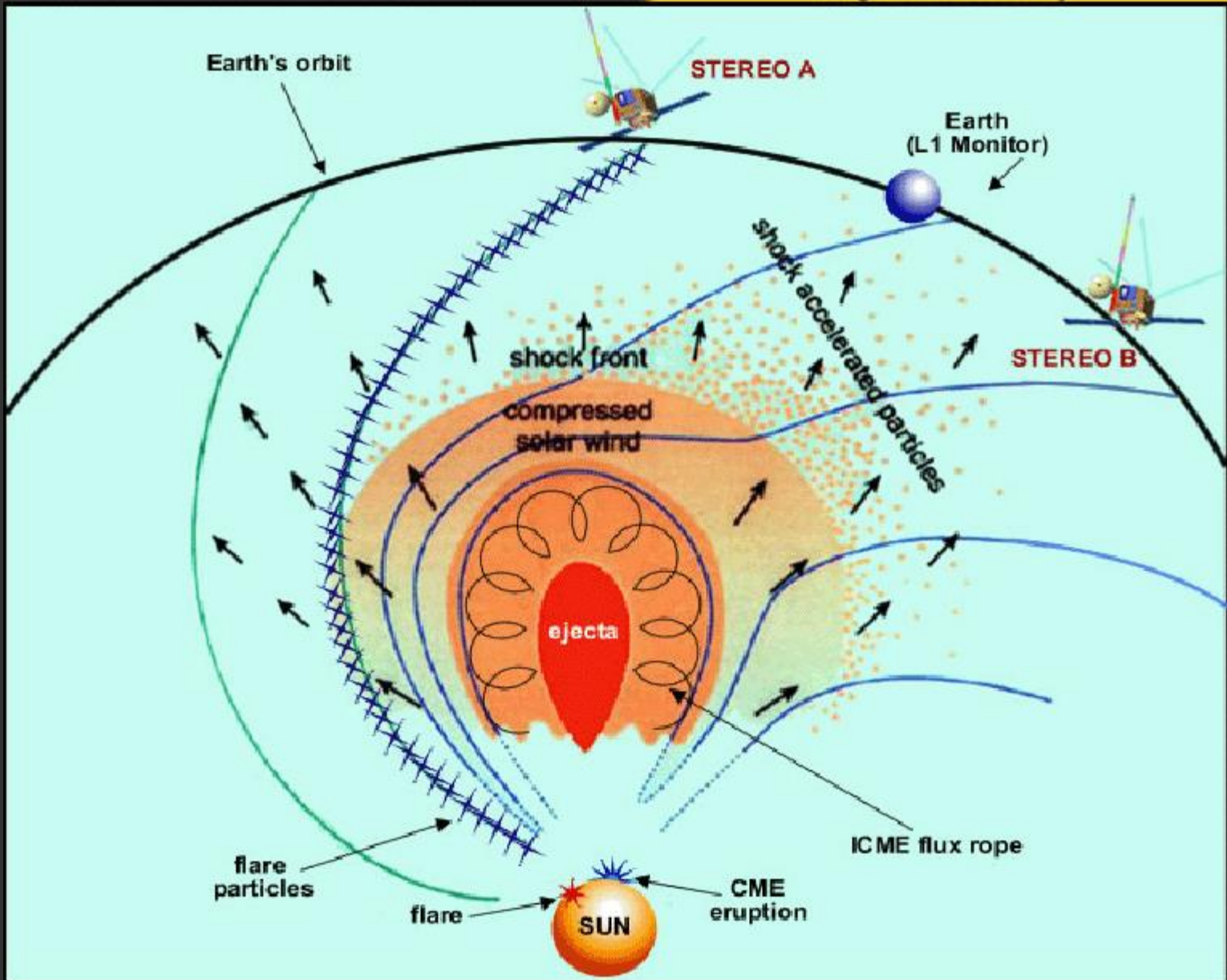




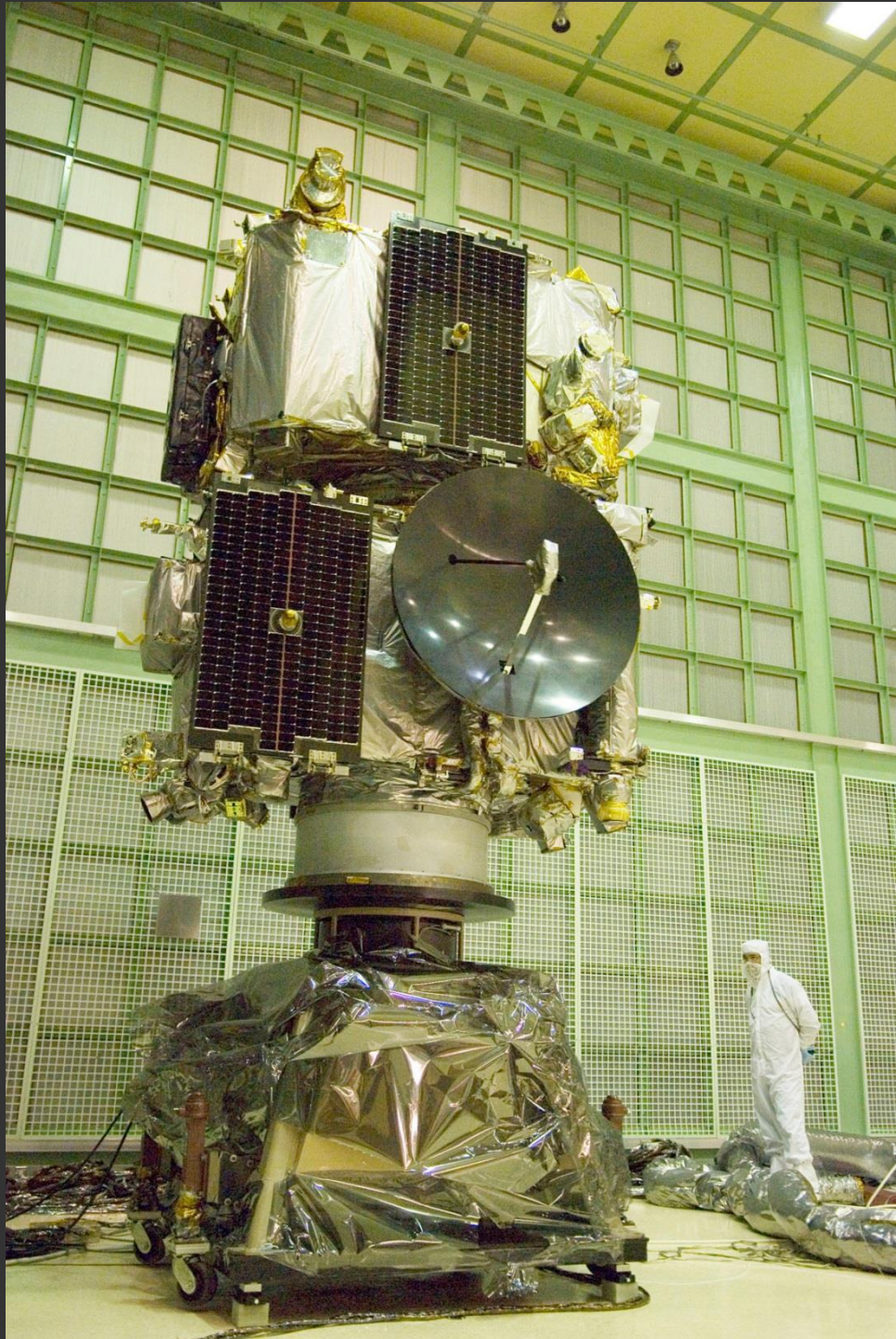


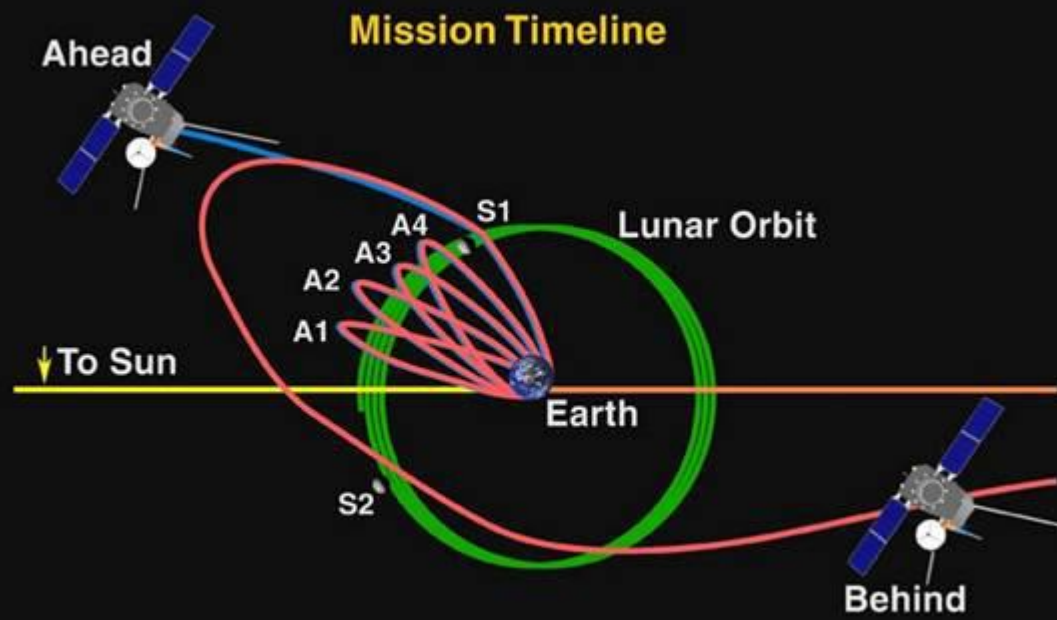
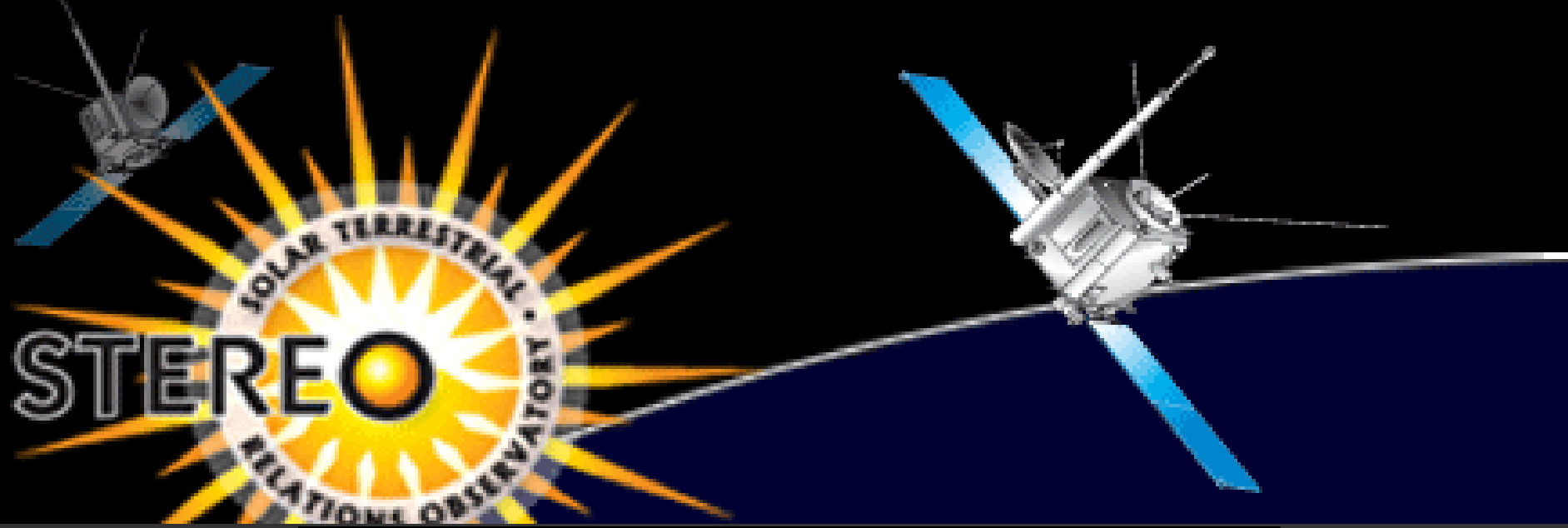
Stereo in-situ Science:

Establishing Heliospheric Consequences of Imaged Solar Activity

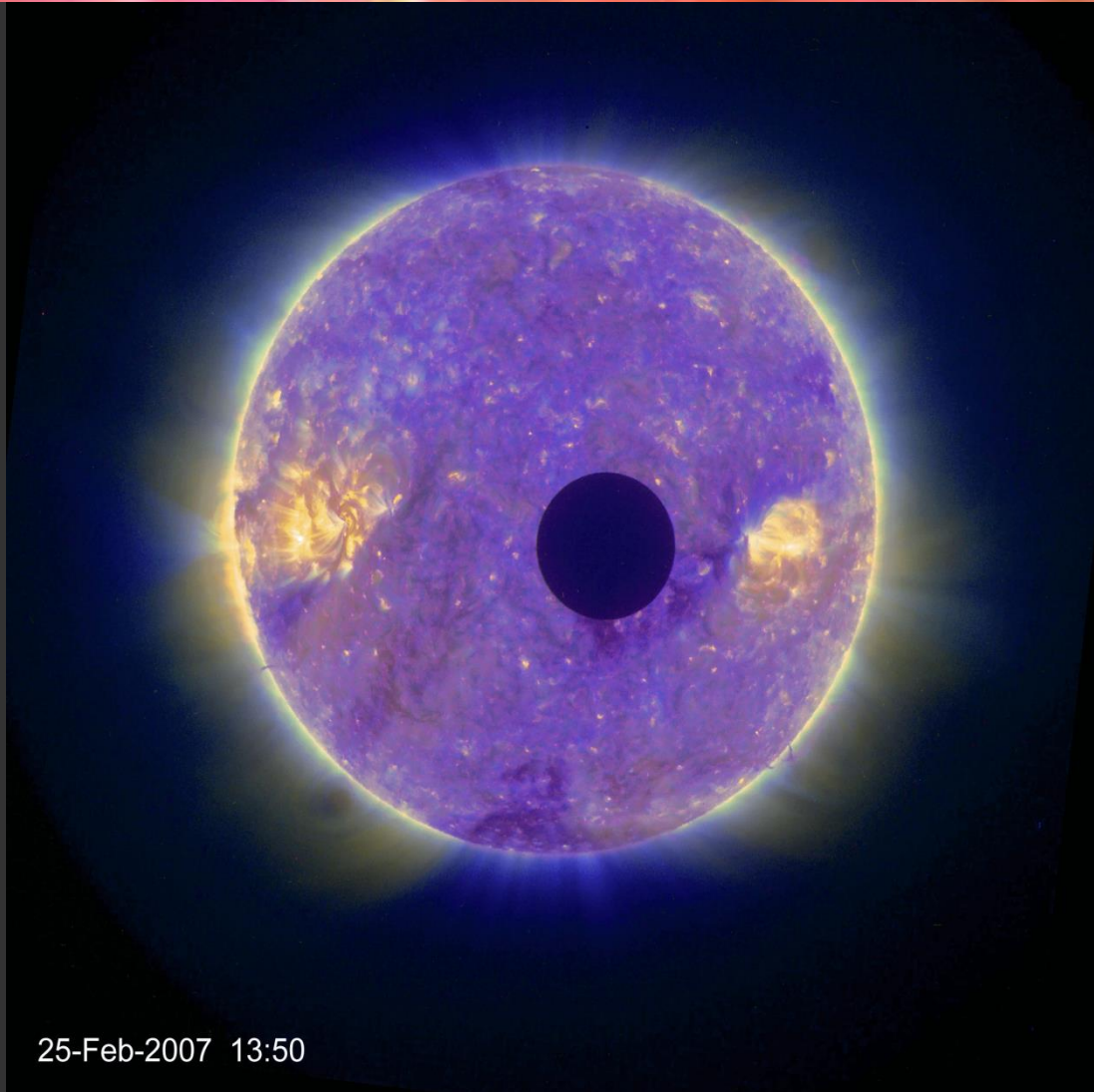






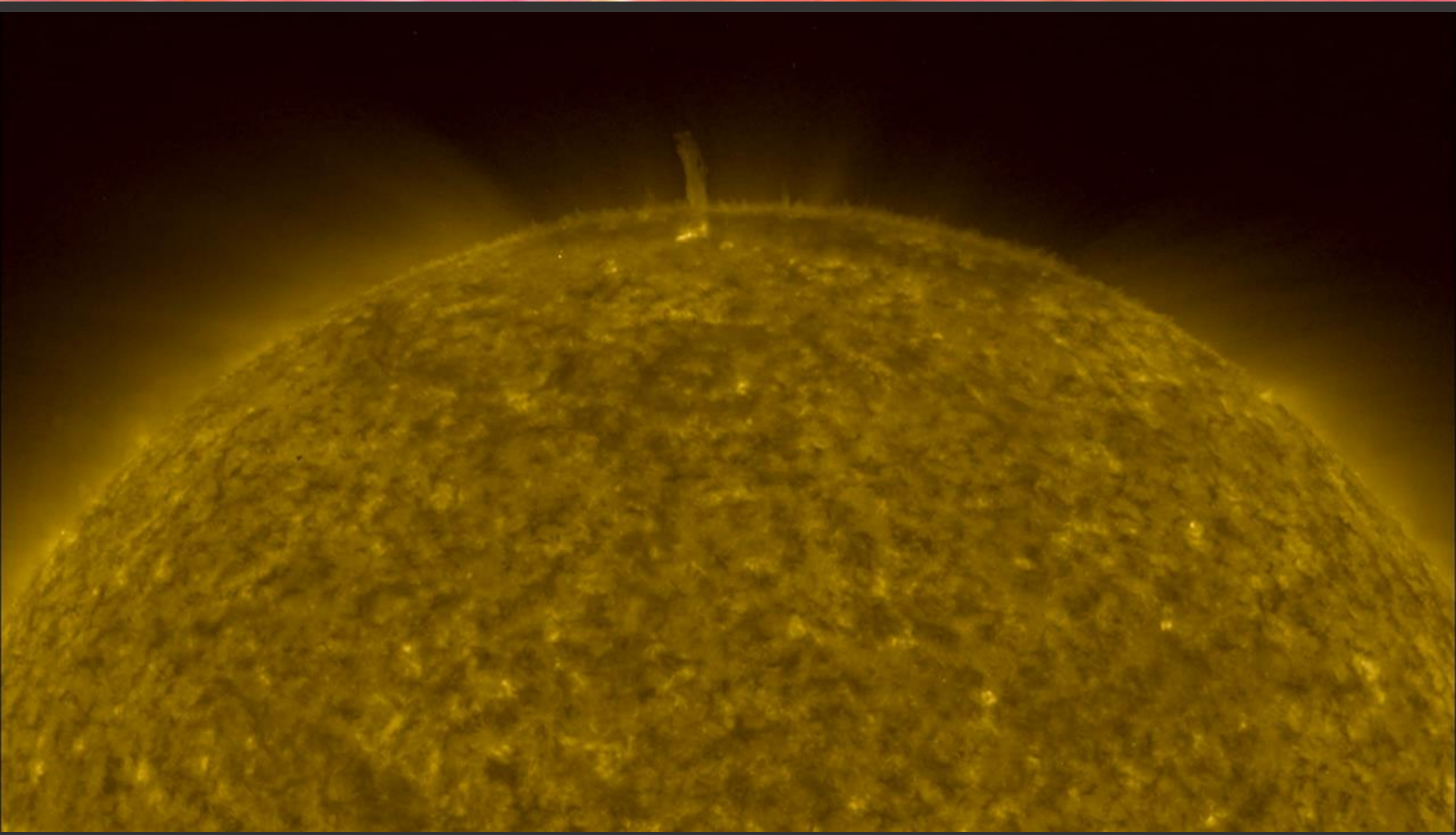


STEREO: FIRST 3-D IMAGES OF THE SUN

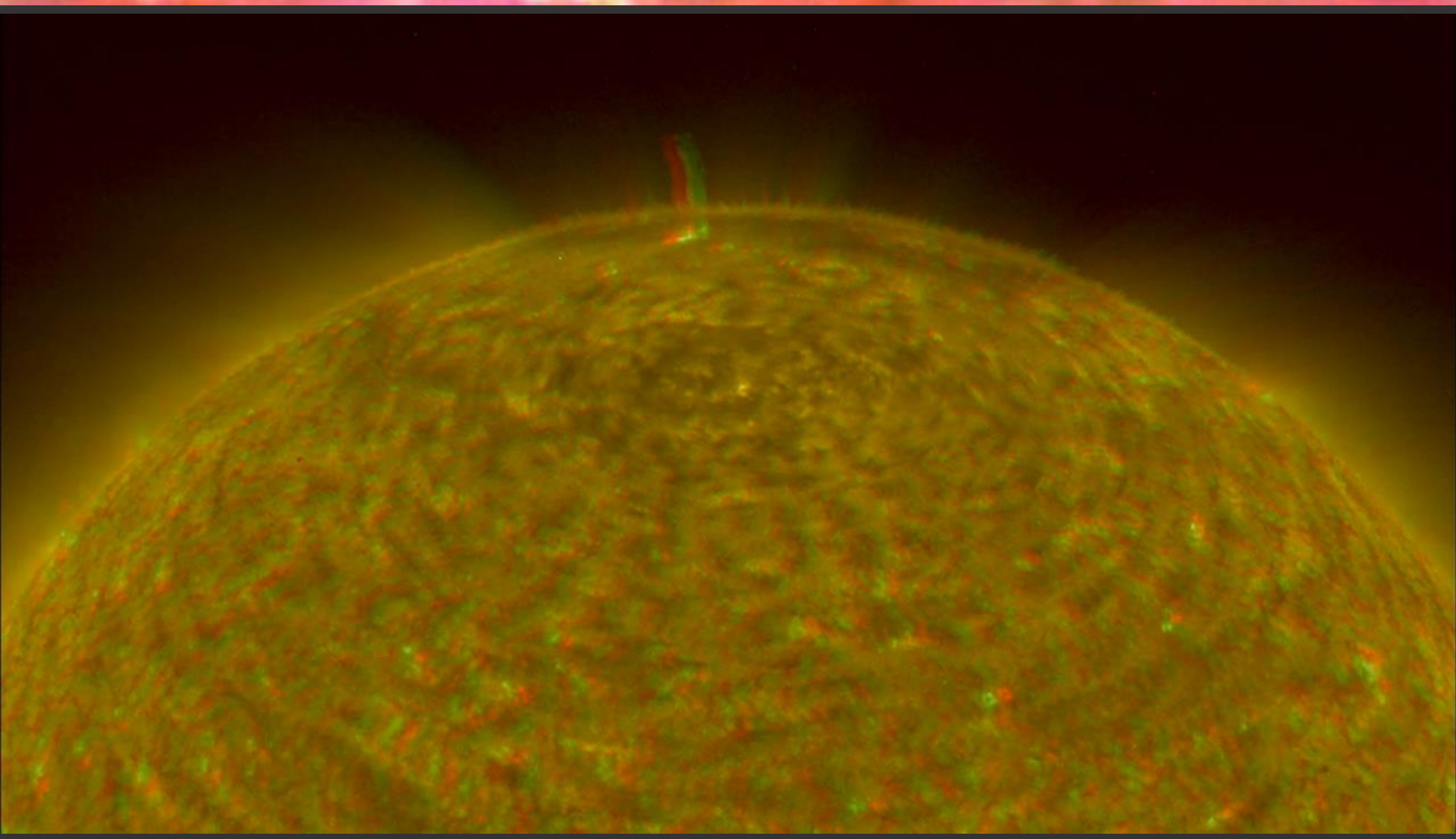


25-Feb-2007 13:50

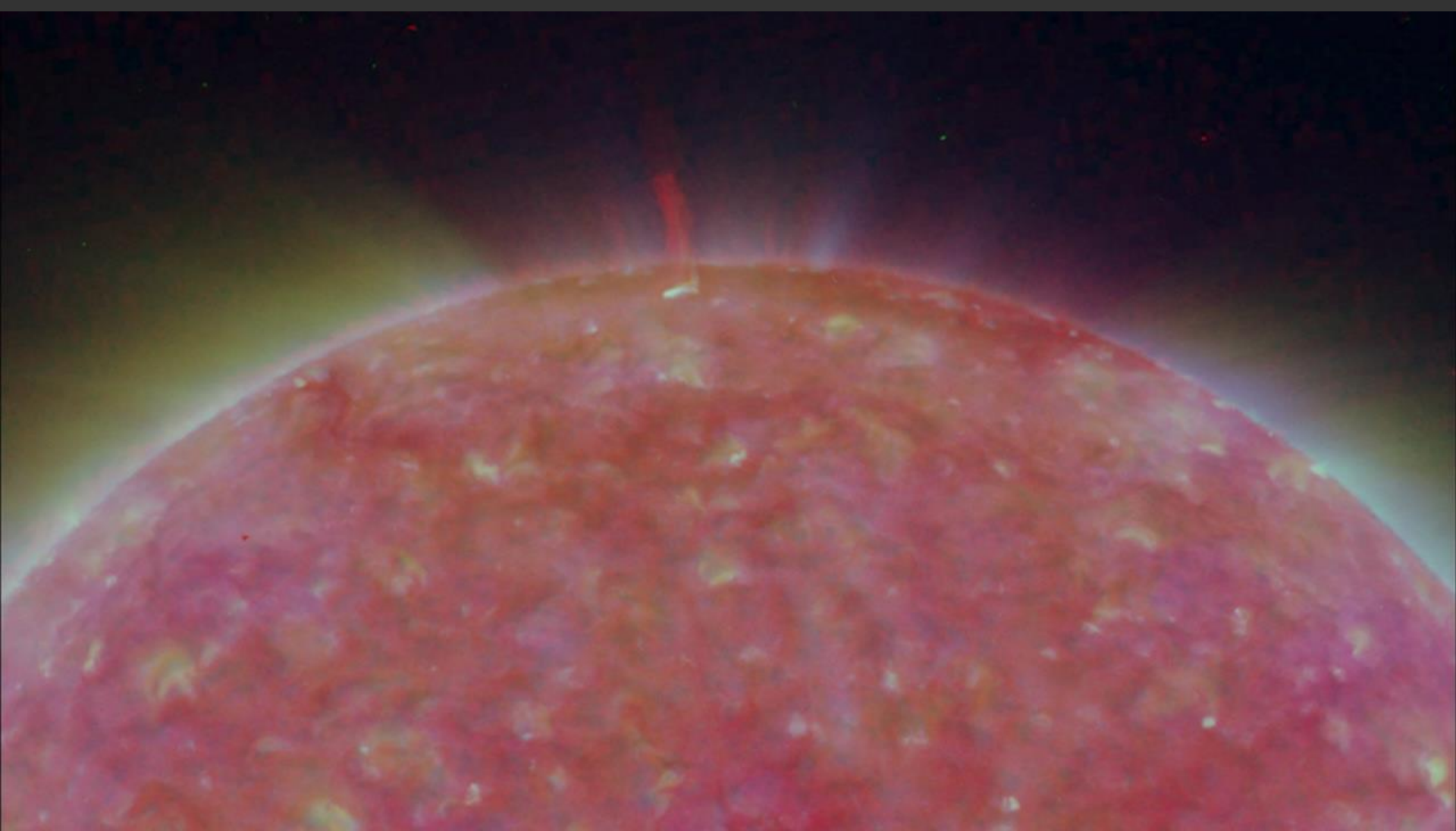
STEREO: FIRST 3-D IMAGES OF THE SUN

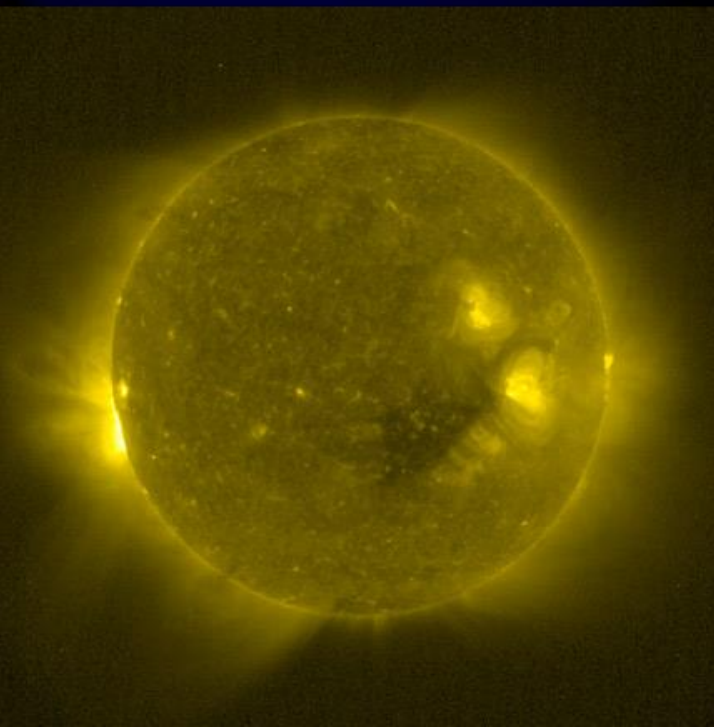
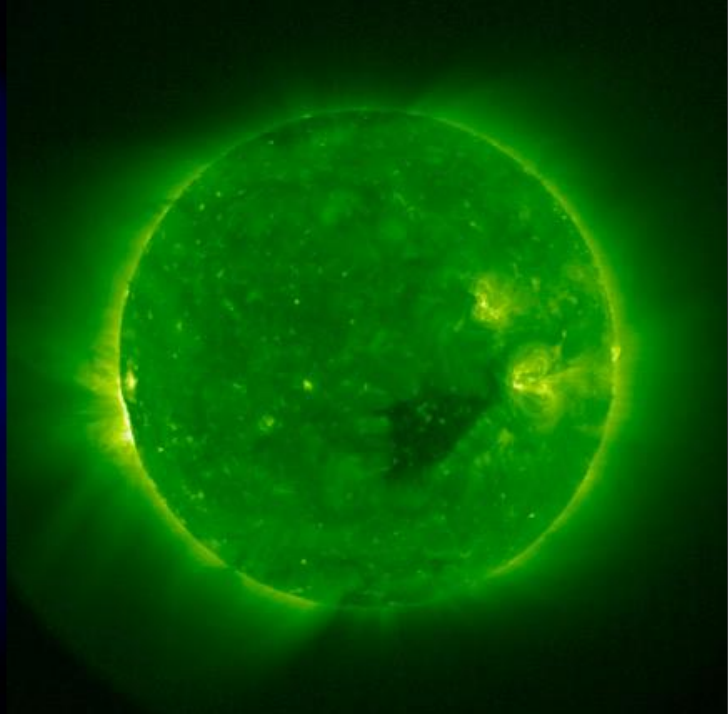
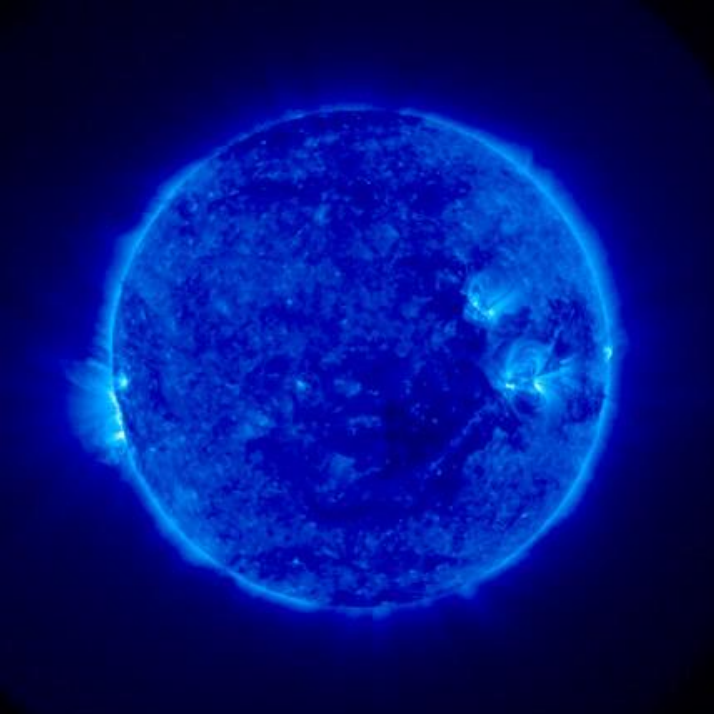


STEREO: FIRST 3-D IMAGES OF THE SUN

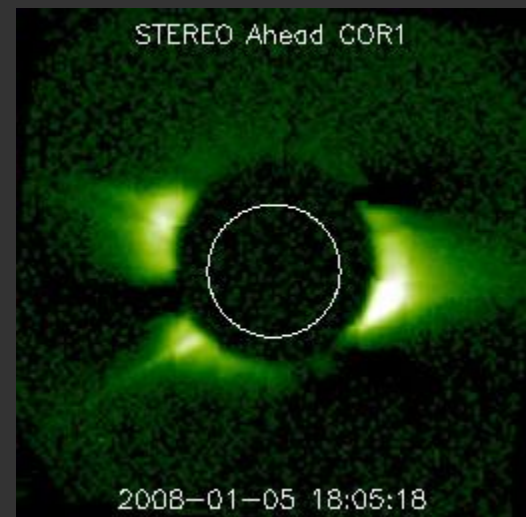
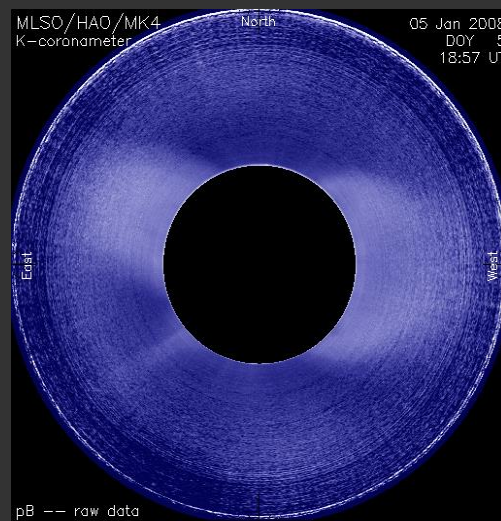
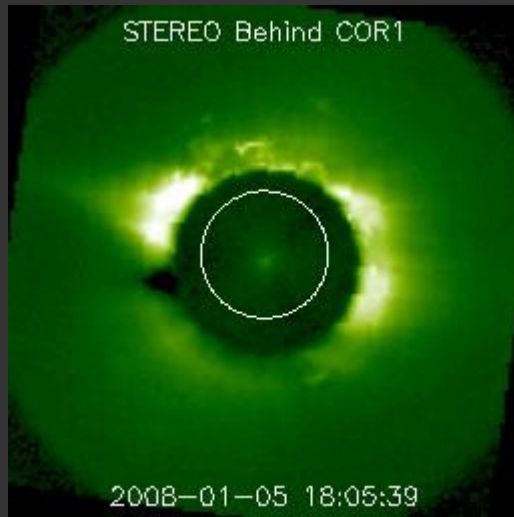


STEREO: FIRST 3-D IMAGES OF THE SUN





STEREO: FIRST 3-D IMAGES OF THE SUN



A close-up of an active region of the Sun from STEREO's Ahead spacecraft in extreme ultraviolet revealed an interesting, yet subtle, phenomenon. Besides a pair of small eruptions over this 40-hour period (Aug. 23-24, 2007), one small point was the source of a steady outpouring of material in all directions around it during the whole time, almost like a sparkler. It may not be an actual outflow into the solar wind - these are likely just the footprints of longer loops that continue upwards at other temperatures. The flow may be due to an imbalance in the heating of the loops. Understanding how and where such loops are heated is a 'hot' topic in solar research.

Ἡλιος:

SP-402 A New Sun: The Solar Results from Skylab

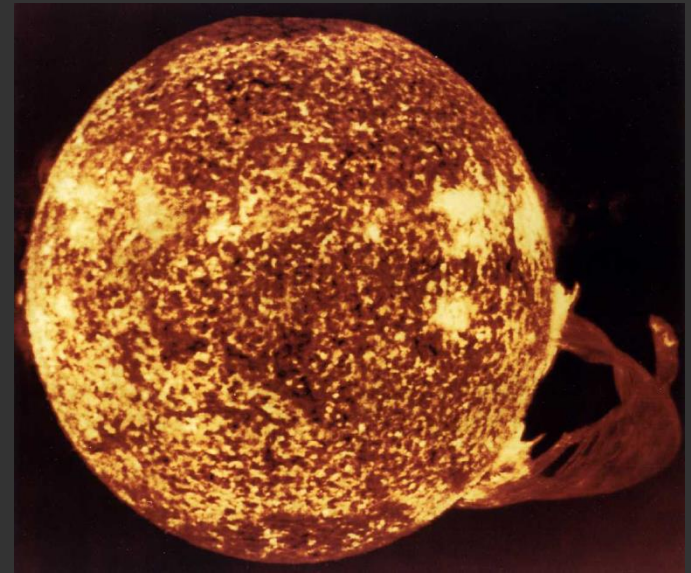
A New Sun: The Solar Results from Skylab

by John A. Eddy

Edited by Rein Ise

Prepared by: George C. Marshall Space Flight Center

National Aeronautics and Space Administration, Washington, D.C. 1979
<http://history.nasa.gov/SP-402/contents.htm>



Ήλιος:

ηλικία 4,5 δις έτη
απόσταση $1,5 \times 10^8$ km

διάμετρος $1,39 \times 10^6$ km
(ή 109 διαμέτροι της Γης ή 9,75 διαμέτροι του Δία)
όγκο $1,3 \times 10^6$ φορές τον όγκο της Γης

Μάζα $1,99 \times 10^{30}$ kg ή 333 000 φορές τηνμάζα της Γης

Μαγνητικό πεδίο

στις κηλίδες 3000 G και στους πόλους 1 G,
στο χρωμοσφαιρικό δίκτυο 25 G

στις εφήμερες περιοχές 20 G
στις (λαμπρές περιοχές , plage) 200 G

στις προεξοχές 10 με 100 G

το μαγνητικό πεδίο της Γη στους πόλους 0,7 G

Επιφανειακή έλξη $273,95 \text{ m s}^{-2}$ (27,9 g)

Ταχύτητα διαφυγής $617,54 \text{ km/s}$

Χαρακτηριστικά Περιστροφής Κλίση του άξονα $7,25^\circ$ (ως προς την εκλειπτική)

Ορθή αναφορά του βόρειου πόλου 1 $286,03^\circ$ (19 h 4 min 31,2 s)

Απόκλιση του βόρειου πόλου $63,87^\circ$

Τροχιακά χαρακτηριστικά:

Μέση απόσταση από το κέντρο του Γαλαξία μας $\sim 2,5 \times 10^{17} \text{ km}$

(26.000 έτη φωτός)

Γαλαξιακή περίοδος $\sim 2,26 \times 10^8$ έτη

Ταχύτητα $\sim 217 \text{ km/s}$

Χημική σύνθεση κατά βάρος:

H 73.46

He 24.85

O 0.77

C 0.29

Fe 0.16

Ne 0.12

N 0.09

Si 0.07

Ma 0.05

S 0.04

αλλα 0.10

Μέση Πυκνότητα 1.41 g/cm^3

κέντρο Ηλίου 160 g/cm^3

φωτόσφαιρα 10^{-9} g/cm^3

χρωμόσφαιρα 10^{-12} g/cm^3

κατώτερο στέμμα 10^{-16} g/cm^3

ατμόσφαιρα της Γης 10^{-3} g/cm^3

Ηλιακή ακτινοβολία 3.83×10^{23} kW

ή 6.29×10^4 kW/m²

ηλιακή σταθερά 0.136 W/cm²

**ηλιακή λαμπρότητα στη φωτόσφαιρα $398\ 000$ φορές η
λαμπρότητα της Σελήνης**

ή $300\ 000$ η λαμπρότητα του κατώτερου στέμματος,

ή 10^{10} η λαμπρότητα του στέμματος

**ή 1000 με 100000 η λαμπρότητα του ουρανού κατά την
ημέρα**

θερμοκρασία:

κέντρο του πυρήνα 15 000 000 K

φωτόσφαιρα 6050 K

σκιά κηλίδας 4240 K

παρασκιά 5680 K

χρωμόσφαιρα από 4300 έως 50000 K

στέμμα 800 000 μέχρι 3 000 000 K

Συνοδική περίοδος:

στον ισημερινό 26.8 ημέρες

σε πλάτος 30 μοιρες 28.2 ημέρες

σε πλάτος 60 μοιρες 30.8 ημέρες

σε πλάτος 75 μοιρες 31.8 ημέρες

Samuel Langley, 1873. Secretary
(Director) of the Smithsonian
Institution in Washington, D.C





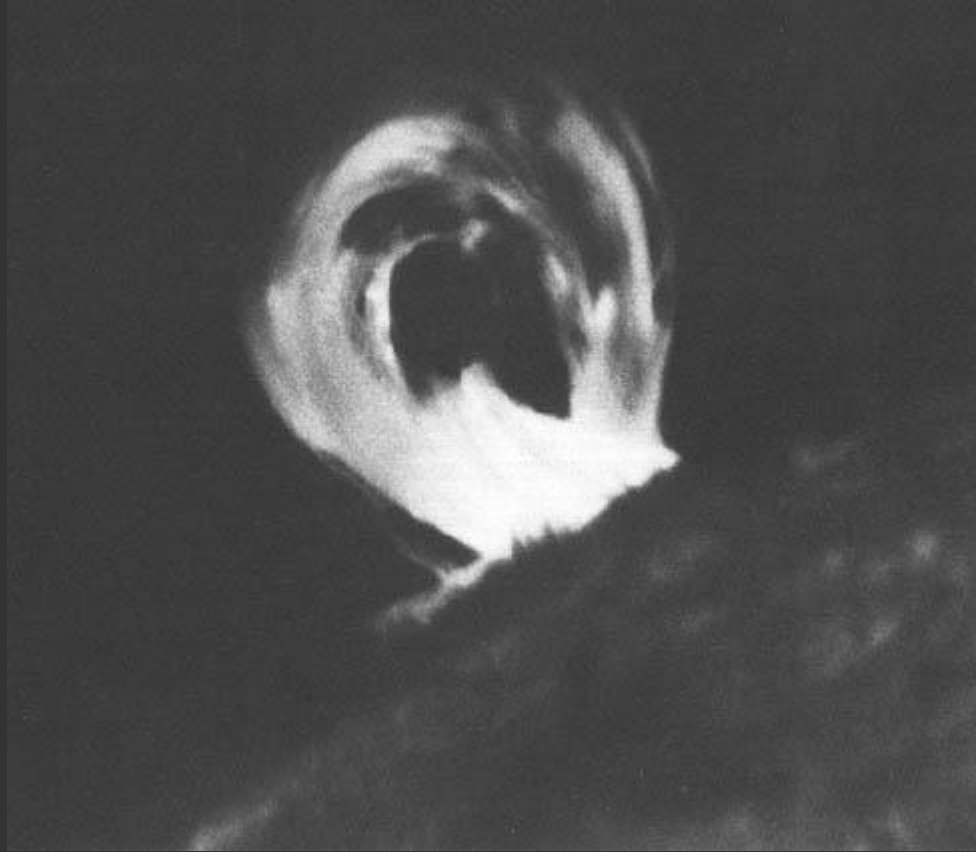
19ος αιών,
J. Norman Lockyer, Αγγλία



CHARLES A. YOUNG,
φασματογράφος
ηλιακή έκλειψη 28 Μαΐου 1900
Wadesboro, N.C.



Ηλιακή προεξοχή, στο χείλος του Ηλίου,
γραμμή Ηα, Sacramento Peak Observatory
7/12/1970. 240 000 km ύψος, διακρίνονται οι
μαγνητικές δυναμικές γραμμές



Ηλιακή προεξοχή, στο χείλος του Ηλίου,
γραμμή Ηα, Big Bear Solar Observatory
3/8/1970, διακρίνονται οι μαγνητικές
δυναμικές γραμμές



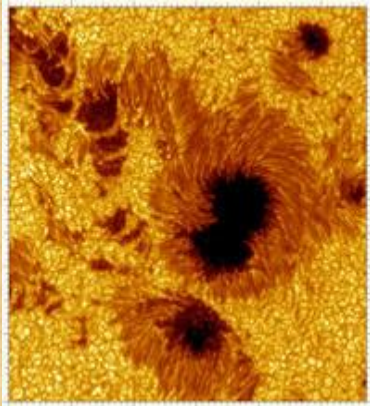
Χρωμόσφαιρα σε
Φασματοηλιογράφημα σε Ηα
από το Mt. Wilson Observatory in
California.

(πάνω από την φωτόσφαιρα και
κάτω από το στέμμα)
φαίνονται τα νήματα (filaments),
που ονομάζονται προεξοχές, όταν
είναι στο χείλος

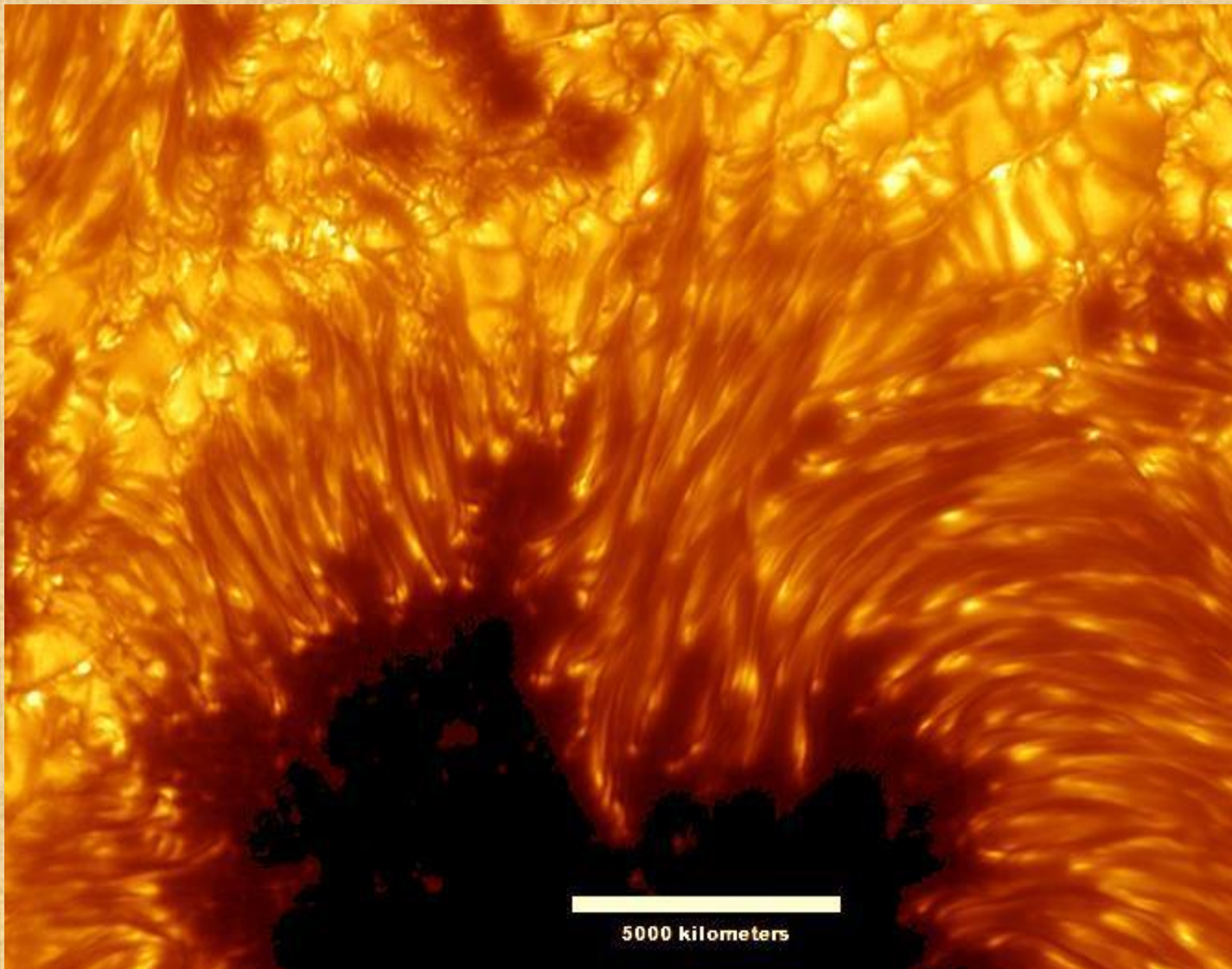
και οι ακίδες
και το χρωμοσφαιρικό δίκτυο
(chromospheric network)
μια ενεργός περιοχή
(chromospheric plage)

Το Σουηδικό ηλιακό τηλεσκόπιο

<http://www.solarphysics.kva.se>



Φωτογραφία του κ. Tim van
Werkhoven.



Η πιο καθαρή εικόνα του Ηλίου

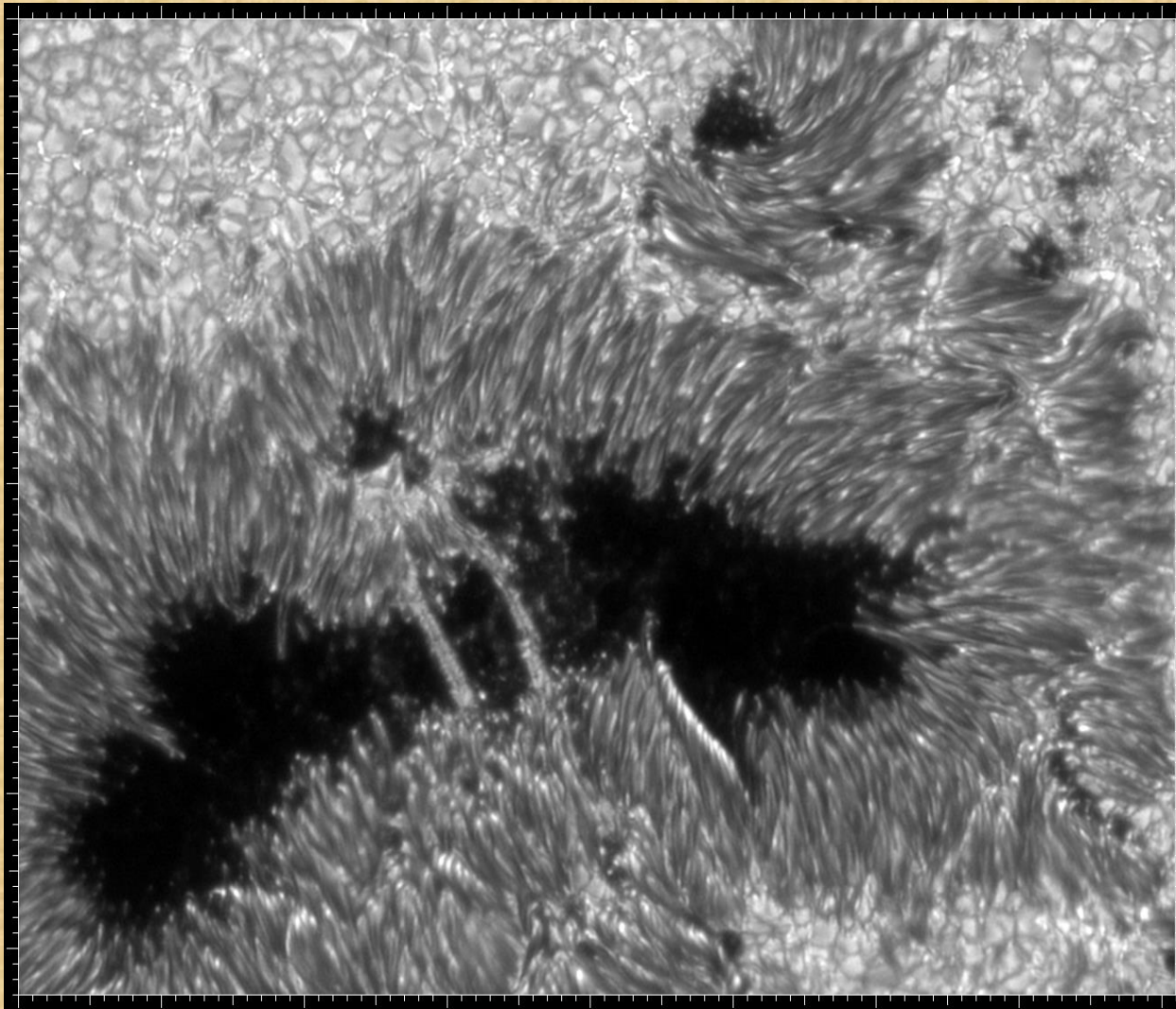
από το Σουηδικό ηλιακό τηλεσκόπιο

<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

The Sharpest View of the Sun

Credit: SST, Royal Swedish Academy of Sciences



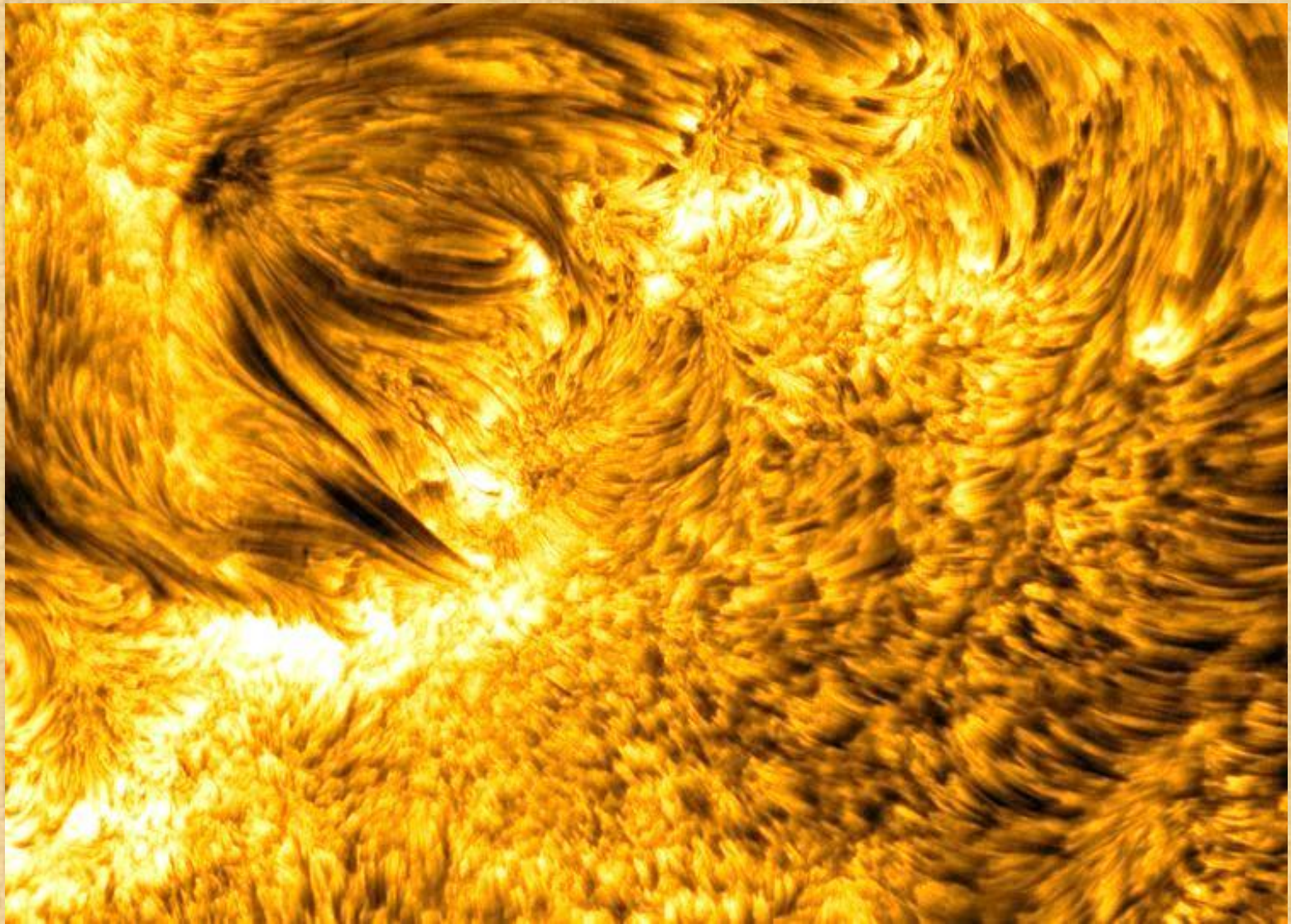
Φωτεινές γέφυρες σε κηλίδα

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Light Bridges on the Sun

Credit: G. Scharmer, L. Rouppe van der Voort (KVA) et al., SVST



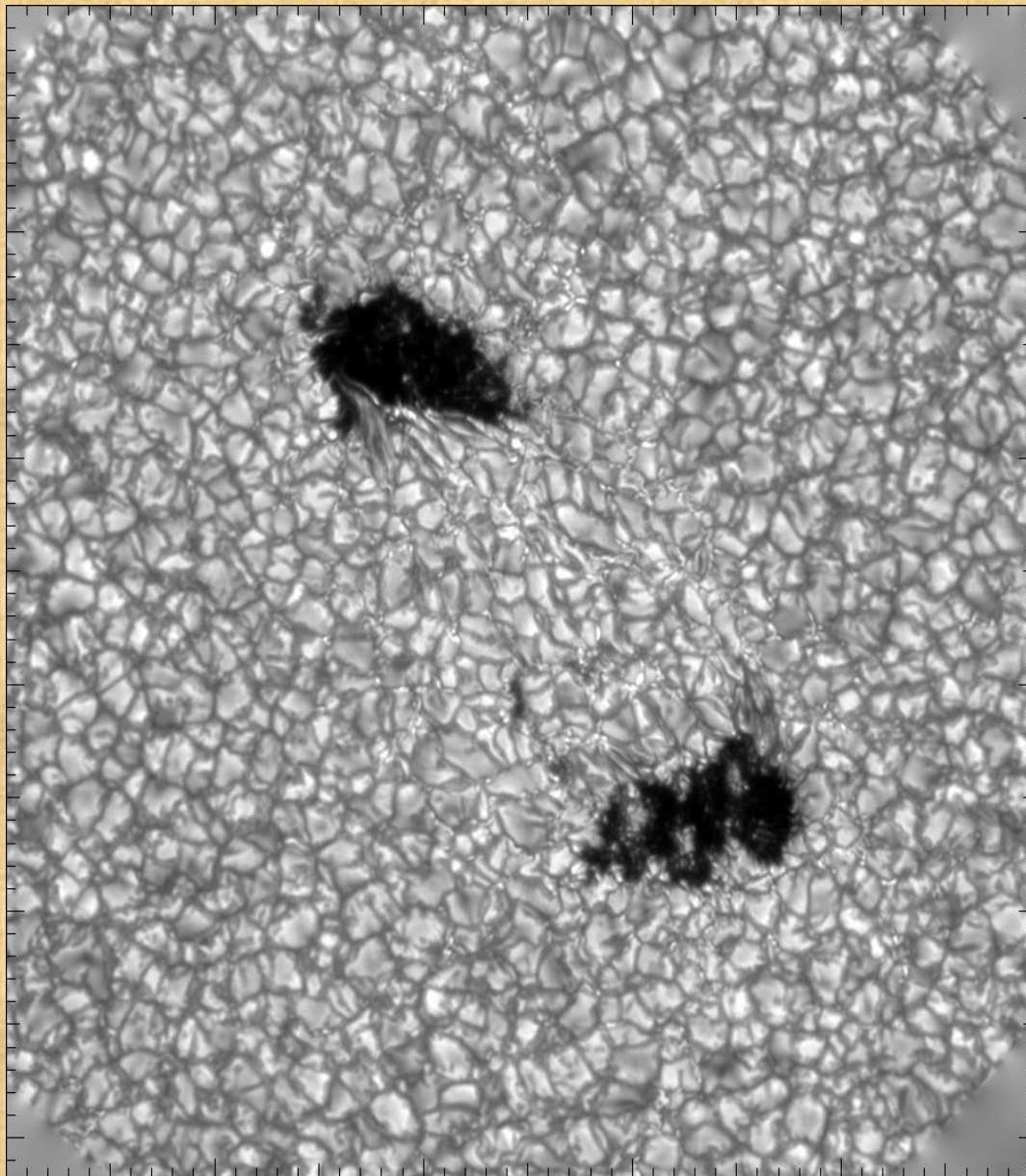
Ηλιακοί πίδακες (spicules)

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Spicules: Jets on the Sun

Credit: SST, Royal Swedish Academy of Sciences, LMSAL

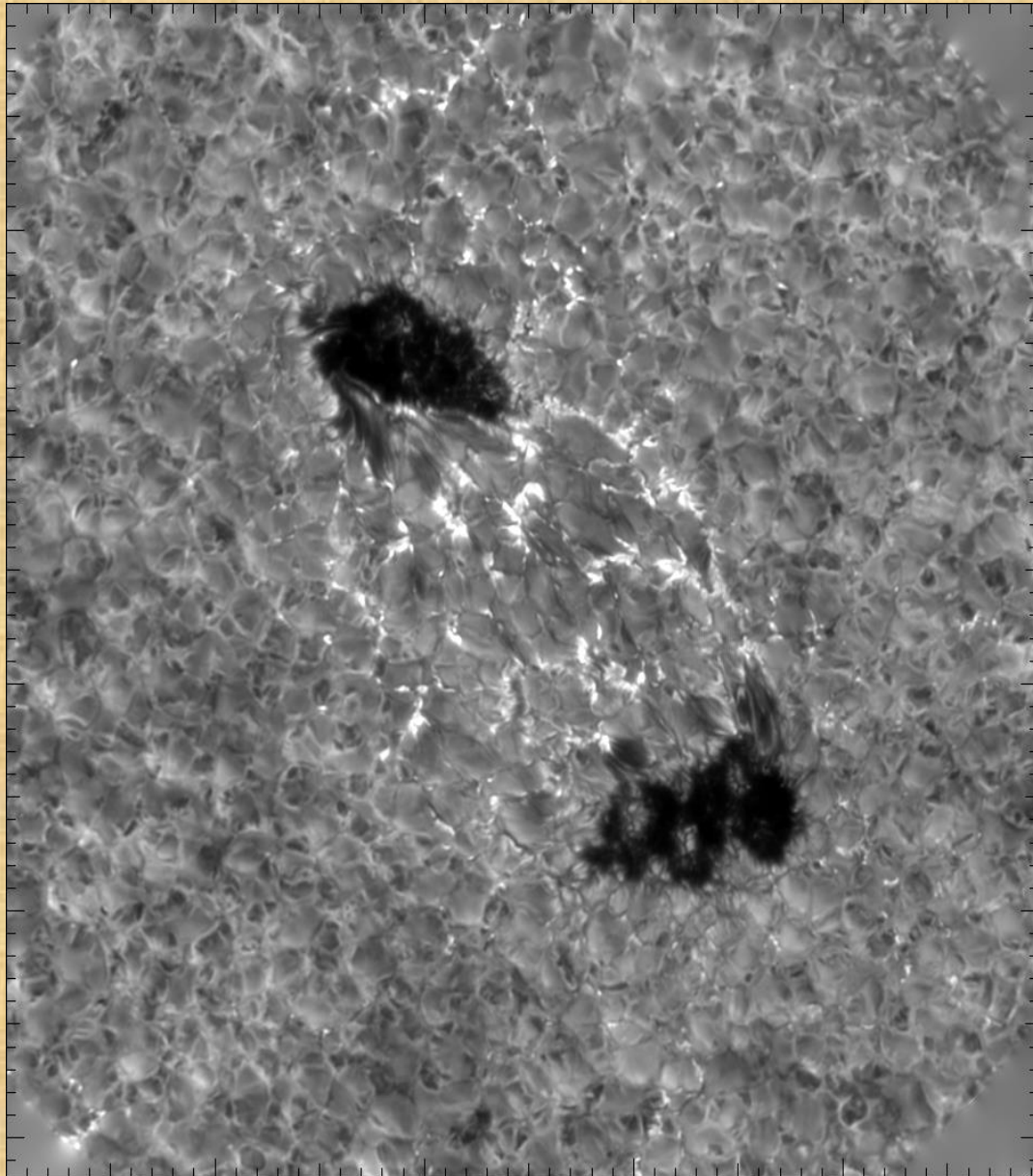


Ηλιακοί πόροι

συνεχές
από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Two pores through CRISP
Observer: Tomas Hillberg
Image processing: Mats Löfdahl
Date: 22 Apr 2008
Wavelength: Fe I 630.2 nm continuum



Ηλιακοί πόροι

CRISP $\lambda_{\text{core}}-5$ pm image.

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

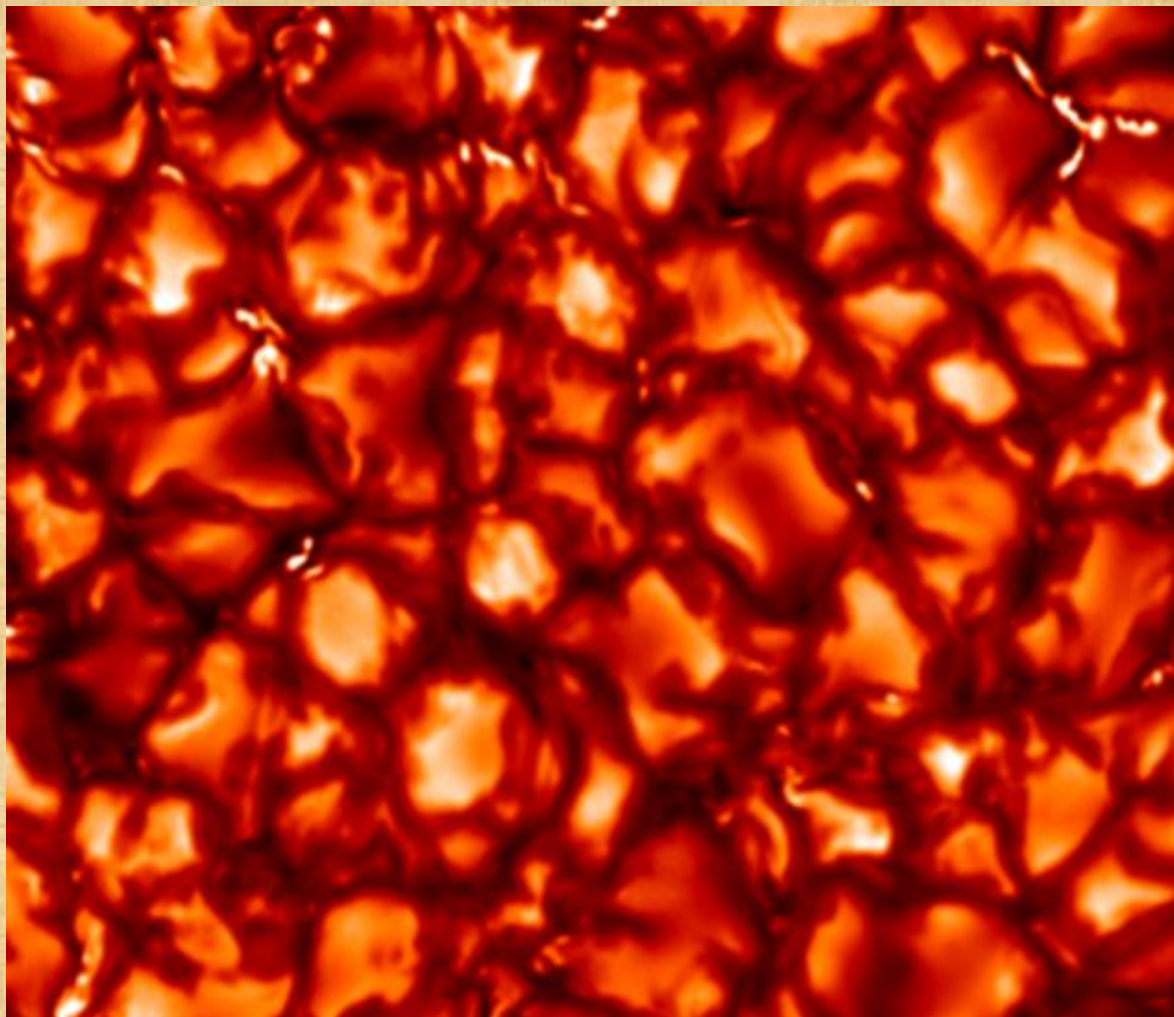
Two pores through CRISP

Observer: Tomas Hillberg

Image processing: Mats Löfdahl

Date: 22 Apr 2008

Wavelength: Fe I 630.2 nm wing ($\lambda_{\text{core}}-5$ pm)



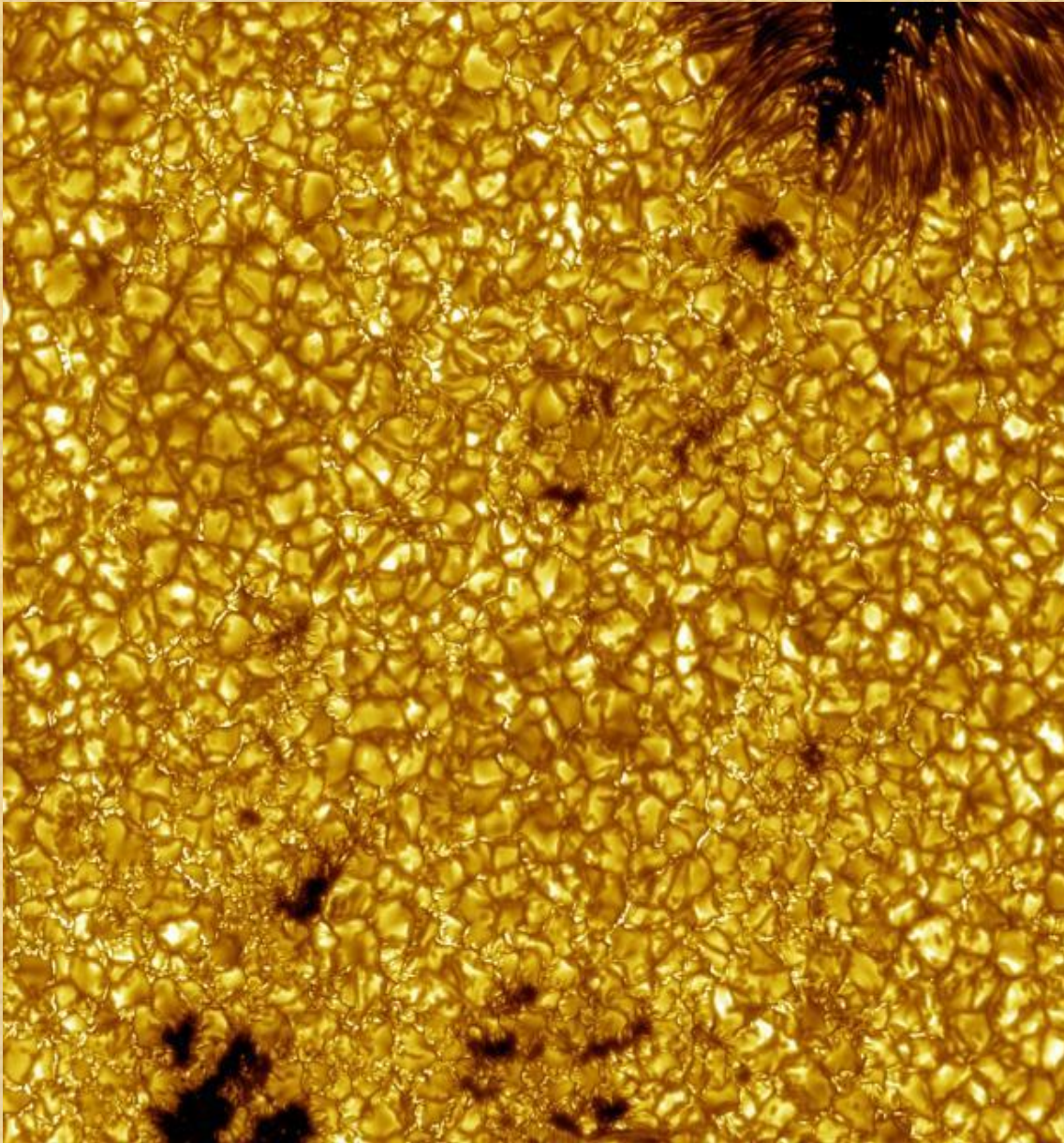
Ηλιακή κοκκίαση.

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

High resolution granulation

Observer: Vasco Henriques
Image processing: Vasco Henriques
Date: 23 May 2010



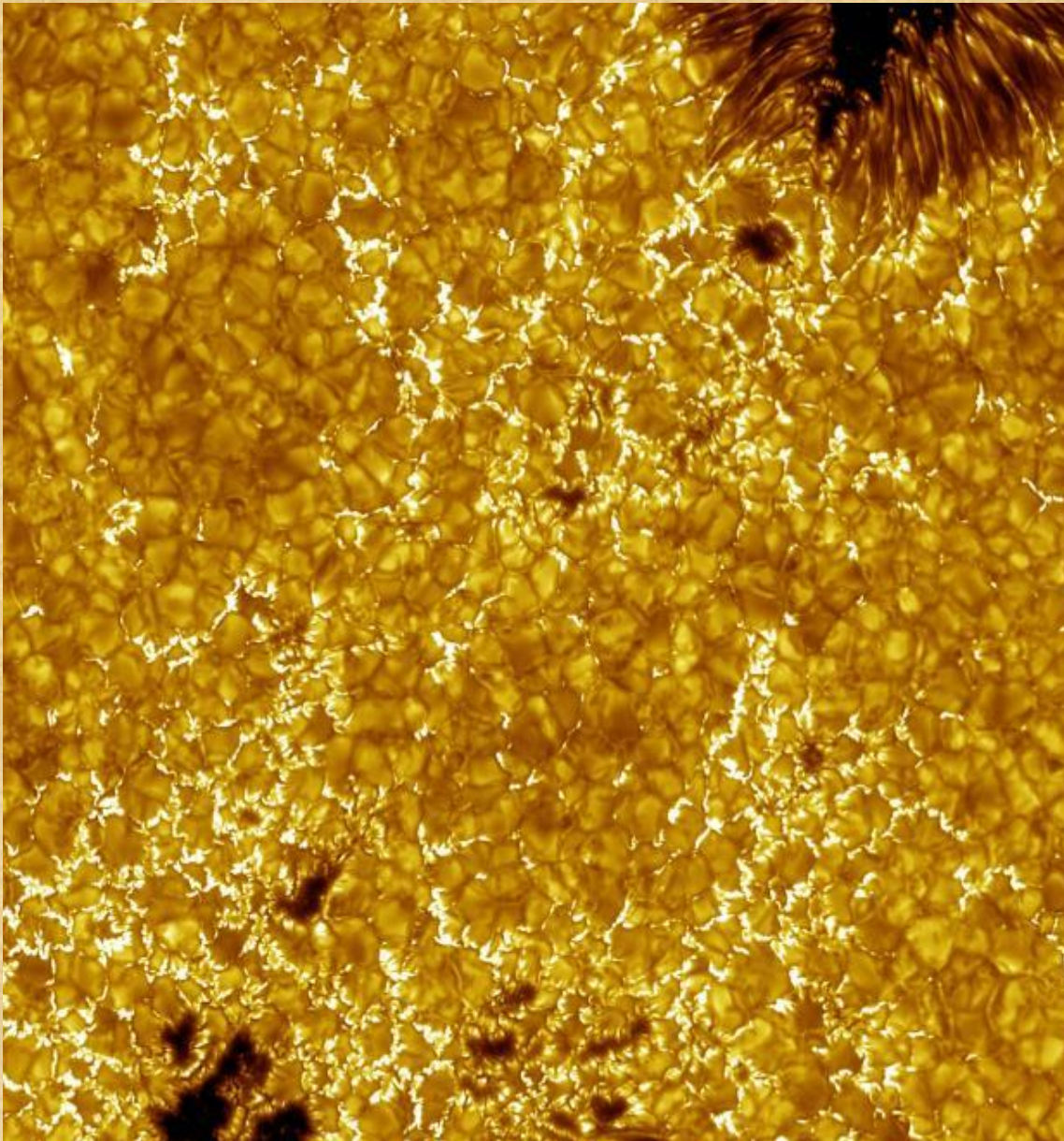
Ηλιακή κοκκίαση.

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

High resolution granulation

Observer: Vasco Henriques
Image processing: Vasco Henriques
Wavelength: 396.37 nm Ca II wideband
Date: 23 May 2010



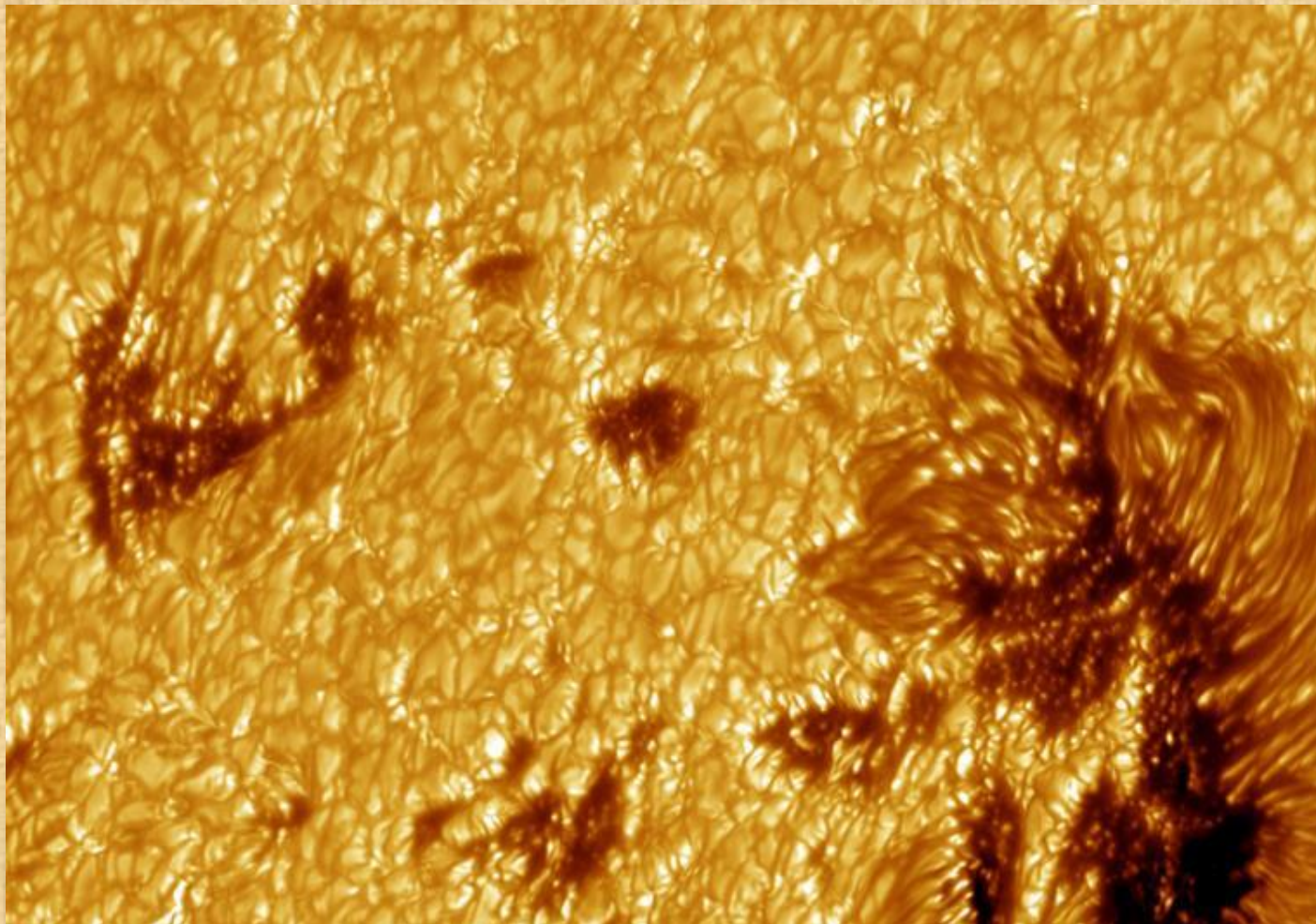
Κοκκίαση.

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

High resolution granulation

Observer: Vasco Henriques
Image processing: Vasco Henriques
Wavelength: 396.47 nm Ca II H wing
Date: 23 May 2010



Κηλίδα

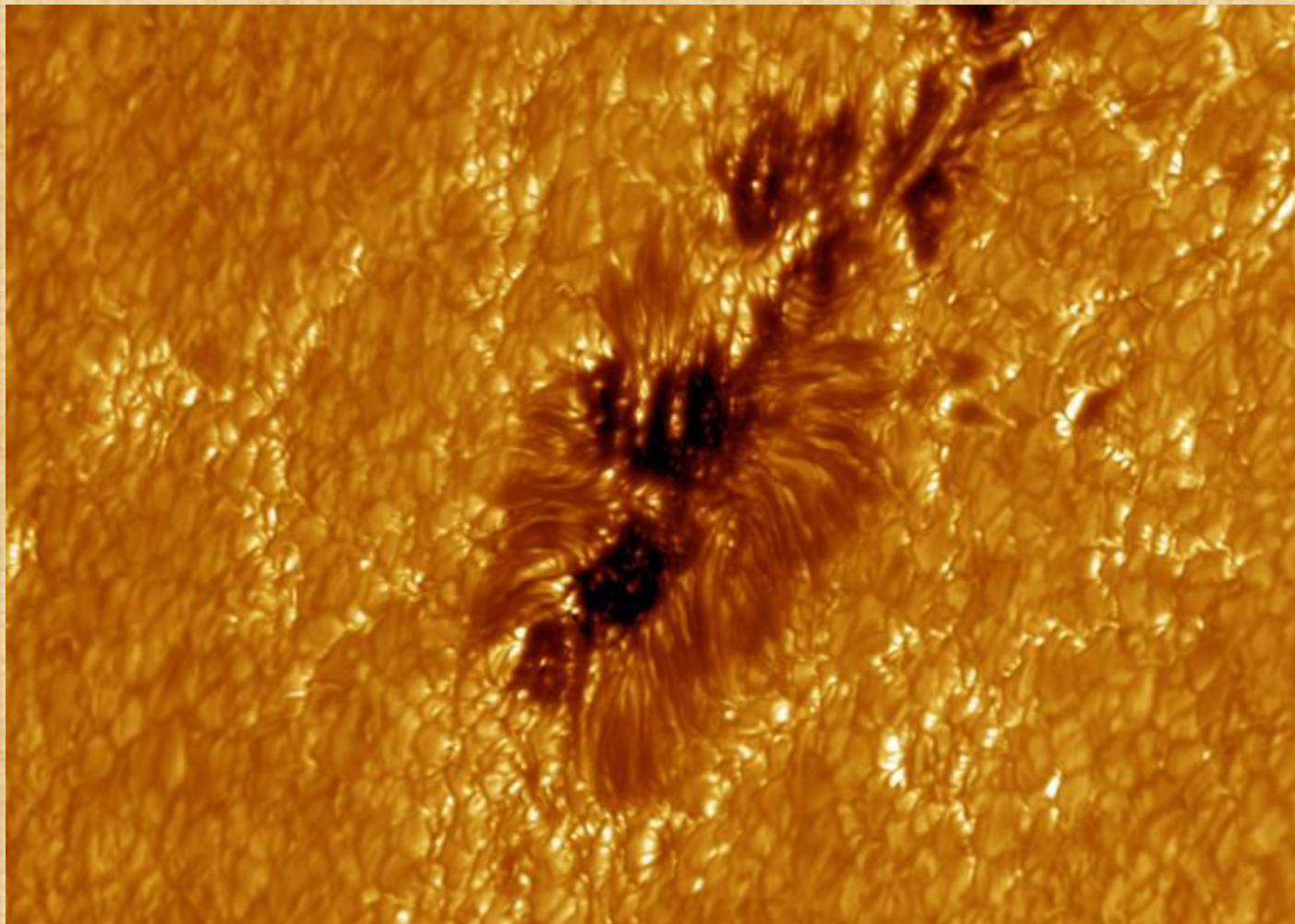
από το Σουηδικό ηλιακό τηλεσκόπιο

<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Spots

Observations: Vasily Zakharov, MPI
Image processing (PDS): Vasily Zakharov
Wavelength: 436.5 nm
Date: 8 September 2004



Κηλίδα

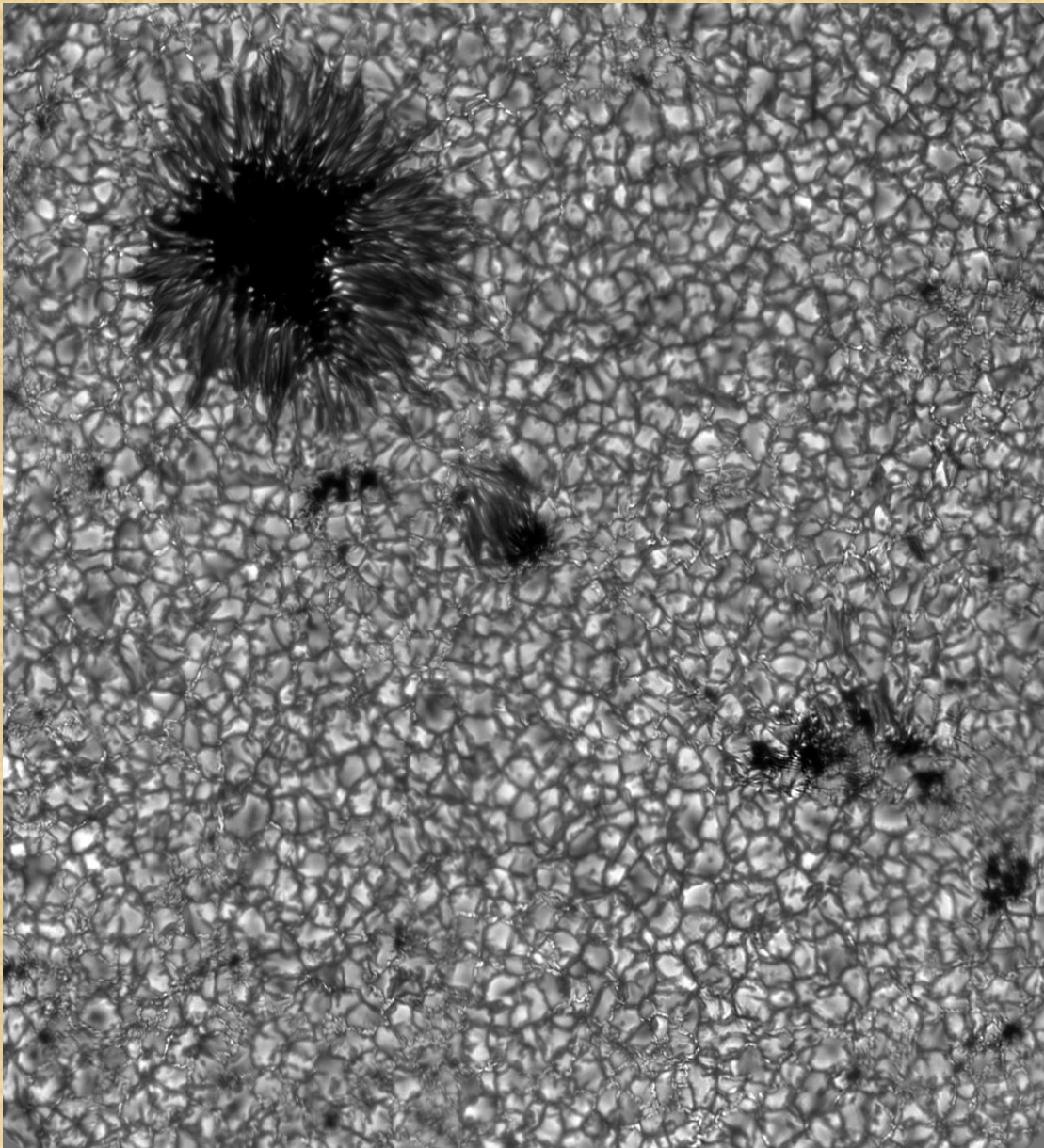
από το Σουηδικό ηλιακό τηλεσκόπιο

<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Spots, Spot near limb

Observations: Vasily Zakharov, MPI
Image processing (PDS): Vasily Zakharov
Wavelength: 436.5 nm
Date: 8 September 2004

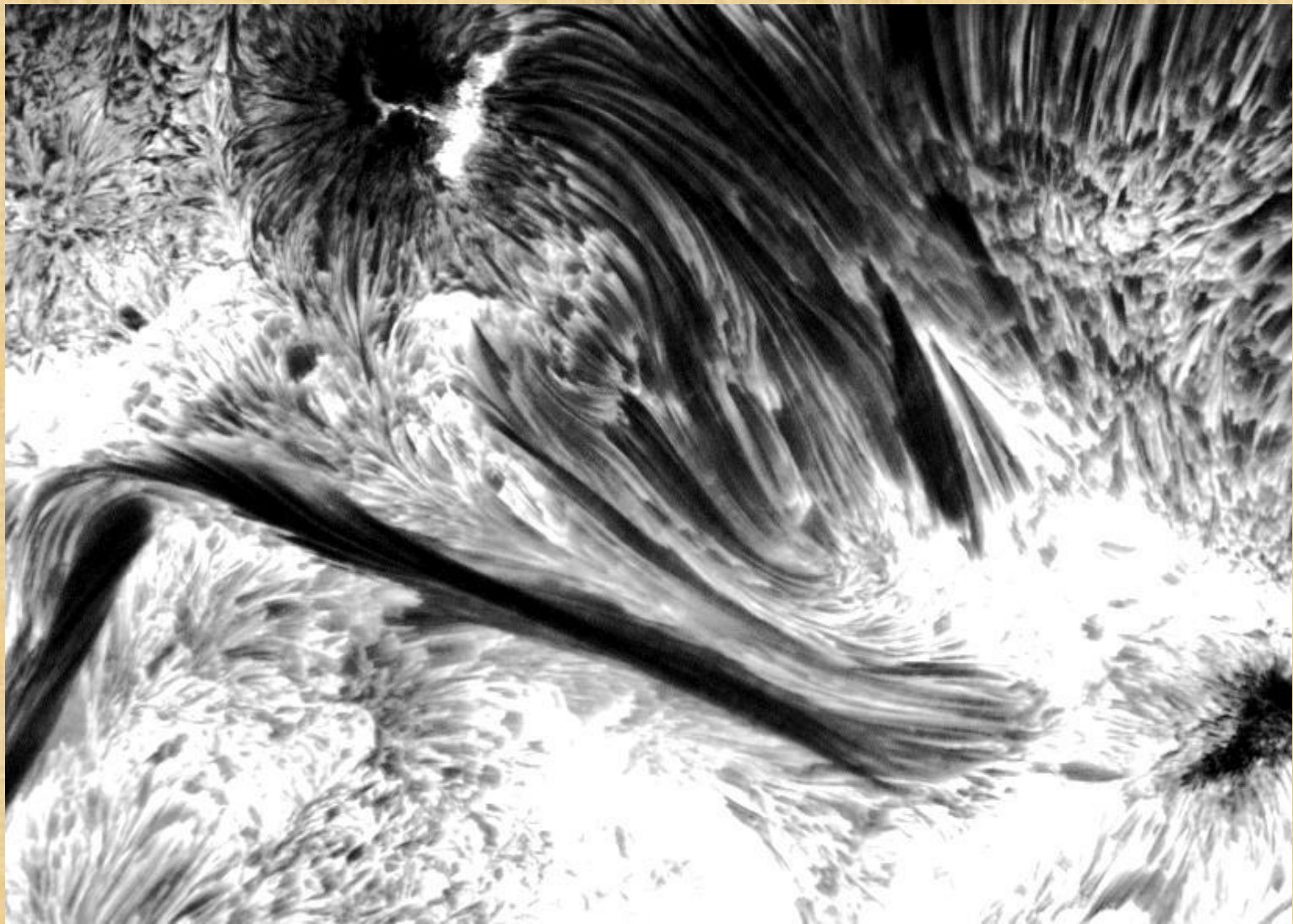


Ενεργός περιοχή στο κυανό χρώμα.

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Active region in blue continuum 1
Observations: Oddbjorn Engvold, Jun Elin Wiik, Luc Rouppe van der Voort, Oslo
Image processing: Luc Rouppe van der Voort, Oslo
Wavelength: 436.4 nm (Continuum)
Target:
Date: 22Aug2003

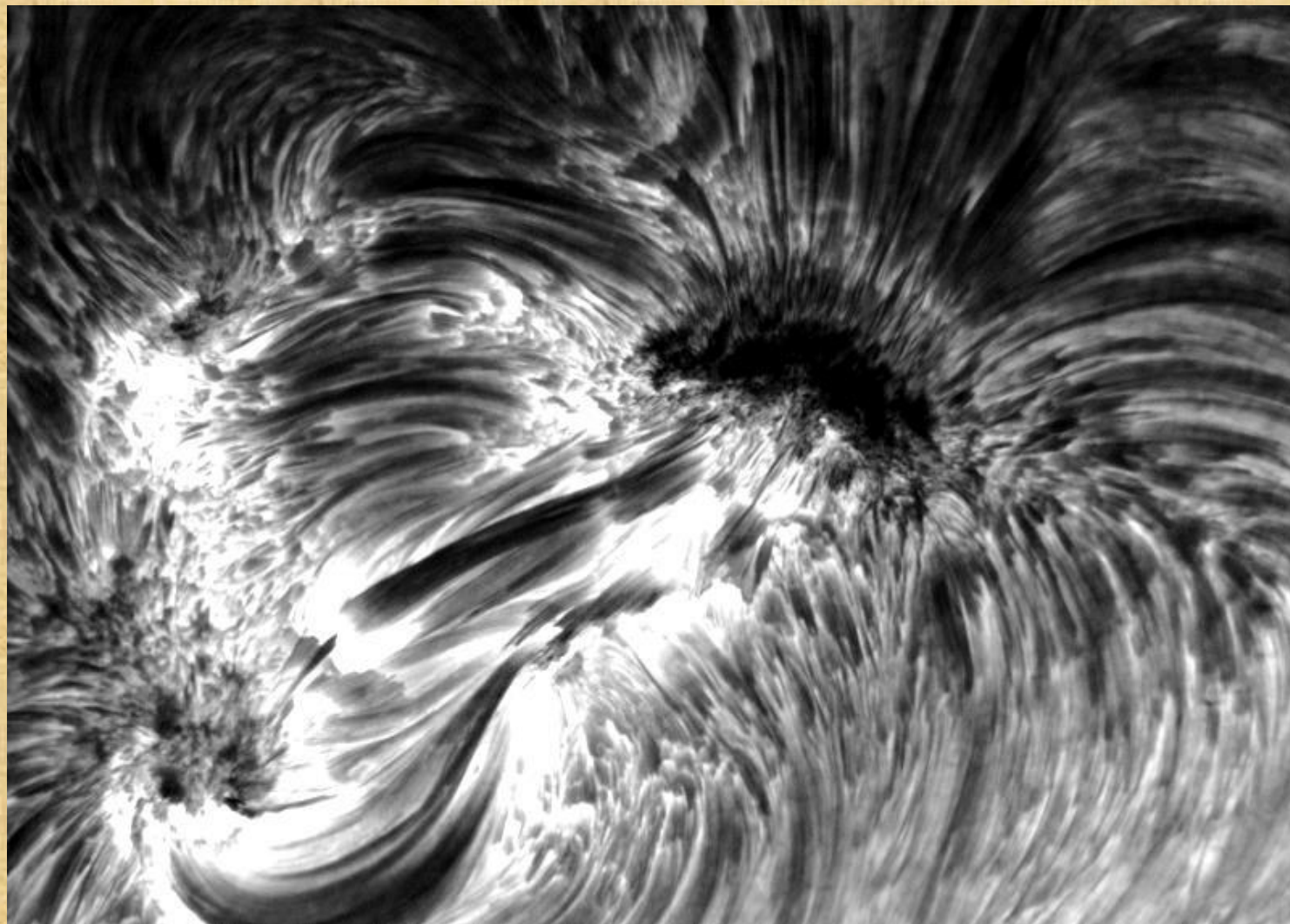


Ενεργός περιοχή

από το Σουηδικό ηλιακό τηλεσκόπιο <http://www.solarphysics.kva.se>
observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Active region in H α 1

Observations: Oddbjorn Engvold, Jun Elin Wiik, Luc Rouppe van der Voort, Oslo
Image processing: Luc Rouppe van der Voort, Oslo
Wavelength: 656.3 nm (H-alpha), Date: 22Aug2003



Ενεργός περιοχή

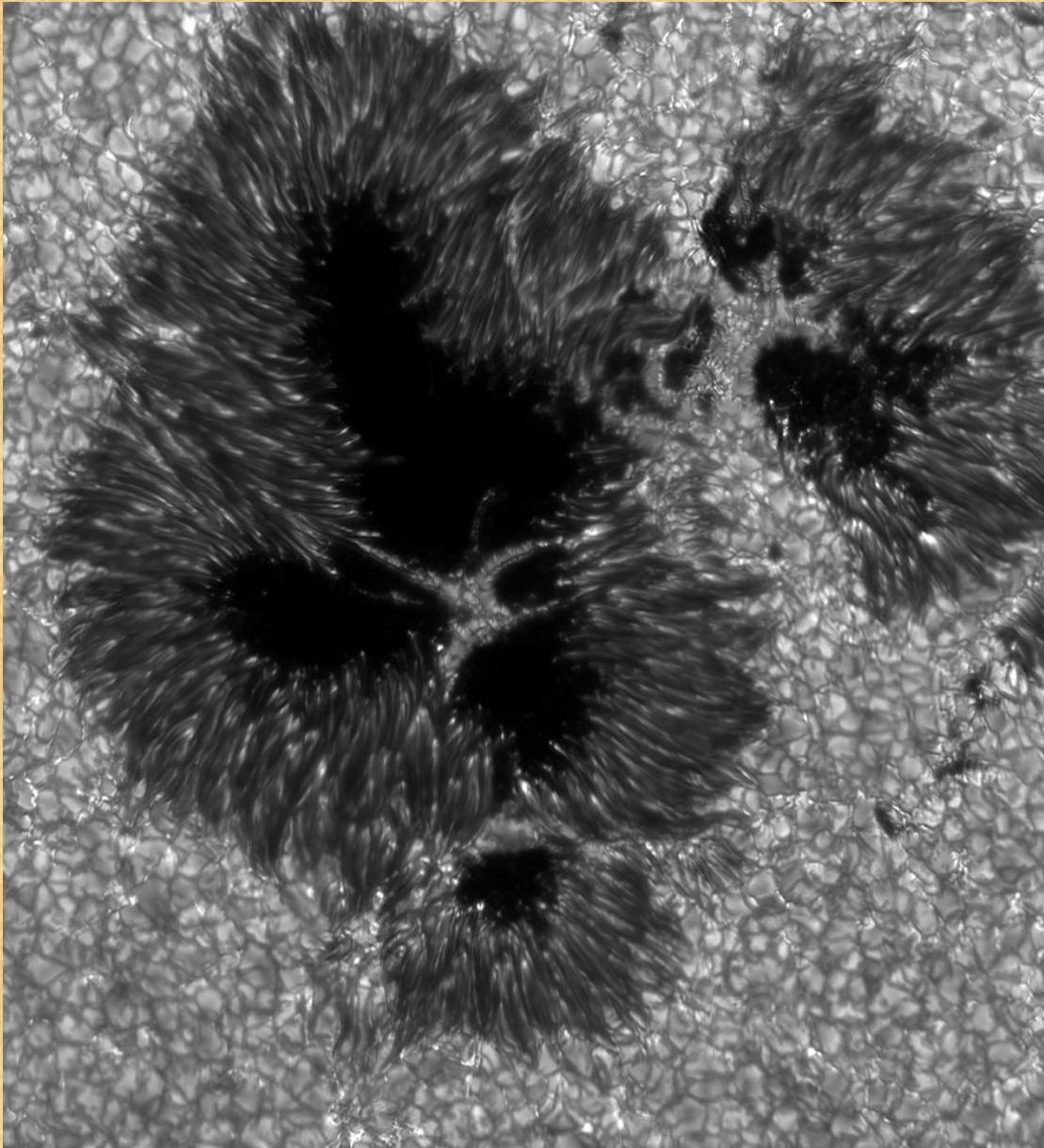
από το Σουηδικό ηλιακό τηλεσκόπιο <http://www.solarphysics.kva.se>
observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Active region in H α 1

Observations: Oddbjorn Engvold, Jun Elin Wiik, Luc Rouppe van der Voort, Oslo

Image processing: Luc Rouppe van der Voort, Oslo

Wavelength: 656.3 nm (H-alpha), Date: 22Aug200



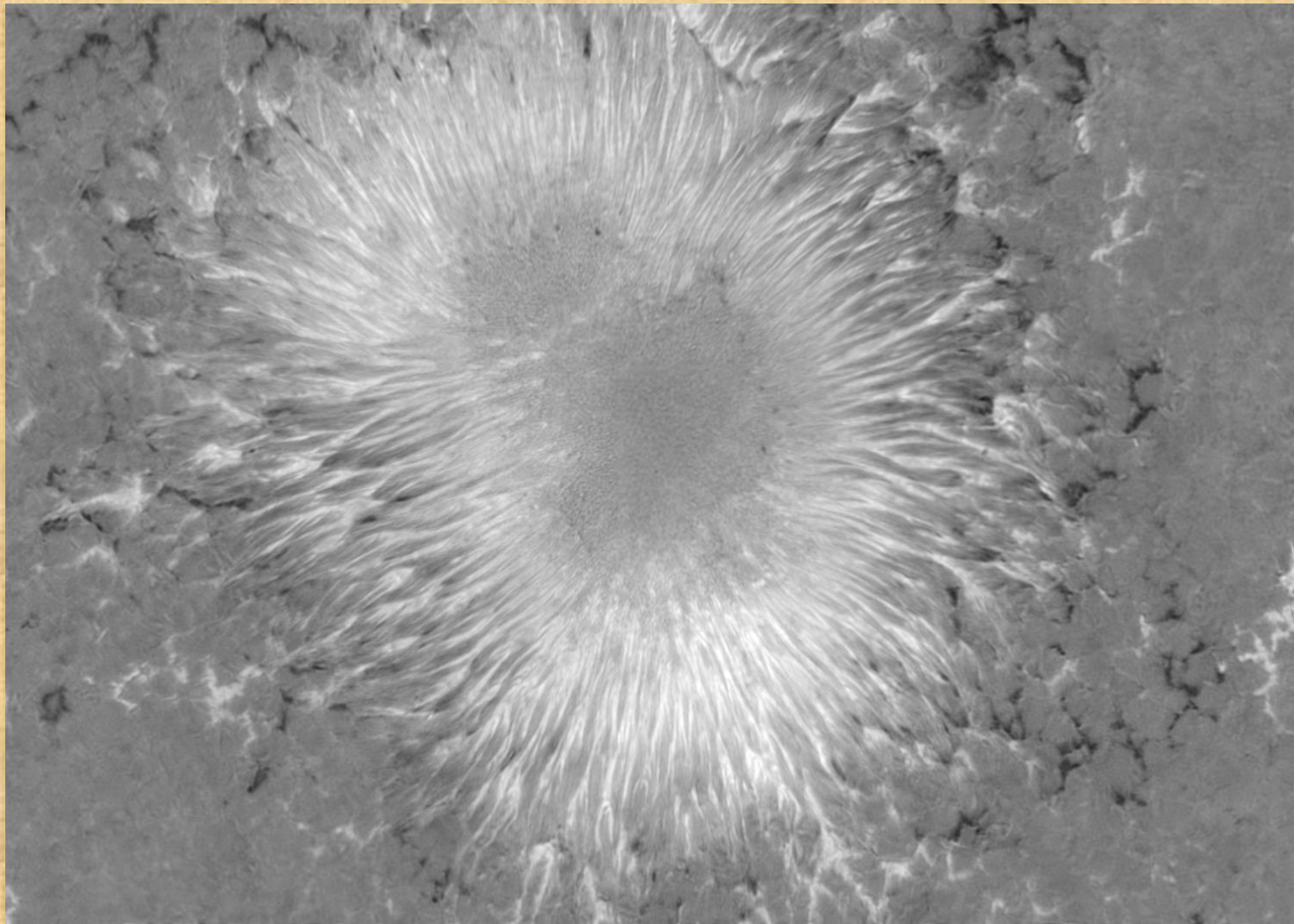
Κηλίδες με «γέφυρες φωτός»

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Light bridges

Observations: Mats Löfdahl, ISP
Image processing: Mats Löfdahl, ISP
Wavelength: 430.5 nm (G-band)
Target: AR 349
Date: 02May2003



Μαγνητόγραμμα κηλίδας

από το Σουηδικό ηλιακό τηλεσκόπιο <http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

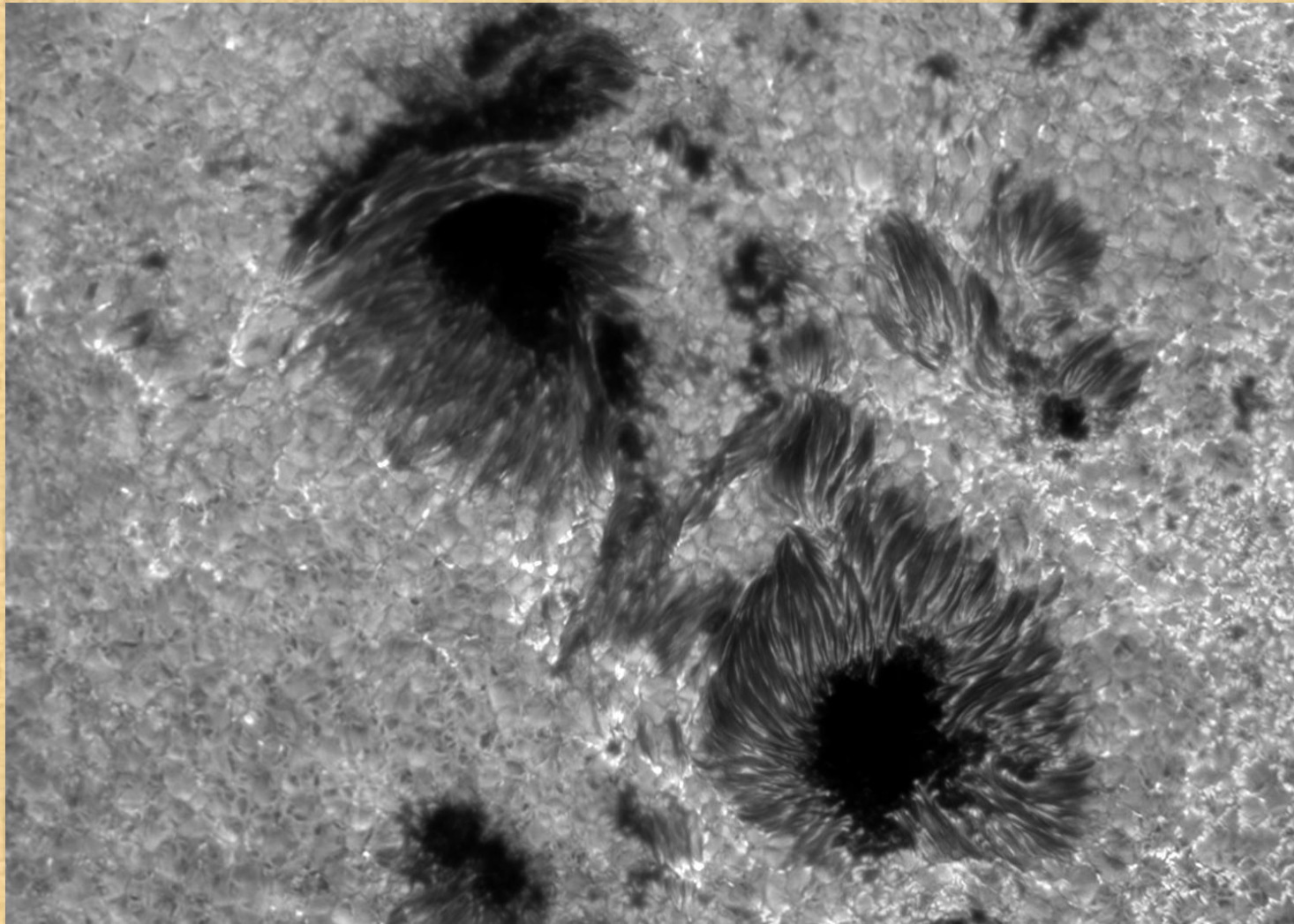
Large regular spot

Observations: Dan Kiselman, ISP

Image processing: Mats Löfdahl, ISP

Wavelength: **Magnetogram** at 630.2 nm (Fe I)

Target: AR 397 Date: 03Jul2003



Ομάδα κηλίδων

από το Σουηδικό ηλιακό τηλεσκόπιο <http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

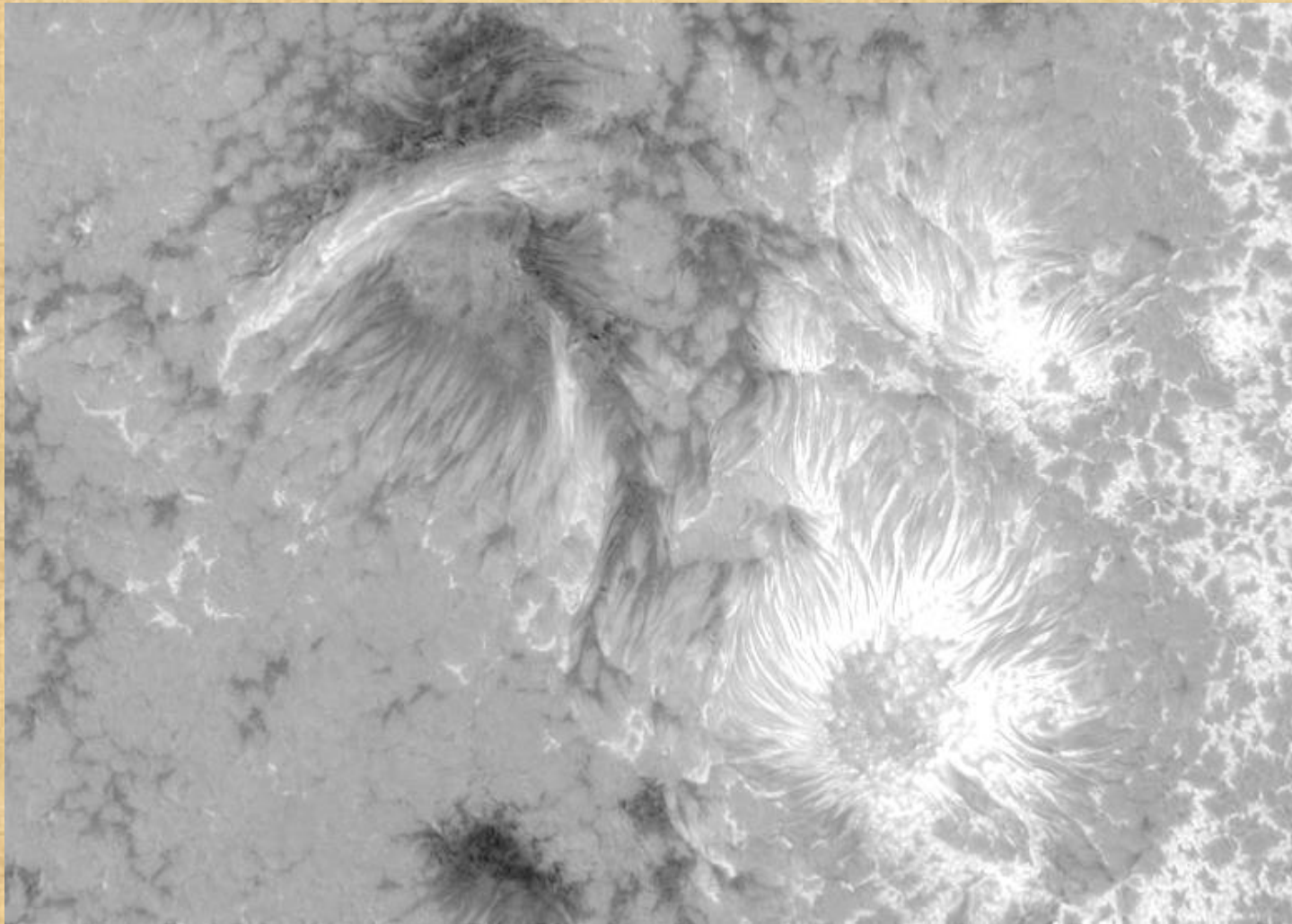
Sunspot group

Observations: Göran Scharmer and Kai Langhans, ISP

Image processing: Mats Löfdahl, ISP

Wavelength: 630.2 nm (Fe I)

Target: AR 431 Date: 14Aug2003



Μαγνητόγραμμα Ομάδας Κηλίδων

από το Σουηδικό ηλιακό τηλεσκόπιο <http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

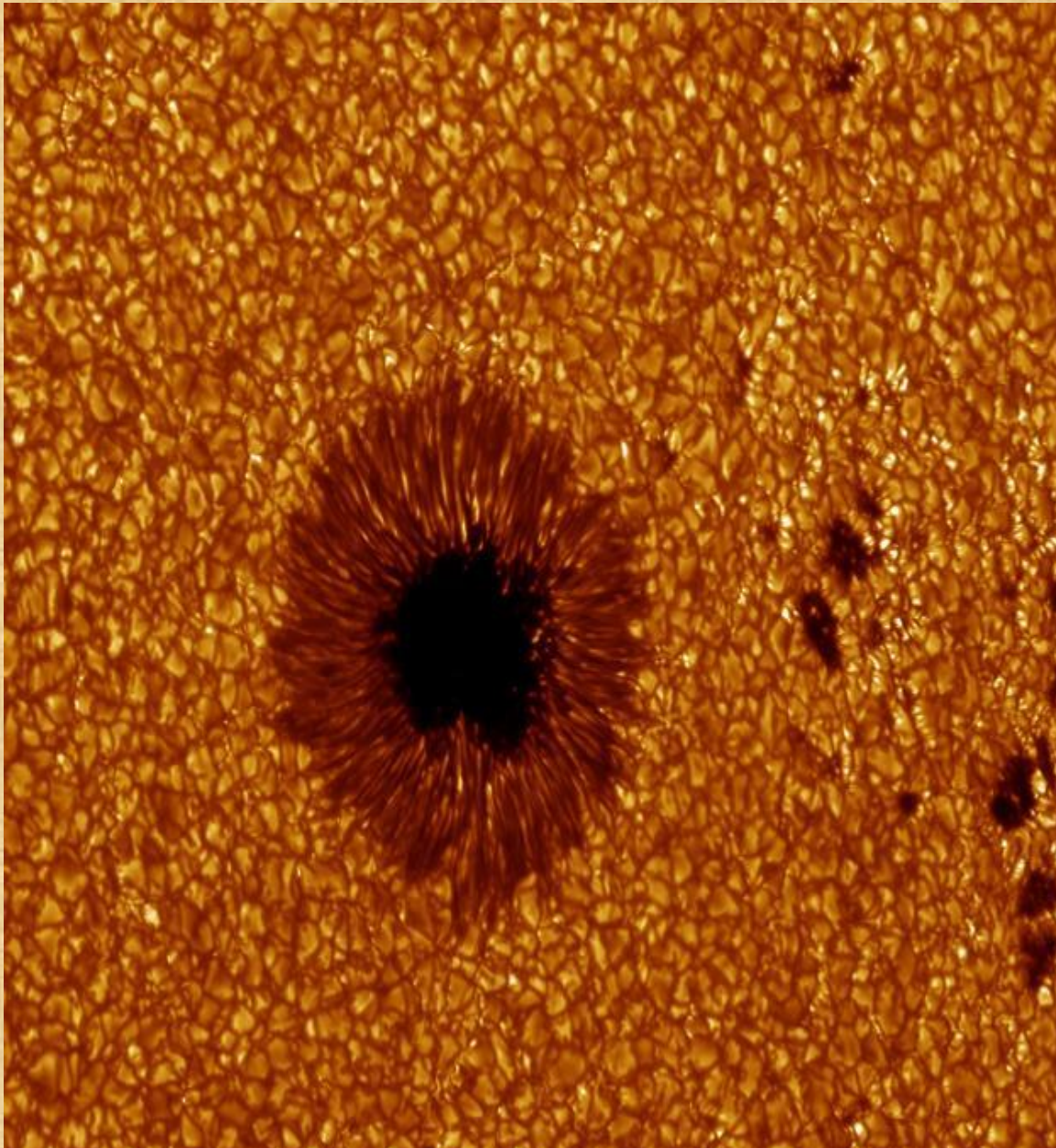
Sunspot group

Observations: Göran Scharmer and Kai Langhans, ISP

Image processing: Mats Löfdahl, ISP

Wavelength: Magnetogram at 630.2 nm (Fe I)

Target: AR 431, Date: 14Aug2003



Μικρή κηλίδα

στοσυνεχές
από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Small regular spot

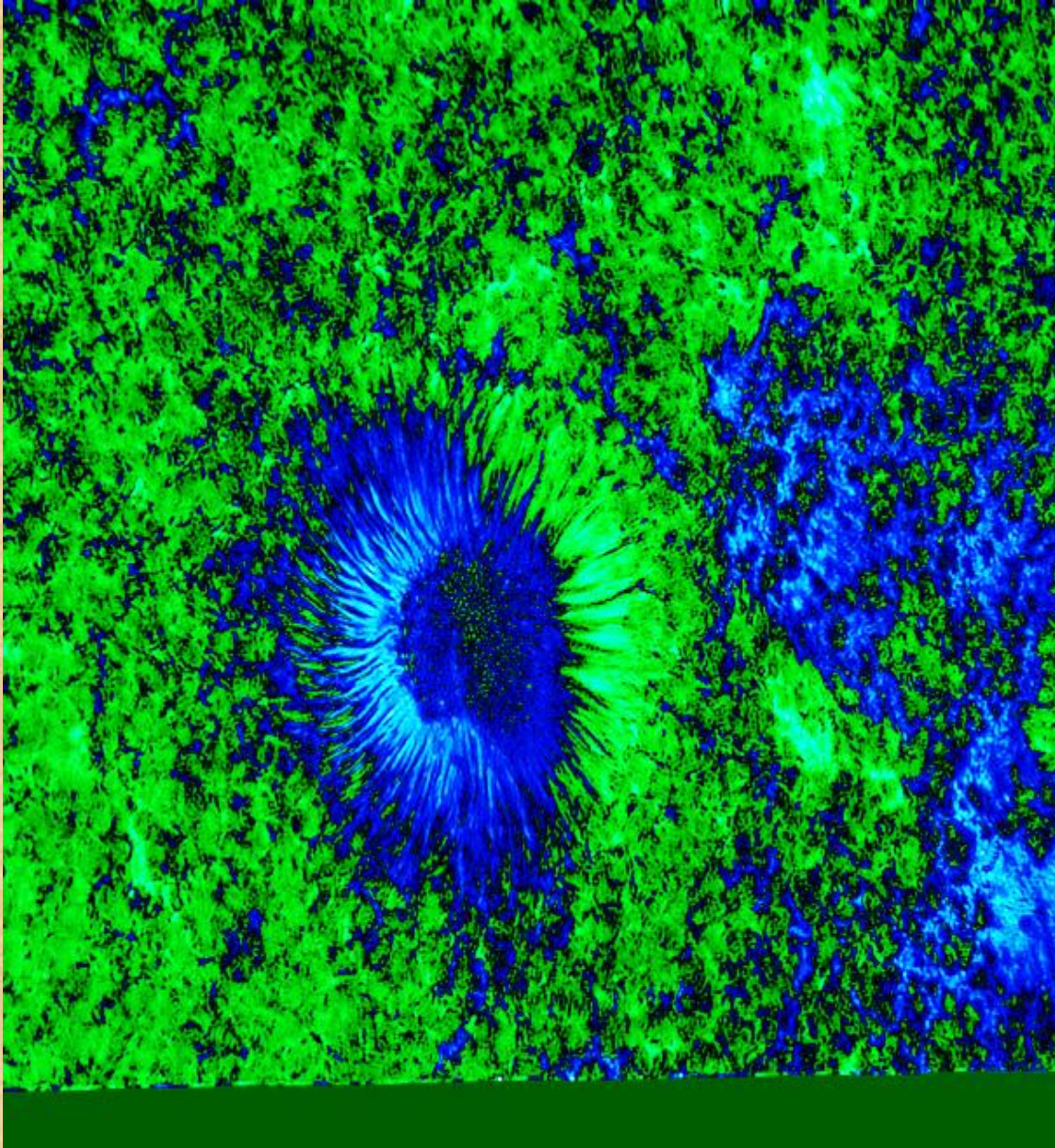
Observations: Göran Scharmer and Kai Langhans, ISP

Image processing: Mats Löfdahl, ISP

Wavelength: 436.4 nm (Continuum)

Target: AR 425 at $\theta=40.5^\circ$, $\mu=0.76$

Date: 04Aug2003



Μαγνητόγραμμα Μικρής κηλίδας

Πράσινο και γαλάζιο
απεικονίζουν βόρεια και
νότια μαγνητικά πεδία.
Προσεξτε πώς
εναλλάσσονται τα πεδία

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

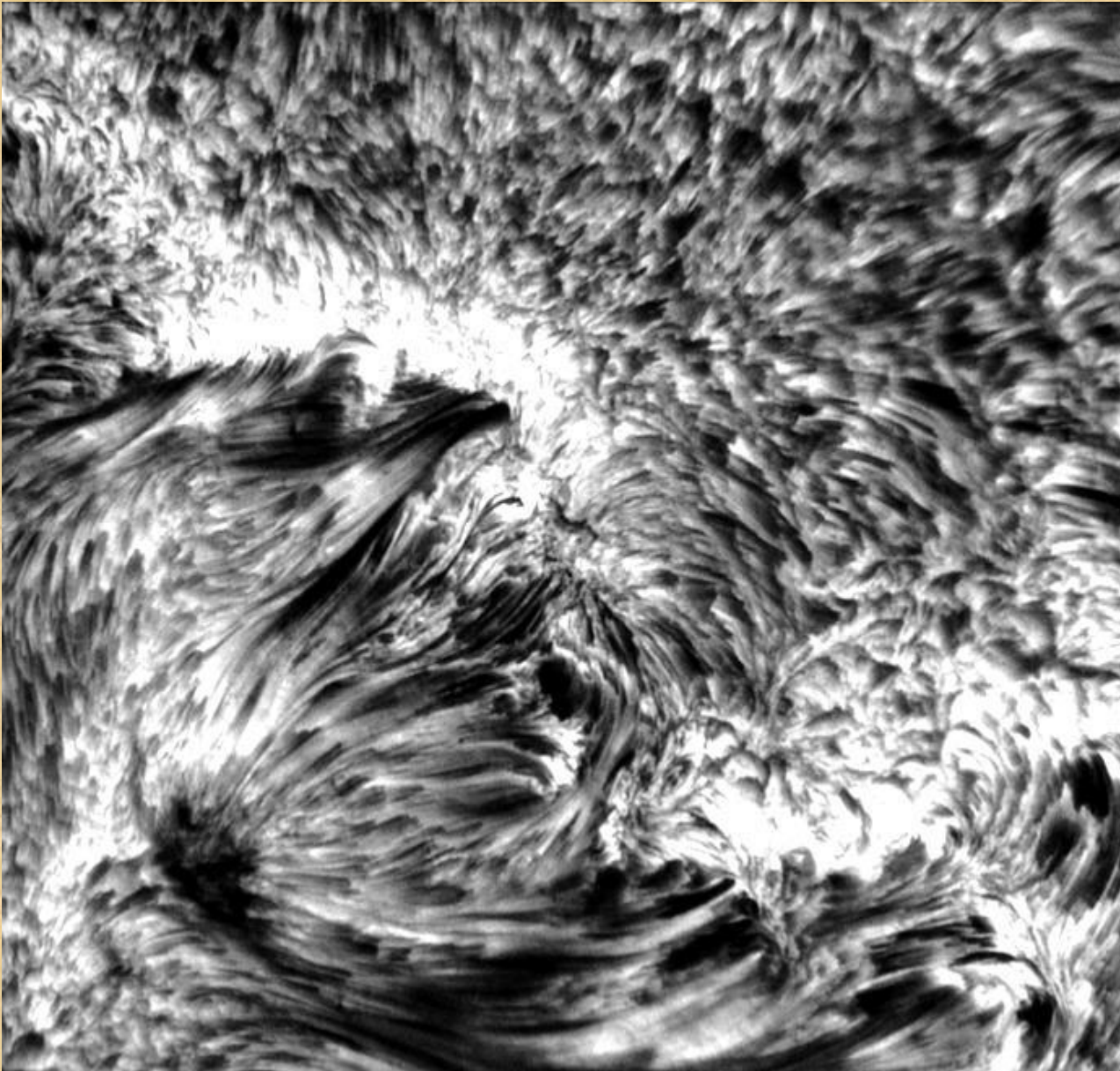
observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Small regular spot

Observations: Göran Scharmer and Kai Langhans, ISP

Image processing: Mats Löfdahl, ISP
Wavelength: Magnetogram at 630.2 nm (Fe I)

Target: AR 425 at $\theta=40.5^\circ$, $\mu=0.76$
Date: 04Aug2003



Ενεργός περιοχή με λαμπρές περιοχές

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m Solar Telescope (SST). The SST is operated on the island of La Palma by the Institute for Solar Physics in the Spanish Observatorio del Roque de los Muchachos of the Instituto de Astrofísica de Canarias.

Active region with faculae, near red wing of H α

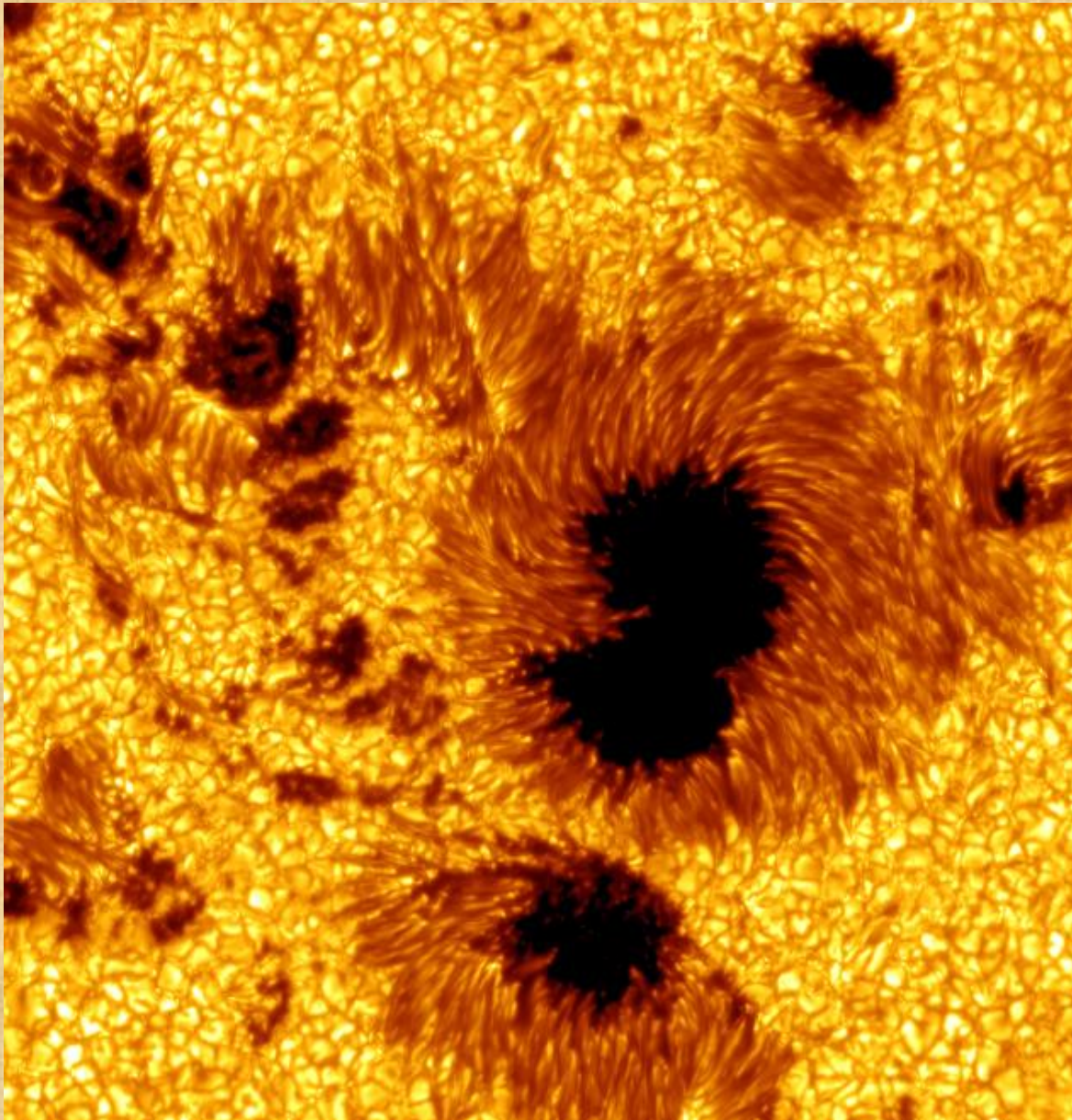
Observations: Bart De Pontieu, LMSAL

Image processing: Bart De Pontieu, LMSAL

Wavelength: 656.3 + 0.035 nm (H-alpha)

Target: Stonyhurst S15 W50, $\theta=51^\circ$, $\mu=0.6$

Date: 16Jun2003



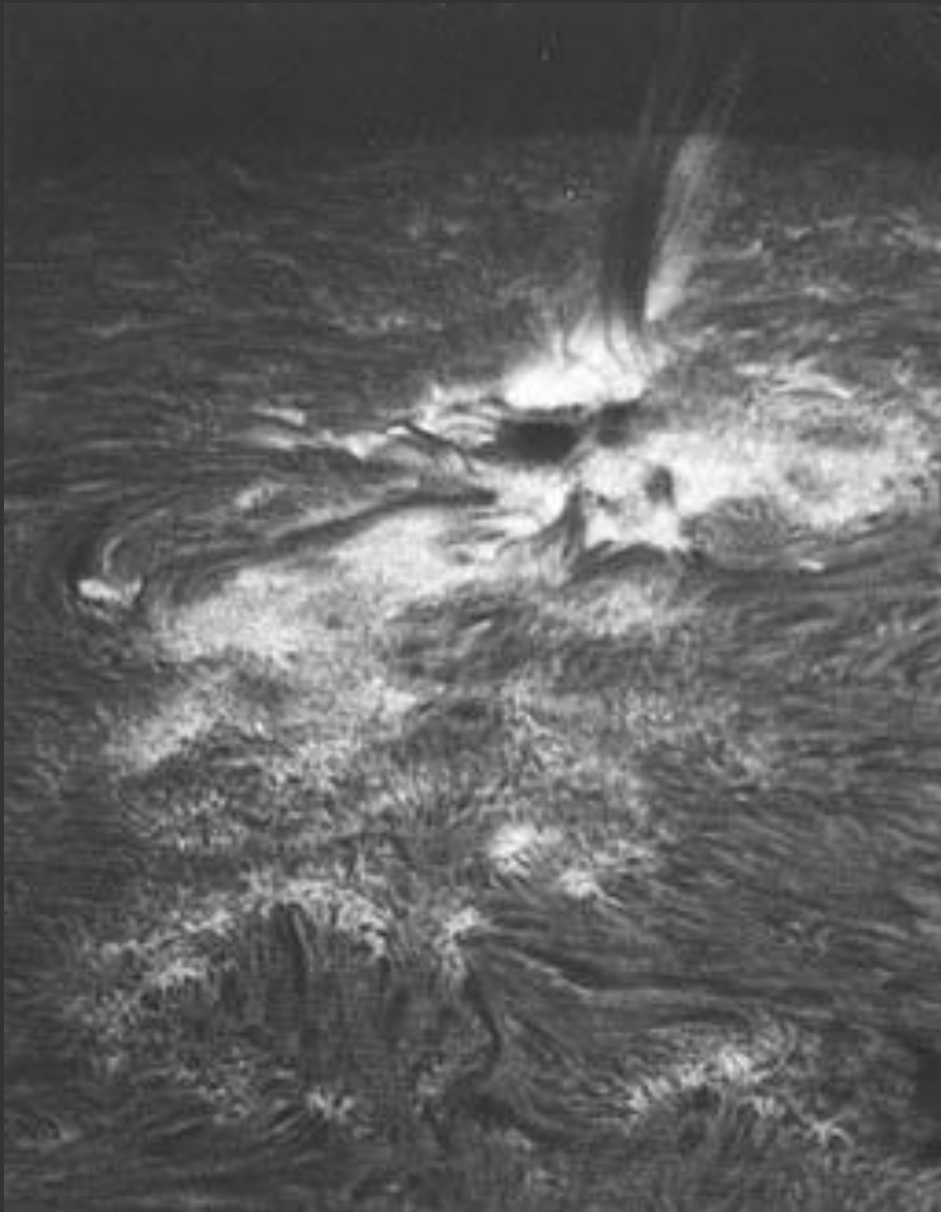
Κηλίδες με έντονη παρασκιά

από το Σουηδικό ηλιακό τηλεσκόπιο
<http://www.solarphysics.kva.se>

observed with the Swedish 1-m
Solar Telescope (SST). The SST is
operated on the island of La Palma
by the Institute for Solar Physics in
the Spanish Observatorio del Roque
de los Muchachos of the Instituto de
Astrofísica de Canarias.

Dark penumbral cores

Observations: Göran Scharmer, ISP
Image processing: Mats Löfdahl, ISP
Wavelength: 487.7 nm
Target: AR10030
Date: 15 Jul 2002



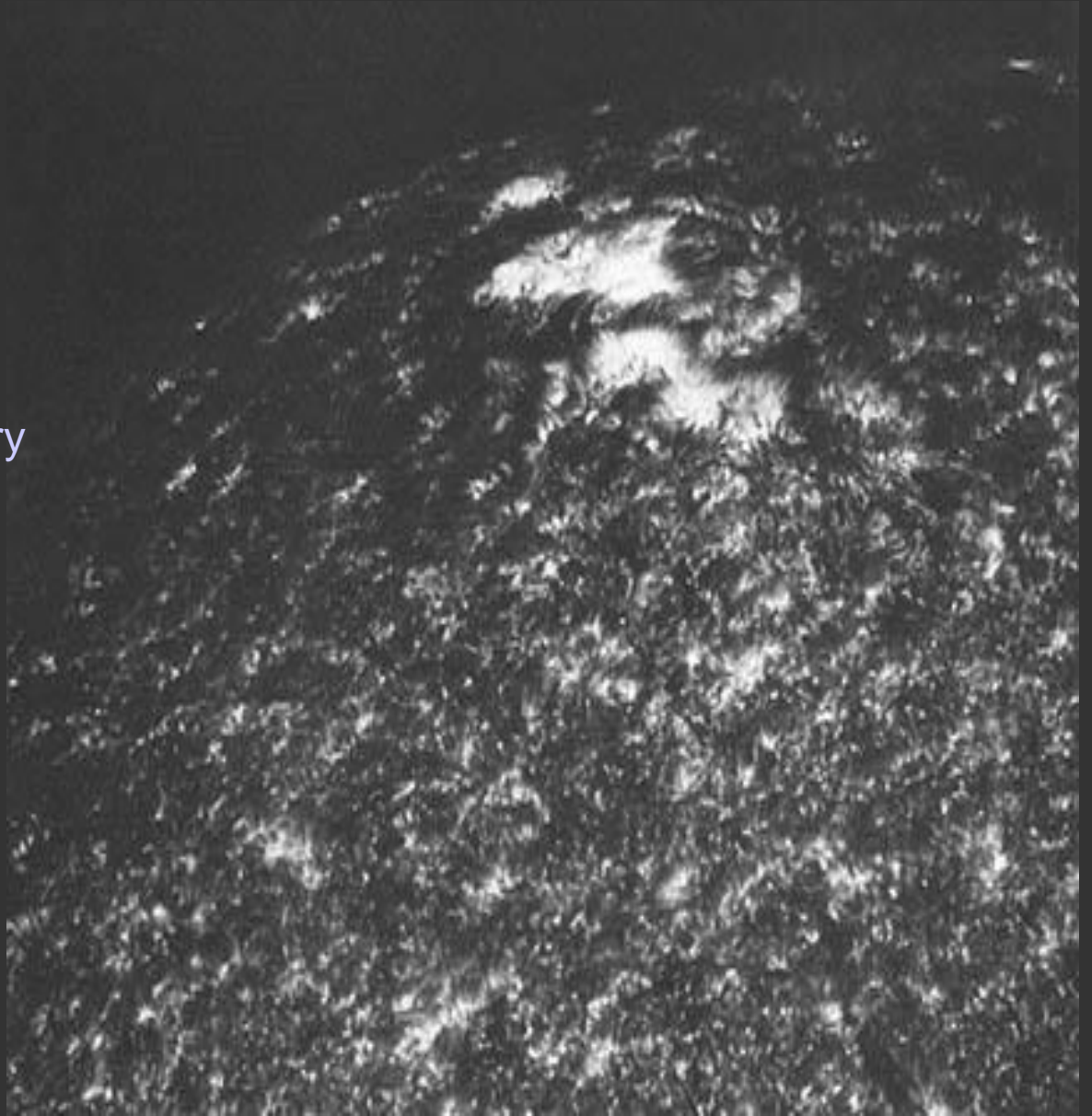
Χρωμόσφαιρα (H α)
διακρίνεται έκλαμψη
(εκρηκτική προεξοχή) σε
ενεργό περιοχή

,
Big Bear Solar Observatory
22/5/1970.

Θερμό και πυκνό υδρογόνο
(H α) σε ενεργό περιοχή
("plages")
πάνω από κηλίδες

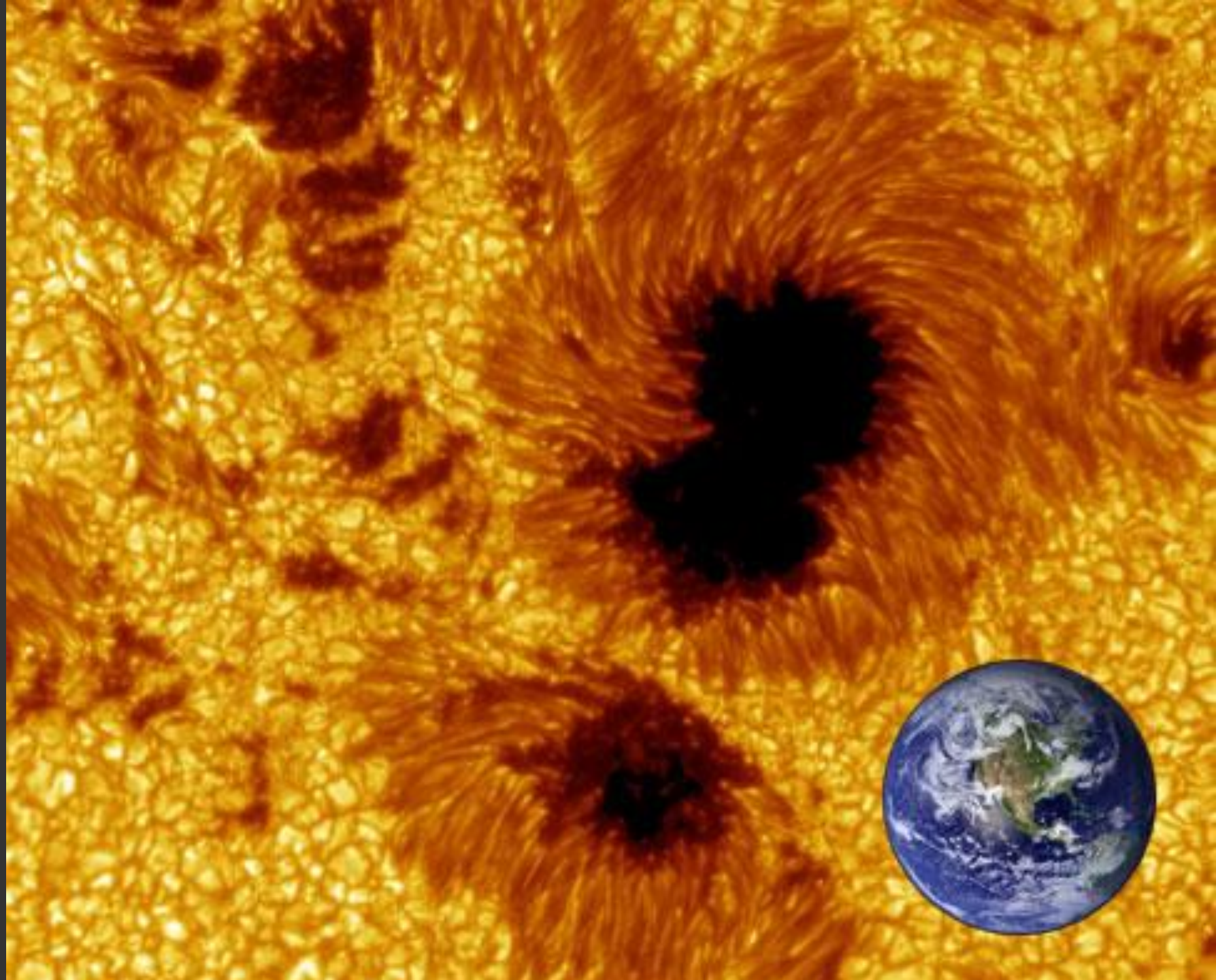
διακρίνονται σκοτεινά
νήματα

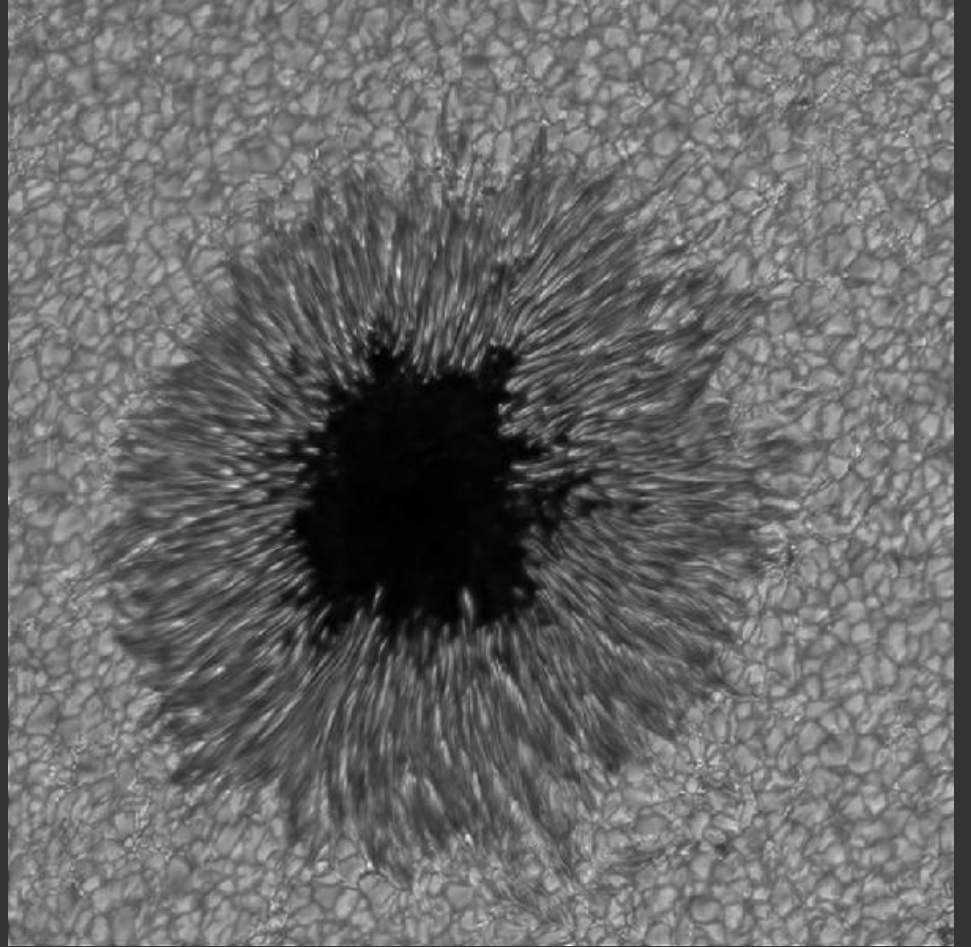
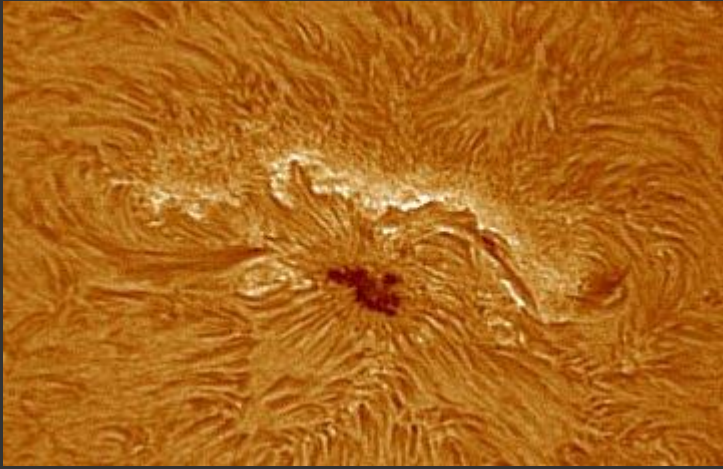
Υπερκοκκίαση
(διαμέτρου 30 000 km)
στην ανώτερη χρωμόσφαιρα
Bruce Gillespie
Kitt Peak National Observatory
17/9/1975.
εικόνα με πολύ στενό φίλτρο
ιονισμένου ασβεστίου



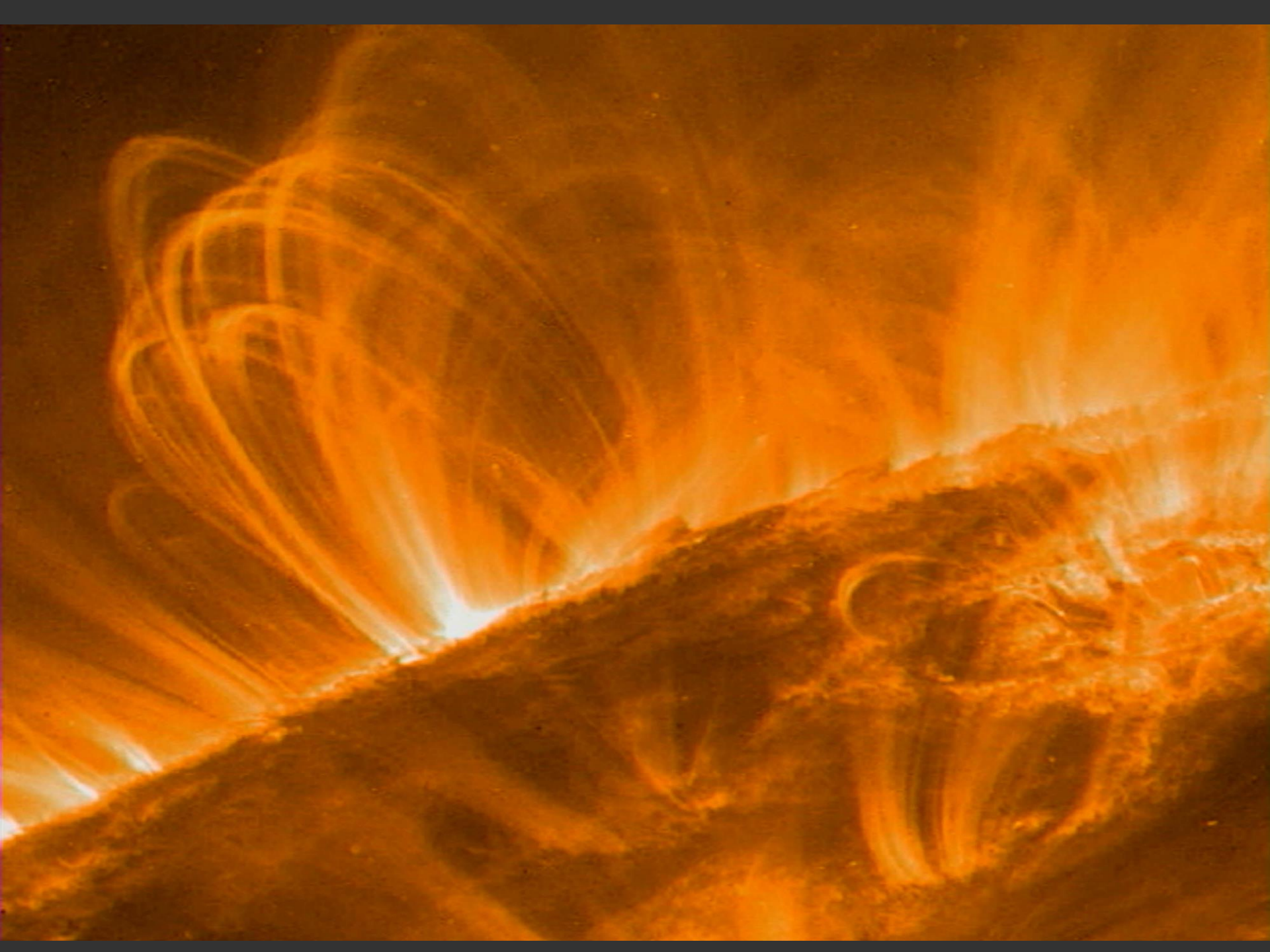
έκλαμψη

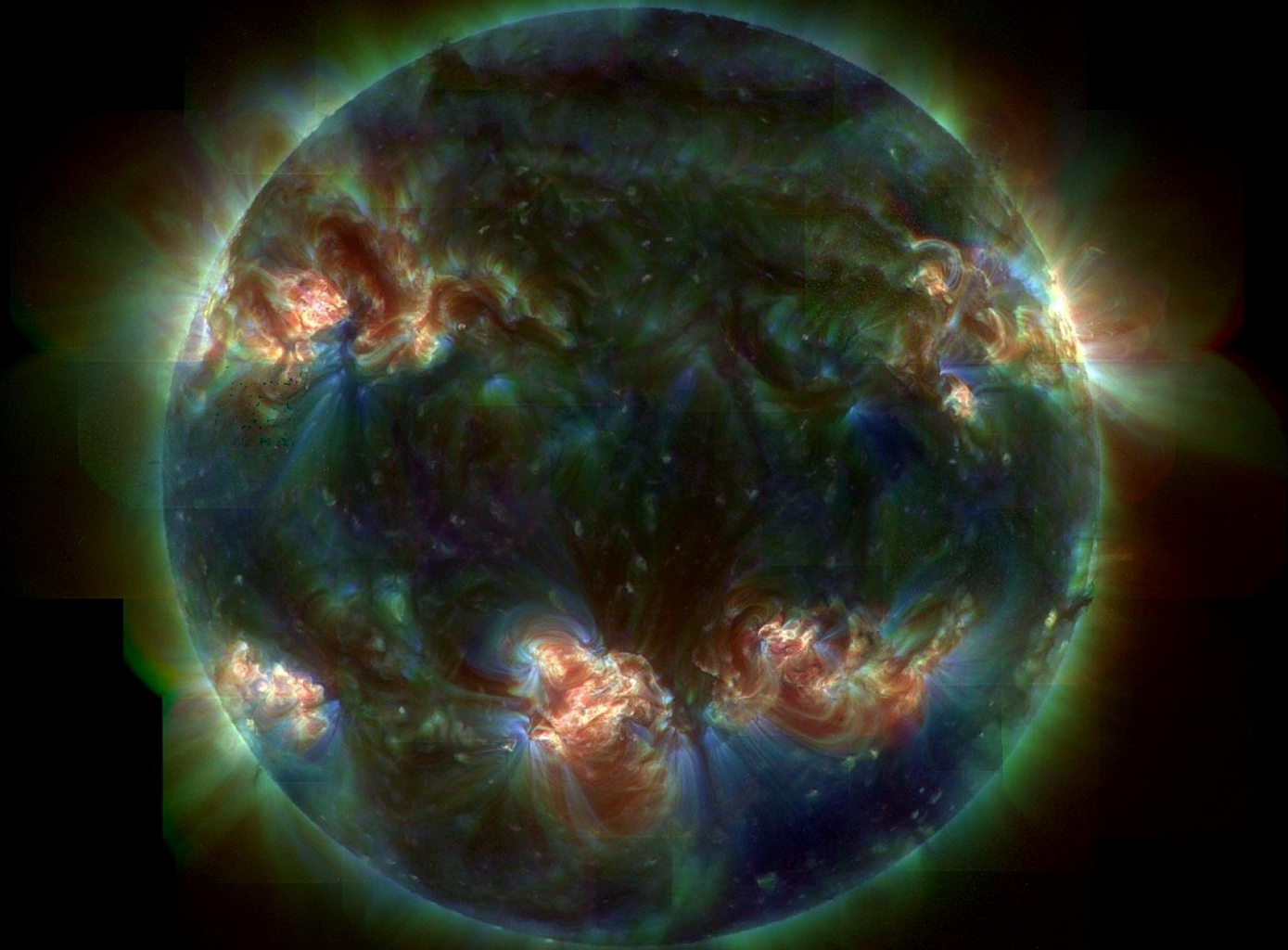


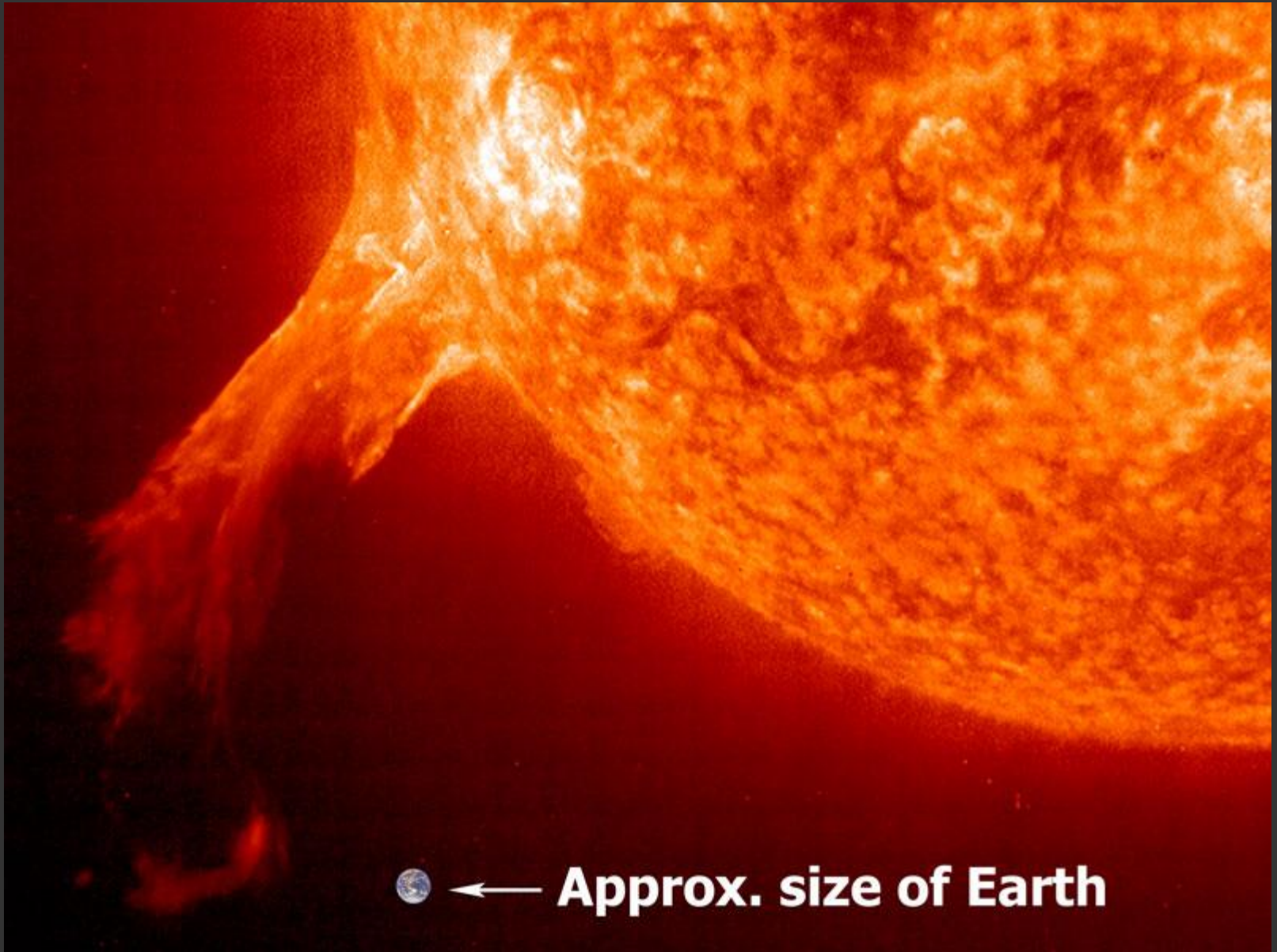







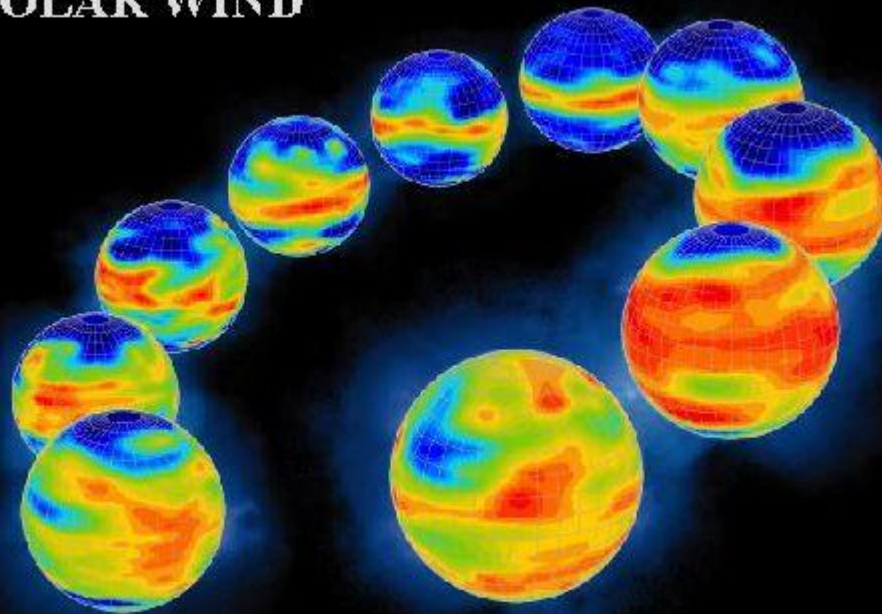




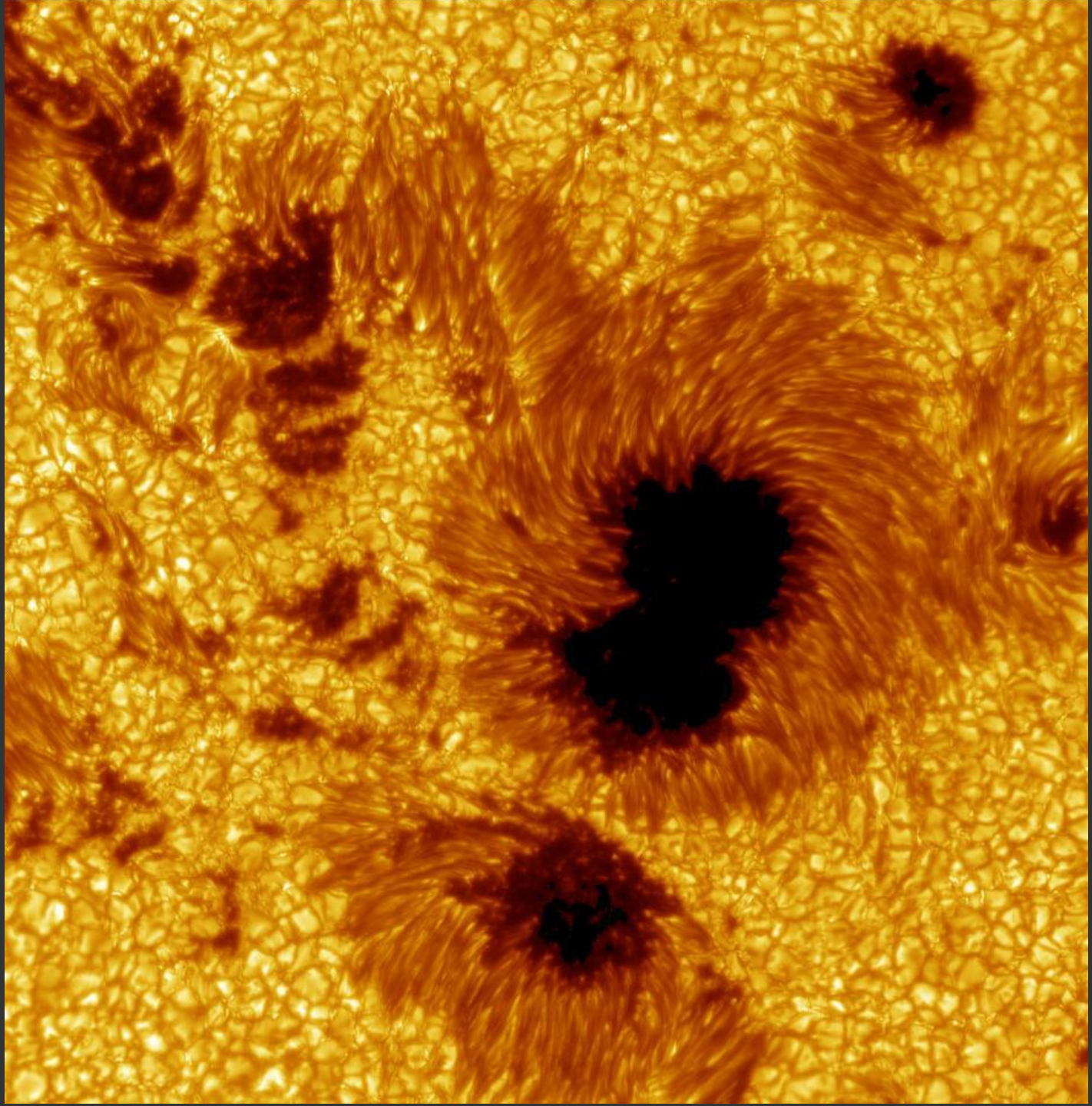


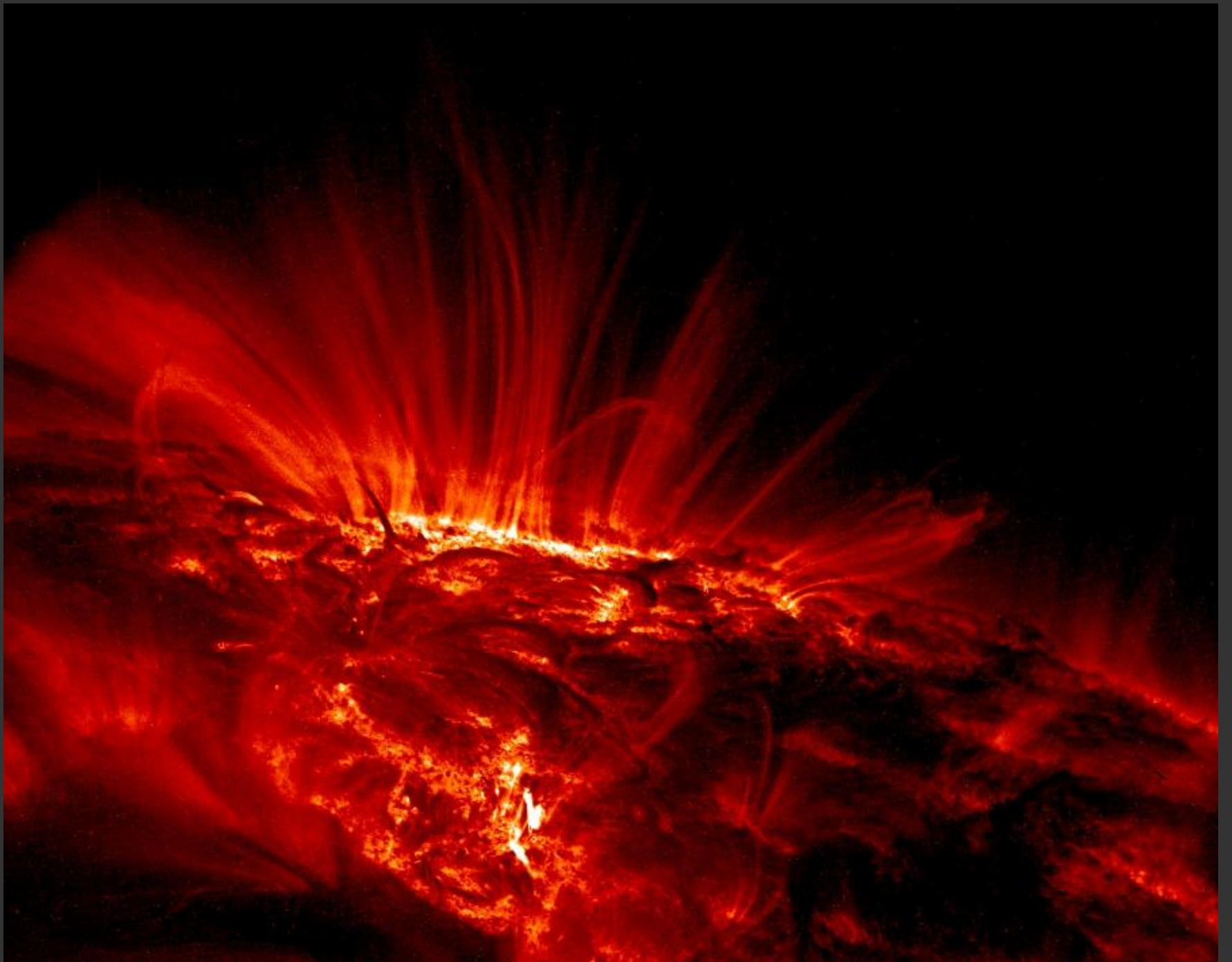
 ← **Approx. size of Earth**

THE SOLAR CYCLE IN SOLAR WIND



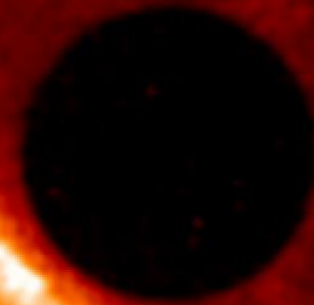
SOLAR-TERRESTRIAL ENVIRONMENT LABORATORY, NAGOYA UNIV.

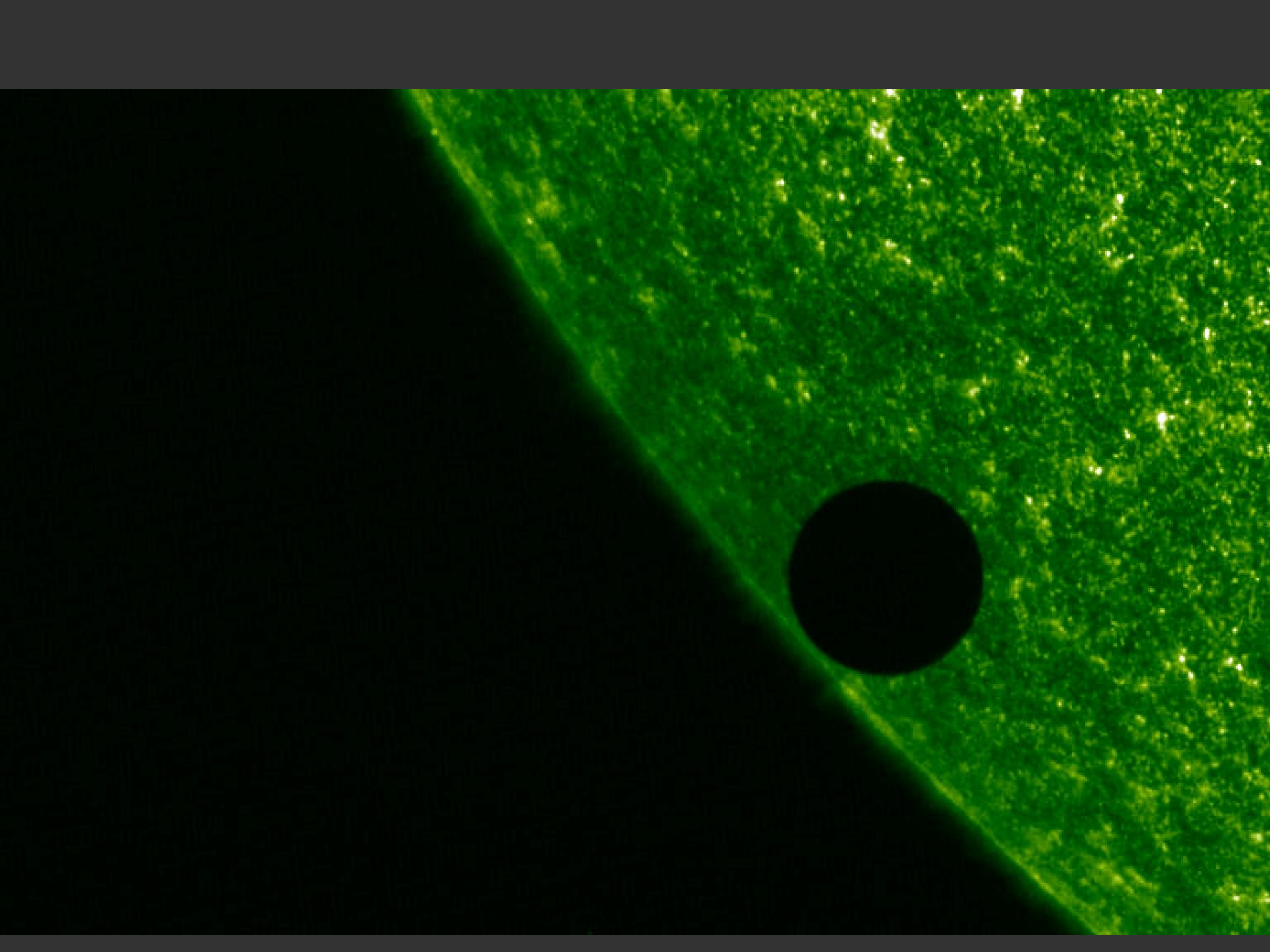




The Venus transit revisited:

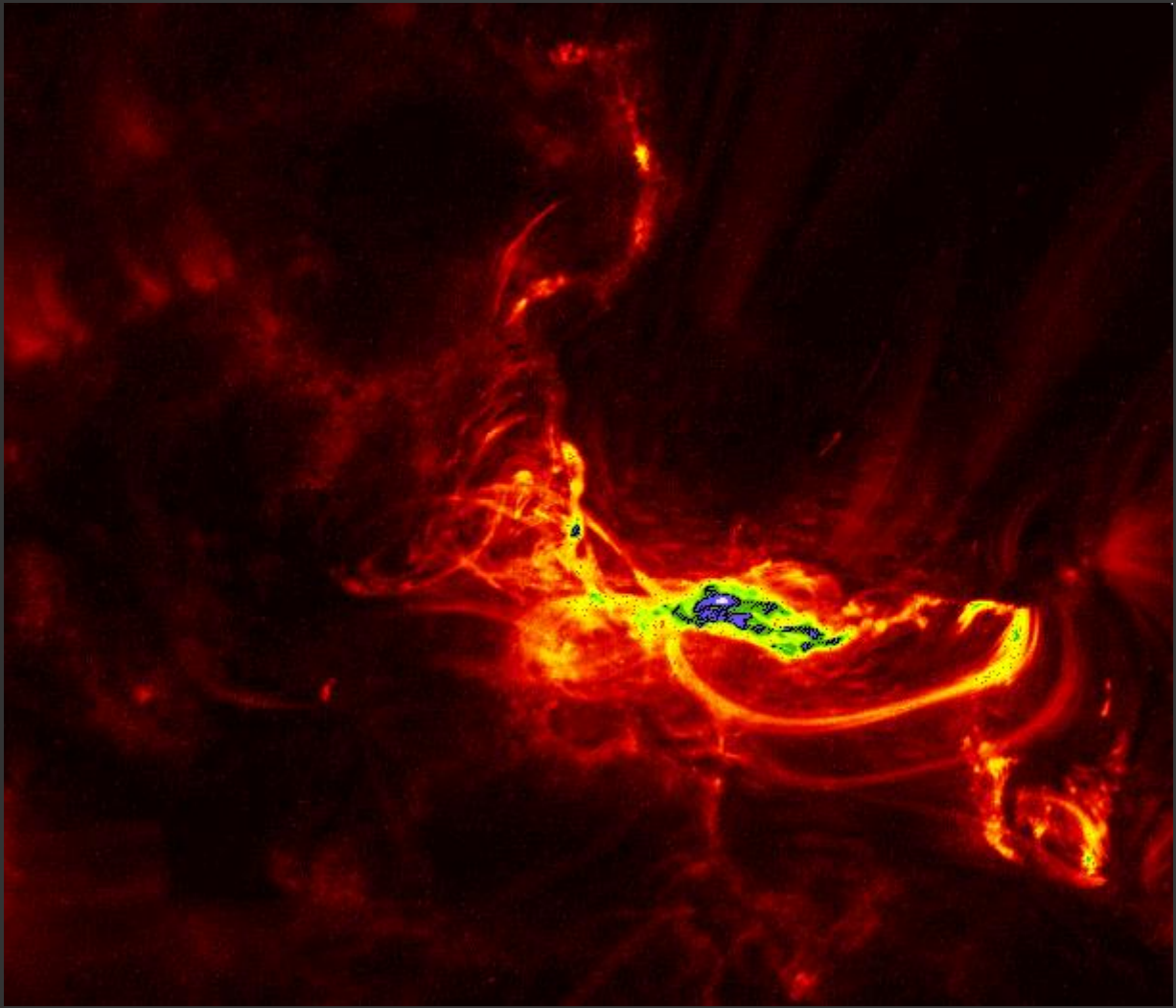
These three images show Venus at the start of its 2004/06/08 transit. The images were taken in the coronal 171\AA , transition-region 1600\AA , and white-light channels of TRACE. The 171\AA image was taken at 05:39:17 UT, the 1600\AA one only 4 seconds later, and the visible-light image 27 seconds earlier. These times differ so little that Venus moved very little in that period relative to the Sun. This reveals an interesting phenomenon about the Sun: the Sun's apparent size depends on the color of the light used to observe it. This is clearly visible in this set of images: in the visible-light image, Venus just touches the edge of the Sun, but it appears to lie well away from it on the other two images: the Sun appears to be almost 10,000 km larger in the extreme ultraviolet 171\AA image than it is to the naked eye. The same effect was seen years before with TRACE during the 1999

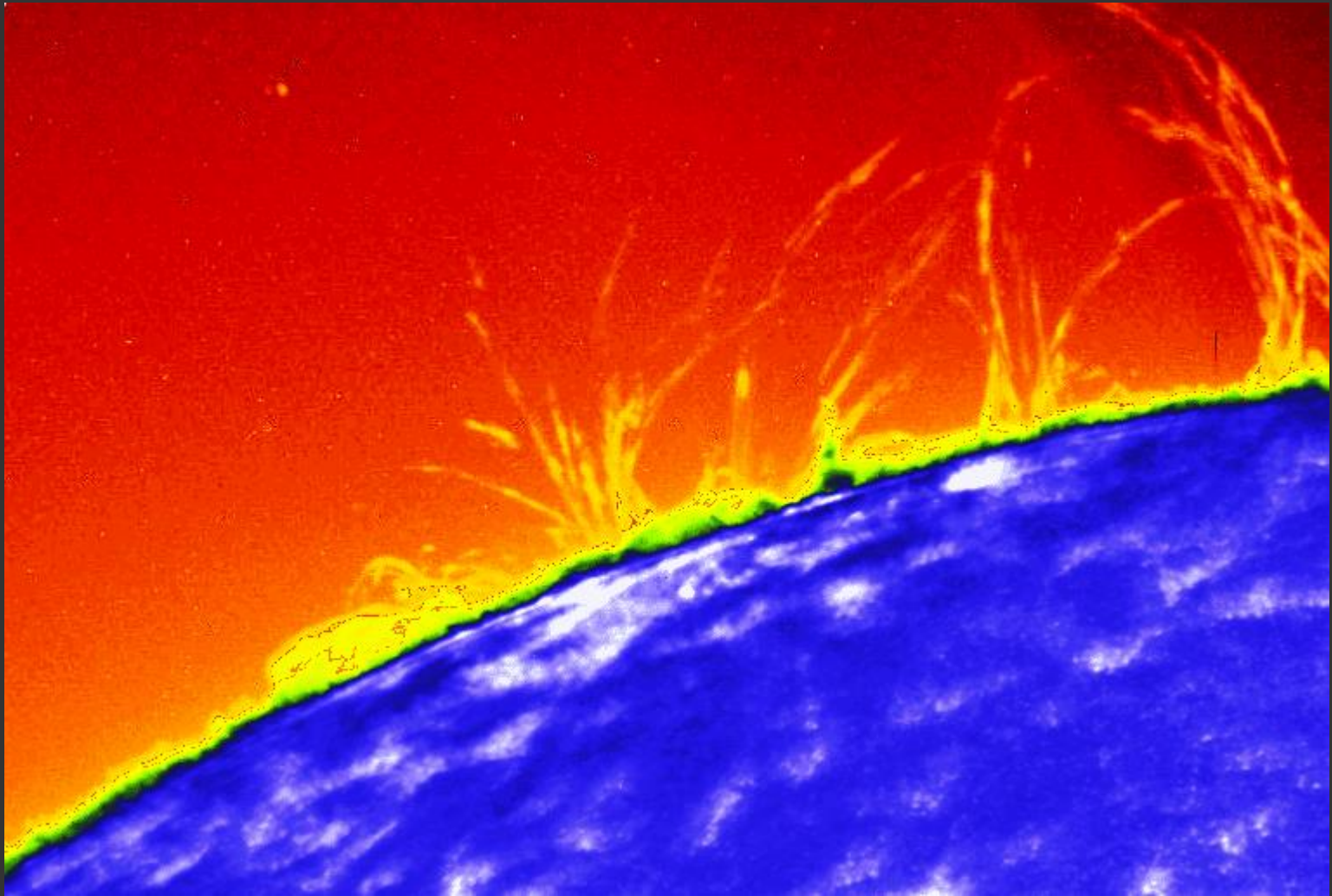


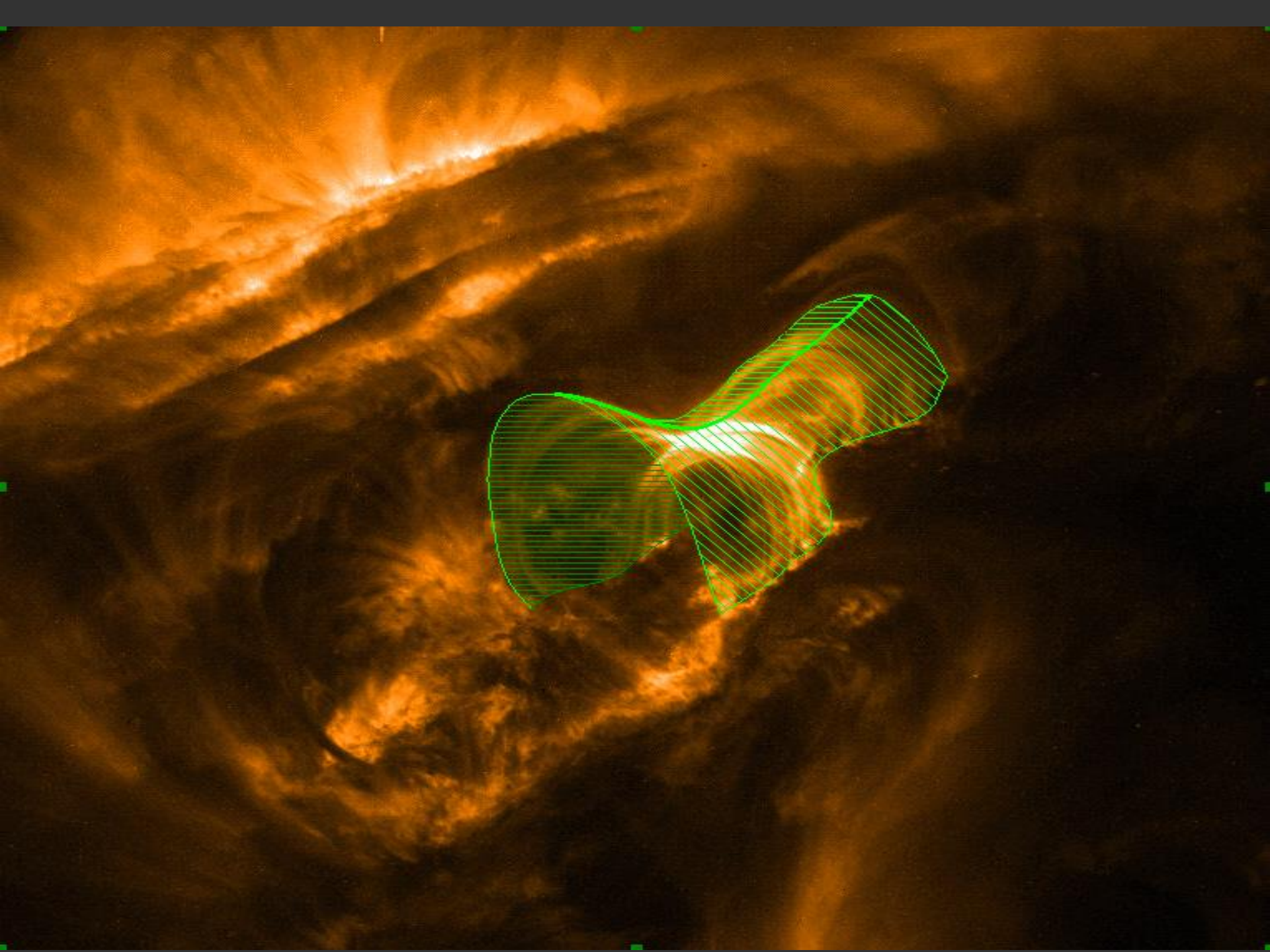


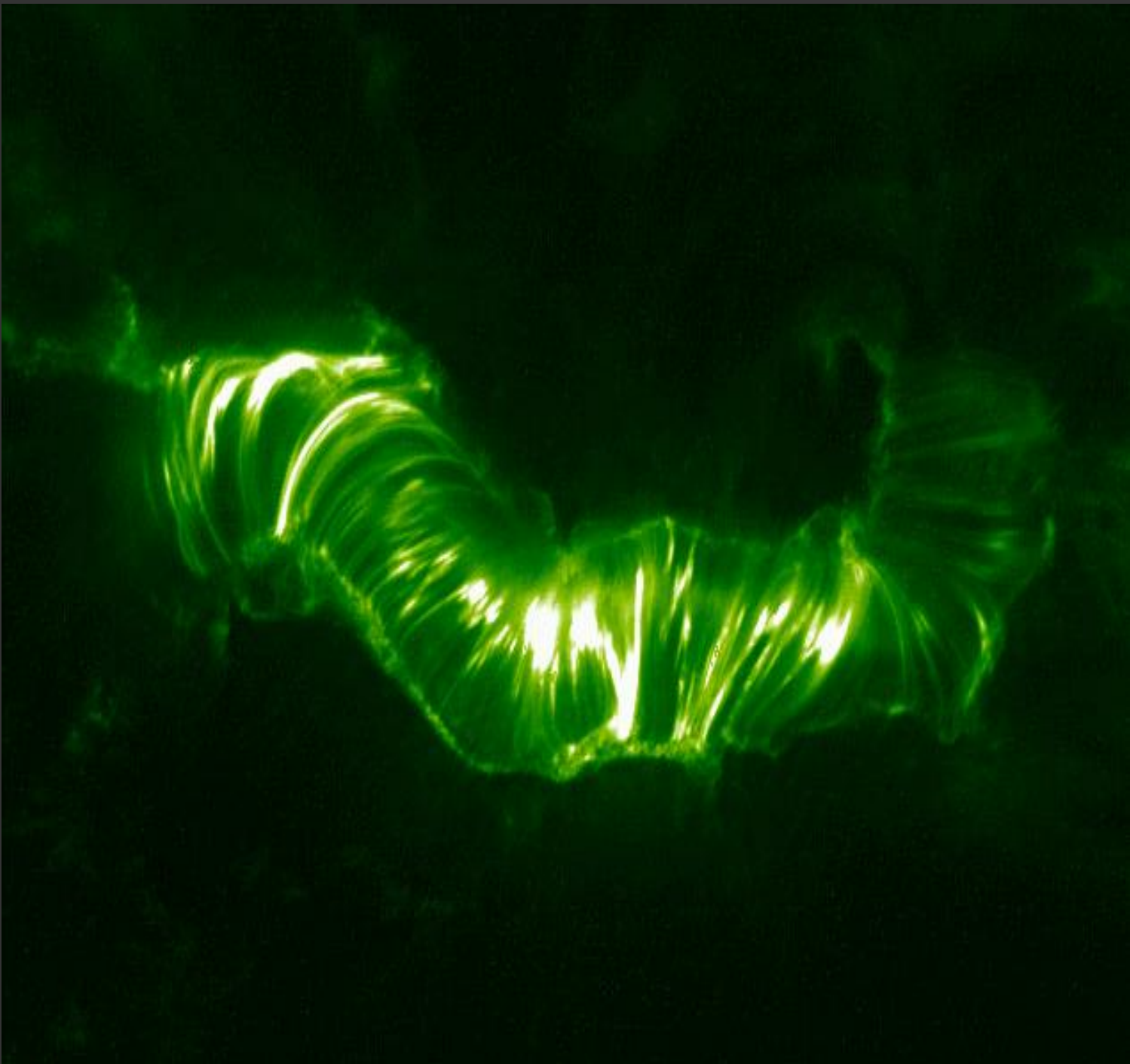
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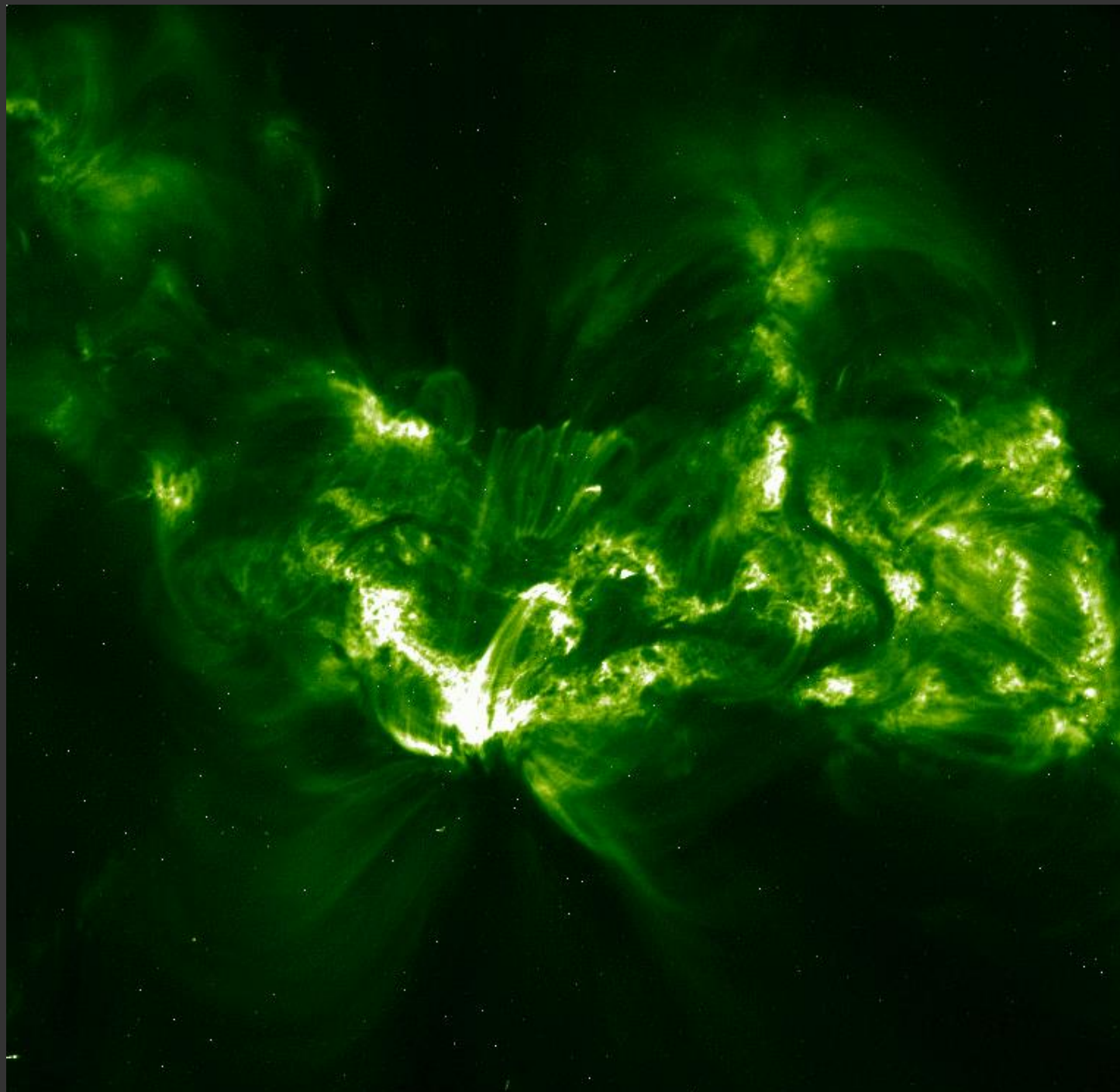


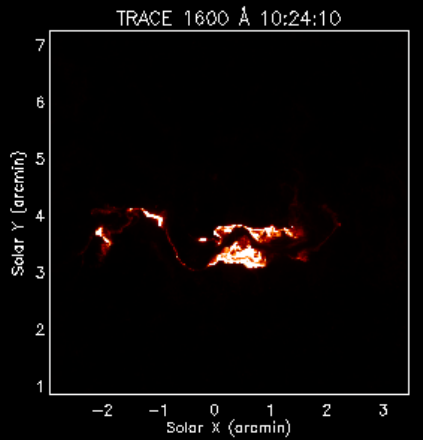
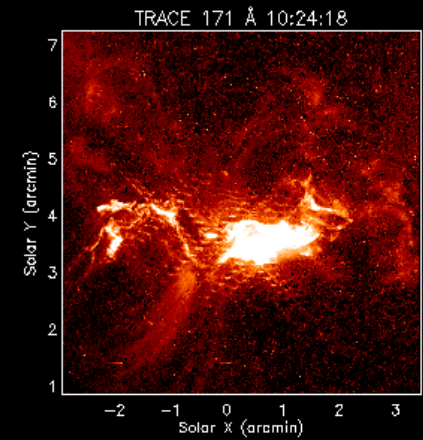
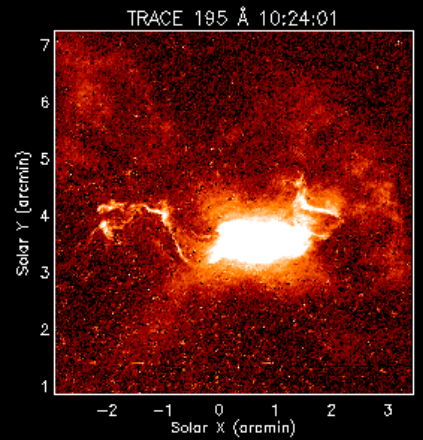
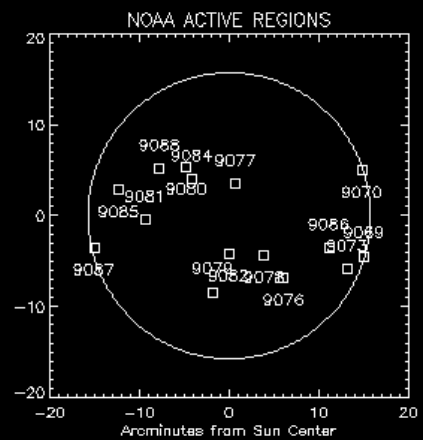
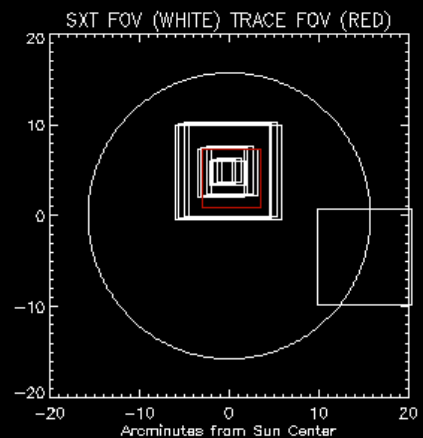
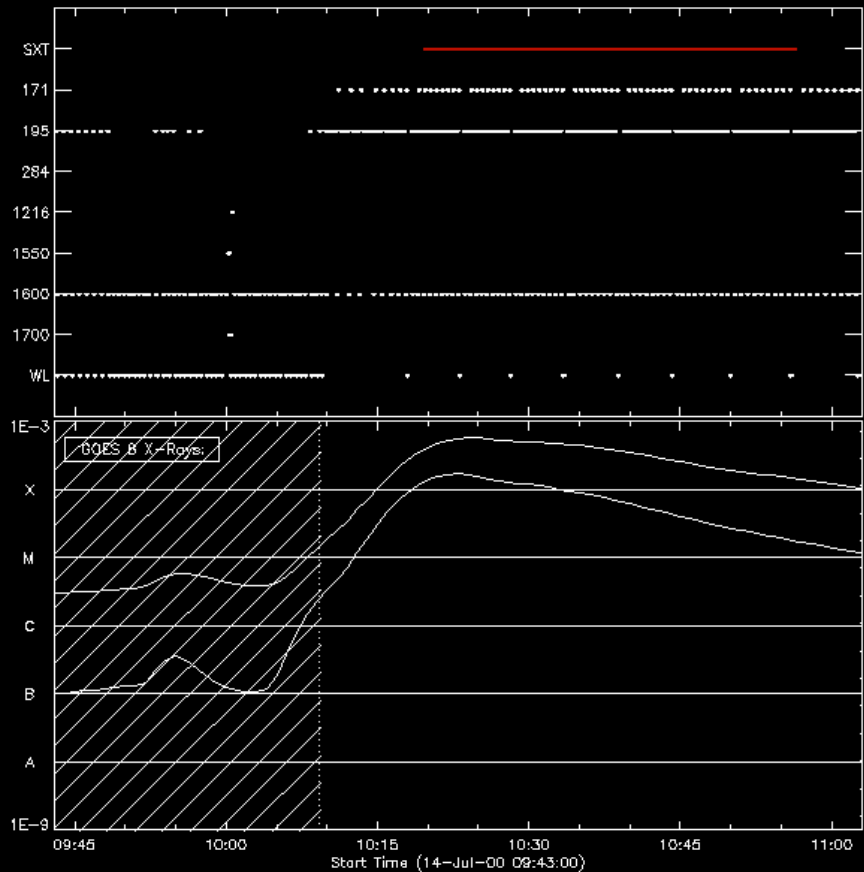


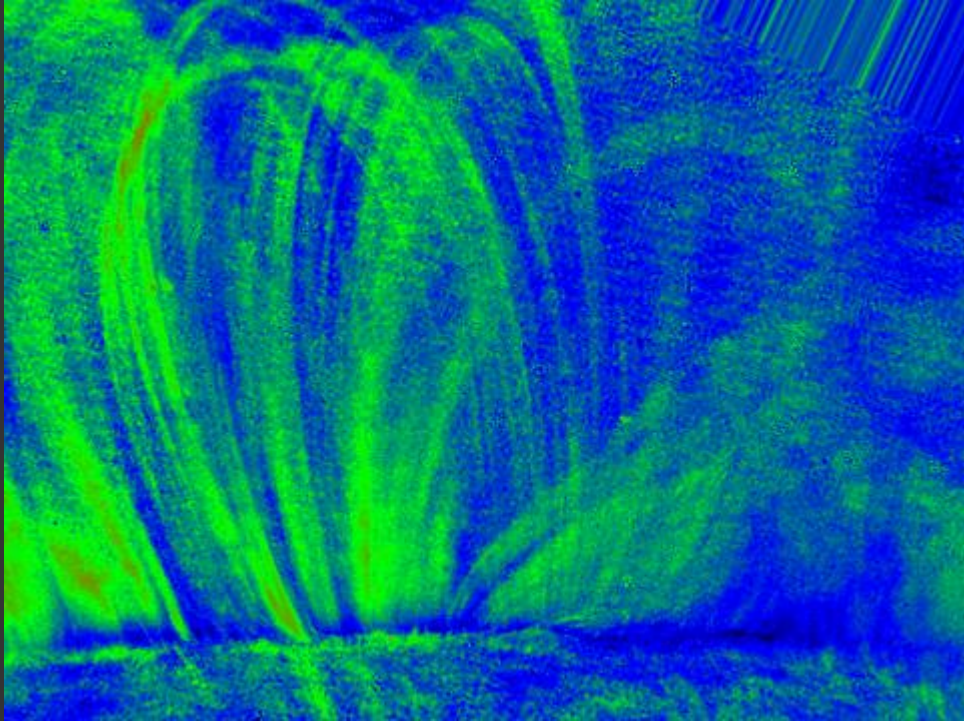


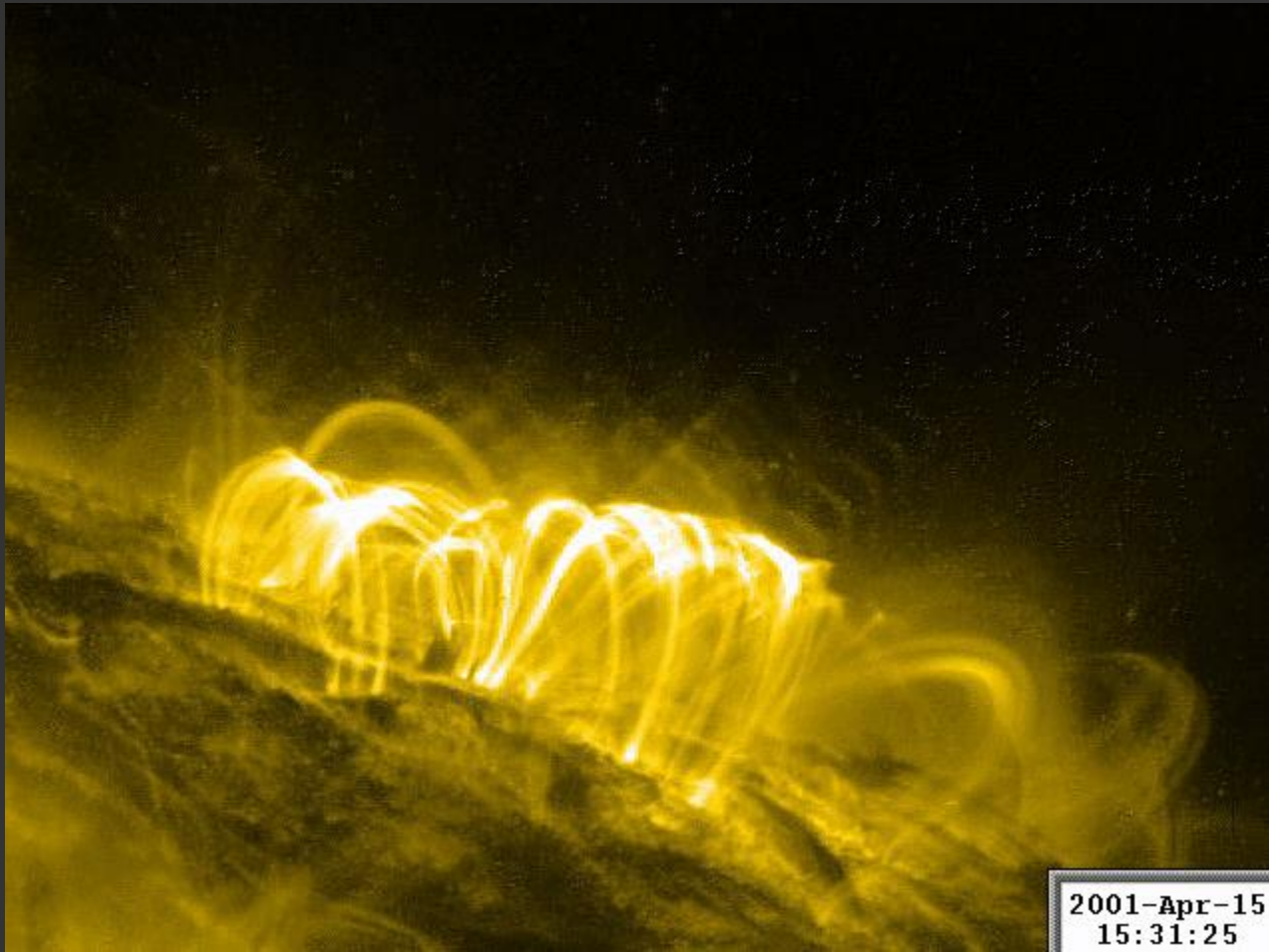




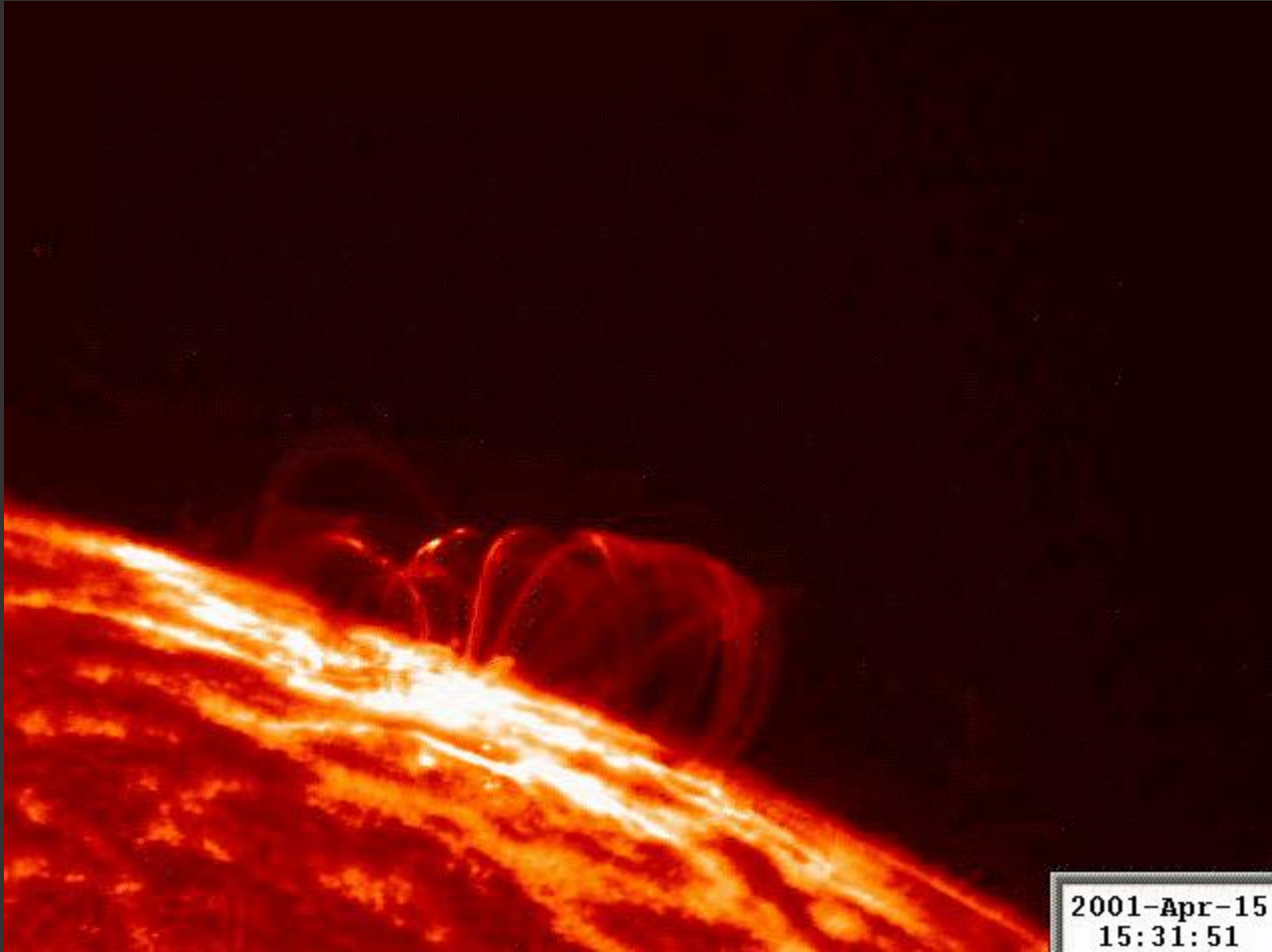


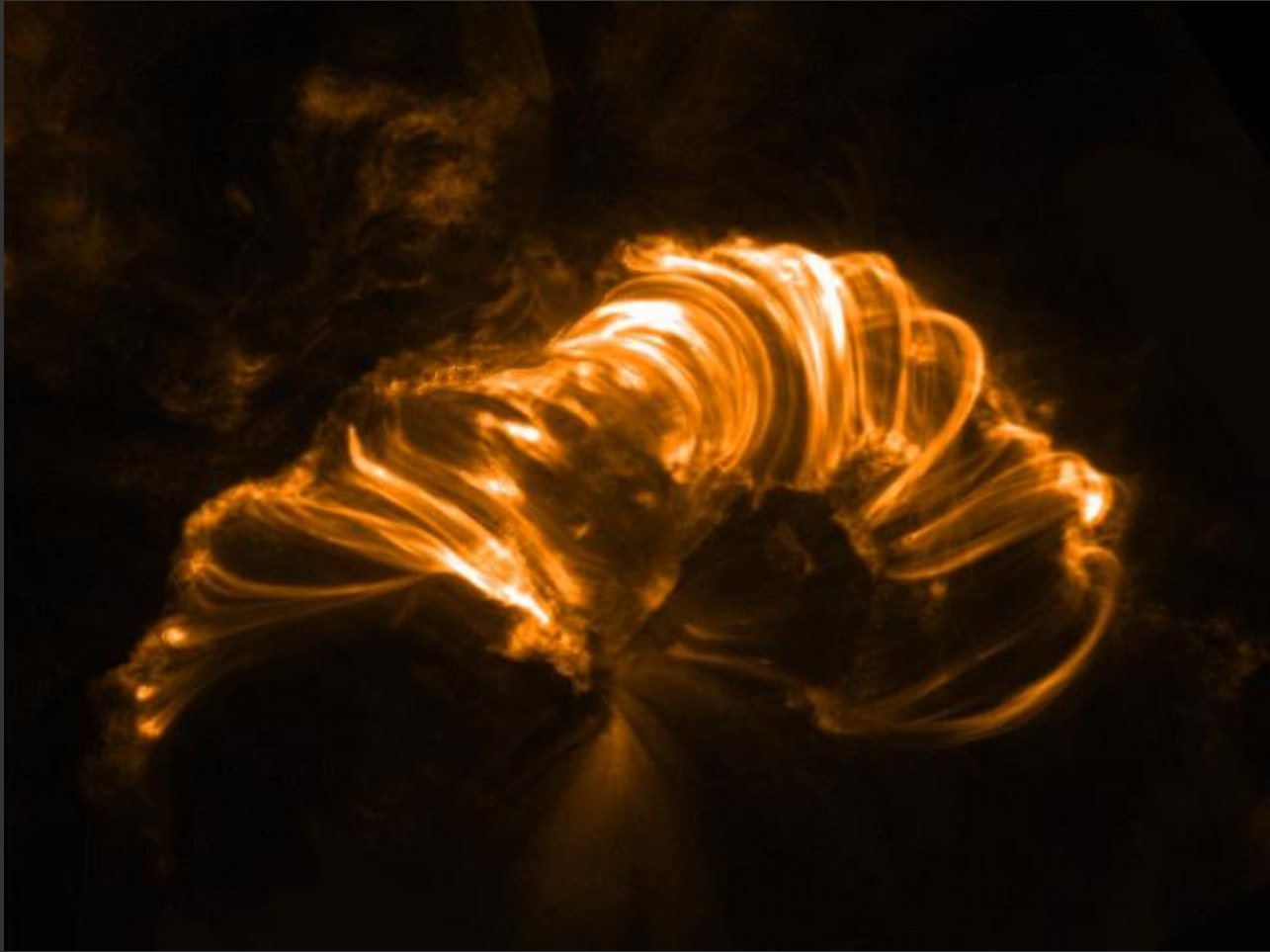


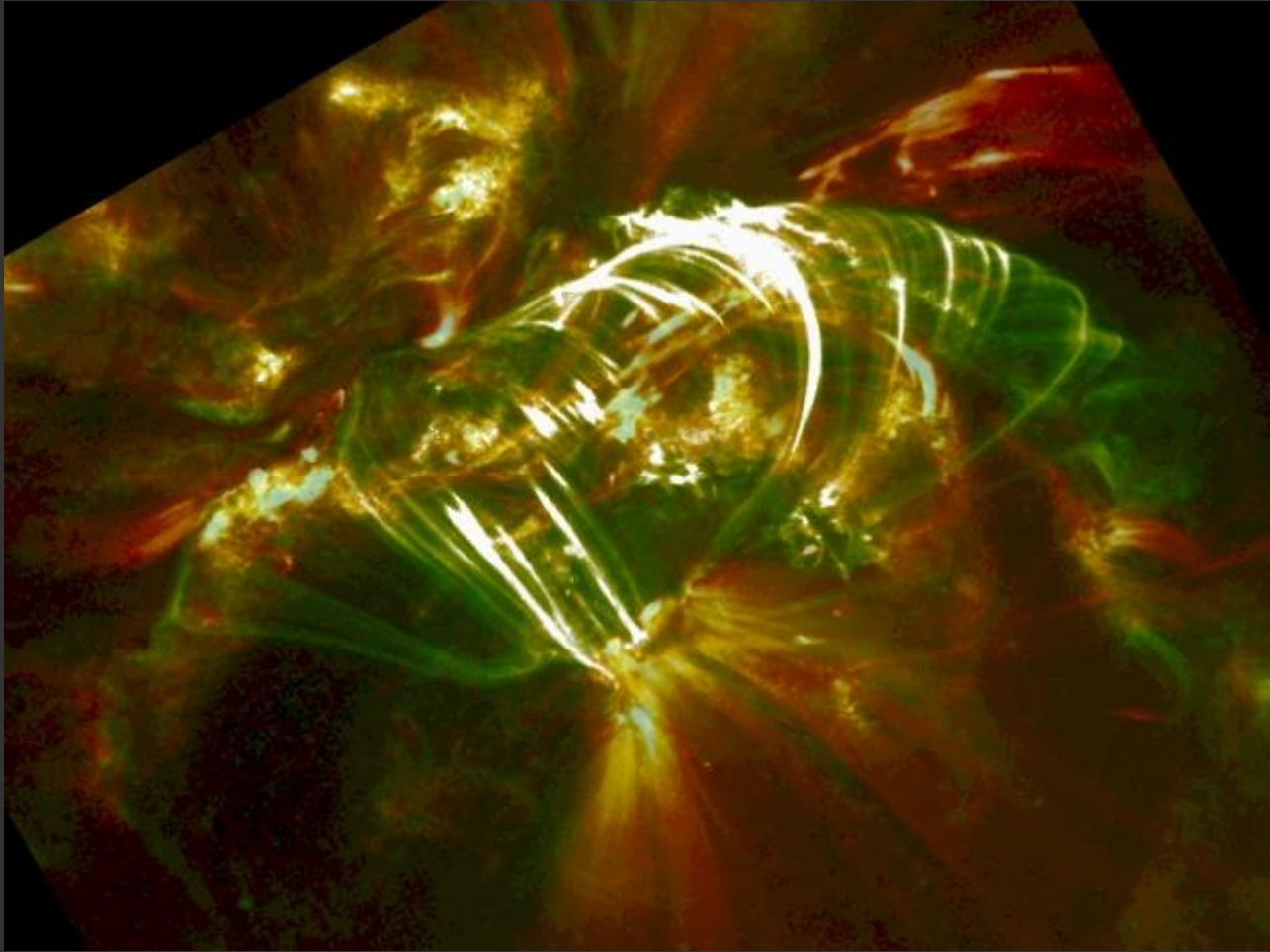


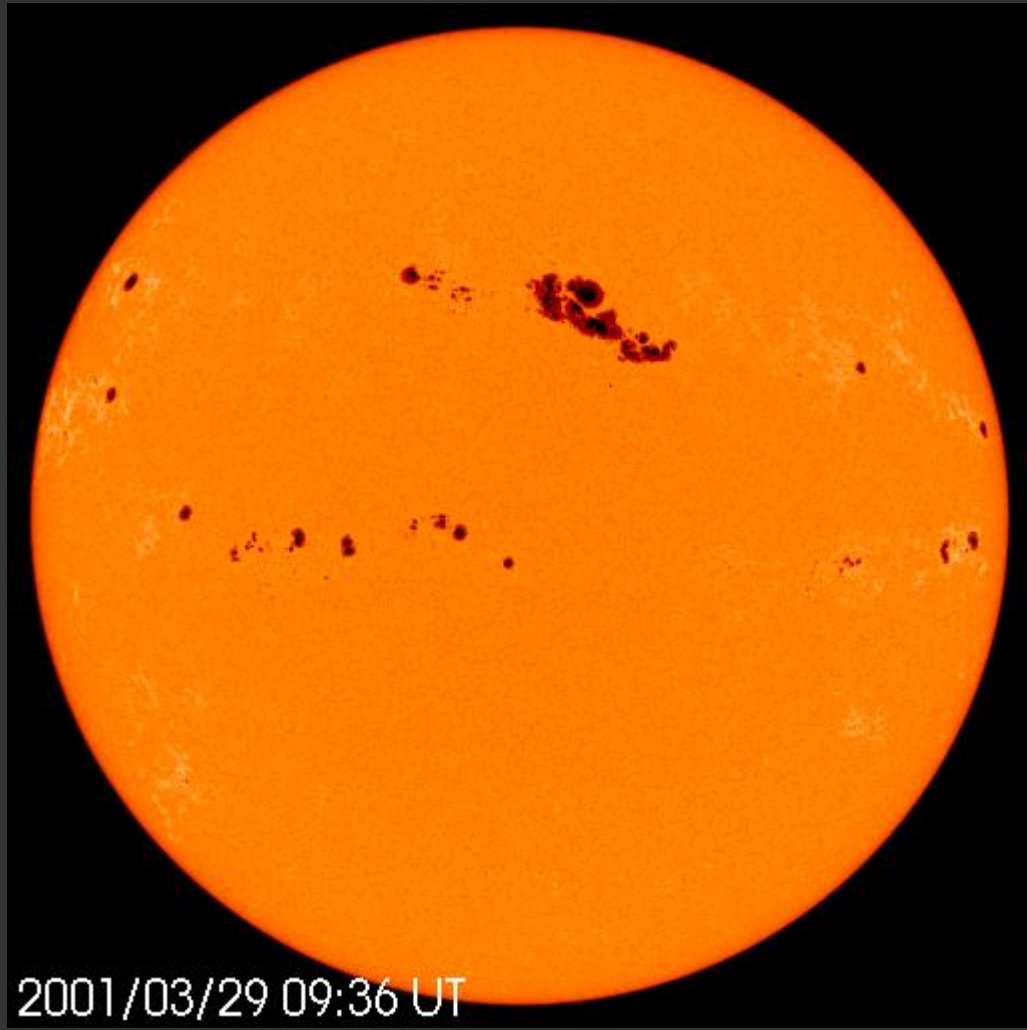


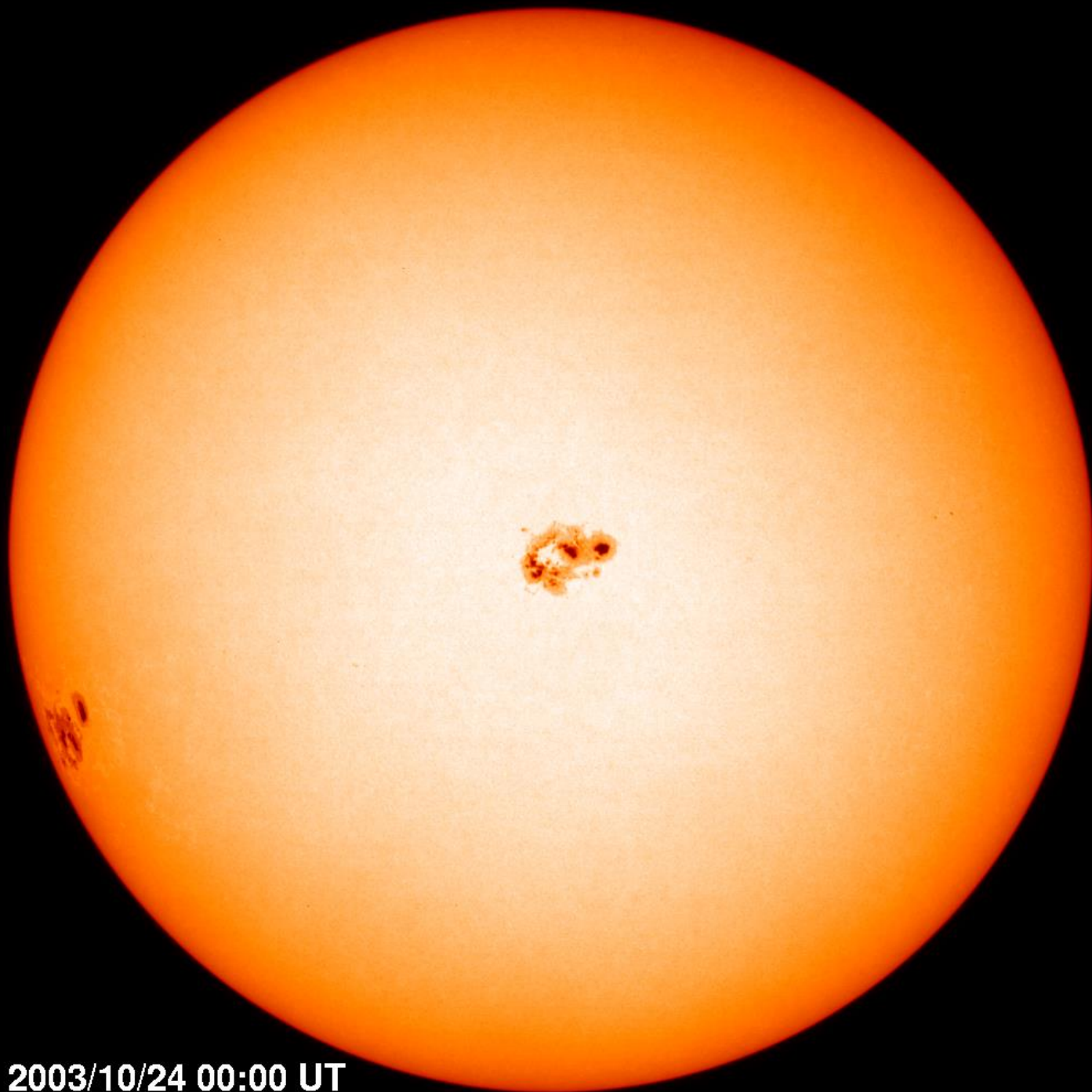
2001-Apr-15
15:31:25



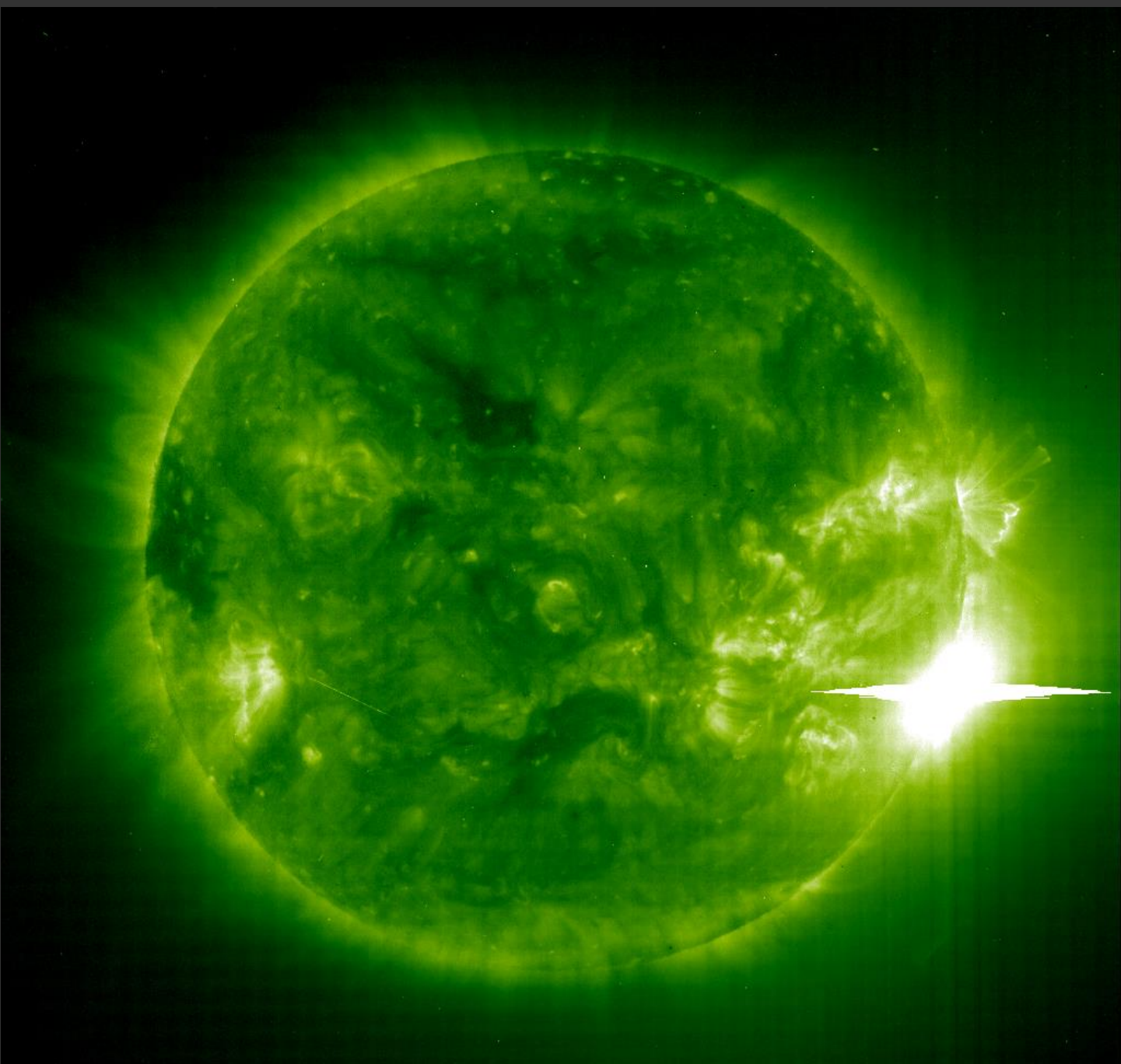




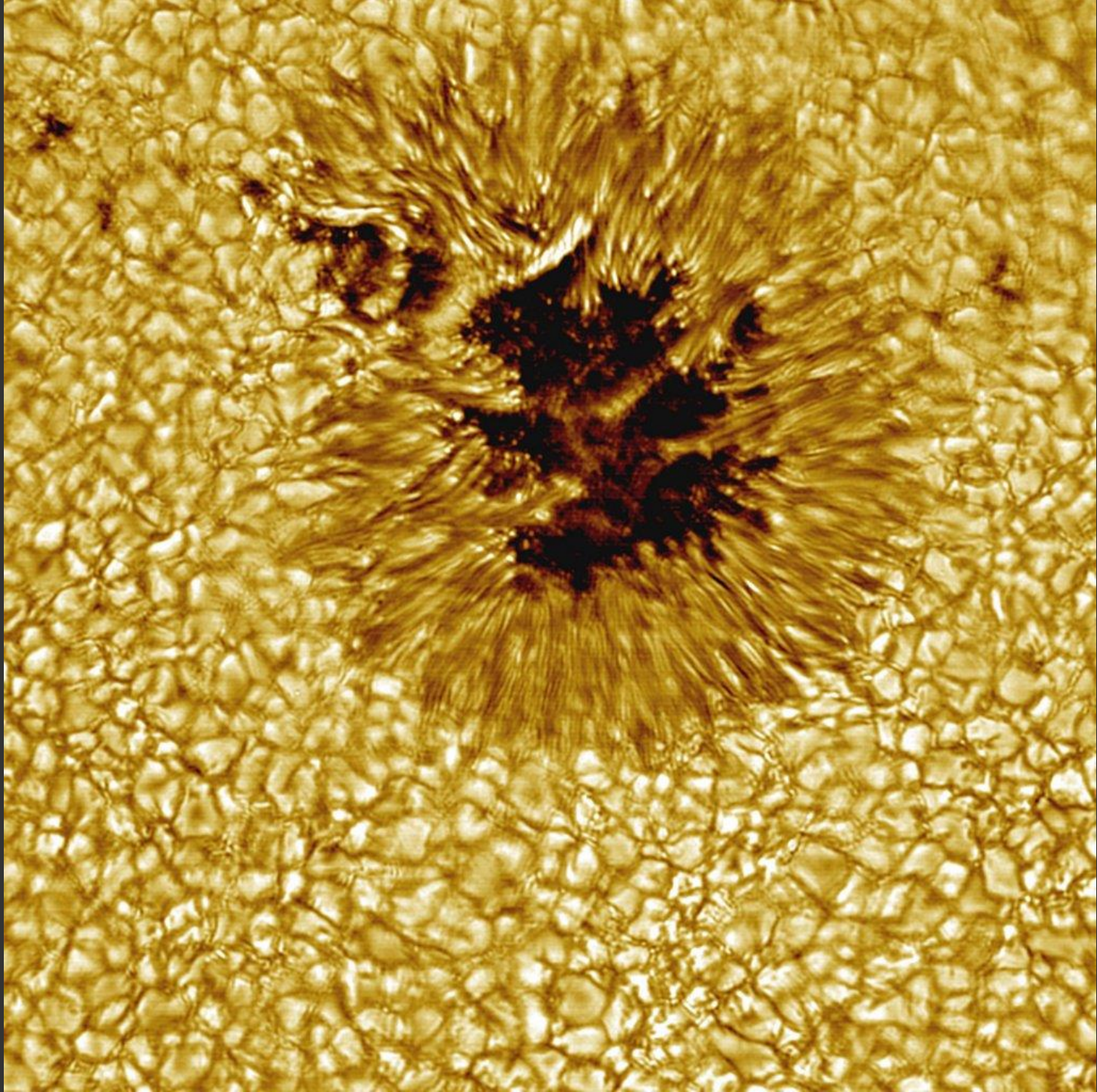


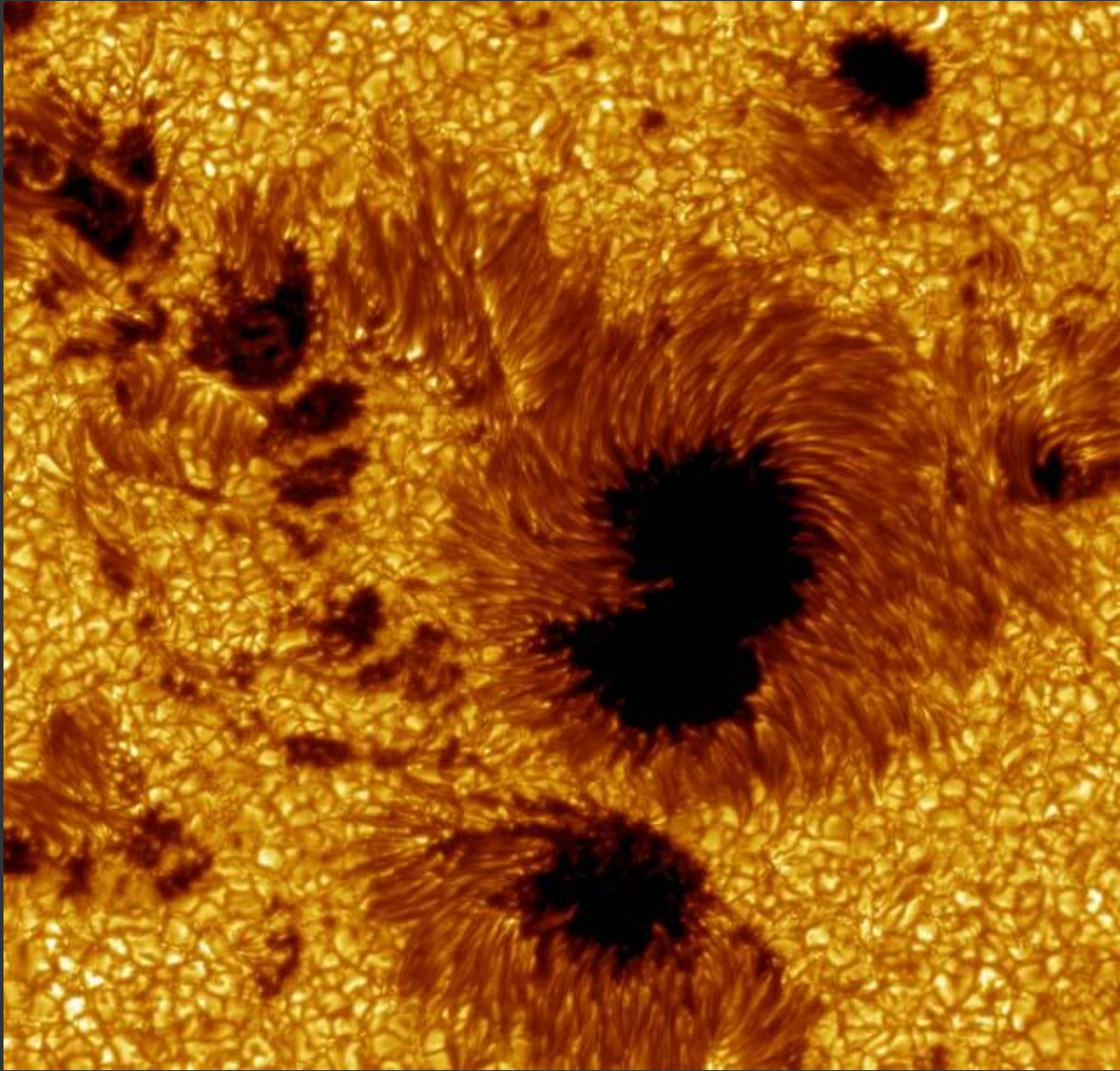


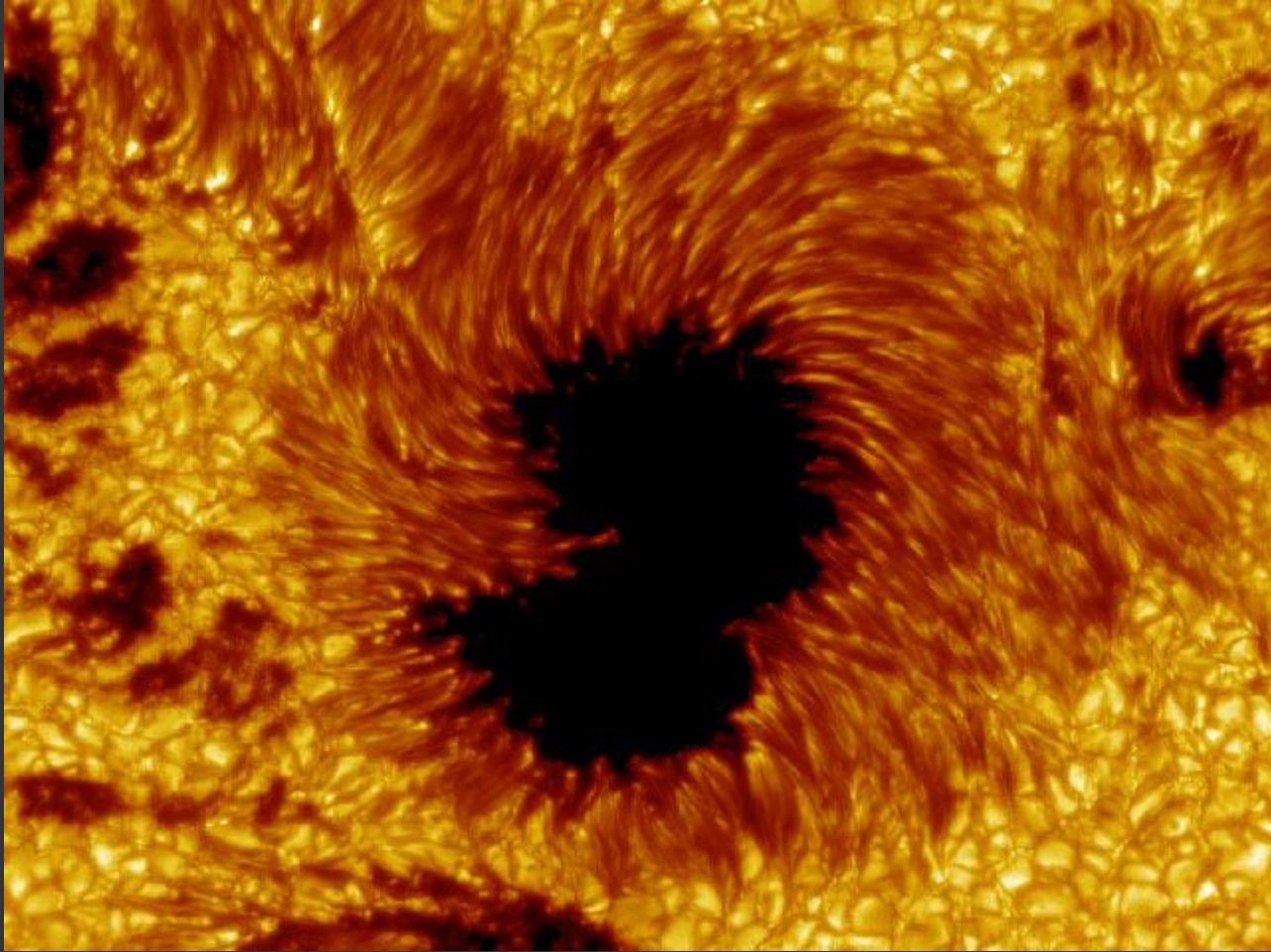
2003/10/24 00:00 UT

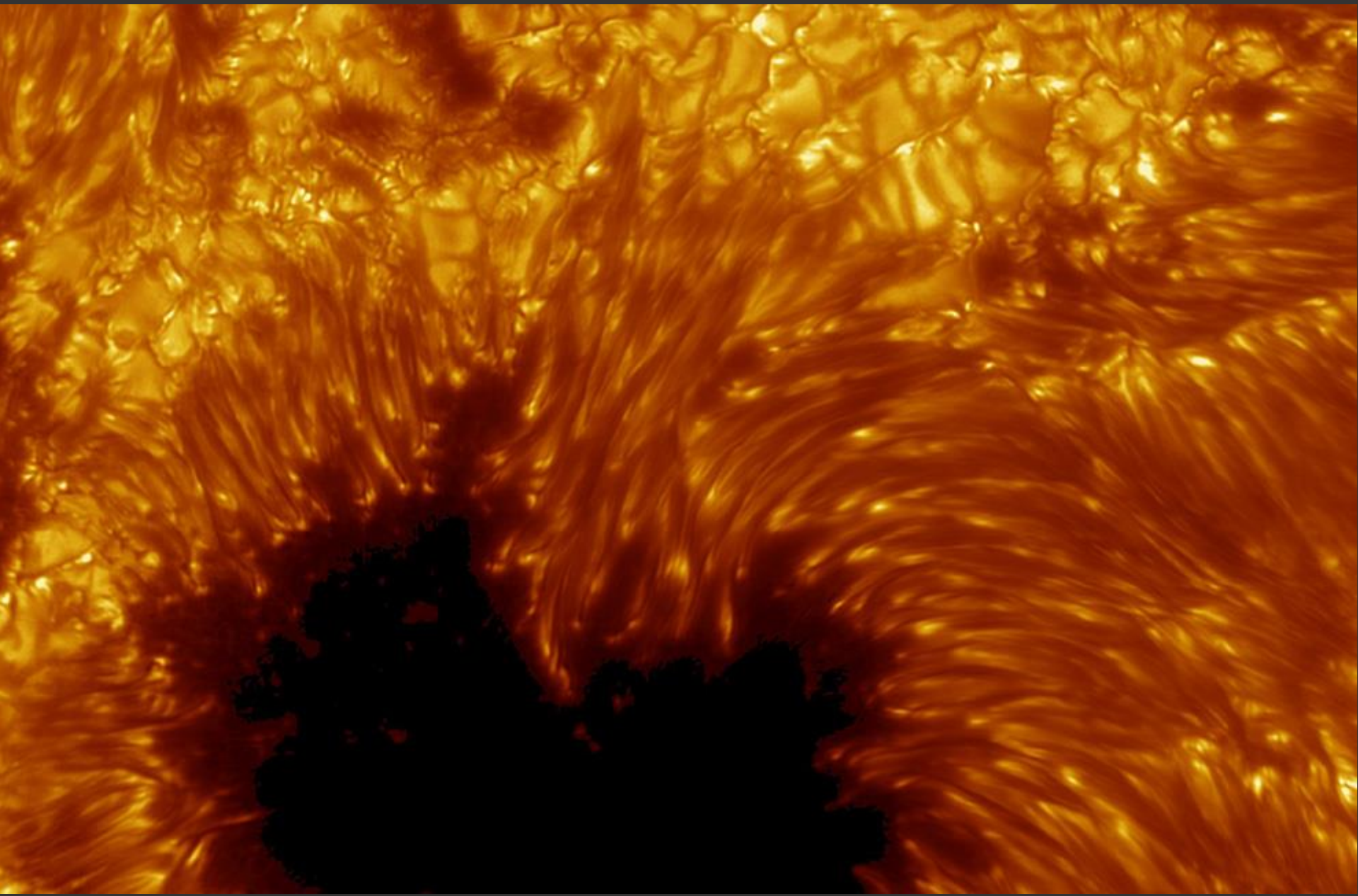


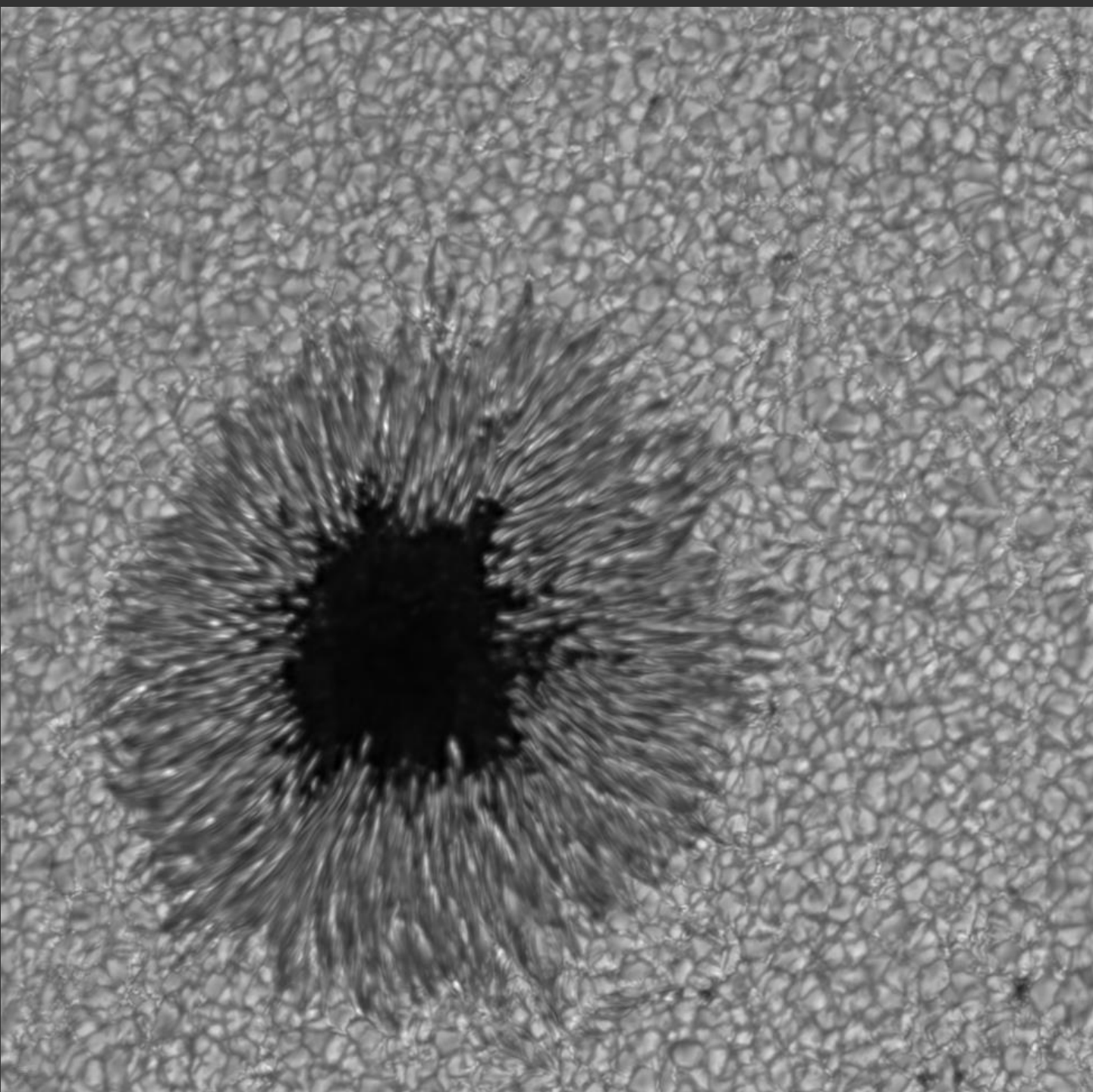
2003/11/04 19:48

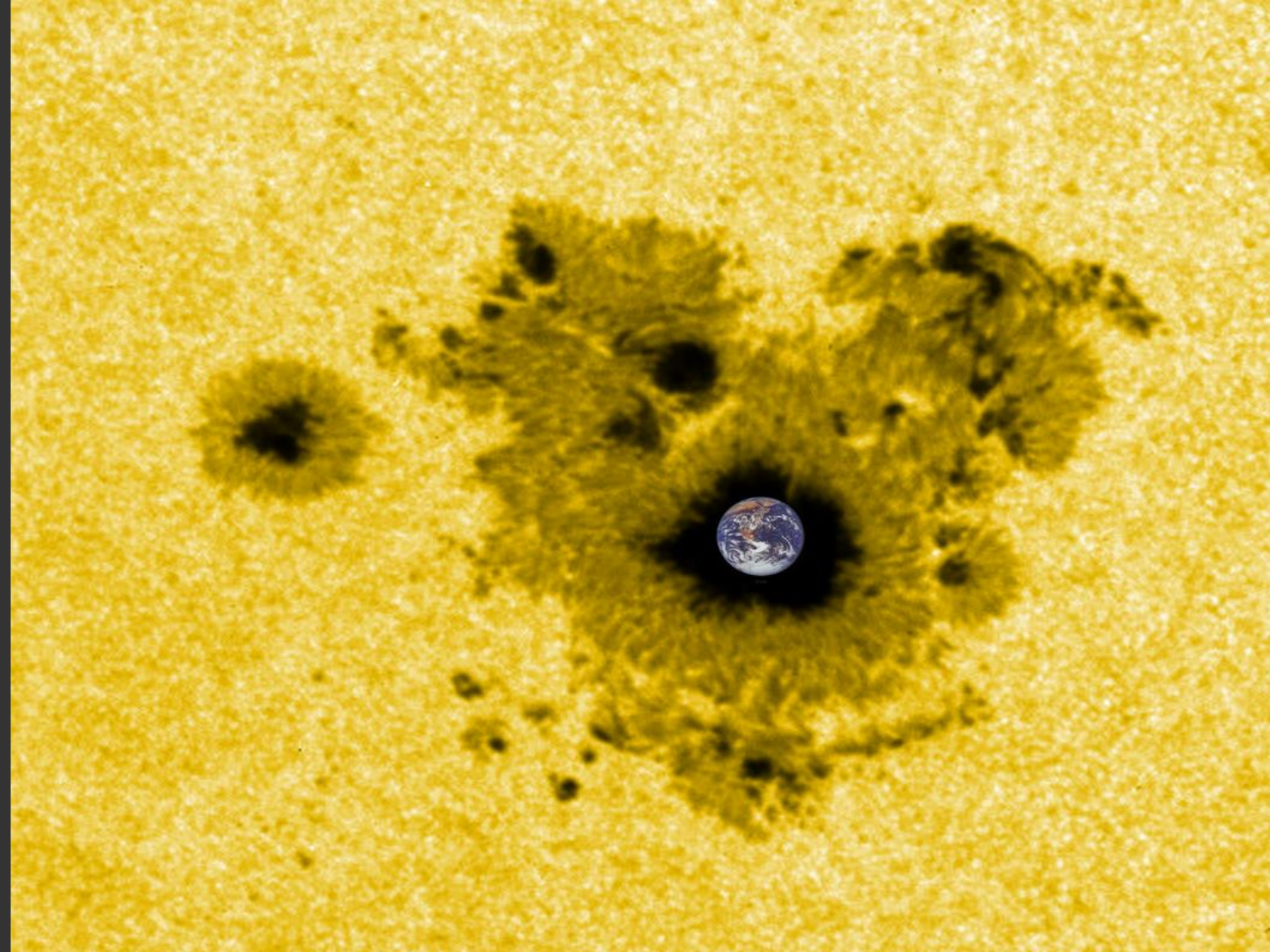


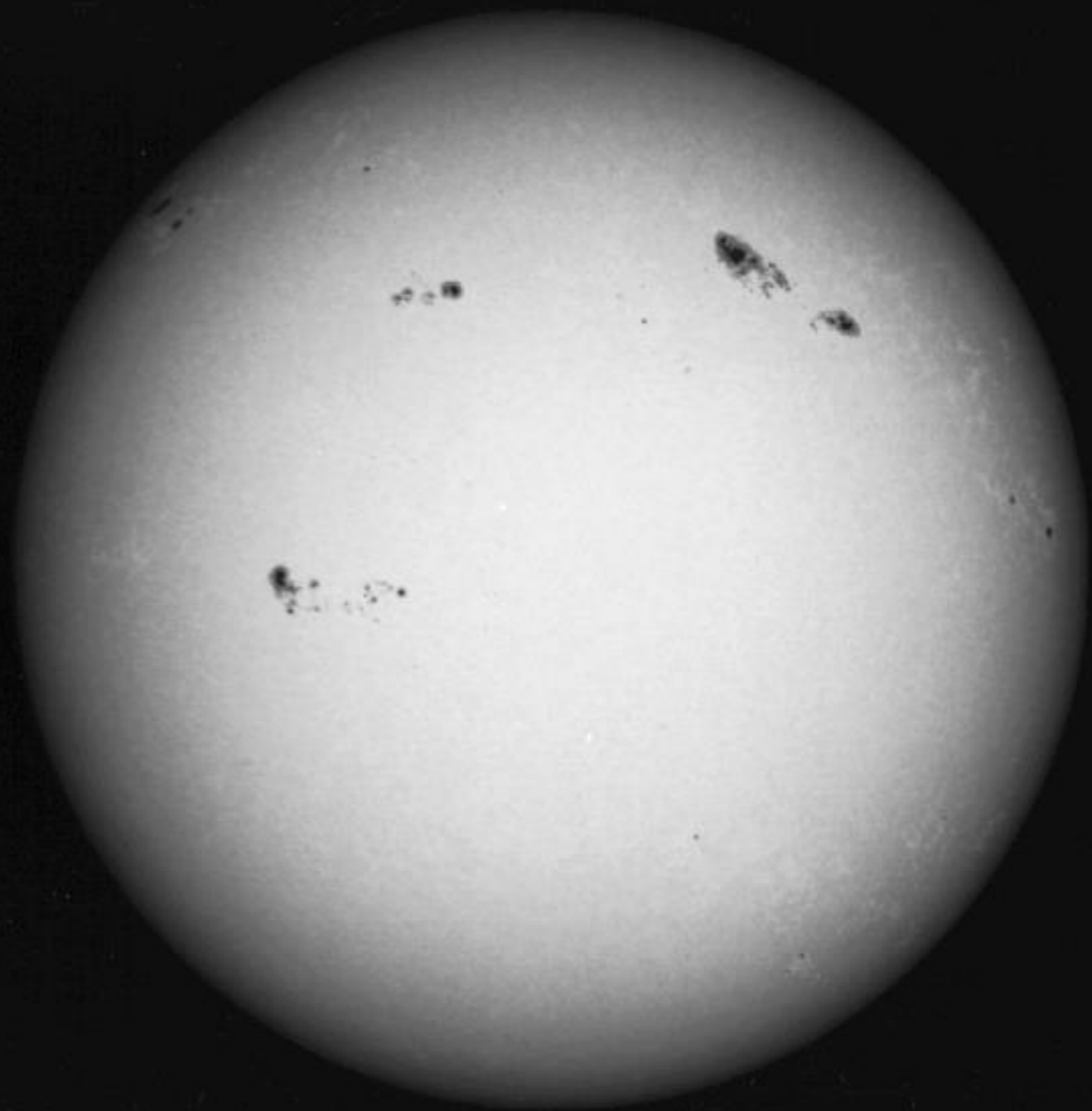


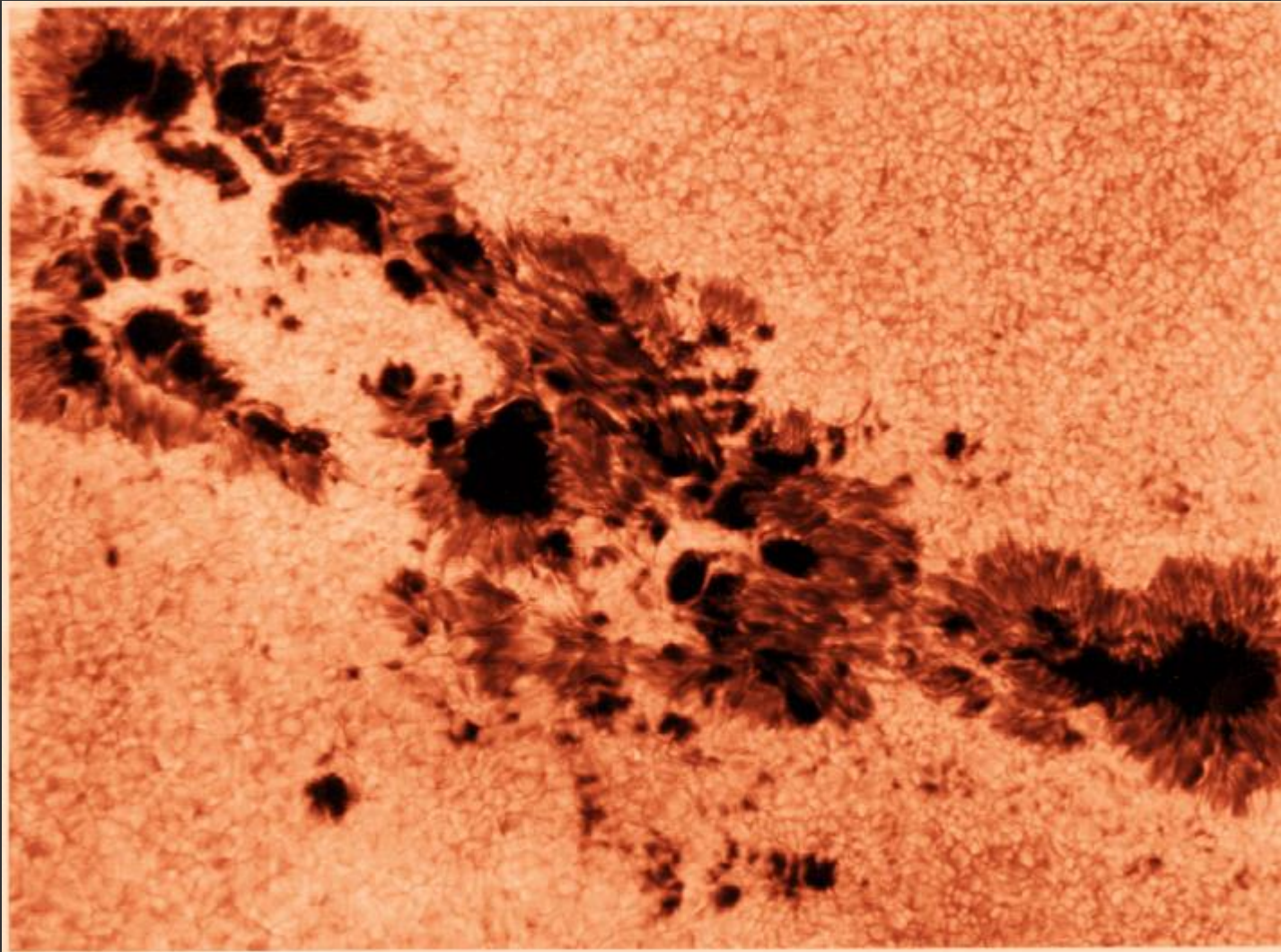


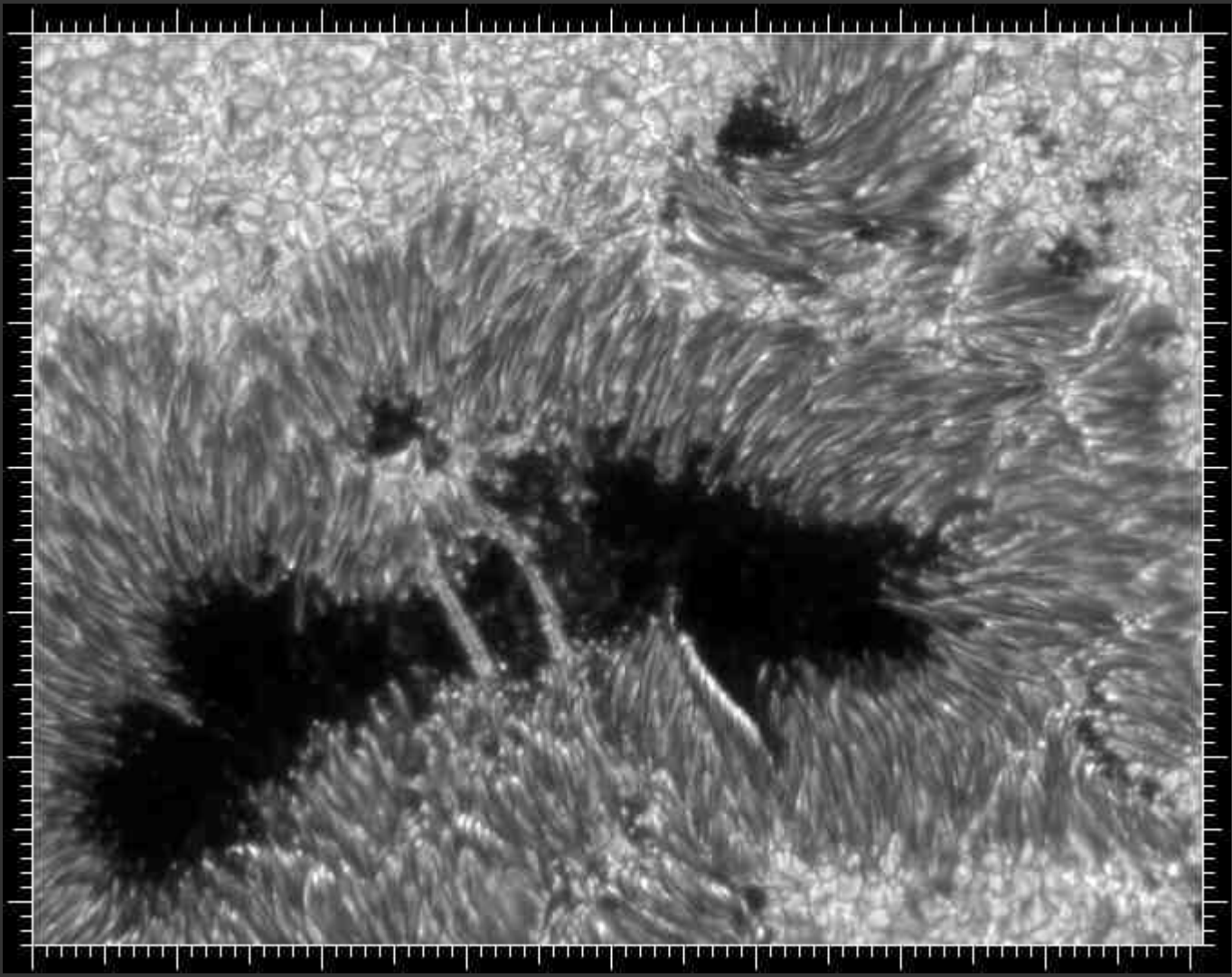


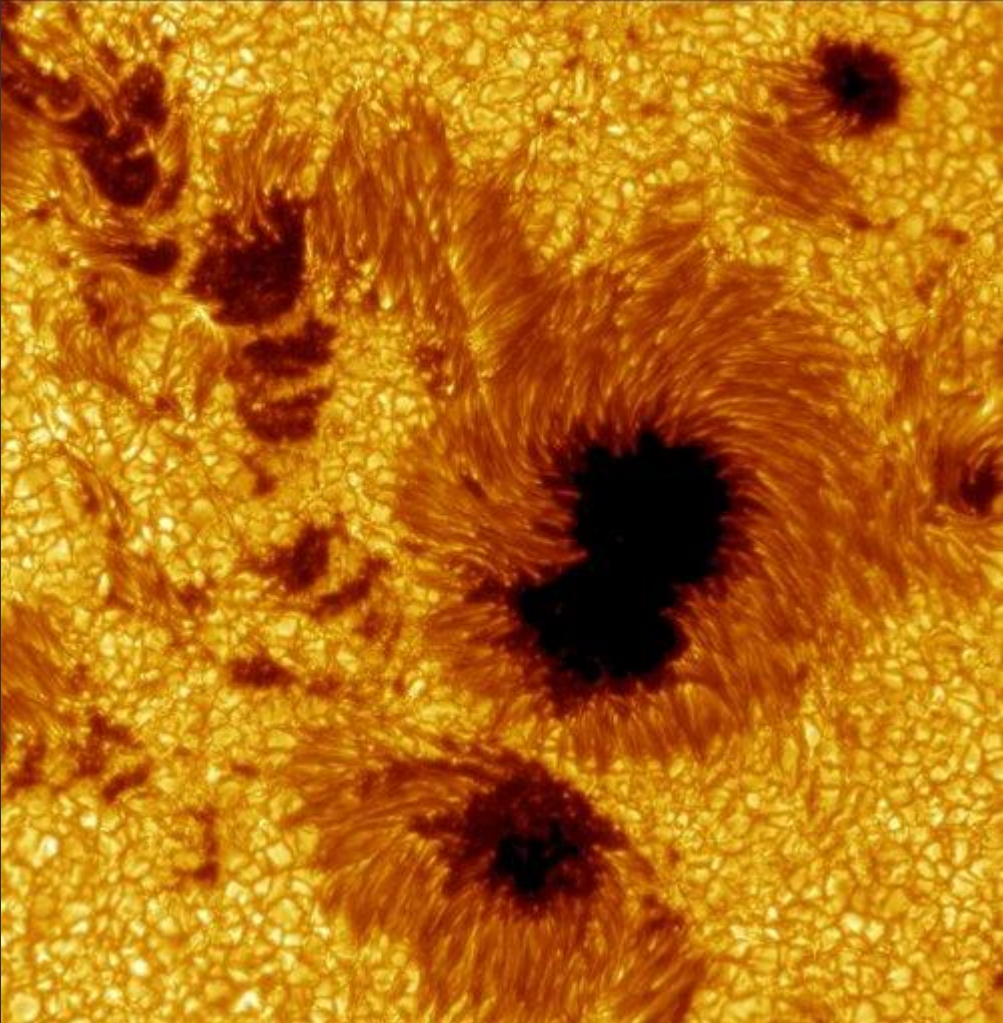


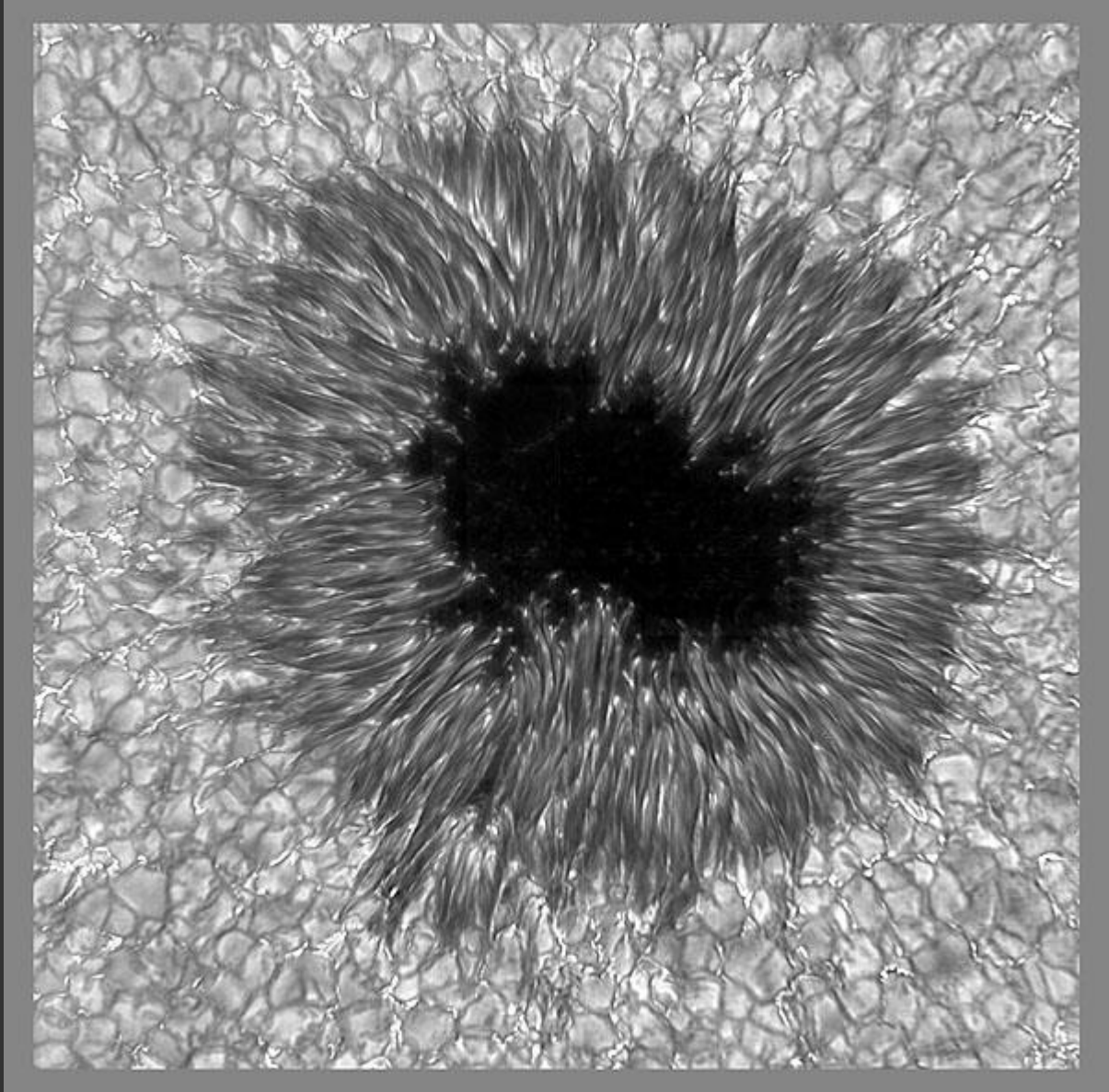


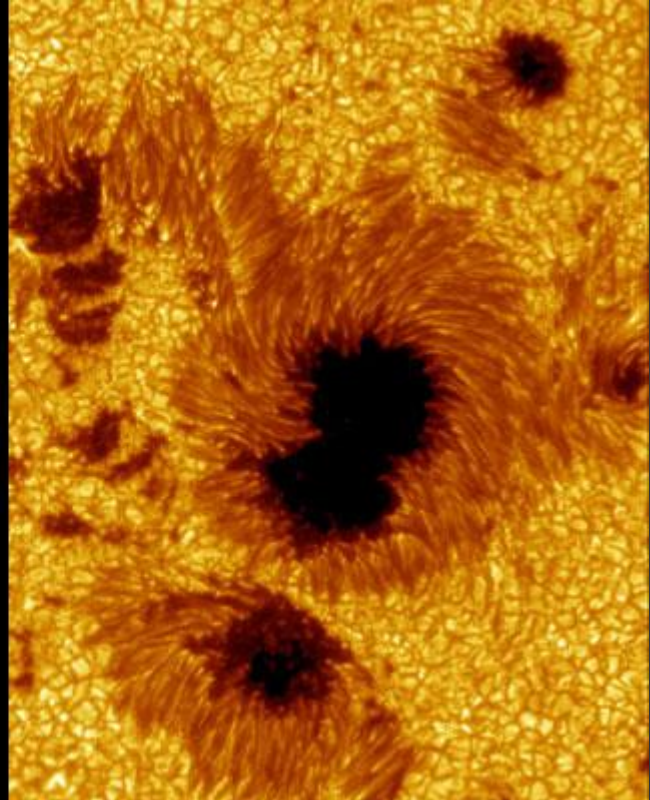




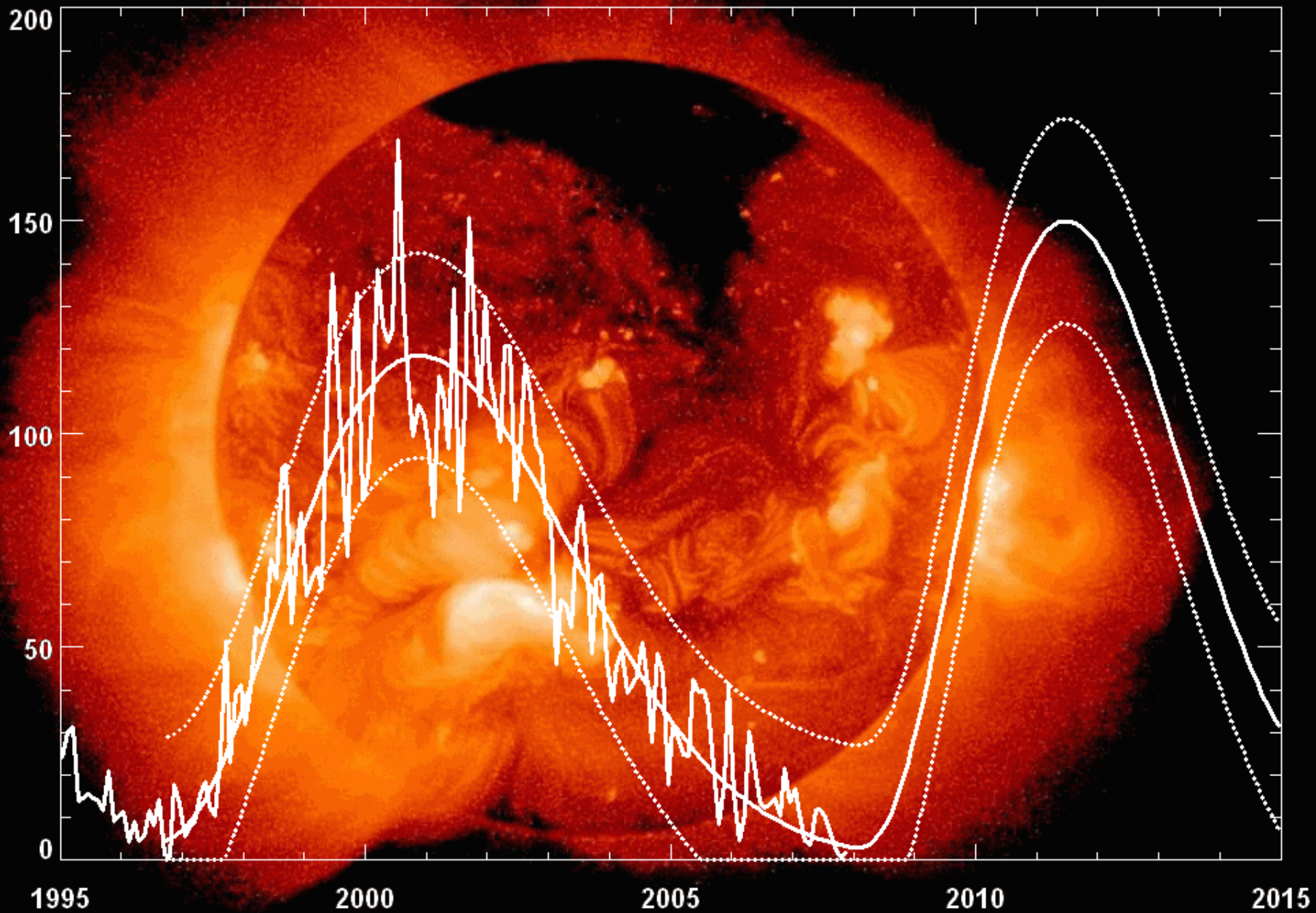


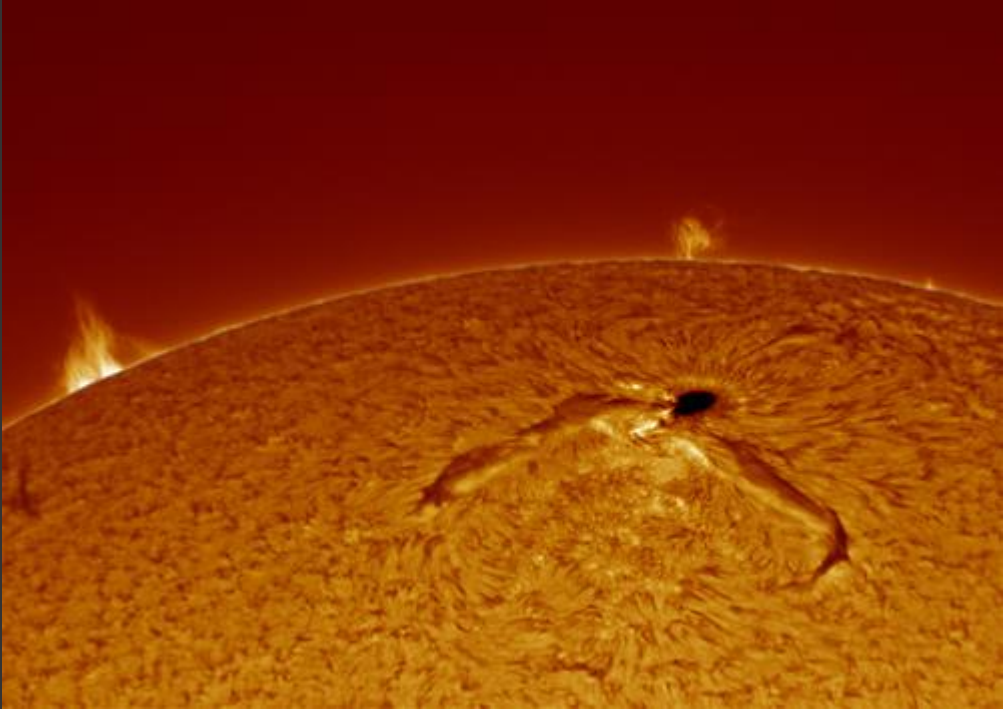


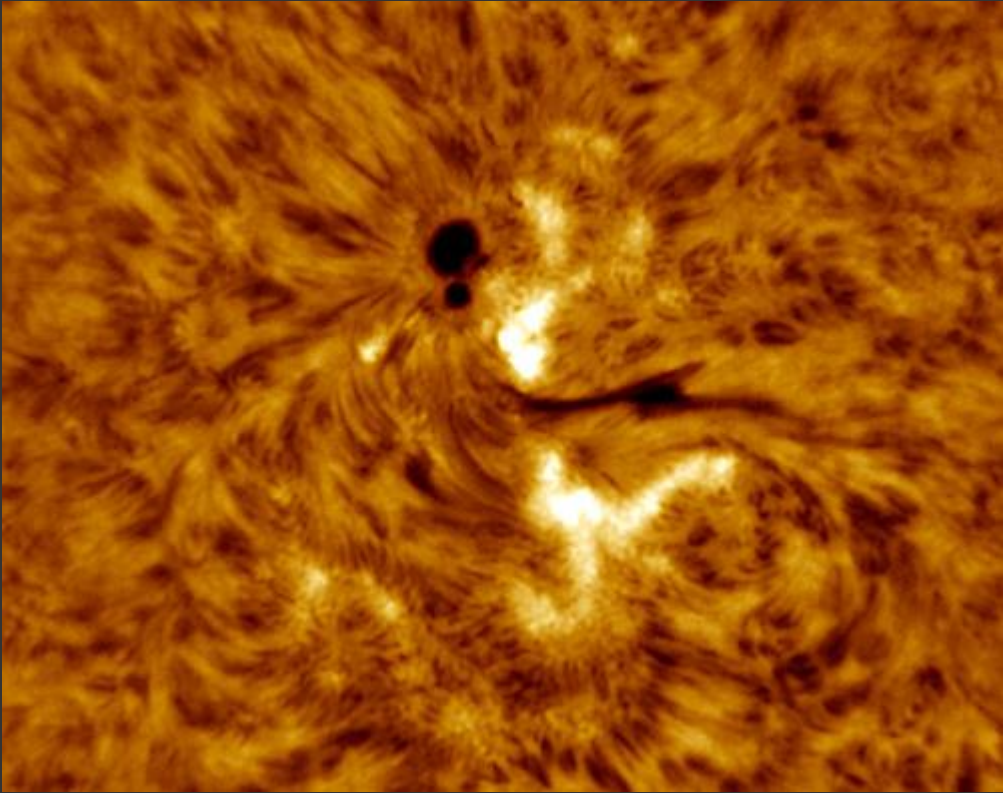


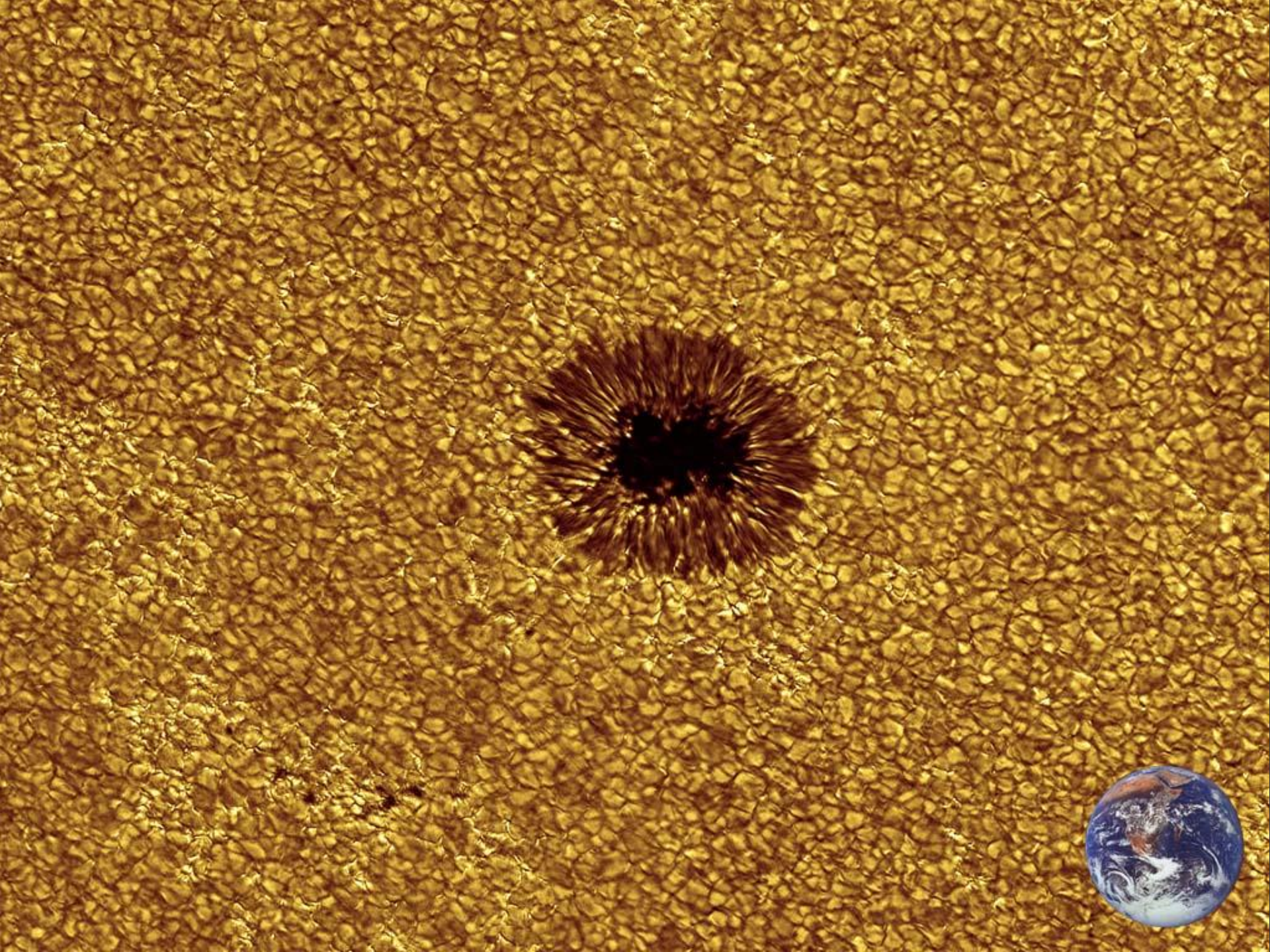


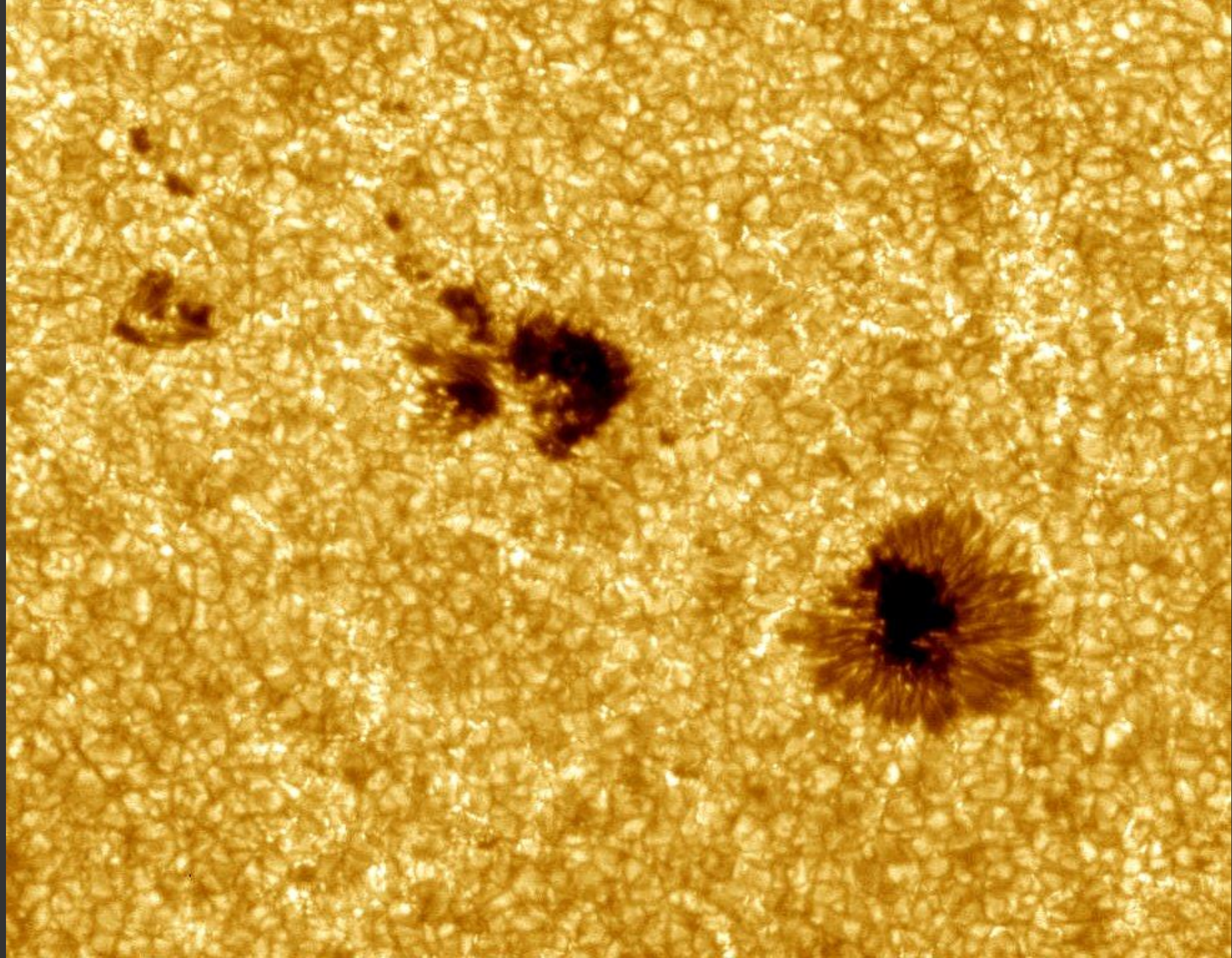
Cycle 23-24 Sunspot Number Prediction (December 2007)

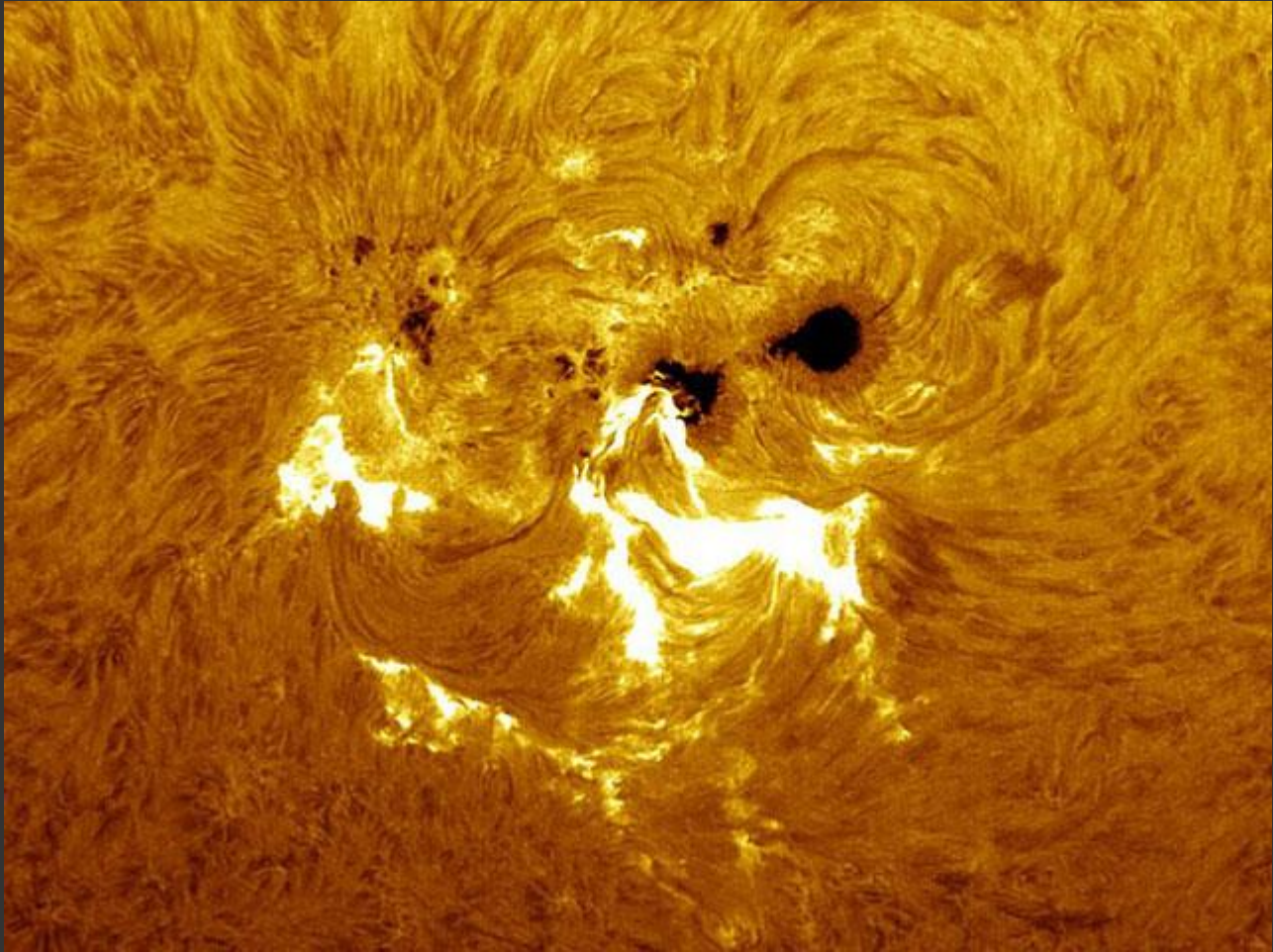




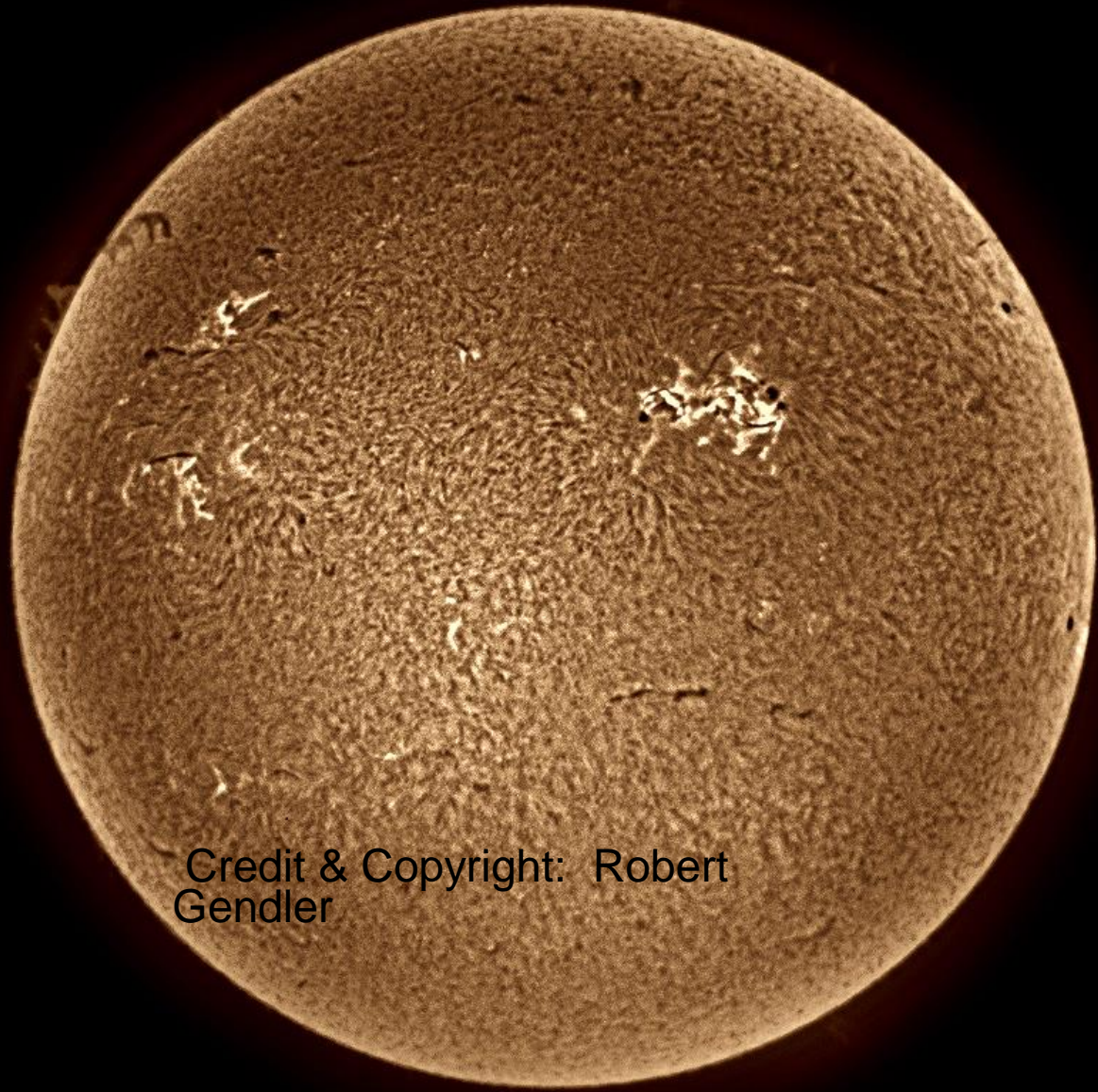




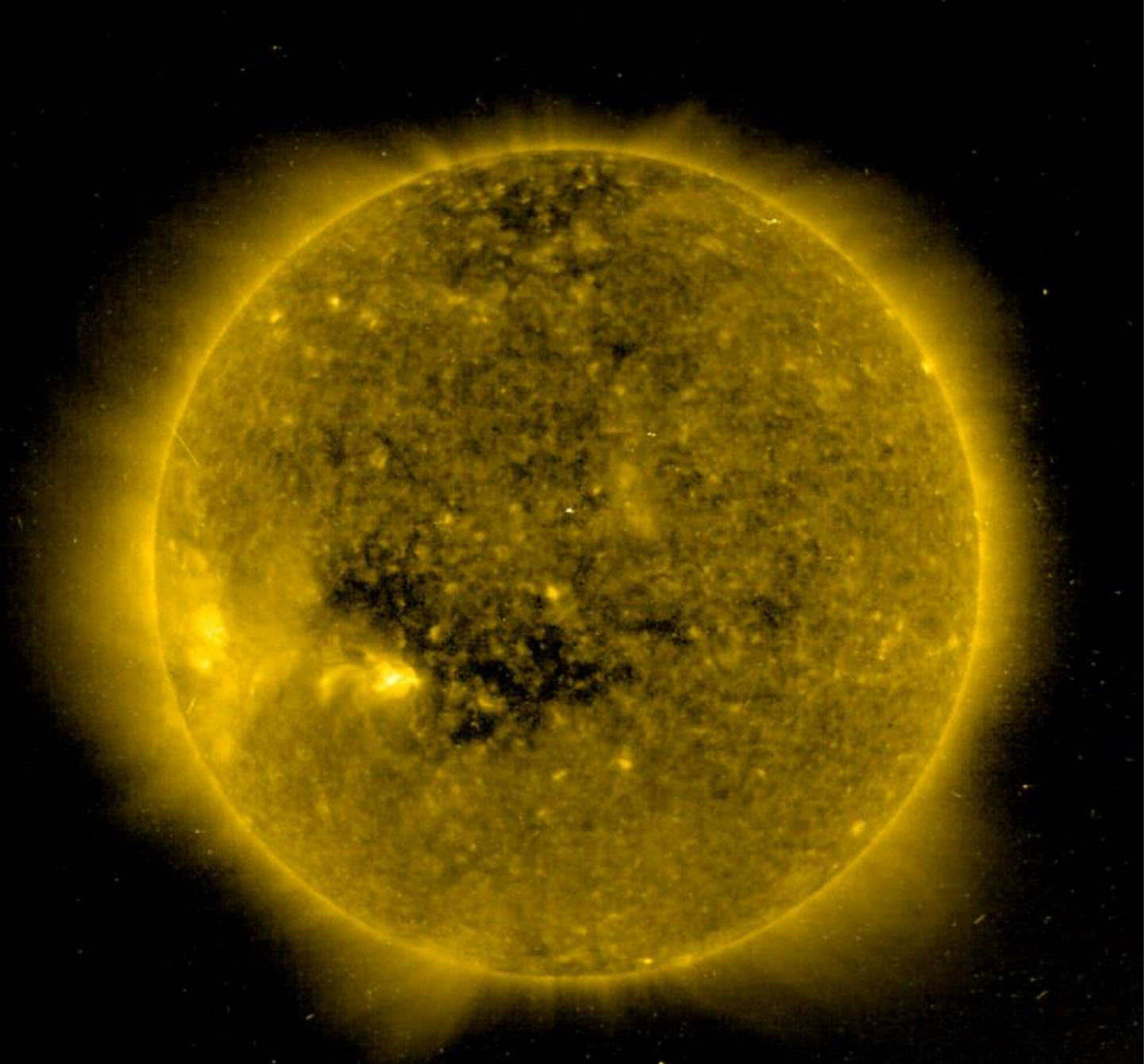




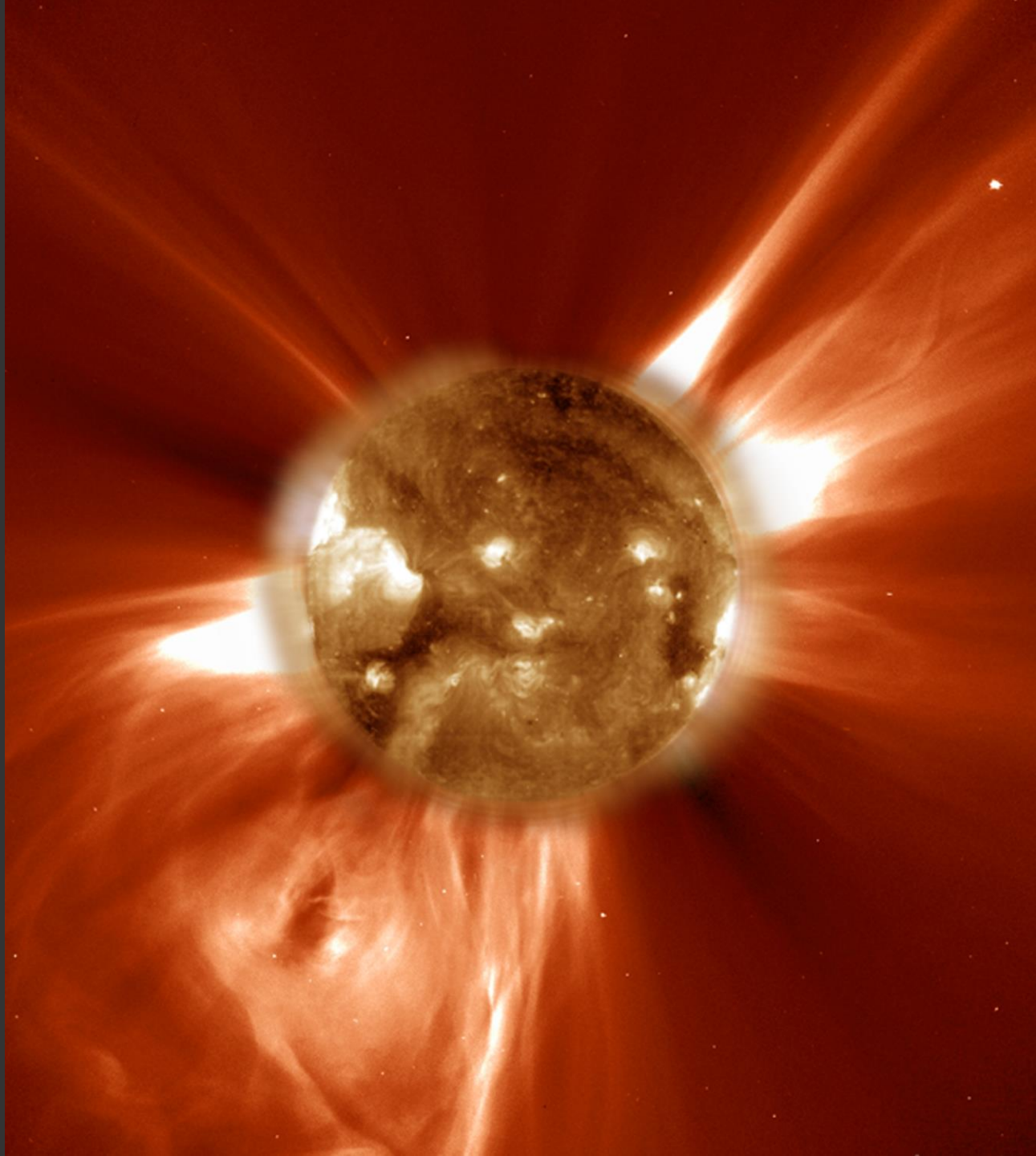


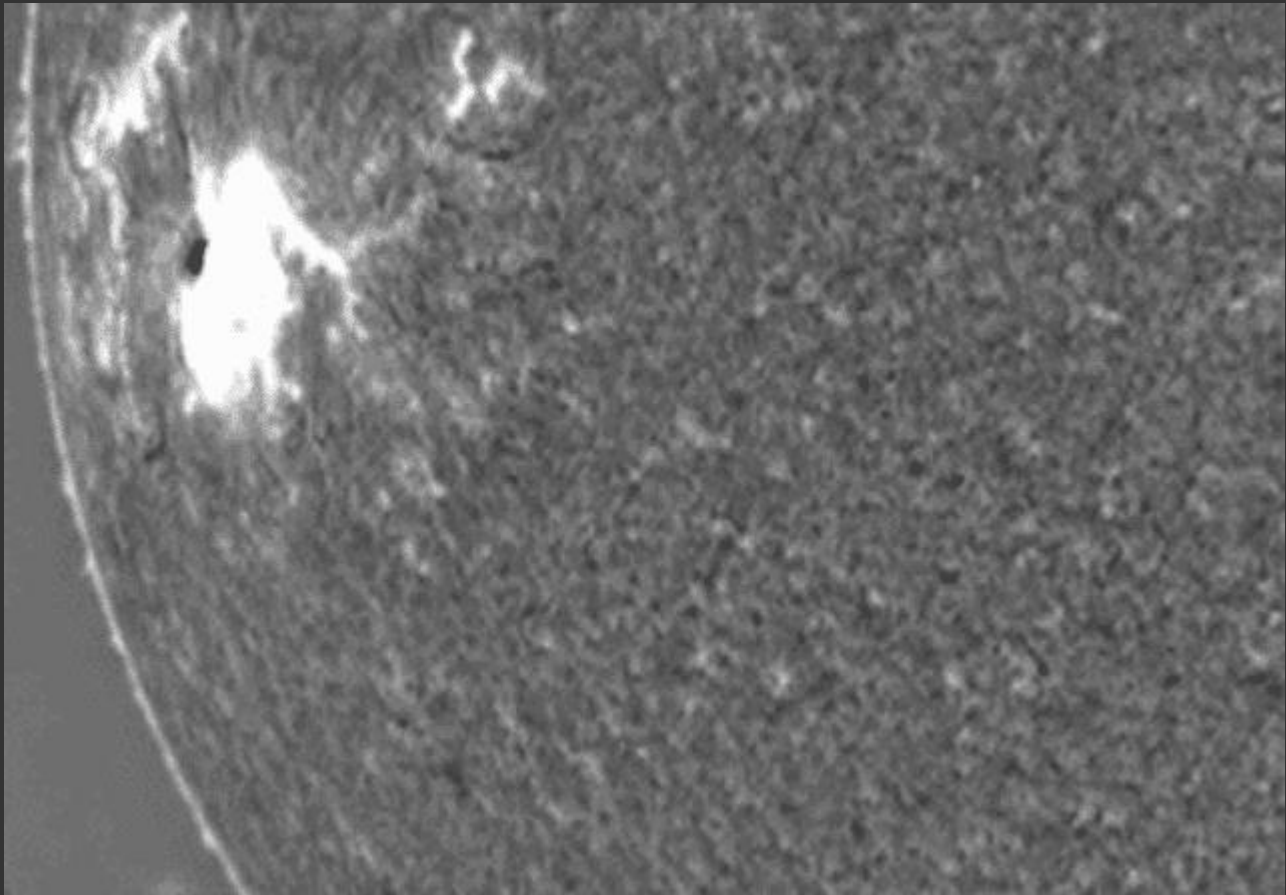


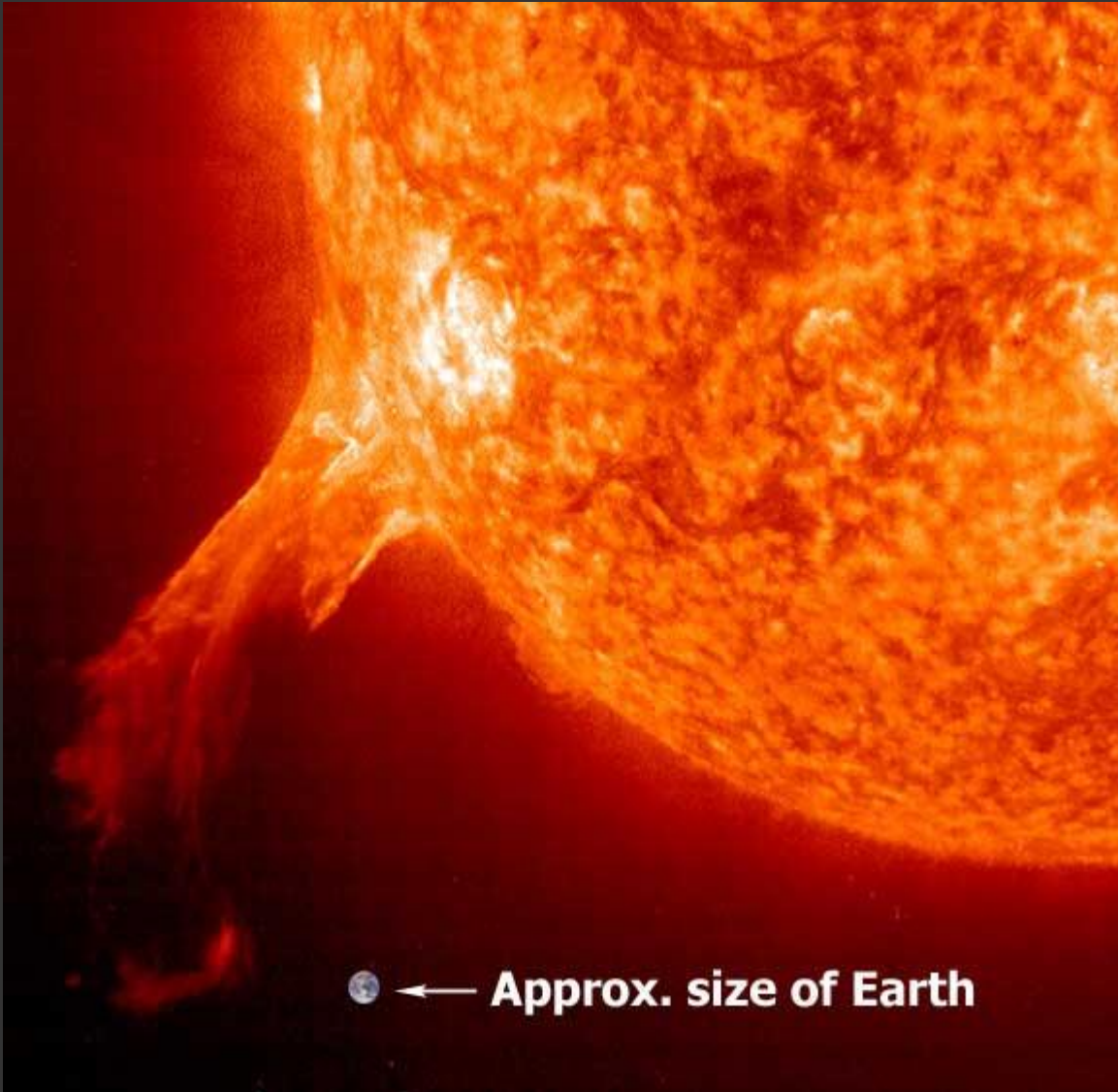
Credit & Copyright: Robert
Gendler



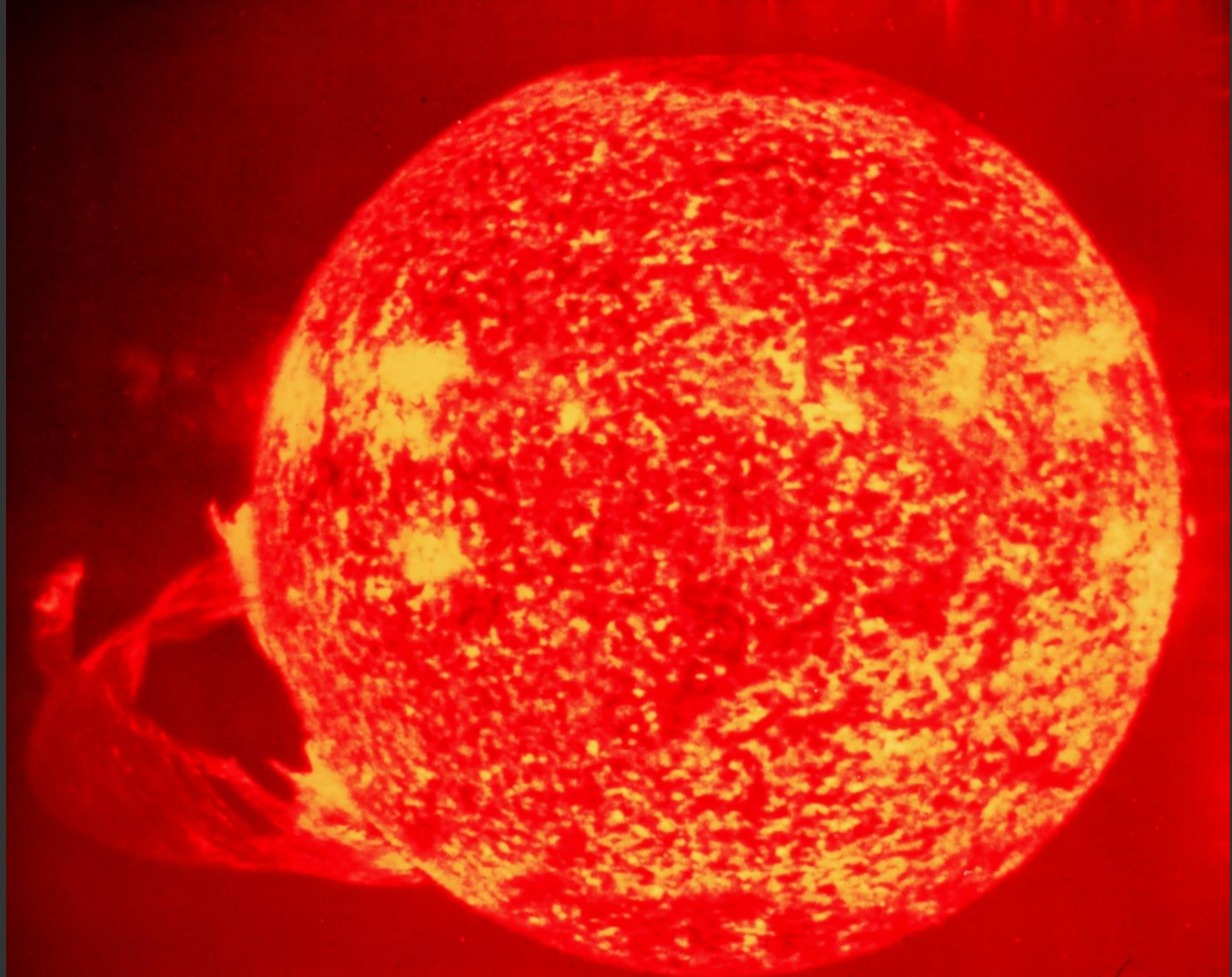
2007/09/19 07:06:09 UT

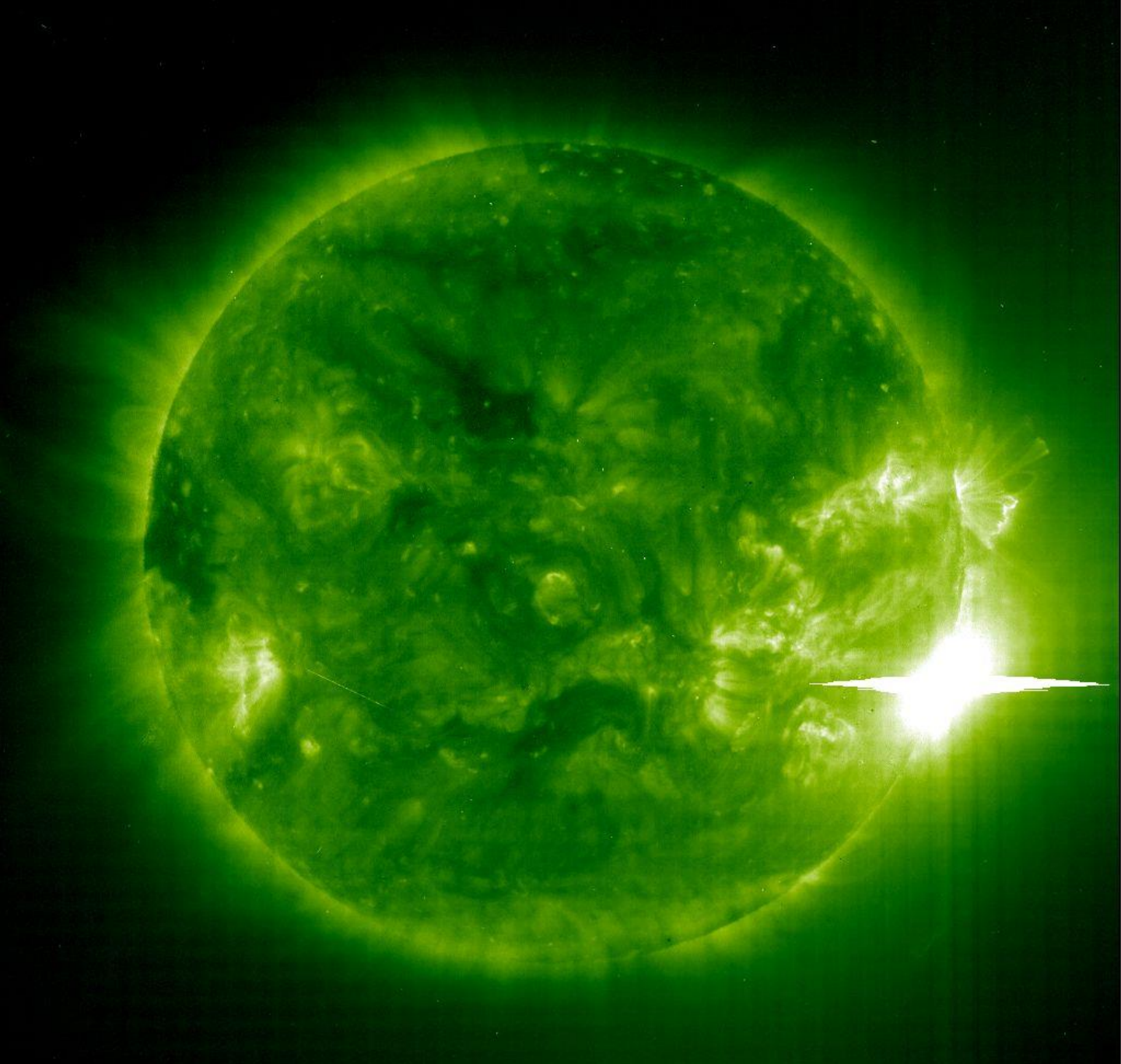




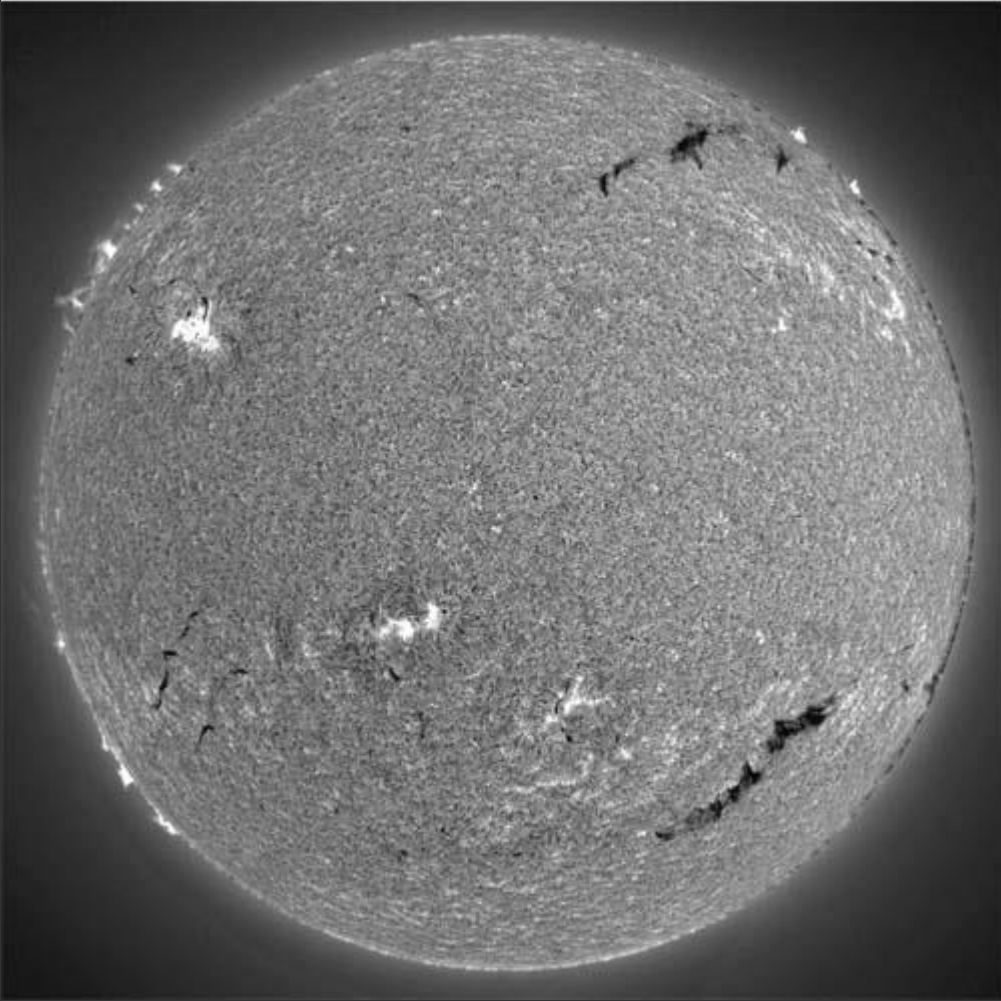


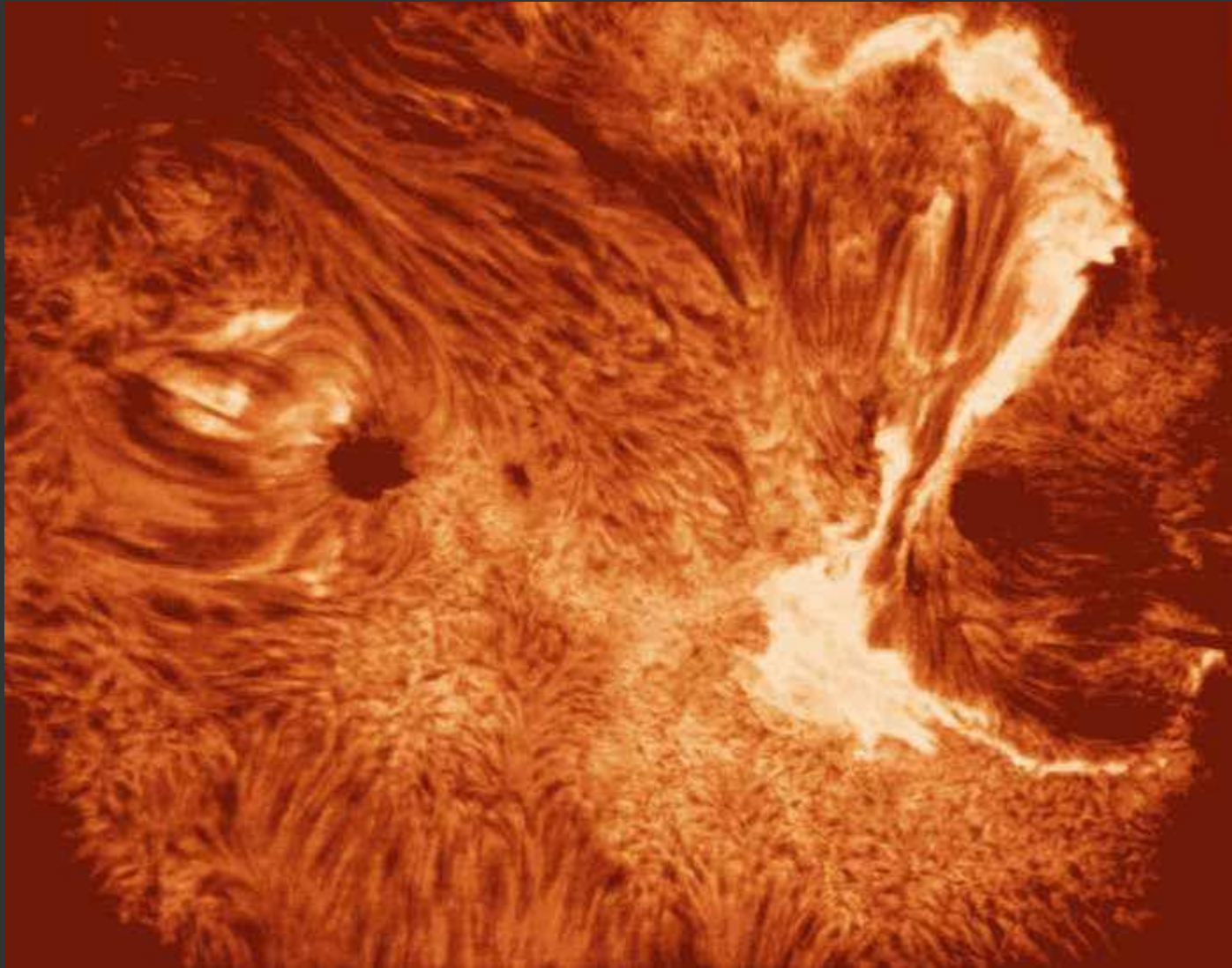
← **Approx. size of Earth**





2003/11/04 19:48





Hinode's Solar Optical Telescope

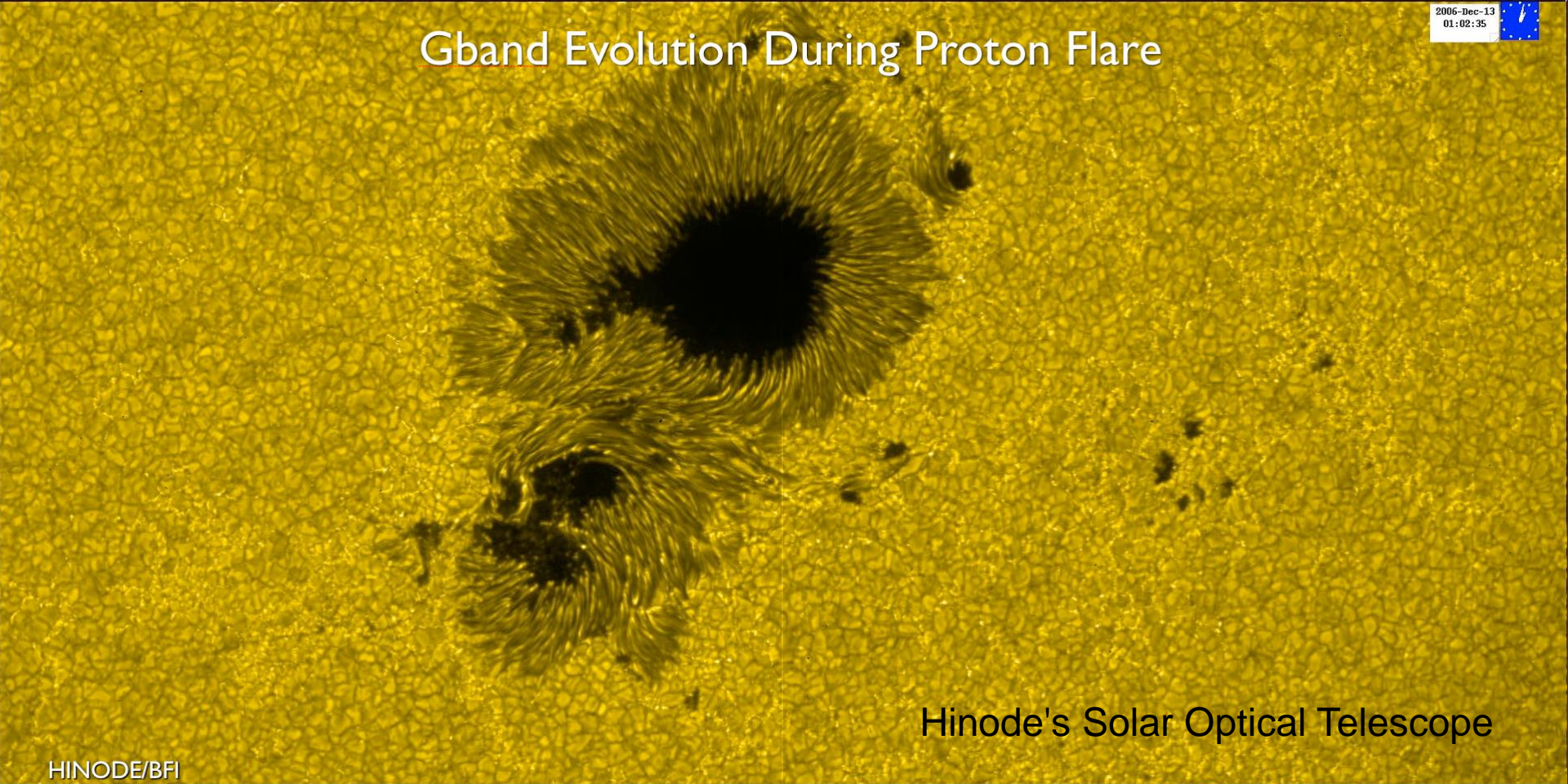


Gband Evolution During Proton Flare

2006-Dec-13
01:02:35

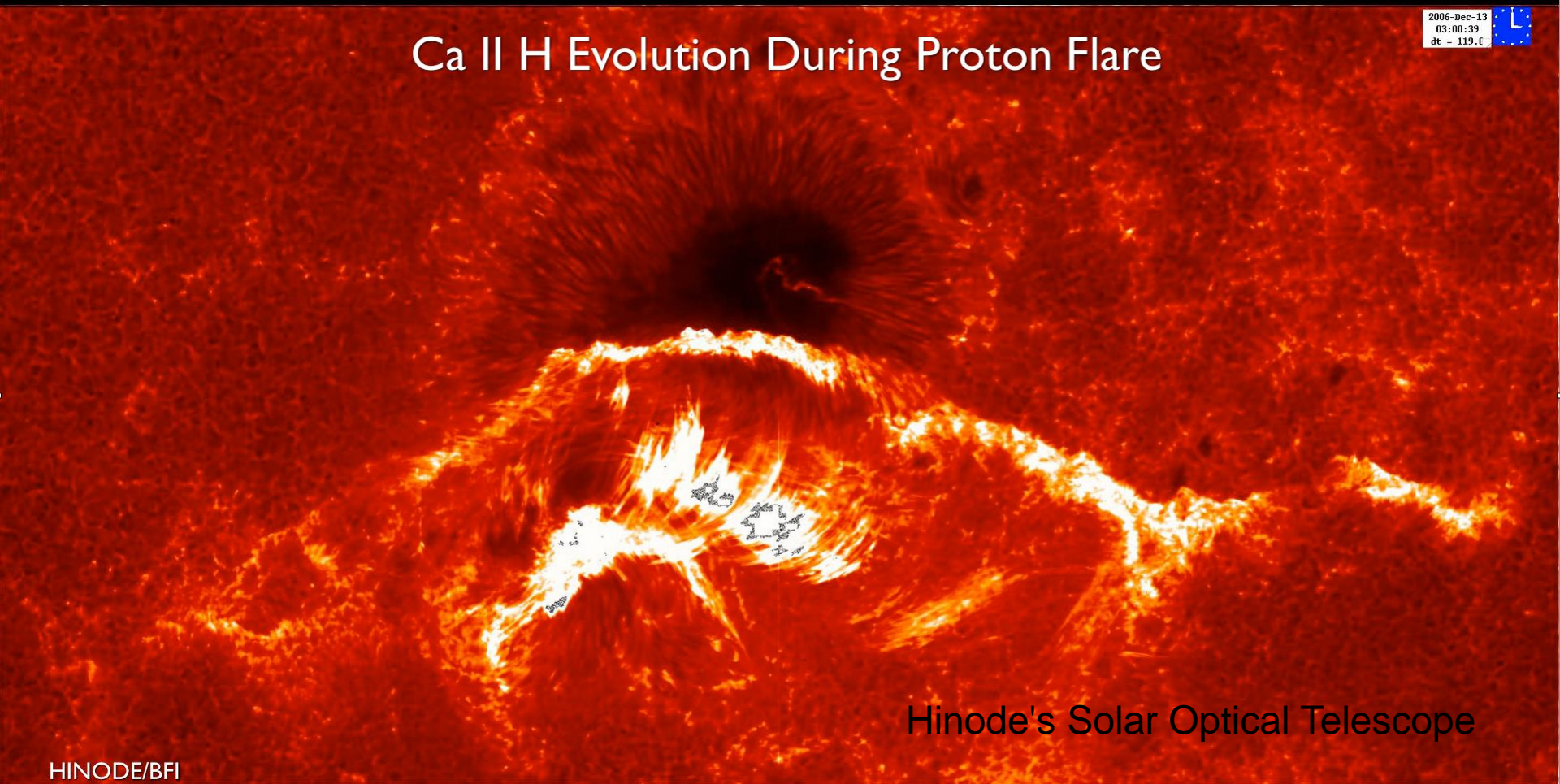
Hinode/BFI

Hinode's Solar Optical Telescope



Ca II H Evolution During Proton Flare

2006-Dec-13
03:00:39
dt = 119.8



Hinode's Solar Optical Telescope

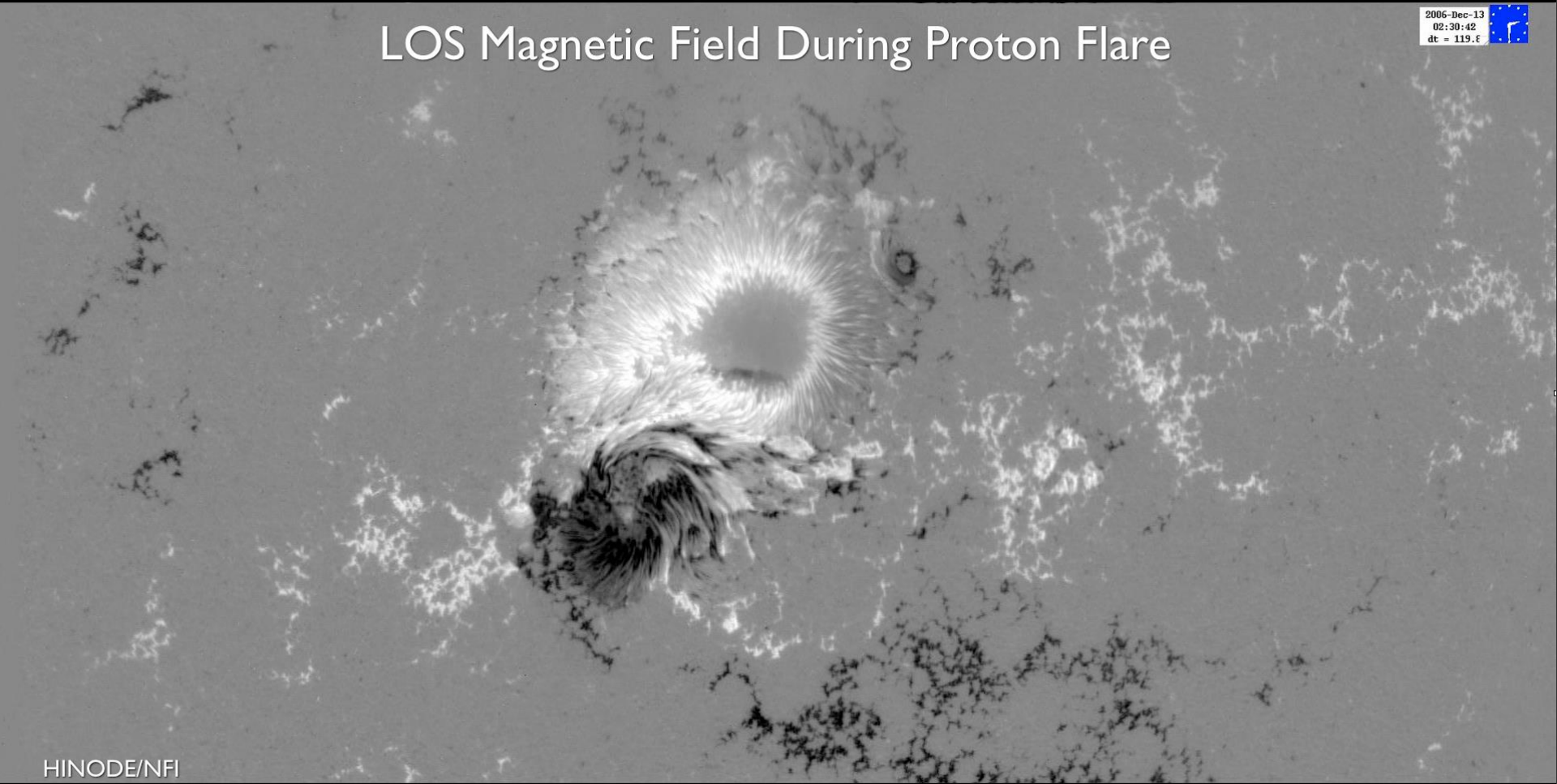
HINODE/BFI

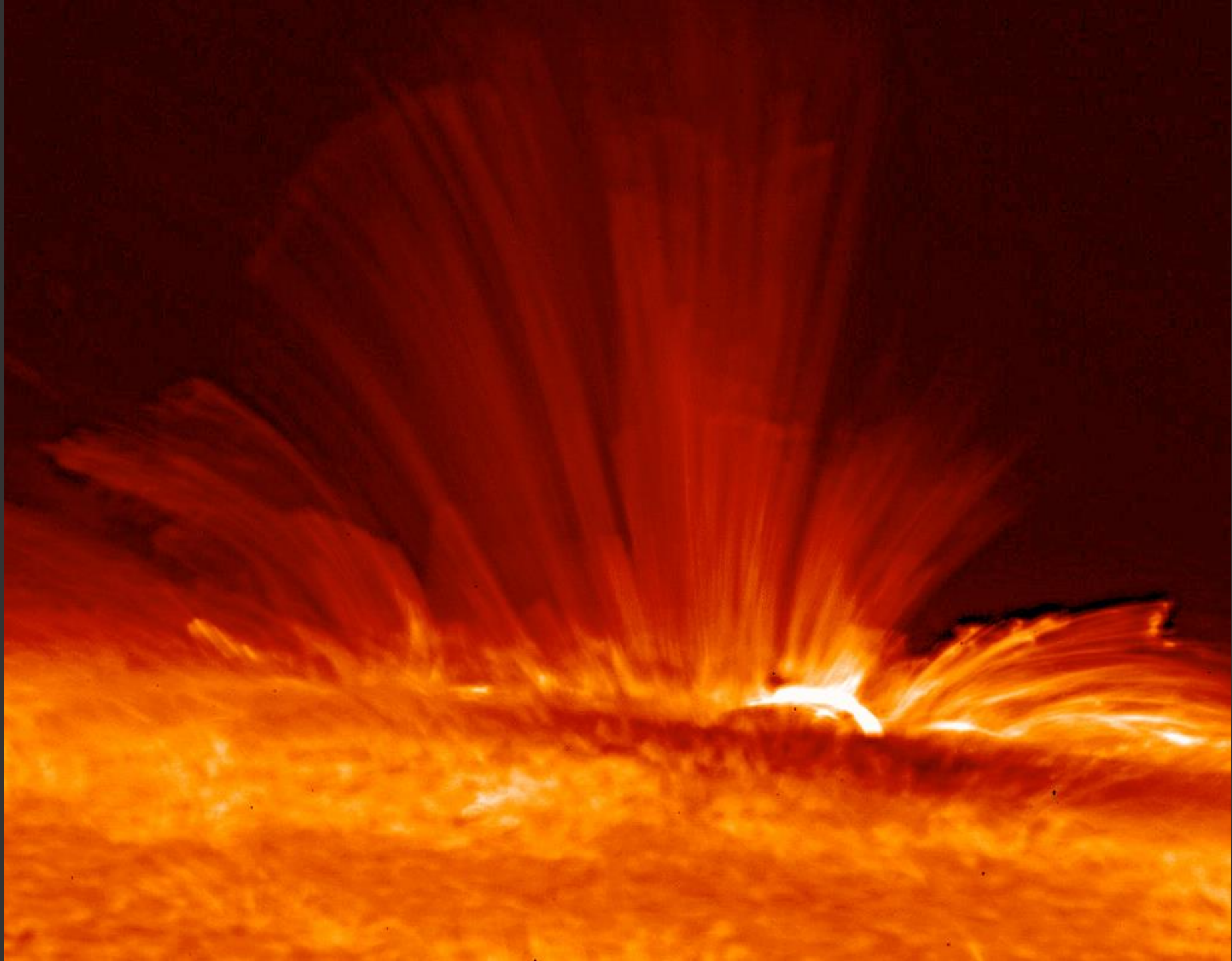
LOS Magnetic Field During Proton Flare

2006-Dec-13
02:30:42
dt = 119.6



Hinode/NFI





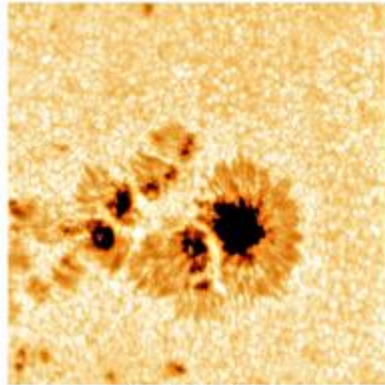
Flare, 4 April 2000, GCT/Tenerife (Field: 91 x 91")

583 nm

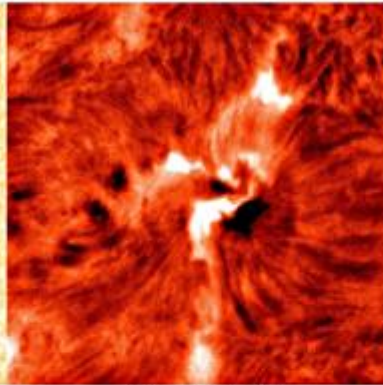
H-alpha

583 nm

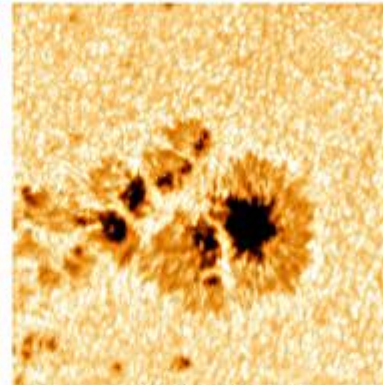
H-alpha



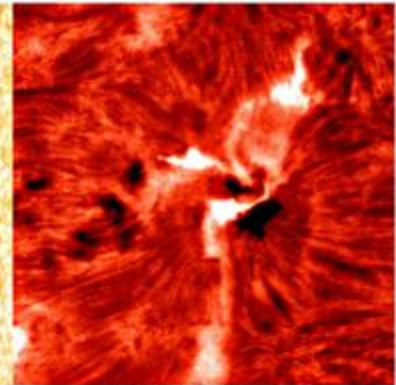
10:39:46 UT



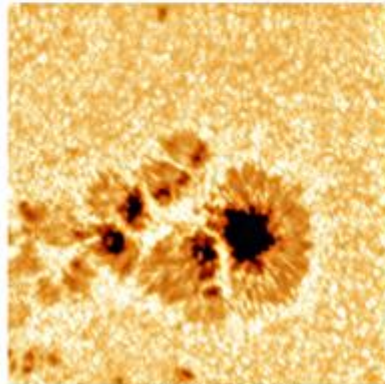
10:39:55 UT



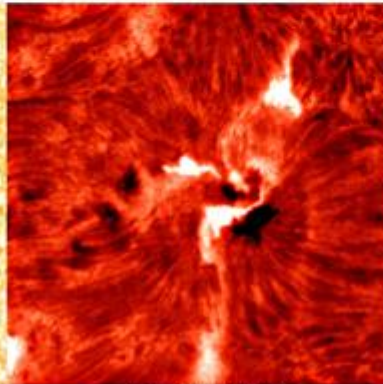
10:49:05 UT



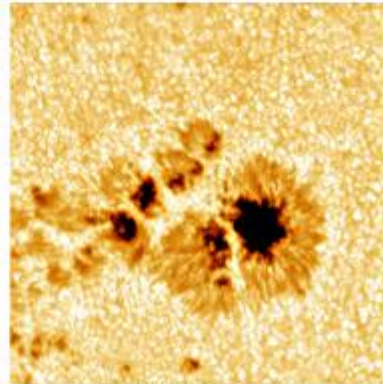
10:49:08 UT



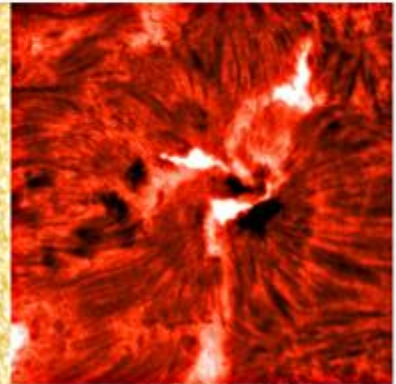
10:43:46 UT



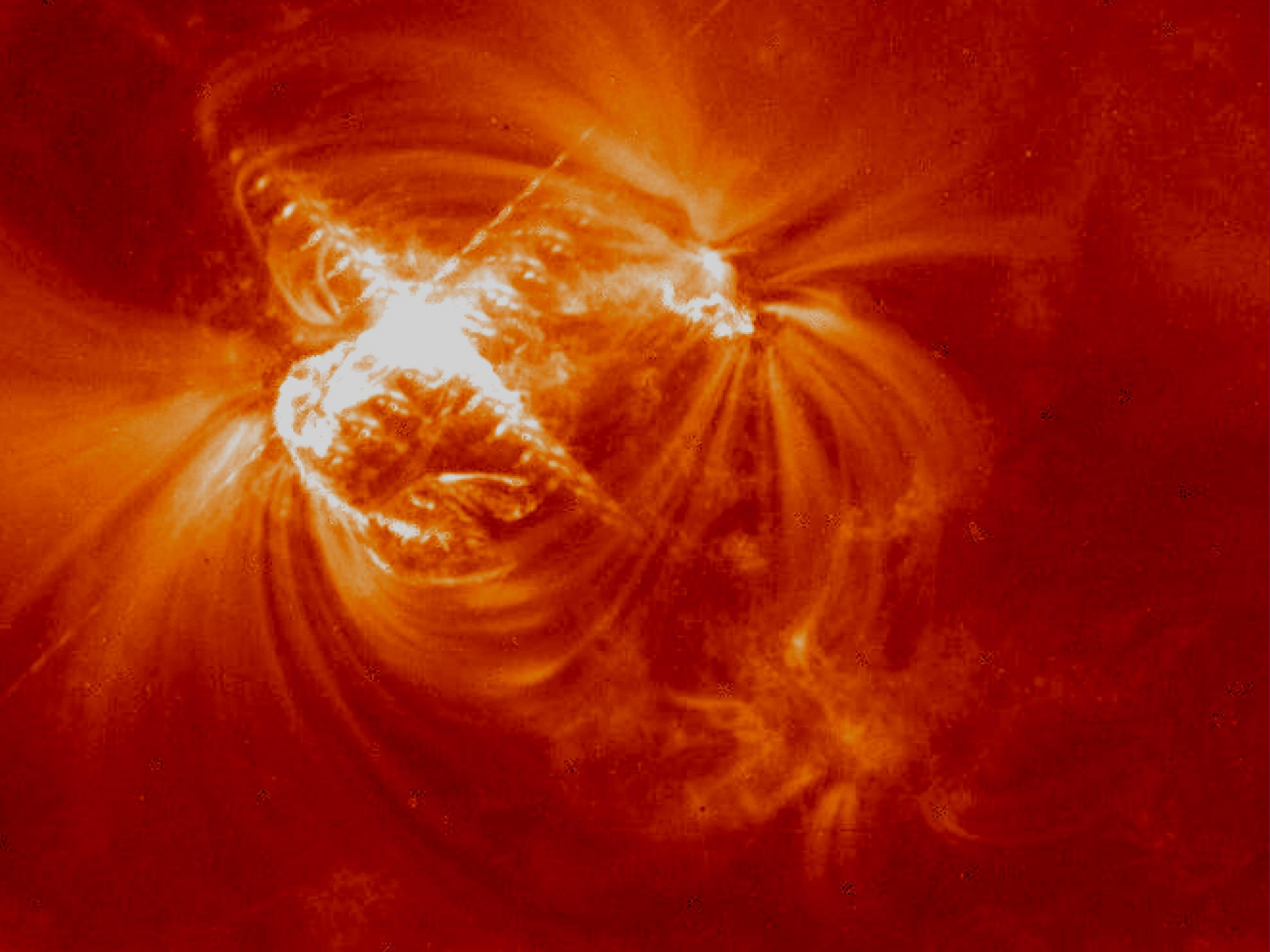
10:43:56 UT



10:51:10 UT

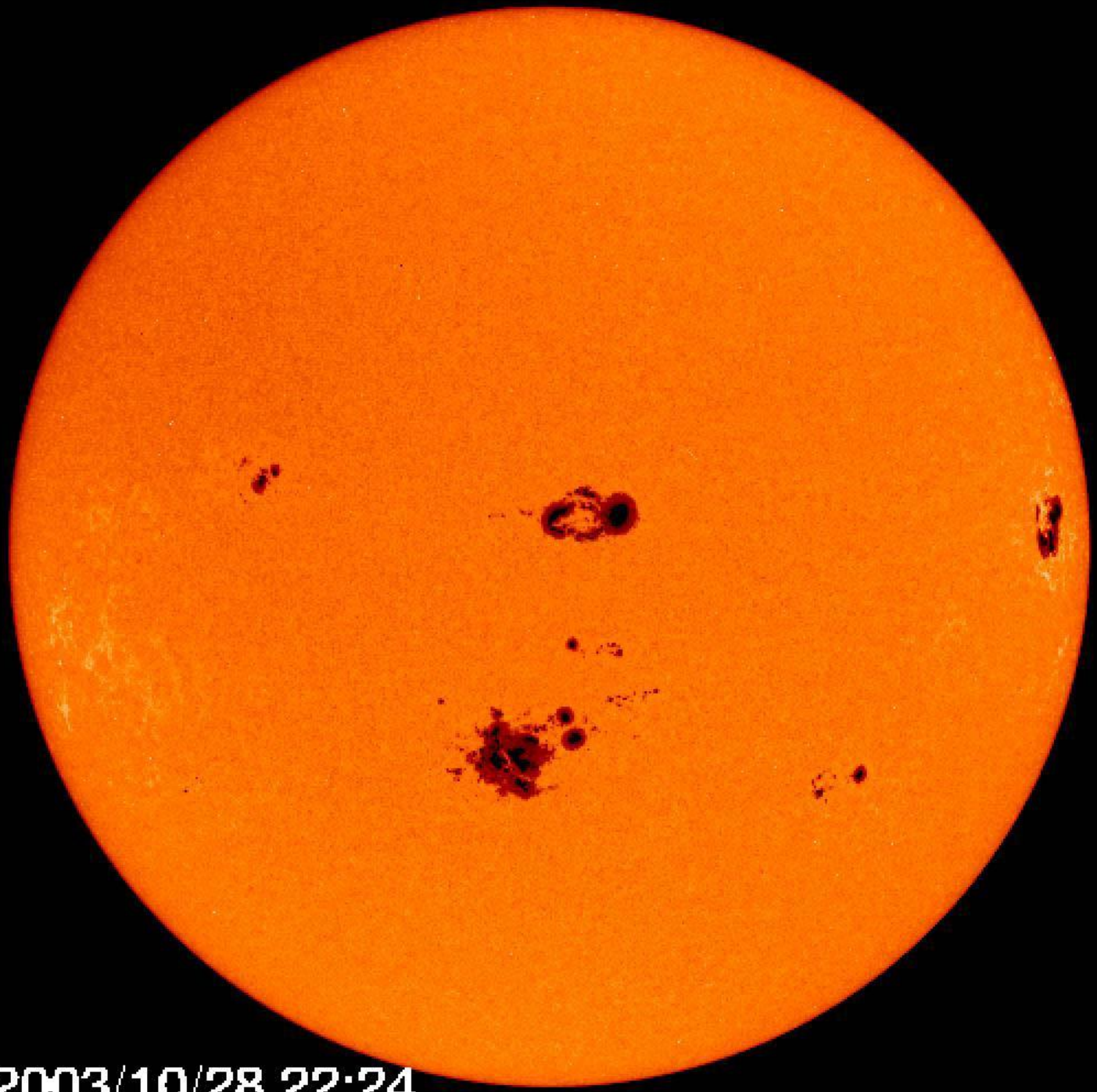


10:51:14 UT

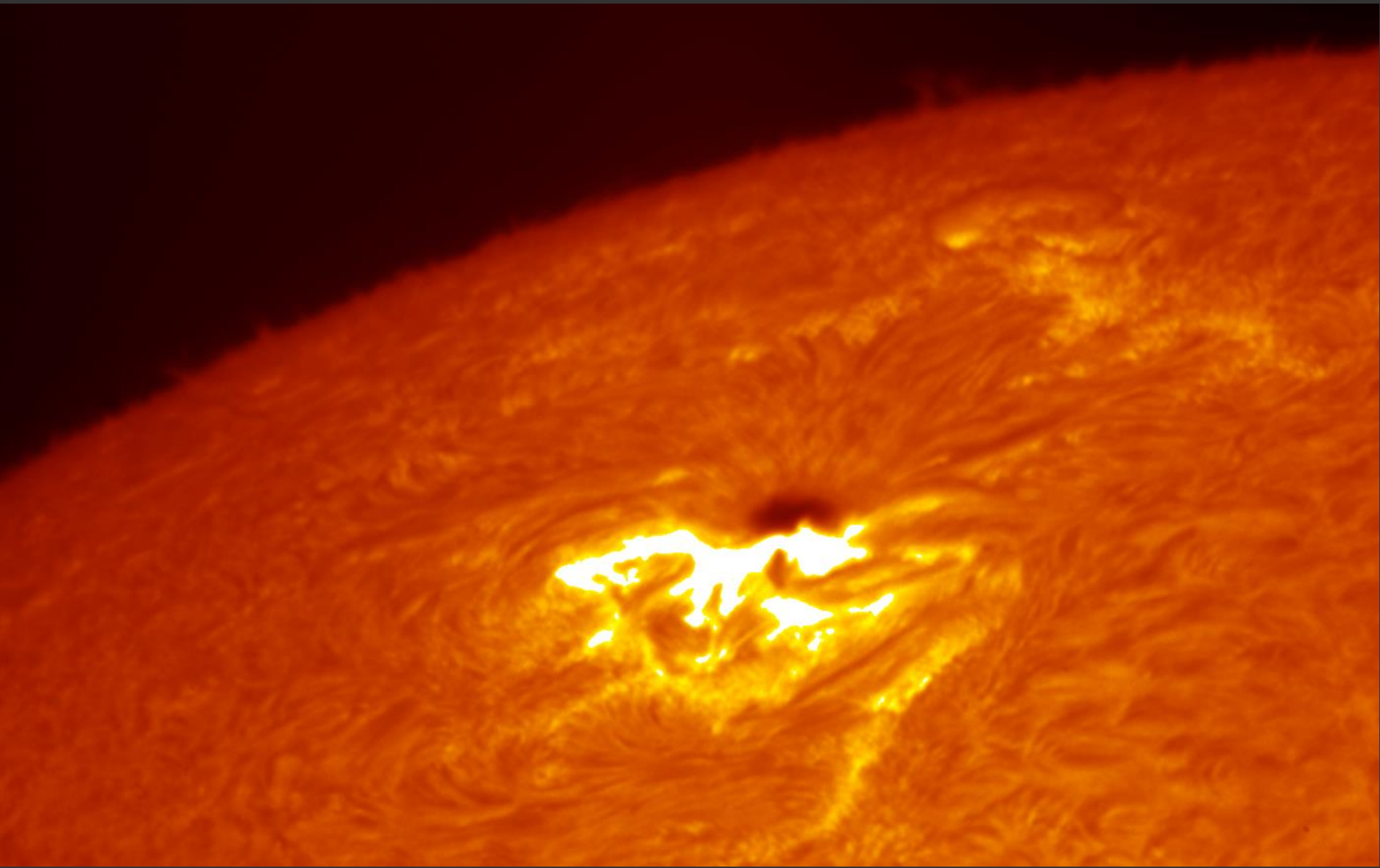


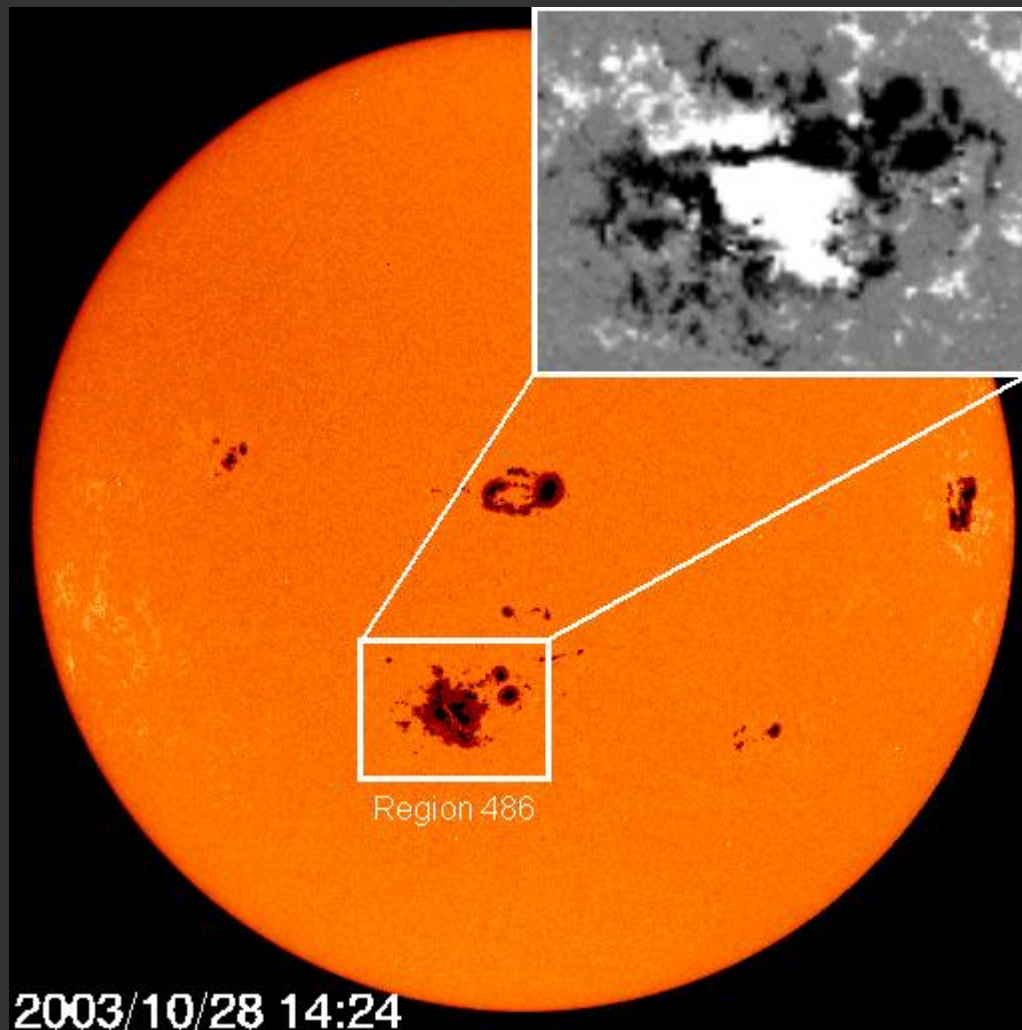


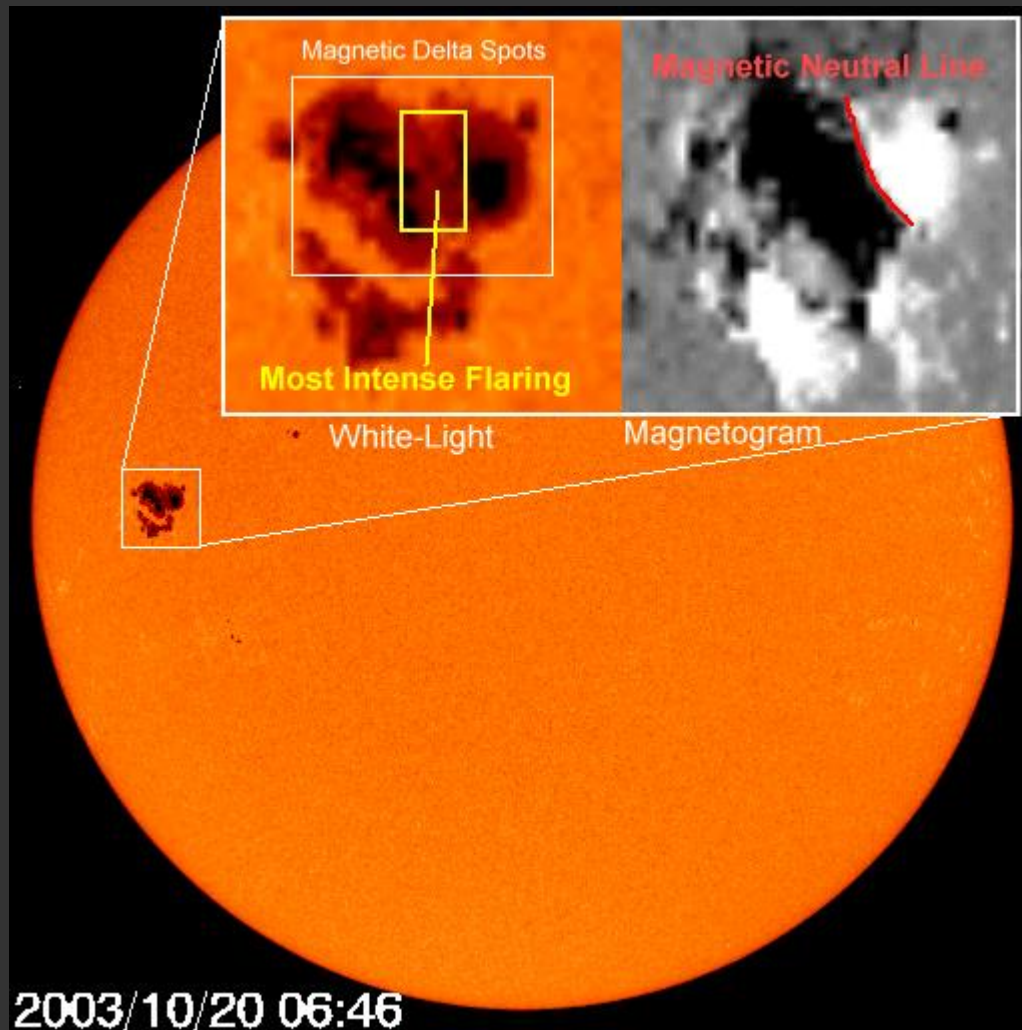


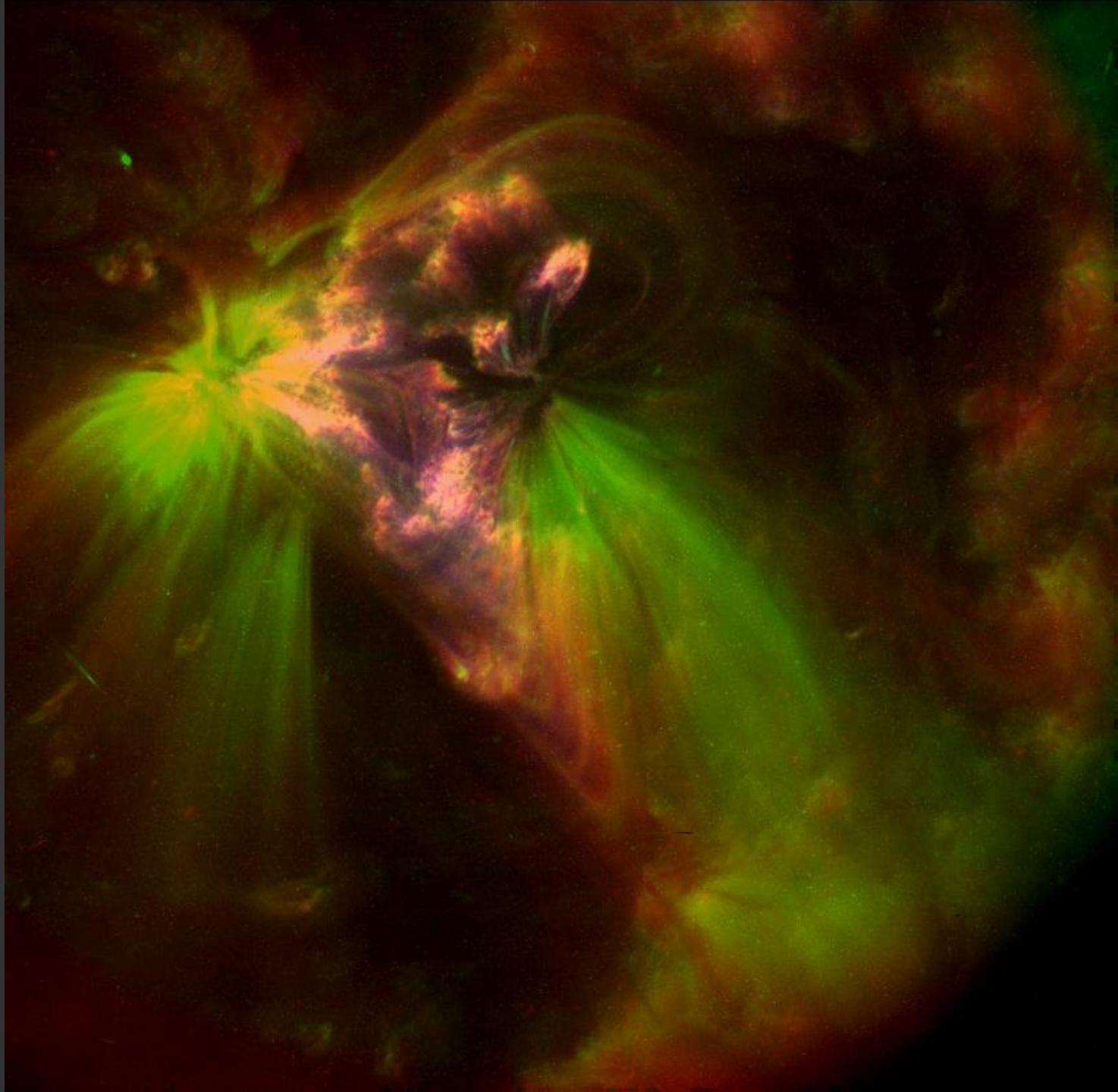


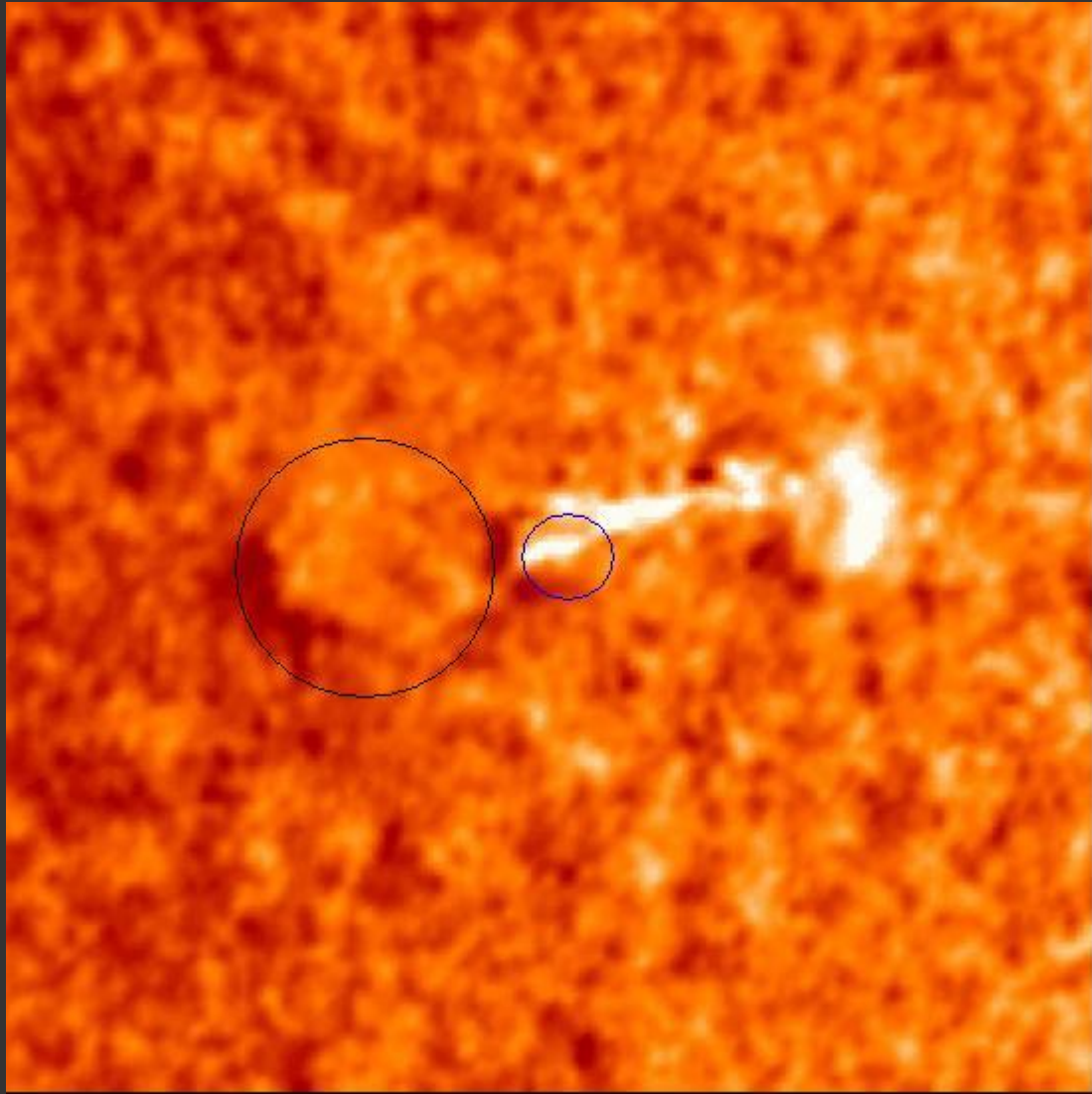
2003/10/28 22:24

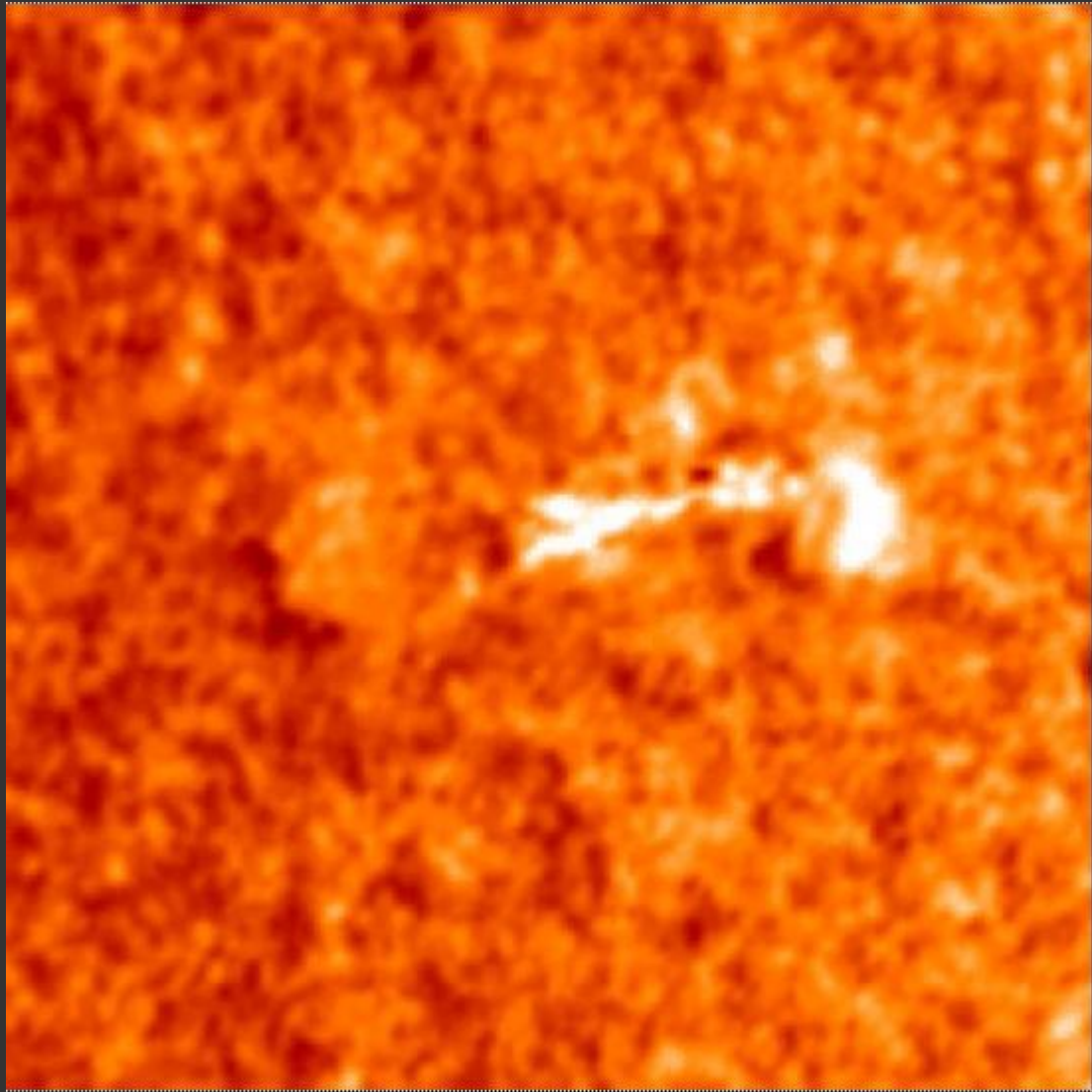


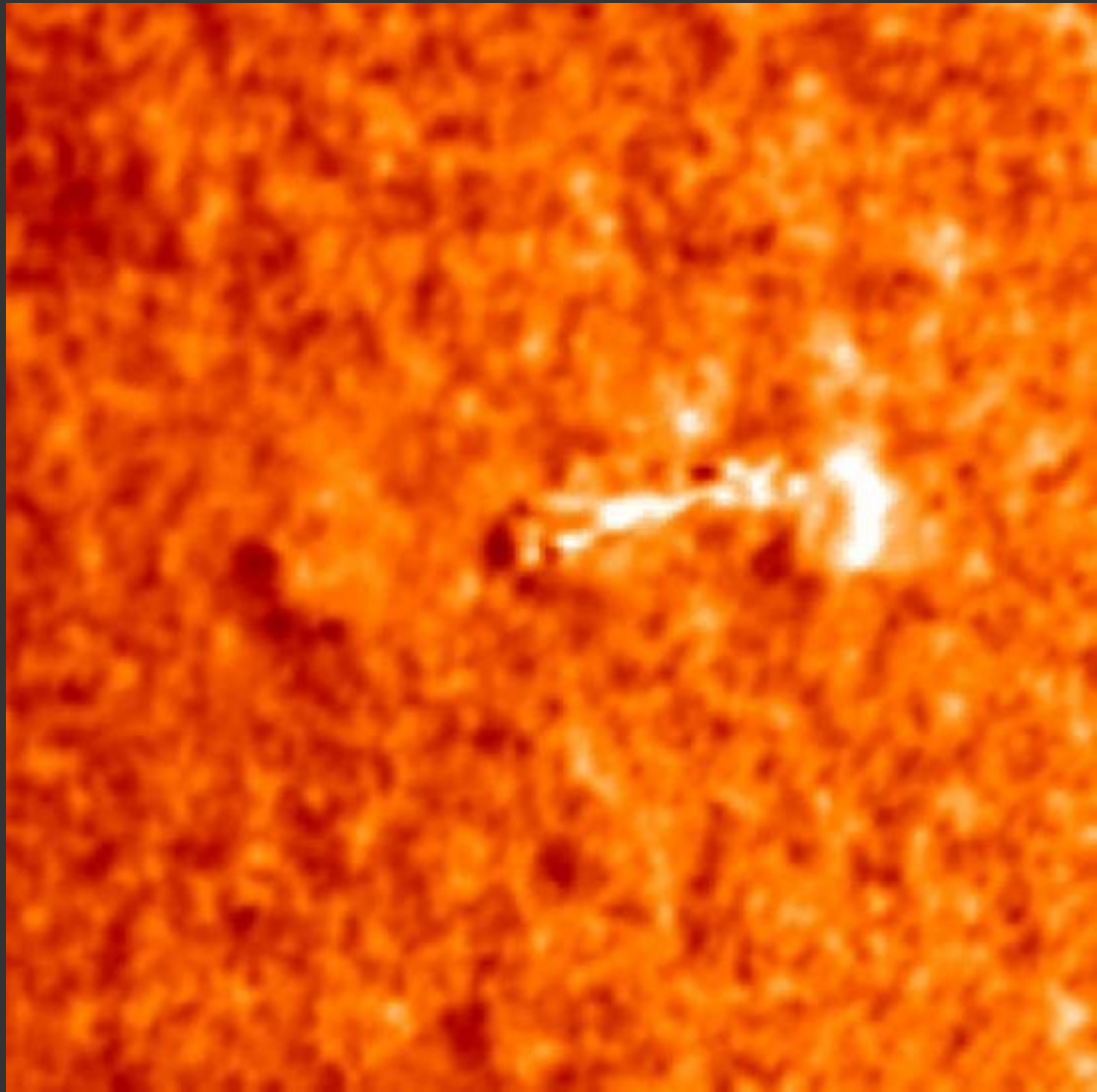


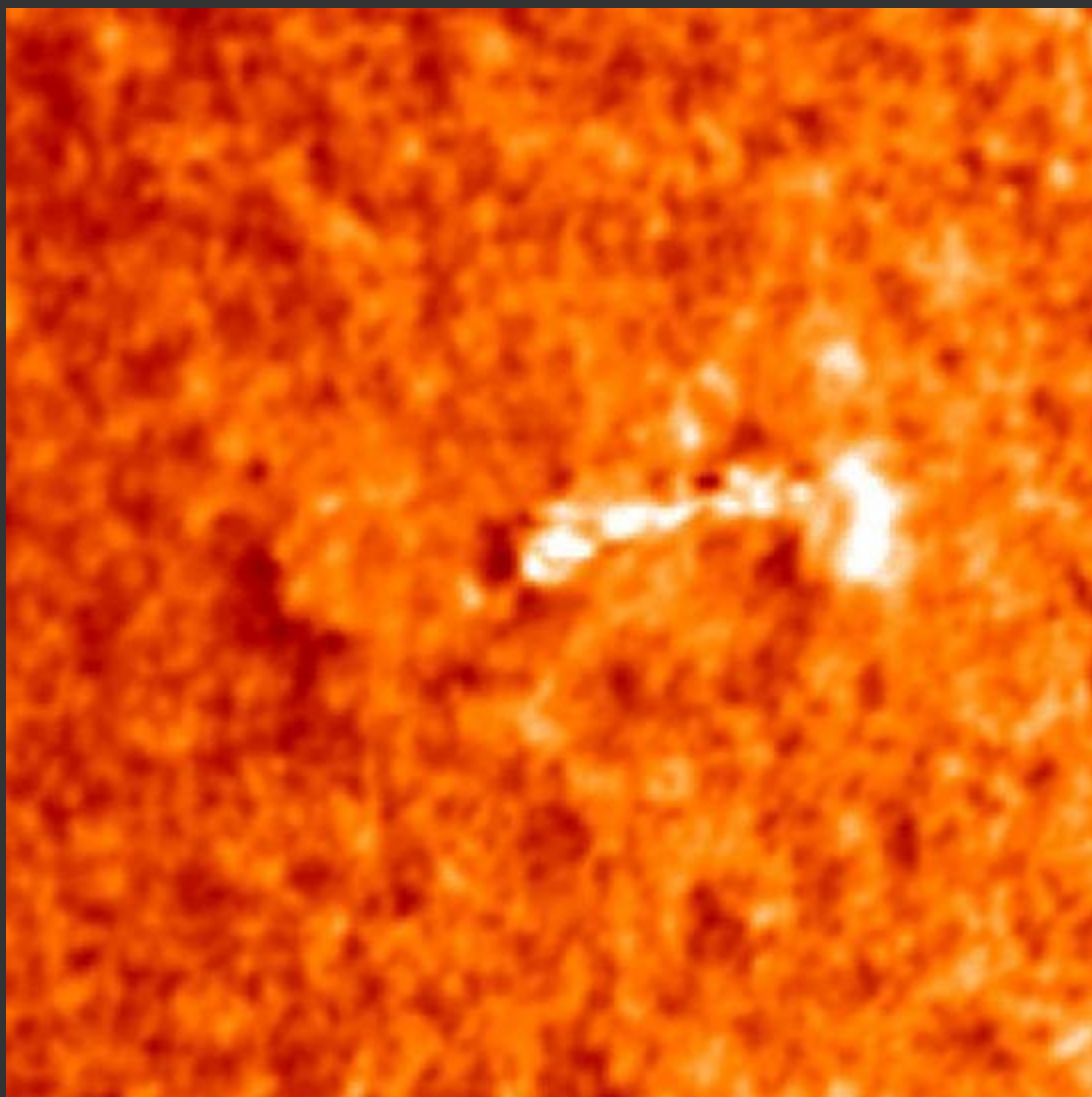


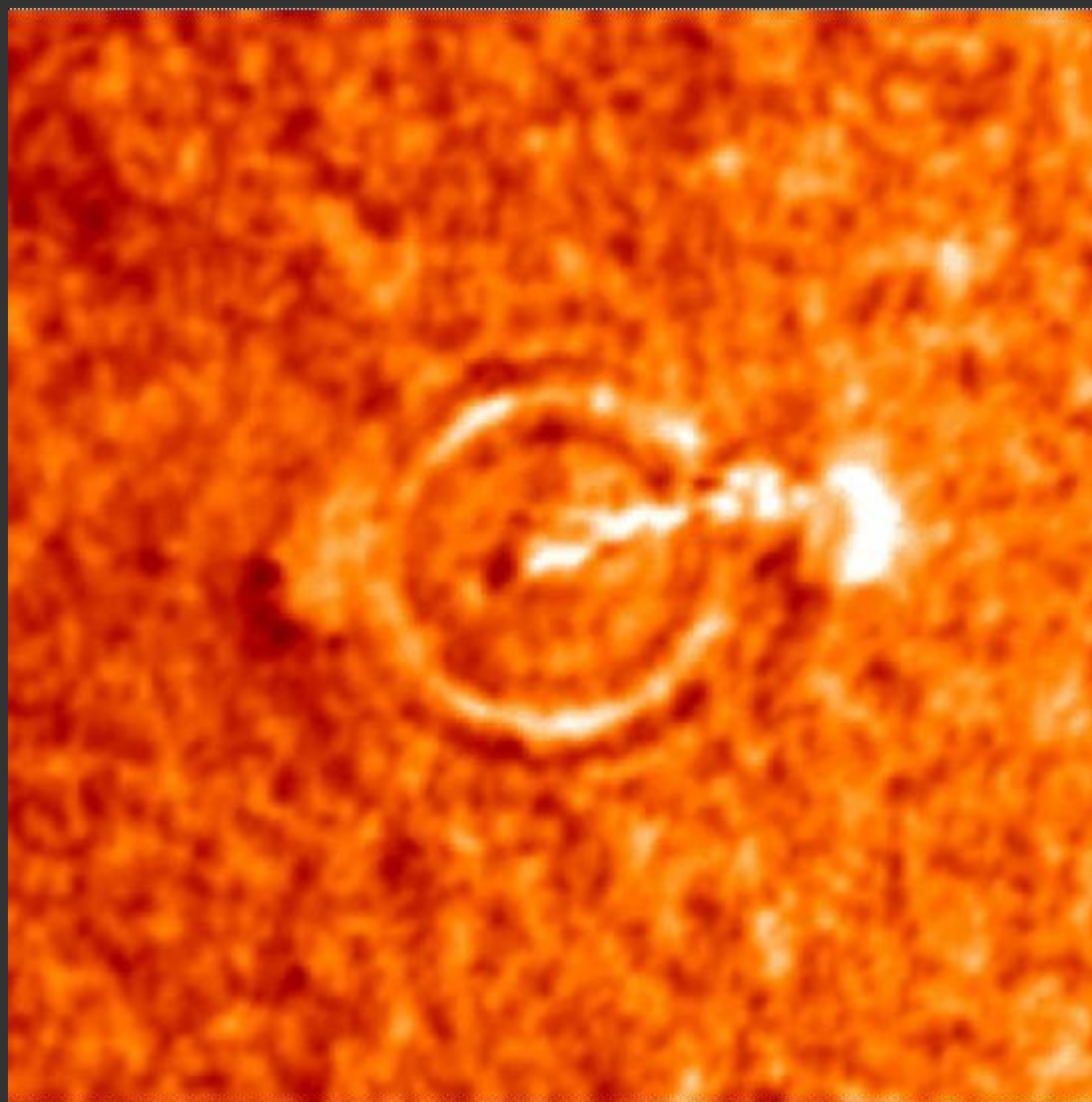


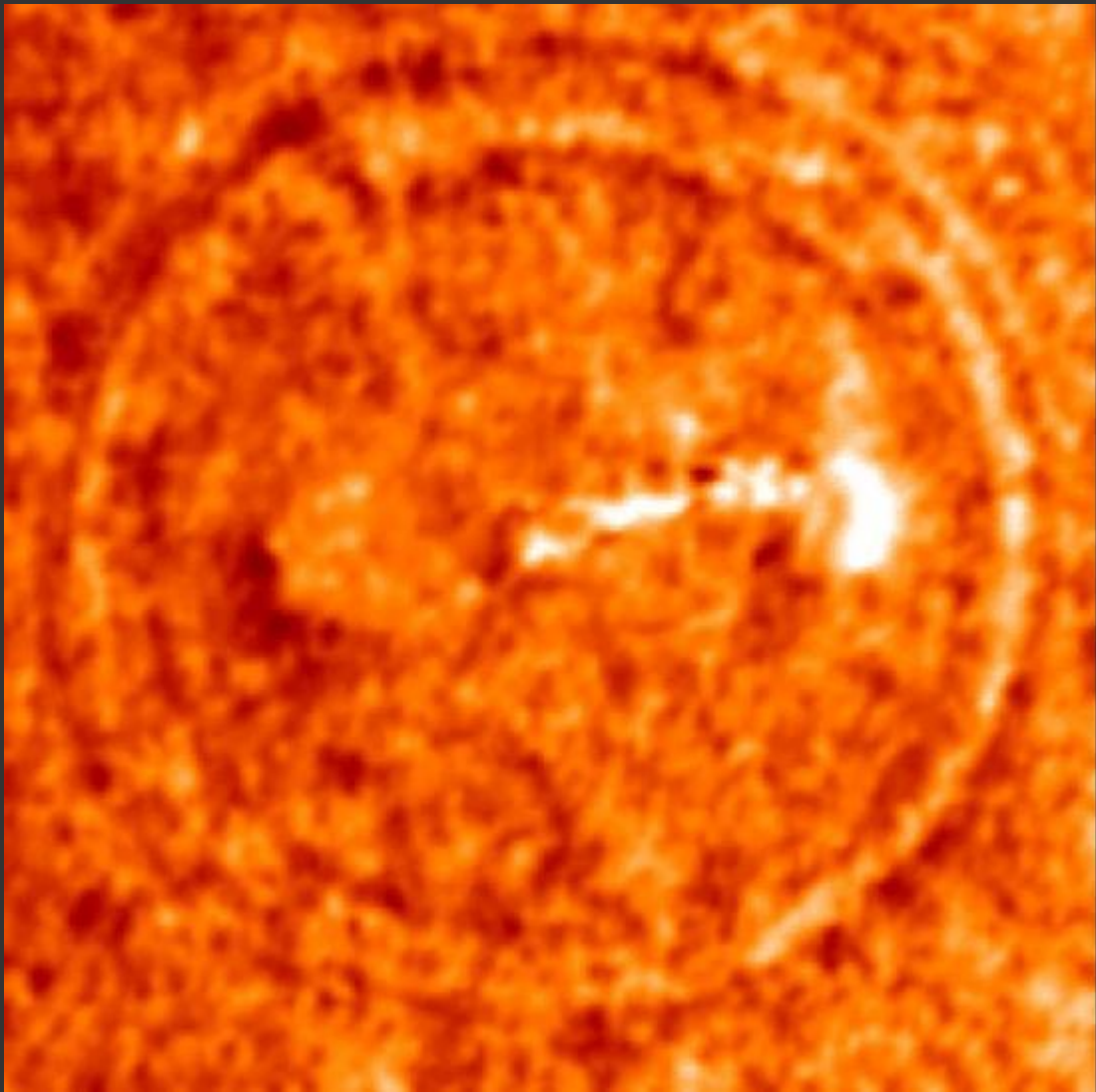


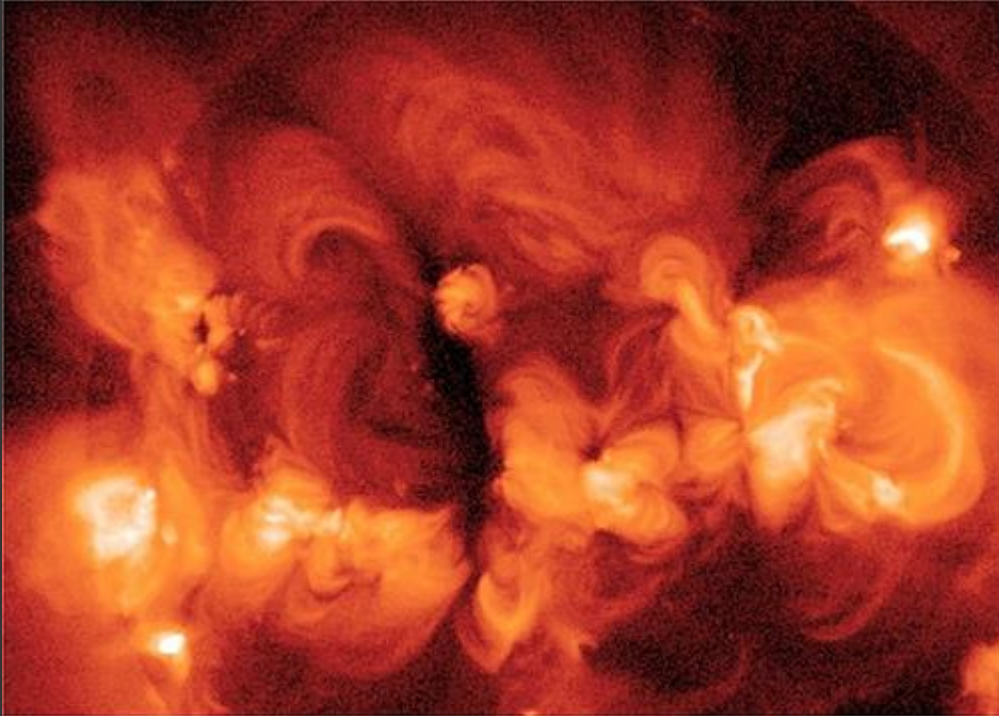


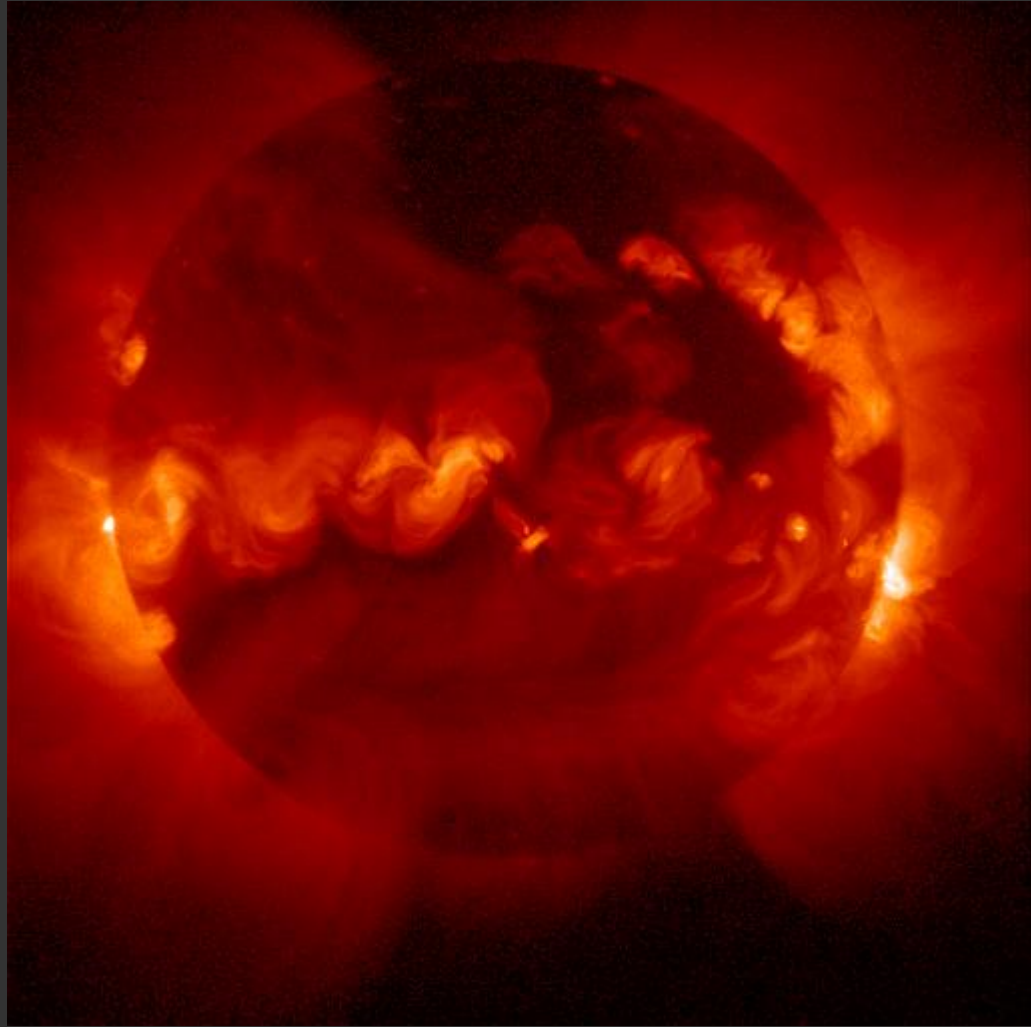


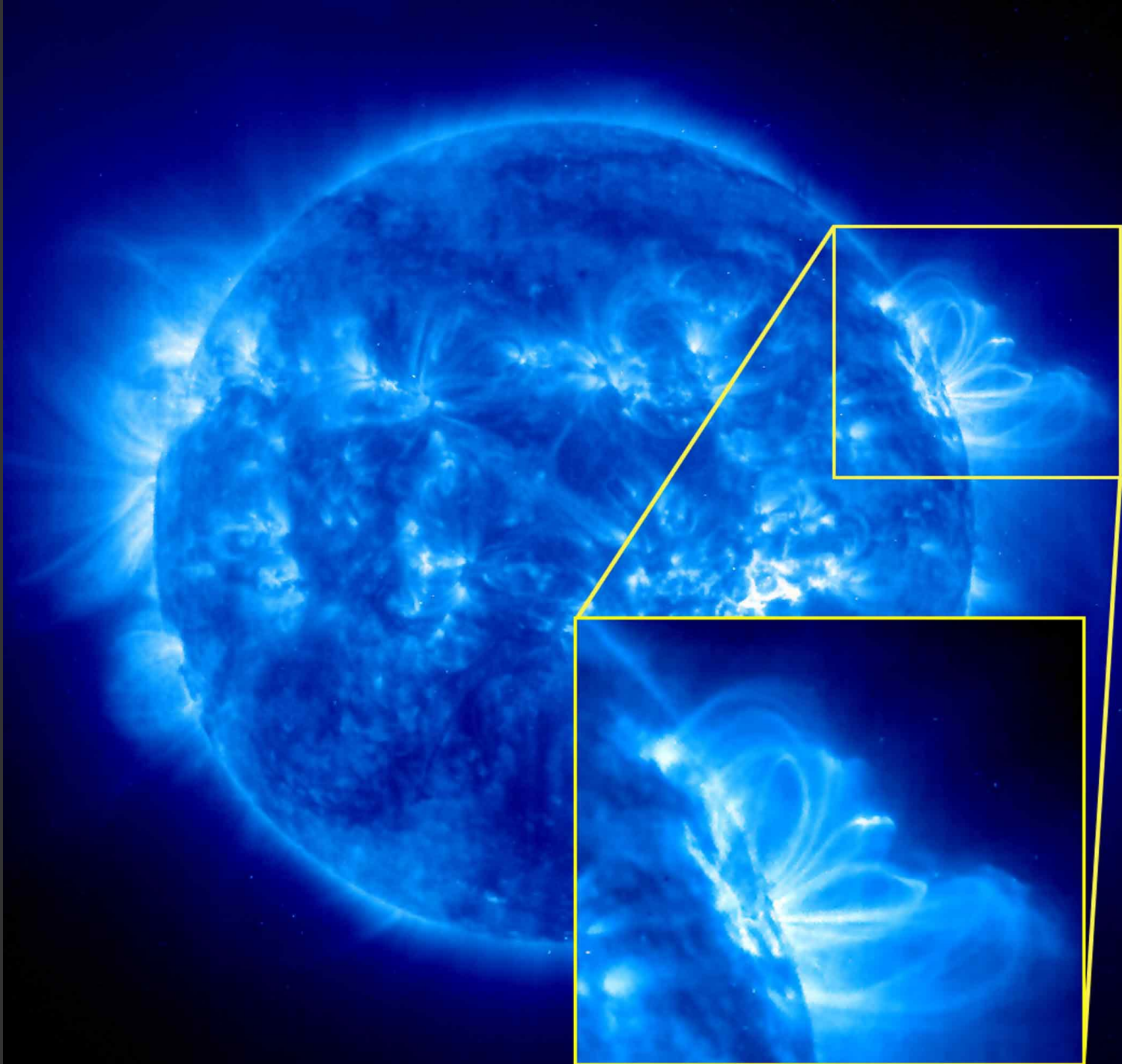


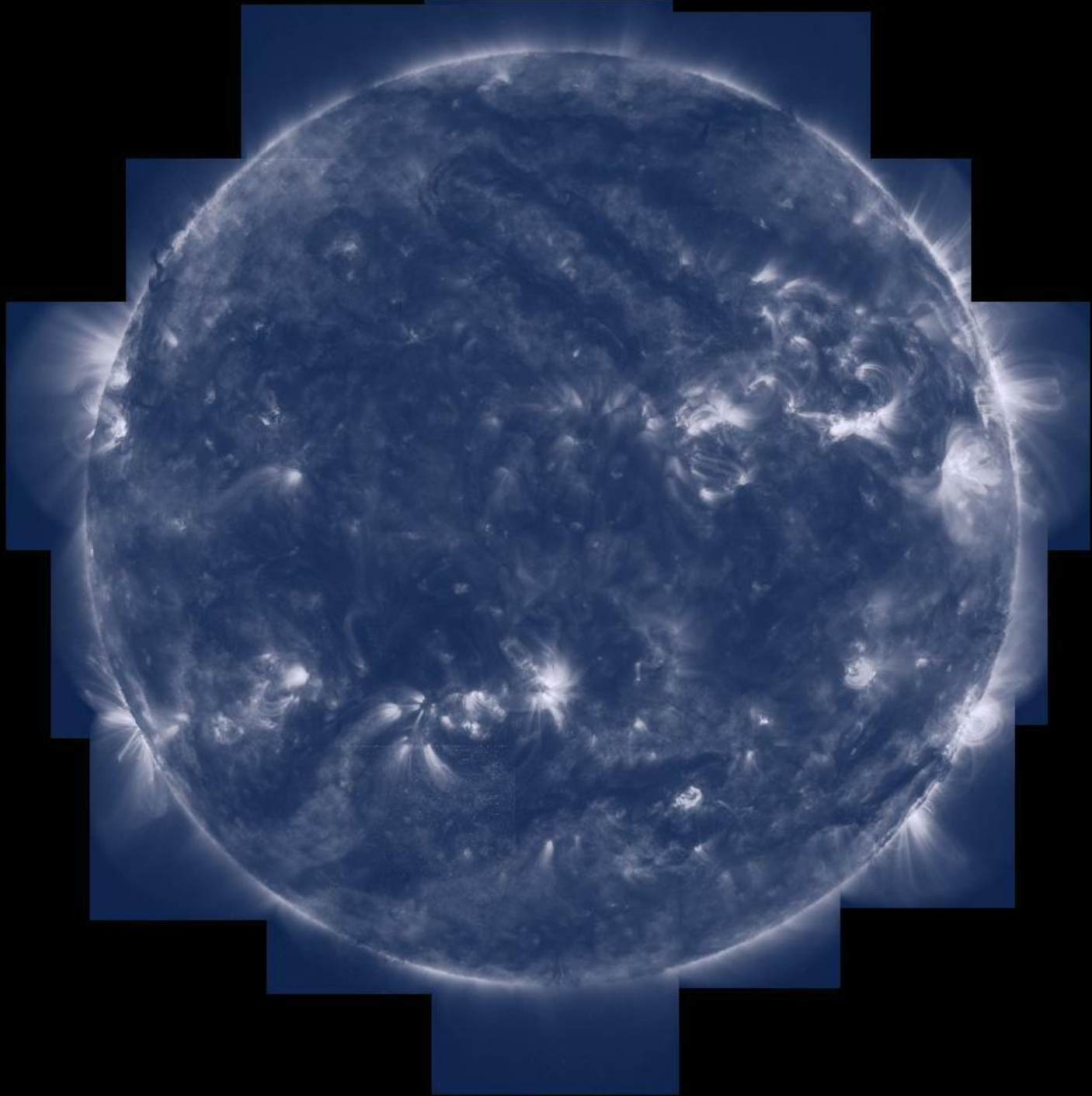












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Έκδοση: 1.0. Αθήνα 2014. Διαθέσιμο από τη δικτυακή διεύθυνση:
<http://opencourses.uoa.gr/courses/PHYS5/>



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