






1

Quiz

How many Earths across is the Sun?

		
10	100	1000

2

Answer: 100




Earth

Sun

3

Quiz

How long does it take the Sun's light to reach the earth?

		
0.008 sec	8 sec	8 min

4

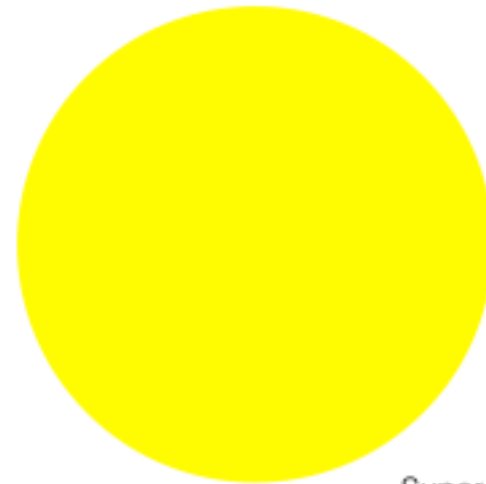
Answer: 8 minutes

distance to the Sun = 1 astronomical unit
= 93 million miles
= 150 million km

Light travels at 300,000 km/s

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Our Sun



Super exciting right?

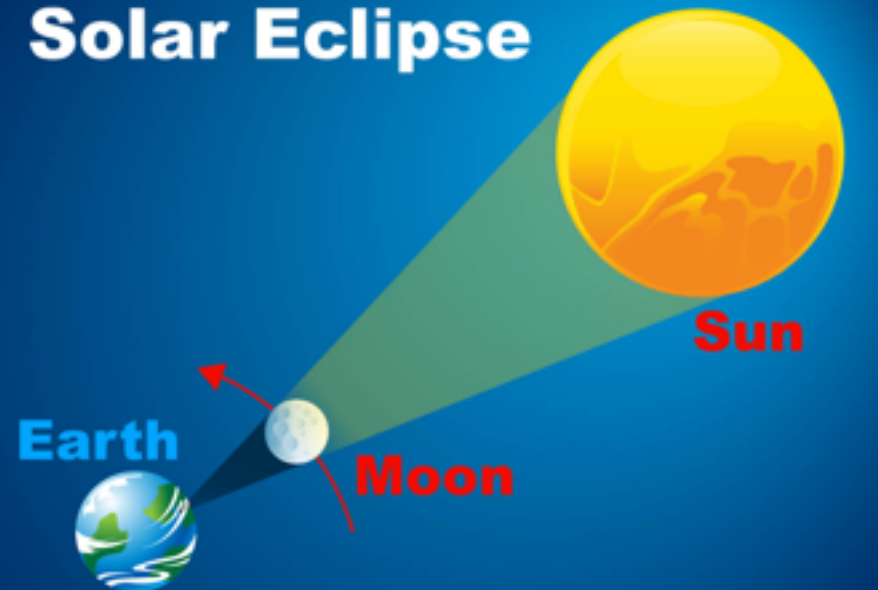
6



Sunset in Bangladesh, 2004

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Solar Eclipse



NASA

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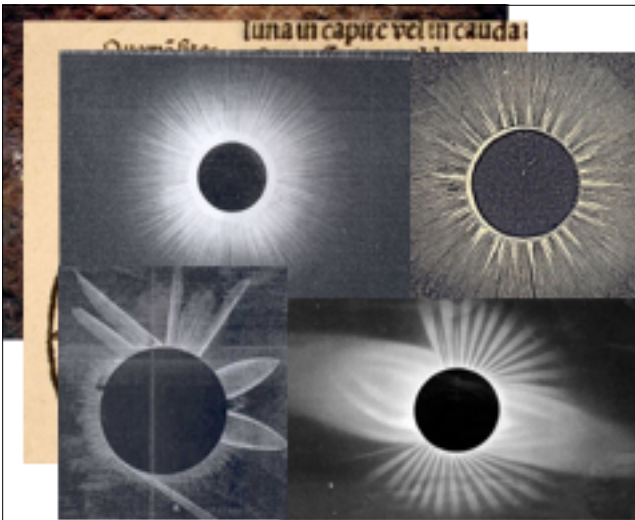
Petroglyph ~1000 AD (source HAO)

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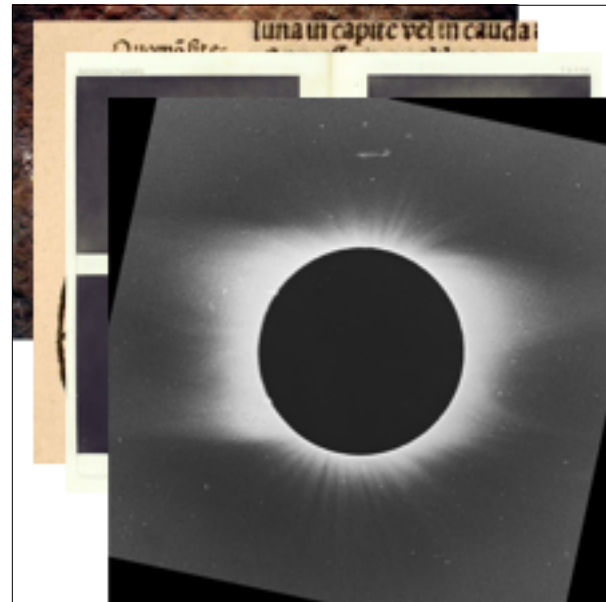
~1000 AD, De temporibus anni, Aelfric

10



Drawings of eclipses in ~1800-1900

11



1889 source: HAO eclipse archive

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Activity

Get in a group with your nearest neighbors

Record your answers.










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Order from coolest to hottest

A  Sunspot	B  The Sun's Corona (atmosphere)	C  Earth's Core
D  Meteor	E  The Sun's Core	F  Surface of the Sun
G  Volcanic lava	H  Comet	I  Lightning

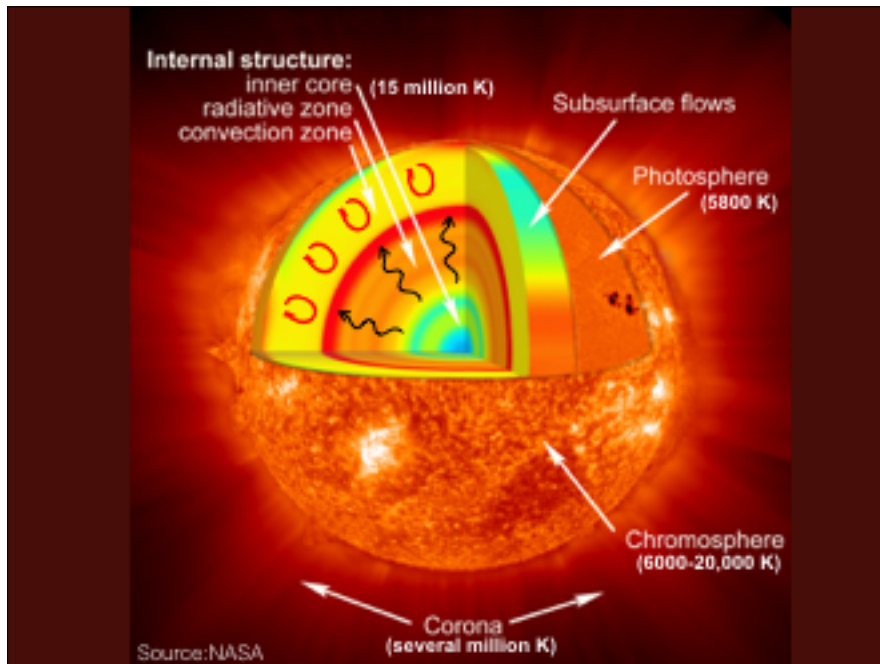
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Answer

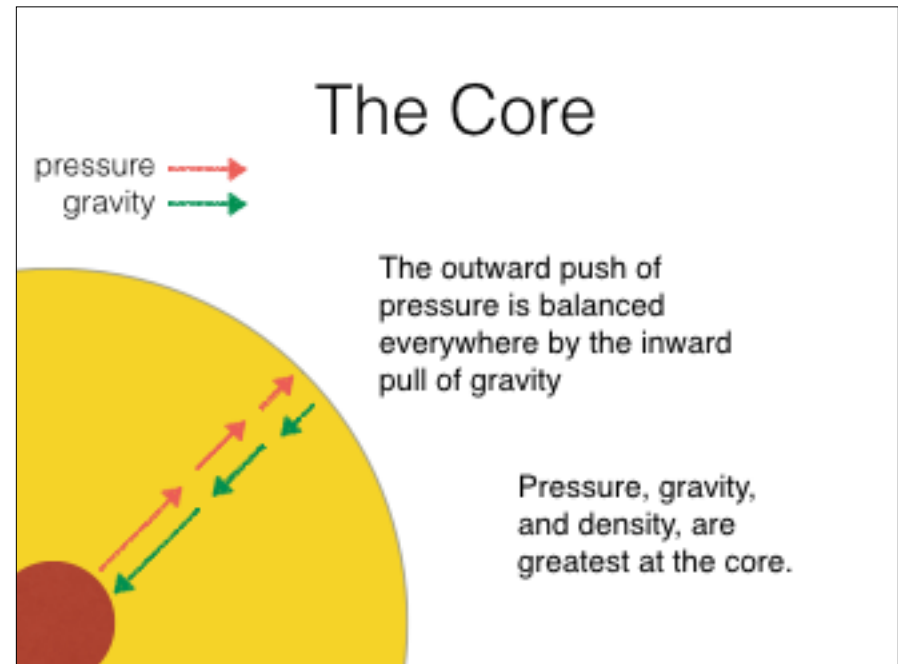
H  Comet -450°F to 200°F	C  Earth's core 6200°K
G  Lava 1450°F to 2000°F	I  Lightning 30,000°K
A  Sunspot 6300°F	B  Sun's corona 5 million °K
D  Meteor 10,000°F or 5800°K	E  Sun's core 15 million °K
F  Sun's surface 6000°K	

Source: <http://solar-center.stanford.edu/activities/HowBig/How-Big-Far-Hot-Old.pdf>

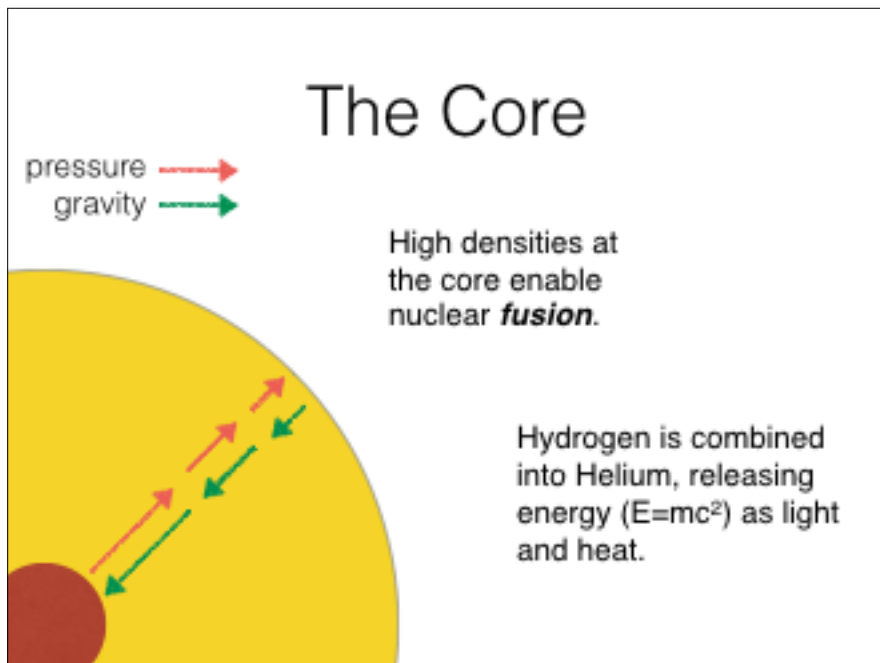
16



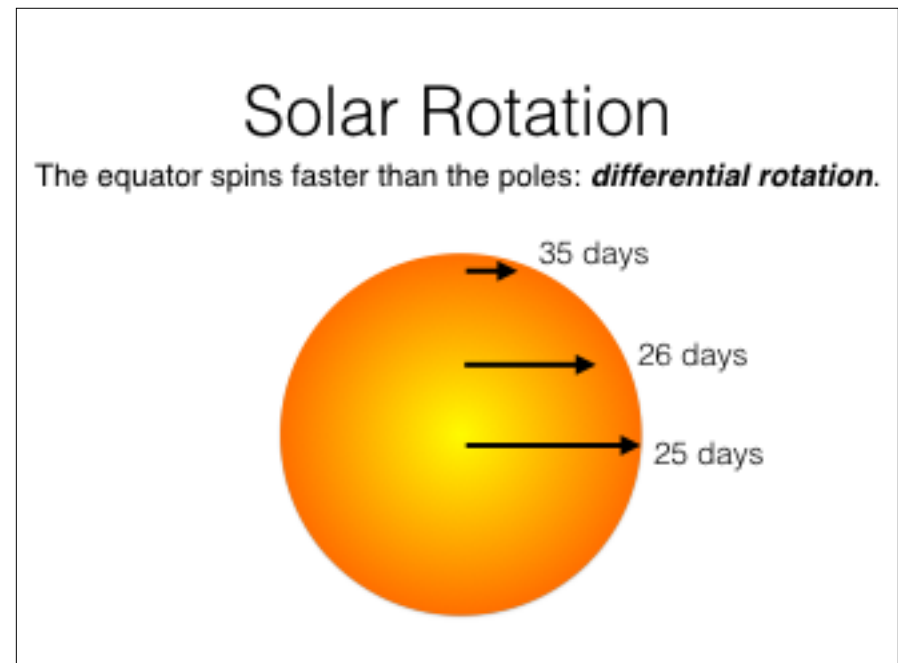
17



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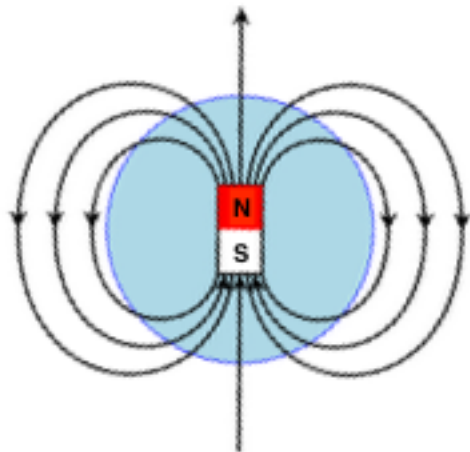
19



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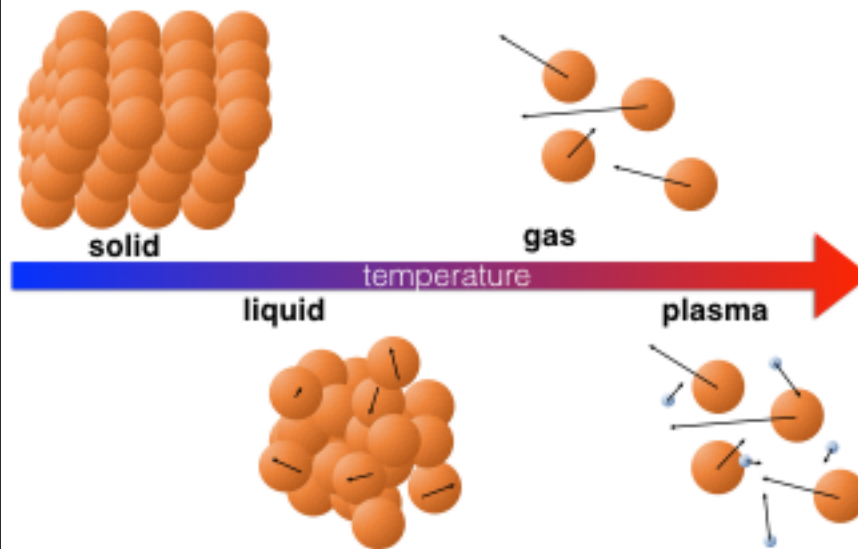
Magnetic field

The Sun, like the Earth, has a global magnetic field.



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Phases of Matter



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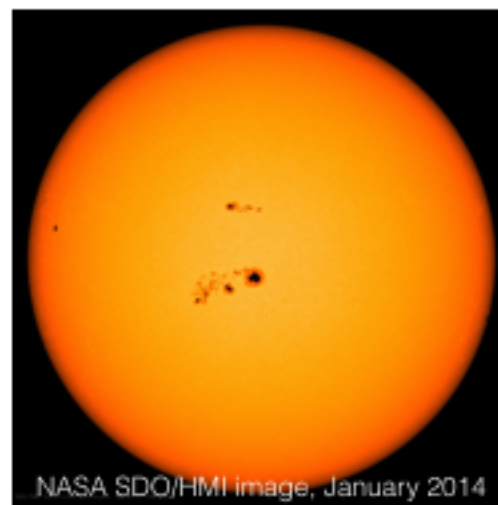


Solar Dynamo

Spinning plasma drags the magnetic field.

Source: SOHO (ESA/NASA)

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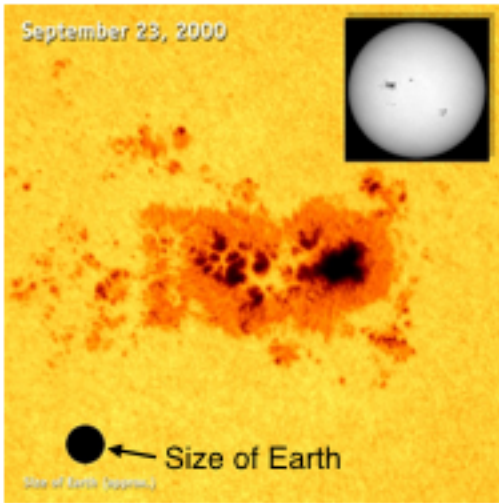


Sunspots

Sunspots form where concentrated magnetic field emerges through the photosphere.

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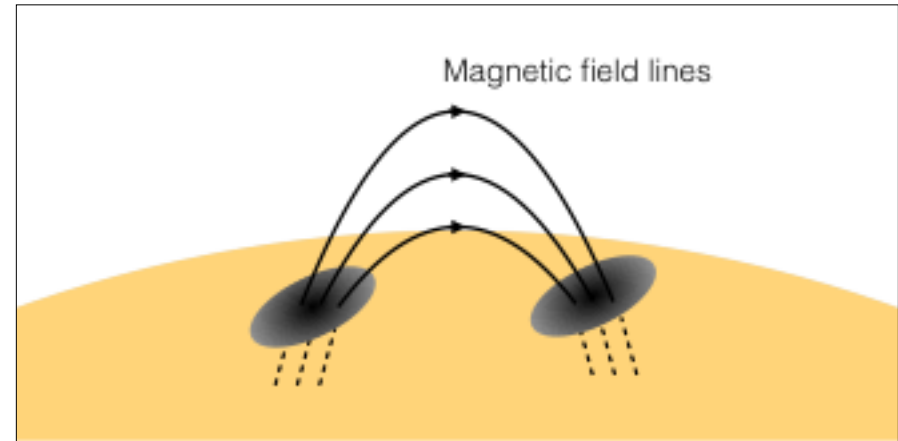
source: SOHO (NASA/ESA)



Sunspots

Smaller sunspots are about the size of the Earth.

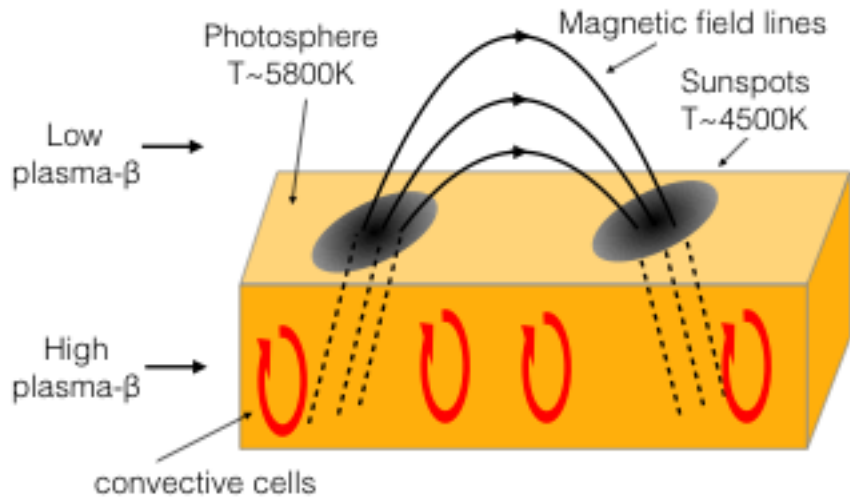
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Sunspots

Strong magnetic field threads through sunspots.

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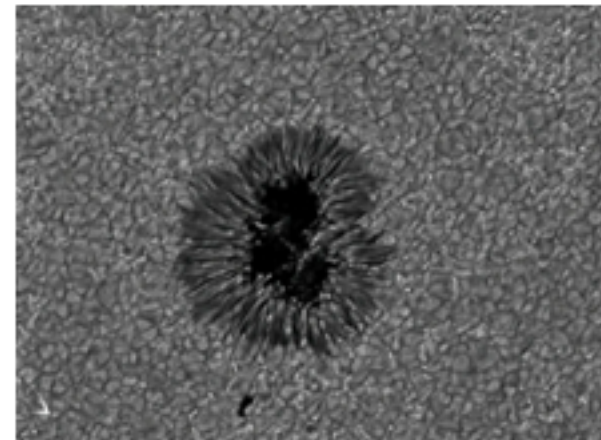


Sunspots

Strong vertical field inhibits convection, making sunspots cooler than the surrounding photosphere.

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Sunspot

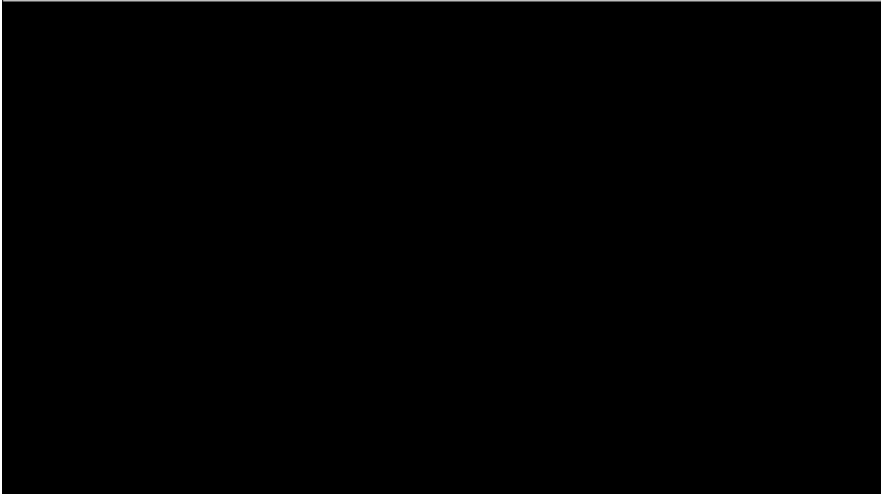


Dutch Open Telescope - 1 April 2001

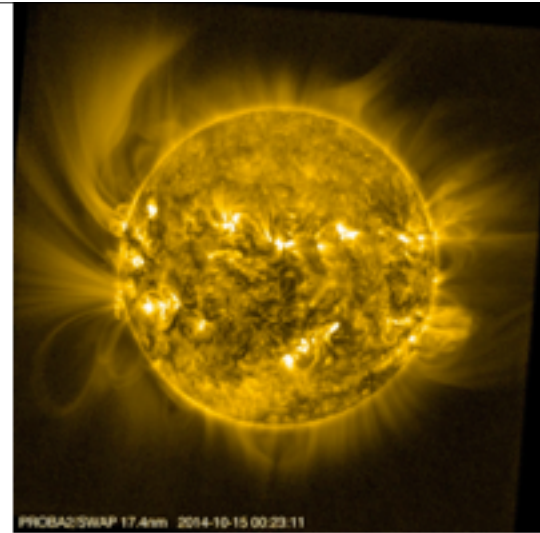
[http://www.staff.science.uu.nl/~rutte101/dot\(albums/movies/album.html](http://www.staff.science.uu.nl/~rutte101/dot(albums/movies/album.html)

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Above Sunspots: Active Regions



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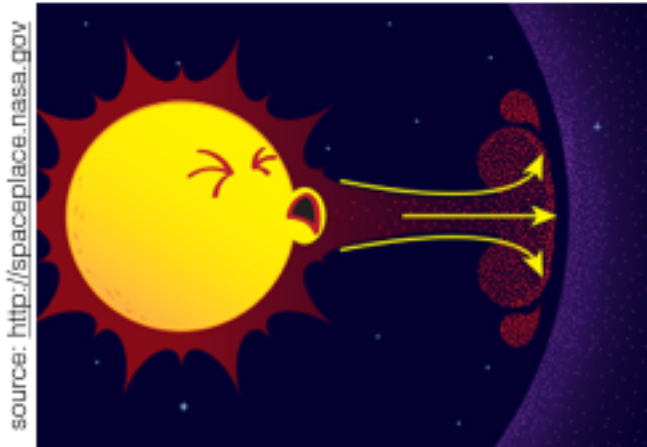
The dynamic corona

PROBA2/SWAP movie of 3 solar rotations

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Heliosphere

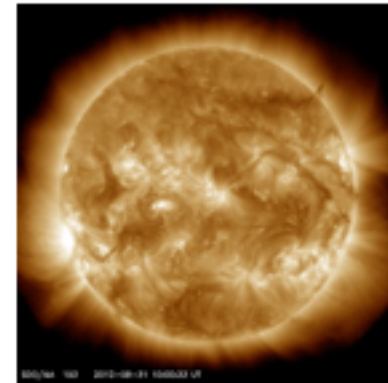
The bubble-like volume surrounding solar system caused by the *solar wind*. Outside the heliosphere is *interstellar space*.



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Eruptions

Major disturbances in the heliosphere are caused by massive explosions in the Sun's atmosphere: **coronal mass ejections**.

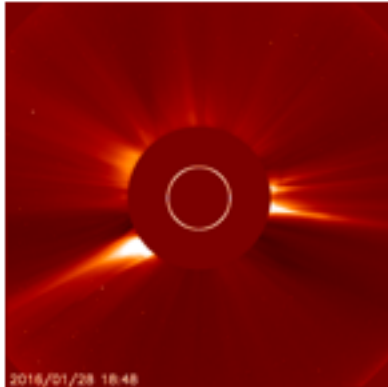


NASA SDO/AIA movie

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Eruptions

Major disturbances in the heliosphere are caused by massive explosions in the Sun's atmosphere: **coronal mass ejections**.






NASA LASCO C2 movie

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Quiz

How fast are these eruptions?

		
5 m/s	5 km/s	500 km/s

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Quiz

How massive are these eruptions?
(1 m³ of water = 1000 kg = 1 metric ton)

		
1 km ³ 10 ⁹ m ³	1000 km ³ 10 ¹² m ³	100,000 km ³ 10 ¹⁵ m ³

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Eruption statistics

- How big? About as big as 1 cubic km³ of water, a few times 10¹² kg.
- How fast? About 500 km/s (1100 mph)

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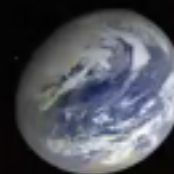
Eruption statistics

- How big? About as 1 cubic km³ of water
- How fast? About 500 km/s (1100 mph)
- How much energy? About 20x the last year's global energy consumption.

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Eruptions in the heliosphere

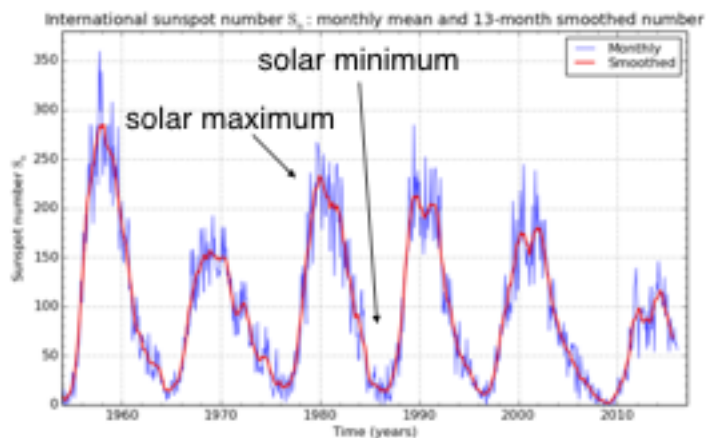
NASA Scientific Visualization Studio



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Activity cycle

There are times when the Sun is more active than others. It is linked to the solar dynamo. The activity cycle period is roughly 11 years.

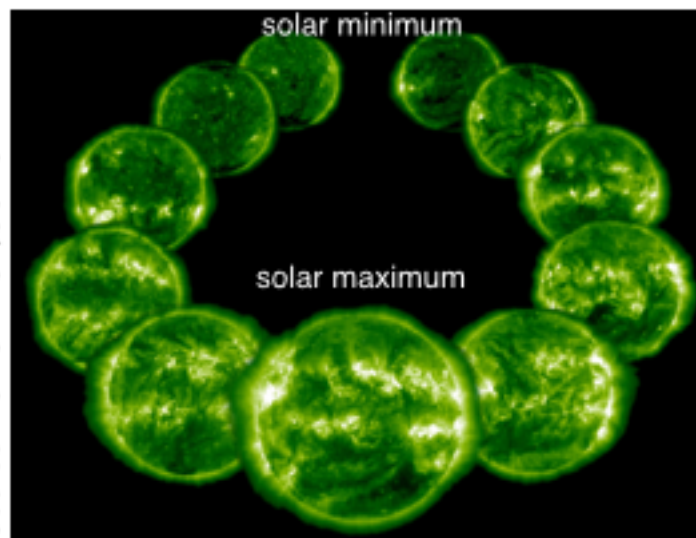


SILSO graphics (<http://sidc.be/silso>) Royal Observatory of Belgium 2016 February 1

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Activity cycle

Source: ESA & NASA/SOHO



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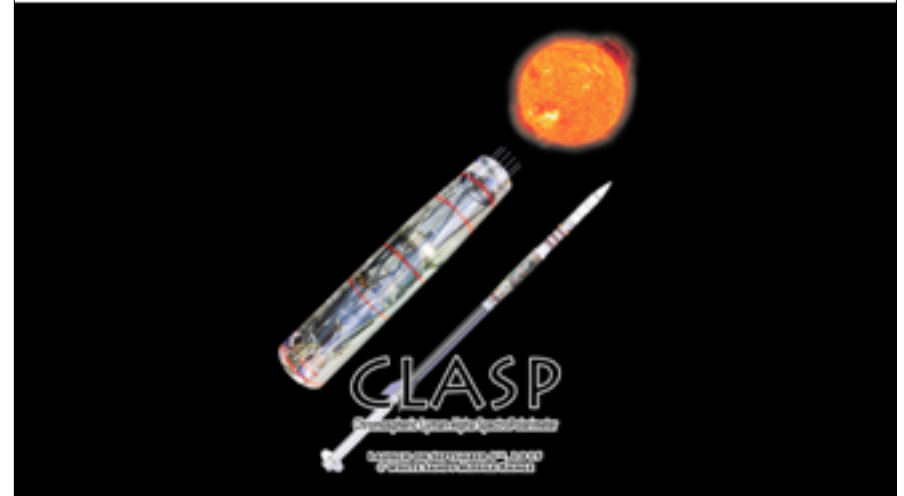
How do we know all of this?

- Theory
- Observations
- Computer modeling



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CLASP launch 3 September 2015, White Sands Missile Range MSFC Sounding Rocket



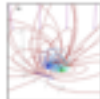



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LASP Sounding Rocket



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My research: magnetic fields in the corona

- Computer models of eruptions. 
- Measurements of the coronal magnetic field. 
- Large-scale structure of the corona. 
- Sounding rockets, measurements of the magnetic field in the chromosphere. 

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