

**NASA Chat: The Sun Has a 'Cirtain' Flare**  
**Expert Dr. Jonathon Cirtain**  
**Oct. 27, 2011**

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*(Moderator Brooke):* Welcome to the solar chat! This is a moderated chat. To submit your own question, please type it in the box at the bottom of the window and click the 'Ask' button on the right side of the box. Thanks for your patience as we answer your questions.

Ludmila: Why is the Solar Corona so hot?

Jonathan: The sun's atmosphere exists with both plasma and magnetic field filling all space. Energy is transferred from the magnetic field and into the plasma. Since the magnetic field is highly curved (geometrically), a vast amount of potential energy can be stored in the field. If only a fraction of this energy is transferred to the plasma, it provides sufficient thermal energy to heat the corona.

Maniza: What exactly are sunspots?

Jonathan: Sunspots are the surface manifestations of areas of high magnetic field concentration.

Astronerd: Can you explain what the Sun had to do with the aurora we saw over northern Alabama earlier this week?

Jonathan: The sun produced a large coronal mass ejection a few days prior to the aurora. When this CME slammed into the Earth's magnetosphere, it accelerated electrons and protons trapped in the ionosphere and when those energetic particles impacted the Earth's upper atmosphere, it formed the Aurora.

Kbordner: What is the average temperature of a sunspot?

Jonathan: 5600 Kelvin.

Comatose: Could a solar flare possibly destroy all life on Earth?

Jonathan: Highly unlikely. A solar flare, although highly energetic, does not pass much energy through the magnetosphere and into the Earth's lower atmosphere.

*(Moderator Brooke):* Thanks for the great questions that are starting to come in. Do YOU have a question for Jonathan? Now is your chance!

Maniza: Does the sun have an atmosphere?

Jonathan: The surface of sun is commonly called the photosphere. Above the photosphere in altitude is the chromosphere which extends from roughly from 3000 to 5000 kilometers and then the corona. This outer envelope of the solar atmosphere extends to the boundary of the solar system, called the heliopause.

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Avner\_M: Would it be remotely possible to create a fusion reactor for energy similar to that of a star such as our sun? Would it require too much pressure and heat than can be generated? I understand it may be far in our future that we actually construct such a contraption, but is it possible?

Jonathan: Fusion research is ongoing. Current estimates indicate a fusion reactor may have a positive energy output within fifty years. Currently, fusion reactors require more energy to operate than they output.

jeff44663: Is it true that sunspots are areas on the surface of the Sun that are cooler than the surrounding areas, where some of the heat from the core is not reaching the surface?

Jonathan: Almost. It is true that sunspots are cooler than the surrounding plasma, but this is primarily due to a lower plasma pressure and thus lower temperature.

Kbordner: What causes sunspots?

Jonathan: Sunspots are caused by what's called the solar dynamo. The sun rotates faster at its equator than at its poles and this differential rotation generates magnetic field in what's called a "dynamo effect." Magnetic fields can cluster or form large flux concentrations that eventually can stick out through the sun's surface and form a positive and negative polarity pair. This is a sunspot group.

mitul.ppatel: How far does the CME travels once ejected from the sun's surface?

Jonathan: Until it runs out of kinetic energy. I would estimate most run out of energy at the edge of the solar system or sooner.

Cancercat: When will the sun explode?

Jonathan: The average lifetime of a star like our Sun is eight to twelve billion years. We have several billion years of hydrogen, helium, carbon and nitrogen fuel left.

*(Moderator Brooke):* Really good questions coming in. This is a moderated chat. To submit your own question, please type it in the box at the bottom of the window and click the 'Ask' button on the right side of the box. Thanks for your patience as we answer your questions.

Maniza: What are solar loops? Are they what cause auroras?

Jonathan: If you're familiar with the bar magnet and iron filing experiment, you will remember that the iron filings map the magnetic field of the bar magnet. Loops map out the coronal magnetic field associated with sunspots.

Lwall: What is your theory on the cause of the red auroras?

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Jonathan: The color of emitted light within an aurora is proportional to the energy of the protons and electrons cascading into the Earth's atmosphere. The more energetic the particle, the more blue the aurora. So a red aurora has mostly lower-energy particles relative to a blue aurora.

Comatose: What's the worst a solar storm could do?

Jonathan: Disrupt satellites.

Jonathan: To continue the answer, disrupt satellites and communication equipment (e.g. radio), disrupt power grids, etc.

Lwall; Would you say that our magnetosphere is damaged?

Jonathan: Not so far as I've ever heard.

Angora: how would a solar flare effect a planet that didnt have as much as a atmosphere as ours

Jonathan: It's not so much the atmosphere that prevents an impact of a CME or flare, but a magnetosphere. The fact that Earth has a magnetosphere is what actually protects us from solar energetic events. So a planet without a magnetosphere can lose its atmosphere as the sun's solar wind and these energetic events are free to strip away layers of the atmosphere over time.

Lwall: What are the chances that a solar flare could cause a blackout for an extended period of time in the USA?

Jonathan: The likelihood is fairly low, but possible. It happened in the late 1980s in Quebec and upstate New York. Power was out for days during that event.

mitul.patel: Why does sunspot looks black?

Jonathan: Its temperature is lower than the surrounding plasma and so it emits less radiation.

Kbordner: What exactly is the solar wind?

Jonathan: The sun has a positive net pressure due to the way the plasma is heated at the base of very long magnetic field lines that extend into the solar system, or heliosphere. This positive pressure drives plasma out along those long field lines and is the solar wind.

Lwall: Was the blackout in California, Mexico, and Arizona on September 8th related to the CME that impacted Earth on the same day?

Jonathan: No.

Kbordner: How long did the aurora's from the CME last on Monday?

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Jonathan: I'm not sure. Less than a day.

Angora: with current technology and resorces how cllose to the sun could we get with something liek a satalite or a probe

Jonathan: 8.5 solar radii, approximately 3 million miles. NASA will launch the Solar Probe+ mission in 2018 and will come this close to the sun's surface.

Maniza: Does the sun orbit around the centre of our galaxy? IF it does, how long does it take to revolve?

Jonathan: Yes. About ten thousand years.

Kbordner: Why does the sun rotate faster at its equator than the poles?

Jonathan: It is a fluid and fluids in rotation rotate faster at 90 degrees from the axis of rotation.

Angora: what woudl it mean if the sun changed stopped producing solar flares?

Jonathan: There are no sunspots and thus the sun's solar cycle had ceased. This has happened previously during what's called the Maunder Minimum.

Magnolia: What gives the sun its color?

Jonathan: The dominant wavelength of light is in the yellow portion of the visible electromagnetic spectrum. This is primarily due to the surface temperature of the sun which is roughly six thousand kelvin. Emission is proportional to temperature, so if the surface was hotter on average, it would be more blue.

*(Moderator Brooke):* Thanks for the great solar questions. Do you have a question for Jonathan? Now is your chance to ask.

mitul.ppatel: what are sunspot numbers and how do you workout sunspot numbers?

Jonathan: Sunspot numbers are the number of sunspots per day on the visible disc of the sun. You work them out by looking at the Sun and counting the spots each day.

Mwerries: Is it understood among the scientific community that the sun will become a red giant in approximately 7.5 billion years? And the destroy Earth and other planets in our Solar System? How accurate is this prediction? And what is it based off of?

Jonathan: The mass of the sun is within a range not likely to form a neutron star or a supernova. It is just not that heavy. When the sun cannot maintain its fusion process any longer due to lack of fuel, the weight of the sun's atmosphere will cause it to contract and then expand into a red giant. At that time,

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the sun's radius will extend out past the orbit of Mars. So the Earth and other inner planets will be toast. But that is, as you say, a few billion years away. Support human spaceflight!

Maniza; How does a solar storm happen?

Jonathan: It is generally agreed that solar flares are caused when the solar atmospheric magnetic field undergoes a relaxation process called magnetic reconnection. During this process, the magnetic field transfers energy into the coronal plasma and launches it into space.

jeff44663: Is it possible that the Earth's magnetosphere can be disrupted from solar activity to the extent that the polarity would be affected, for example, magnetic compasses having incorrect readings?

Jonathan: No. You can quote me on that.

Astronerd: Has this happened in the past? (disrupted satellites and communication equipment) If so, how much damage from the Sun have these CME causes spacecraft?

Jonathan: Yes. It is now standard practice for satellite operators and mission control for the International Space Station to monitor space weather and in the event of an energetic event, power down critical systems or have astronauts hide in safe rooms.

Astronerd; A Coronal Mass Ejection... is the 'mass' a wave of energy then? Or is it something physical moving towards Earth?

Jonathan: It is actually a large volume of matter travelling at four hundred to a thousand kilometers per second. This matter is mostly hydrogen and helium.

Lwall; How much radiation would you estimate the average person is exposed to during a solar storm (on Earth).

Jonathan: An immeasurably small amount. Most of the emitted radiation during these events is ultraviolet or x-ray and the Earth's atmosphere is opaque to this radiation, so most people are never affected. Of course, if you fly over the Pole during an aurora or after one of these large events, you could get an appreciable radiation dose. Commercial airlines know this and assess routes for flights accordingly.

Rhydic: how hard is it to predict solar flares?

Jonathan: Very hard. There are teams of scientists funded both by NASA and NOAA and the Air Force that are working to develop this capability. Currently, a statistical approach is used that assesses the magnetic complexity of a sunspot group and uses that measure of complexity to predict the likelihood of a flare. However, this approach is not accurate to the hour and often does not accurately predict flaring activity.

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Sullivan: I'm just wondering, how much would this effect people with Pacemakers?

Jonathan: It wouldn't.

Angora: is there anything we can still learn from the solar storms our sun emmits

Jonathan: Well, it's not clear the exact process allowing the magnetic field to transfer energy. This is a current area of research. Also, we do not know enough about the process to predict it with any degree of accuracy, so I say we only know enough to know that there's a lot more we need to know.

Maniza; Is the sun's luminosity going to increase even as it turns into a red giant?

Jonathan: No.

Lwall: Why do sunspots have lower pressure than surrounding areas?

Jonathan: The concentration of magnetic field pushes the plasma out to the boundaries of the large magnetic flux concentration, so the lower pressure is due to the high magnetic field pressure.

*(Moderator Brooke):* We have about 10 minutes left in our chat, so Jonathan has time for a few more questions.

pleuroma10: Can scientists do or suggest anything to prevent blackouts like the one that happened in 1980?

Jonathan: Yes. A back EMF is the cause for the power outage. This is due to the current generated by all these high-energy particles raining down from the ionosphere. If you know this is going to happen because you're aware a CME is going to impact the magnetosphere, you can take protective countermeasures. You can also build a robust RC circuit and capture that power and store it for later.

Dave\_Wilhelm: Now that we have two satellites parked at the sun, have we learned anything more about the birth of sunspots and why cme's develop to the intensity they do?

Jonathan: We don't have two satellites parked at the sun. It is actually not possible to park in space. However, NASA and our international partners maintain an operation and scientific fleet of observatories to study sunspot formation, the sun's atmosphere, the origin of the solar wind and the plasma dynamics within the Earth's magnetosphere, radiation belts and ionosphere. We also still get fantastic data from Voyager I and II on the structure of the outer heliosphere. Using a technique called helioseismology, we can study the internal structure of the sun and assess flow velocity, density, etc. and use this information to learn about the location from which magnetic field is generated and how it rises through the sun's surface.

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Dave\_Wilhelm: Quick question. does the sun as a body itself orbit at a dead center point in relation to our Solar System or does it travel (orbit) to the solar system's dead center point?

Jonathan: The sun orbits the center of mass of the solar system. This point actually resides within the envelope of the sun and so really the sun just wobbles about the gravitational center of the solar system. But the center of the sun is not the center of the solar system. They are offset by a few tens of thousands of kilometers.

spacenut: hi

Jonathan: Good afternoon.

ScienceDominates: How exactly did humans first make a reliable measurement of the Sun's distance from Earth?

Jonathan: This was Kepler. He did it through a relationship of the orbits of the planets and Earth to the sun and developed a model that estimated the distance.

*(Moderator Brooke):* We have time for 1-2 more questions before the top of the hour...

Cancercat: People are saying that natural disasters are going to happen on 11-9-11, due to many many coincidences with the Pacific wave excersize, emergency alert system excersize, is this true?

Jonathan: I cannot predict natural disasters, however I can spell "exercise." :-)

Spacenut: how often do solar storms happen?

Jonathan: We generally see a CME every few days, but activity for energetic events goes with the number of sunspots. The frequency of sunspot production is cyclic and at the maximum, many CMEs per day are commonplace.

Maniza: After the sun explodes, will it create a neutron star or a dwarf star?

Jonathan: Eventually it will burn most of its fuel and contract from a red giant and into a brown dwarf.

Angora: can solar winds effect the orbit of an object?? if not a planet maybe commet or something smaller?

Jonathan: Yes. It creates drag and can slow an object down, thus affecting orbit. Also, comets can be obliterated by a CME. This was just observed by a NASA instrument called "LASCO" a few weeks ago.

Manchester: why is the aurora boreallis seen as red in the United States

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Jonathan: It's not always red. I've seen a green one in Montana. Often, in Canada and Alaska, there will be streaks of blue in the aurora. However, the lower the altitude, the less likely one will observe an aurora that's anything but red, because particles of energy sufficient to create green or blue emission rarely, like, almost never, occur.

Jonathan: Thank you for all the great questions. I hope you enjoyed this session!

*(Moderator Brooke):* Thanks to Jonathan for the great answers to everyone's questions. Our chat is over, but a transcript will be available within a few business days. Have a great afternoon.