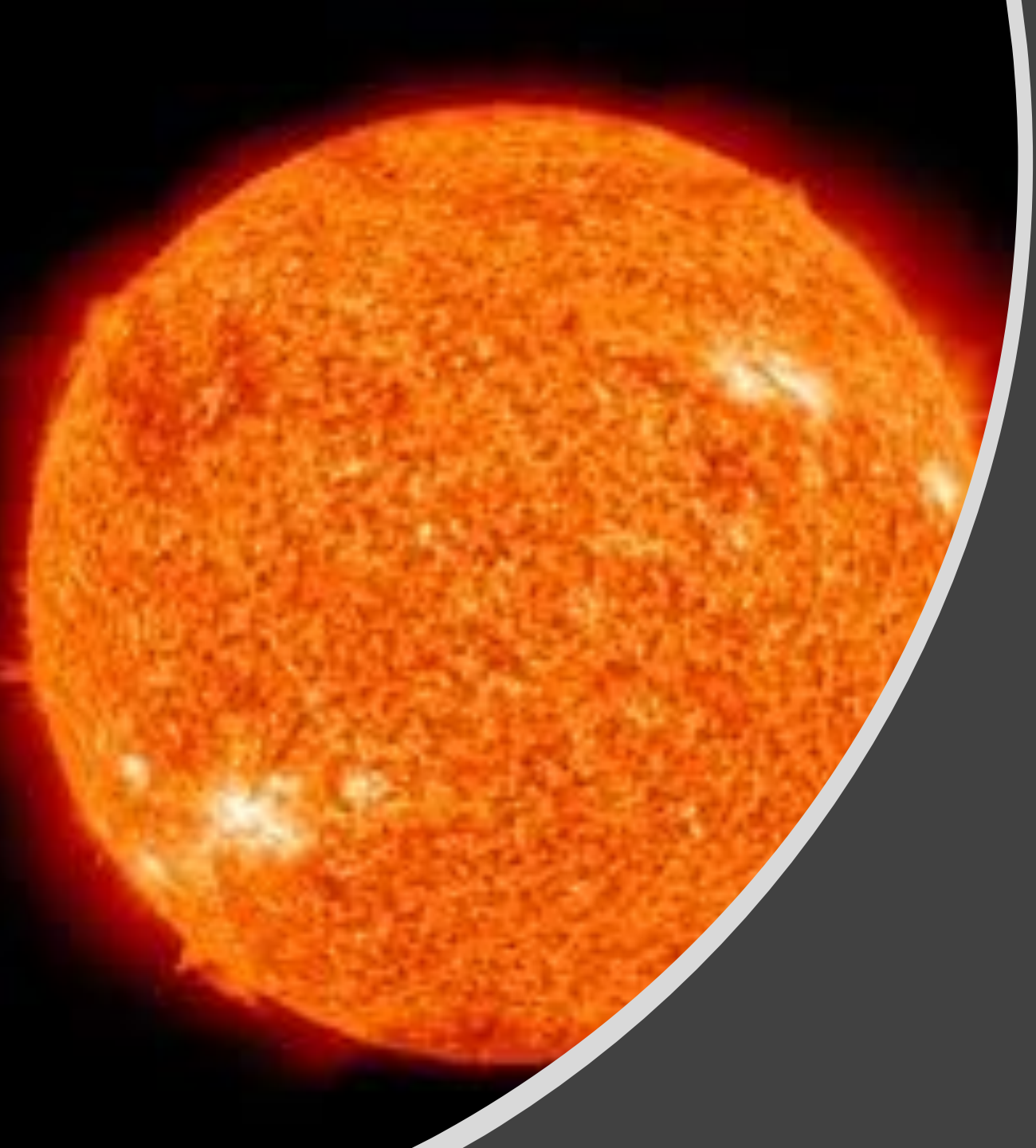
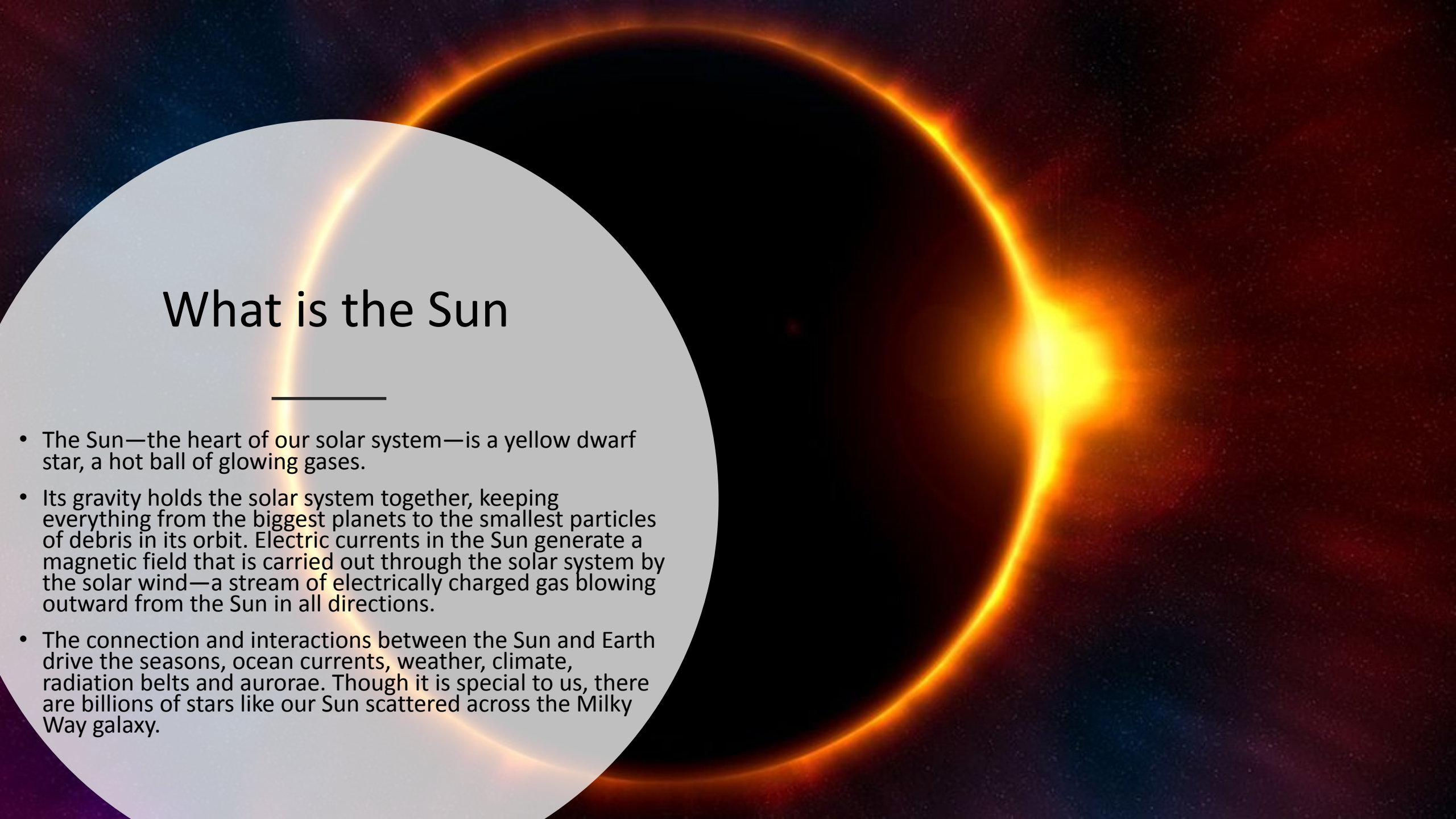


The Sun

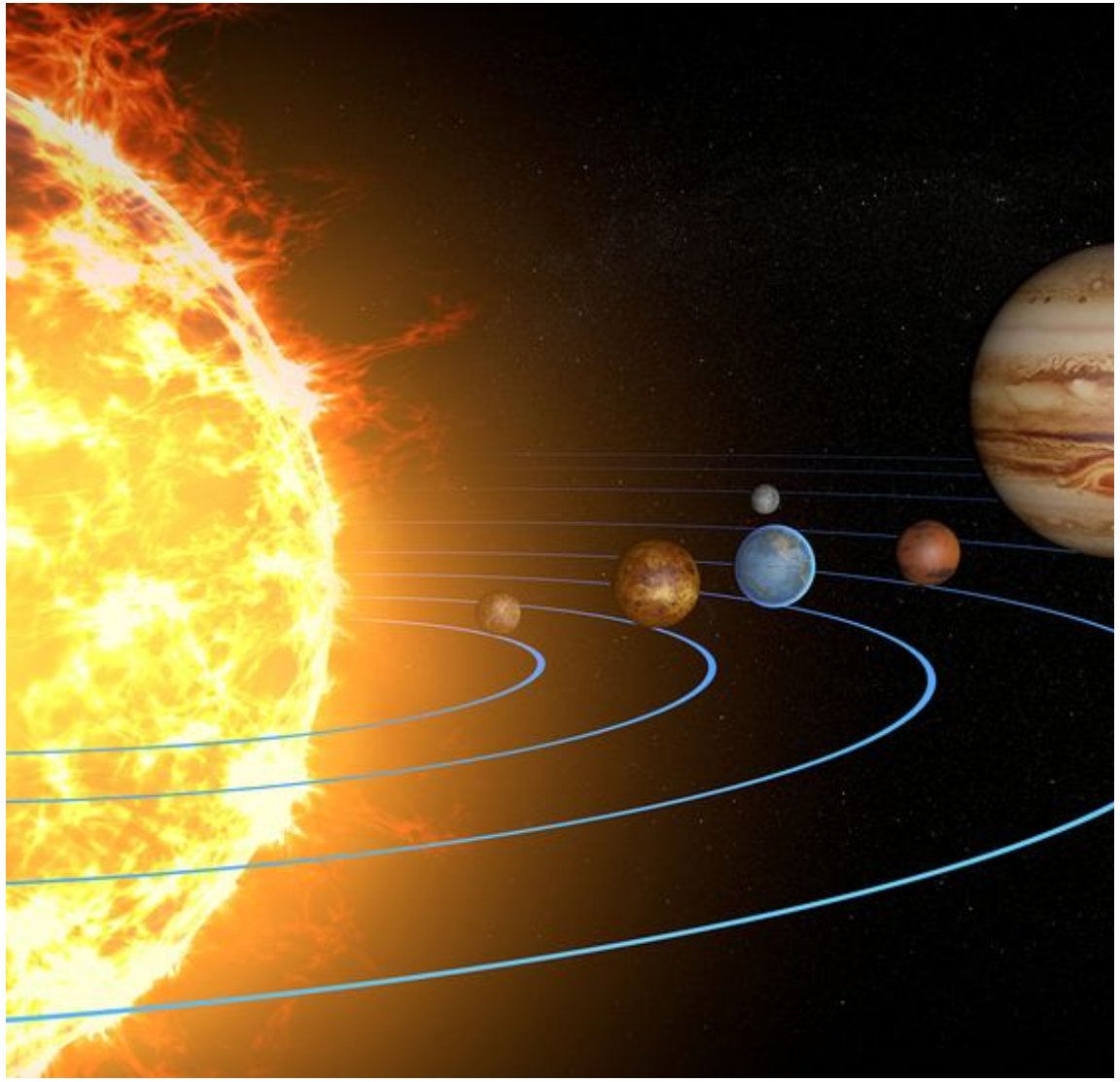


What is the Sun

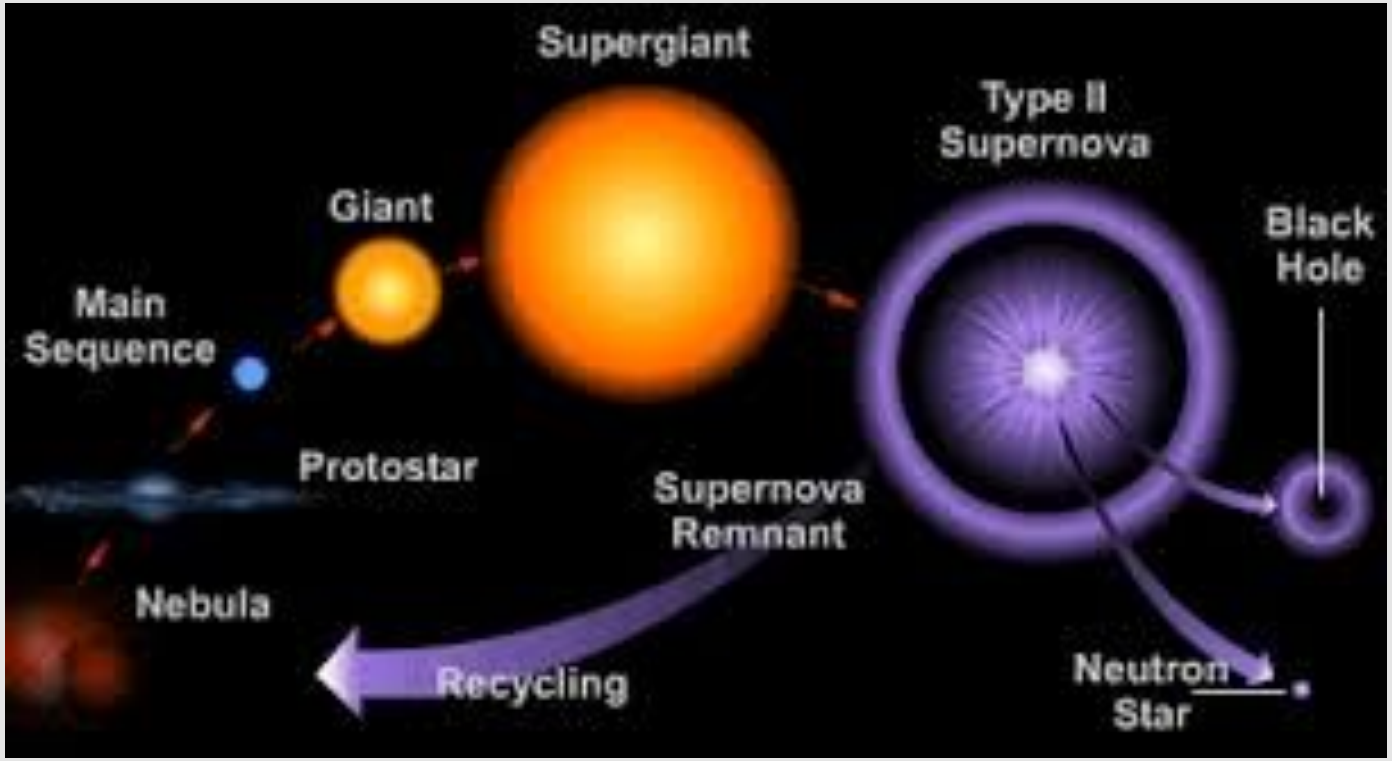
- The Sun—the heart of our solar system—is a yellow dwarf star, a hot ball of glowing gases.
- Its gravity holds the solar system together, keeping everything from the biggest planets to the smallest particles of debris in its orbit. Electric currents in the Sun generate a magnetic field that is carried out through the solar system by the solar wind—a stream of electrically charged gas blowing outward from the Sun in all directions.
- The connection and interactions between the Sun and Earth drive the seasons, ocean currents, weather, climate, radiation belts and aurorae. Though it is special to us, there are billions of stars like our Sun scattered across the Milky Way galaxy.

How Big is the Sun

- Sun Video



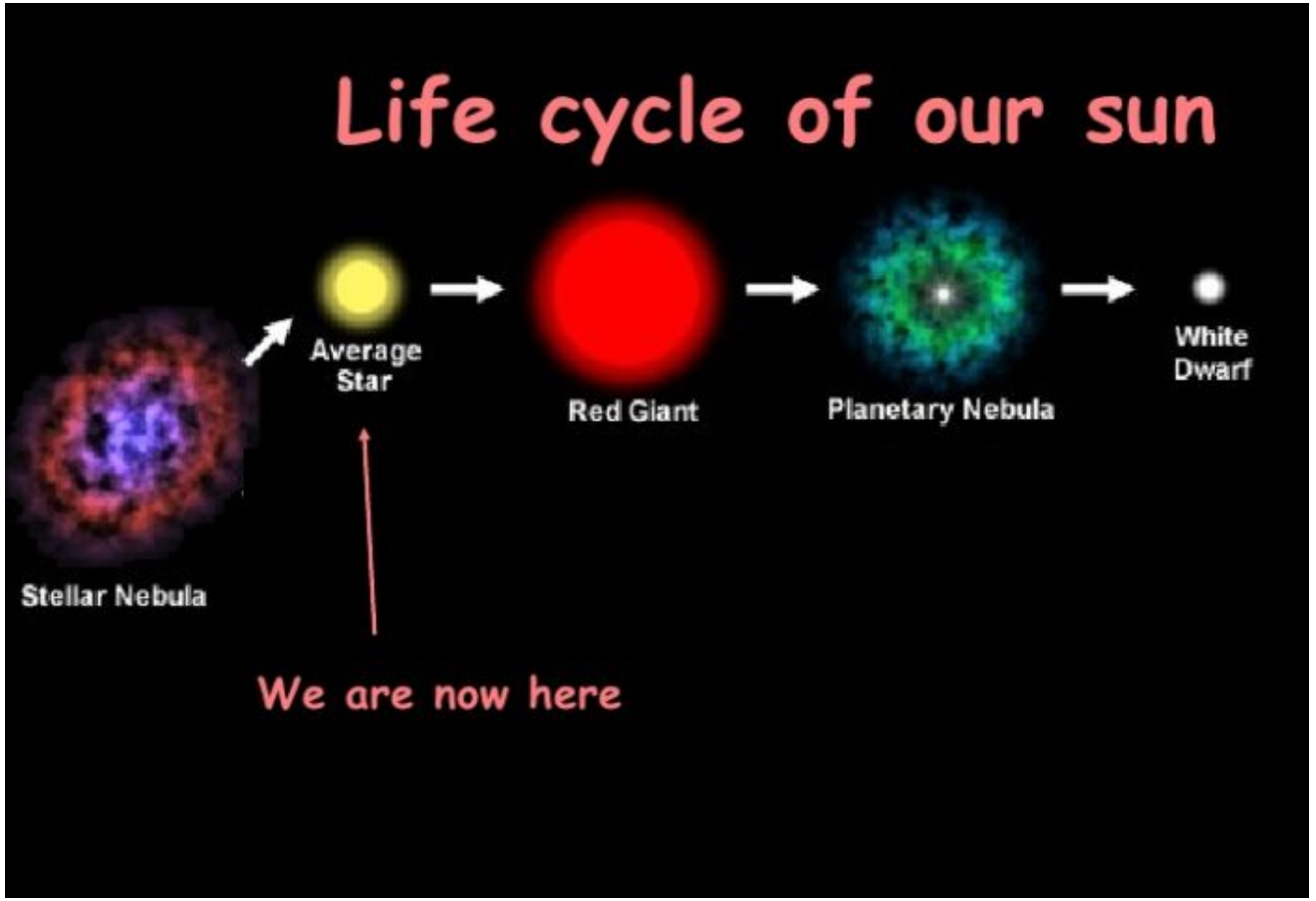
The Life Cycle of stars (in general)



- A nebula is a cloud of dust and gases (mainly hydrogen). These materials can be pulled together by their own gravity. As the cloud contracts, it becomes denser. The hydrogen becomes hotter as it spirals inwards. As more mass is attracted, the nebula's gravitational pull gets stronger and heats the material even more. The star is now in it's protostar stage.
- Eventually, the temperatures and pressures in the centre of the protostar become high enough to force hydrogen nuclei to fuse together and form helium. Fusion reactions like this release a lot of energy as electromagnetic radiation. The outward pressure from the hot gases just balances the compression due to gravity. The star is now in the main sequence part of its life-cycle. Our sun is currently in this stage of it'sl life cycle.
- Stars with considerably more mass than the Sun are hotter and brighter. They fuse hydrogen into helium faster, and then become red supergiants. At the end of the red supergiant period the star rapidly collapses and then explodes in a supernova. The outer layers of the supergiant are cast off and expand outwards.
- If what is left is four or more times the mass of the Sun, gravity pulls the remains together to form a black hole. The gravitational pull of a black hole is so strong that not even light can escape it. If the remains are not massive enough to form a black hole, gravity pulls them together to form a small, very dense star called a neturon star.

The Life Cycle of the Sun

- Stars of similar sizes to our Sun remain stable for about 10 billion years. When they have fused most of their hydrogen into helium, the core is not hot enough to withstand gravity and it collapses. The outer layers expand to form a red giant star, much larger than the original star.
- Other fusion reactions happen inside red giants, such as combining helium nuclei to form heavier elements. The star remains as a red giant for about a billion years before throwing off a shell of gas. The rest of the star is pulled together by gravity and collapses to form a white dwarf star. NO fusion reactions happen inside a white dwarf and it gradually cools over about a billion years to become a black dwarf.

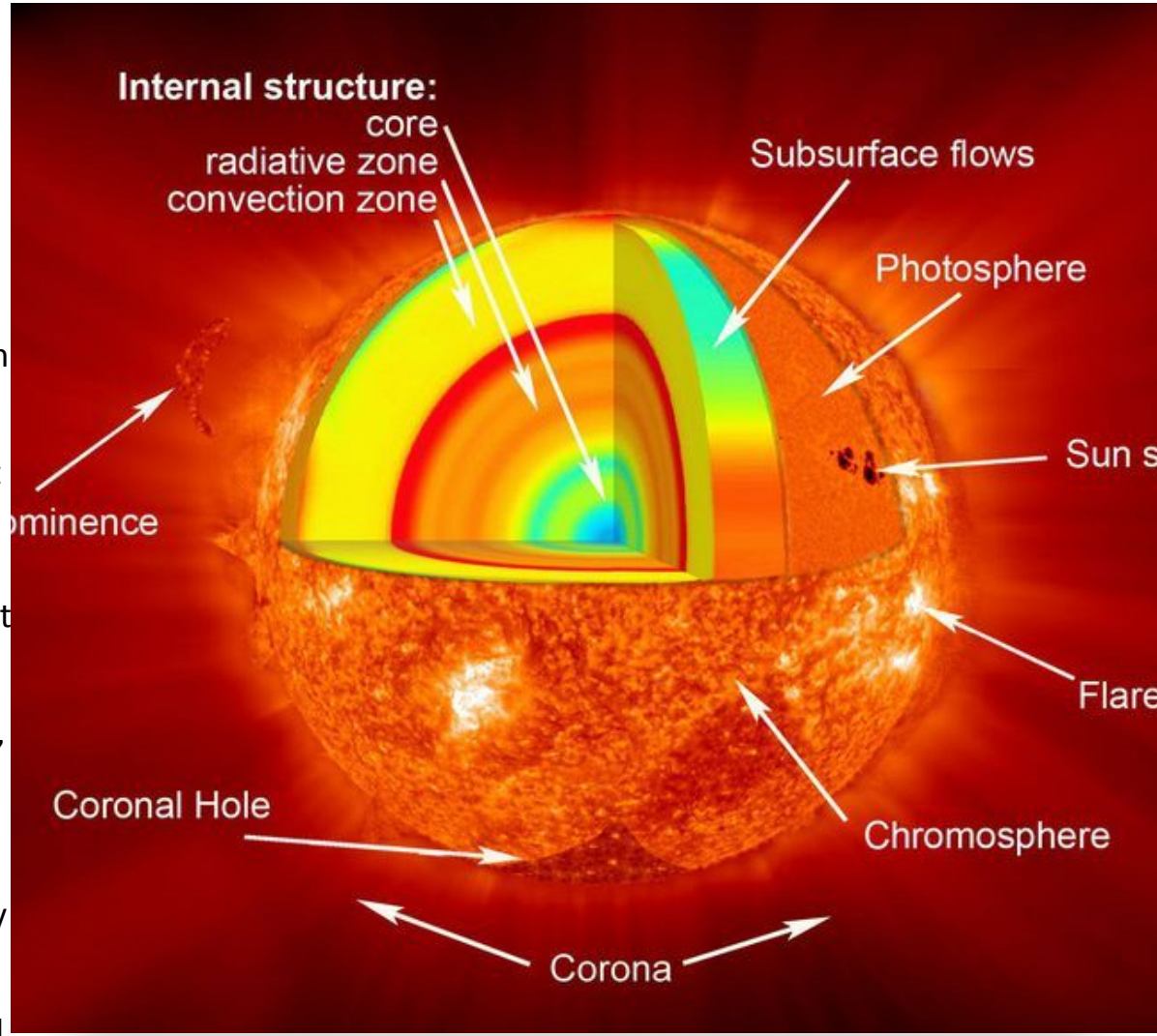


What is the Sun made up of

- The Sun is a huge, glowing sphere of hot gas. Most of this gas is hydrogen (about 70%) and helium (about 28%).
- Carbon, nitrogen and oxygen make up 1.5% and the other 0.5% is made up of small amounts of many other elements such as neon, iron, silicon, magnesium and sulfur.
- The Sun shines because it is turning hydrogen into helium via the process of nuclear fusion in its extremely hot core. This means that as time goes on, the Sun has less hydrogen and more helium.

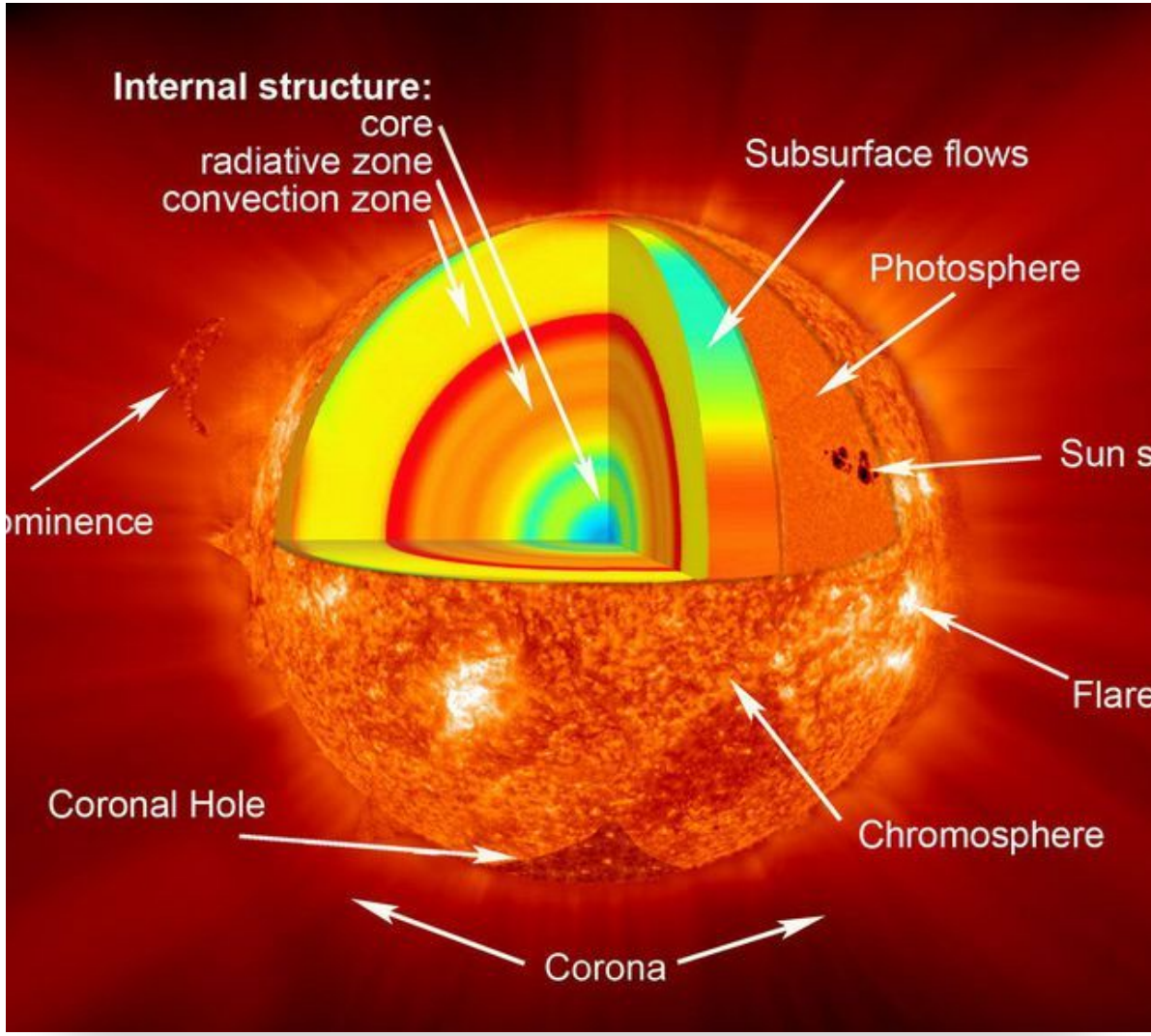
The Sun's layers (the inner layers)

- The inner layers are the core, radiative zone, and convection zone.
- **Core:** The core is the Sun’s middle region where energy is generated through thermonuclear reactions which creates extreme temperatures of about 15 million degrees Celsius. These nuclear reactions use hydrogen to produce helium. As a result, energy is released which leaves the sun’s surface as light and heat which we receive on earth, according to NASA studies. The core extends to roughly one quarter of the way from the Sun’s center.
- **Radiative Zone:** This zone is amidst the core and the convective zones, and it is roughly 70 percent of the Sun’s radius. Energy produced through nuclear fusion in the core moves steadily outwards as electromagnetic radiation, taking over 170,000 years to radiate through the radiative zone. In this zone, energy is carried outwards through radiation by photon carriers in a process where it bounces many times through zigzagging paths.
- **Convection Zone:** This layer of the sun is above the radiative zone and it is the outer most layer of the Sun’s interior. It stretches from depths of roughly 200,000 kilometers right up to the visible surface. Temperatures at the bottom of the convection zone are about 2 million Celsius. Energy moves towards the sun’s surface through convection currents of heated and cooled gas.



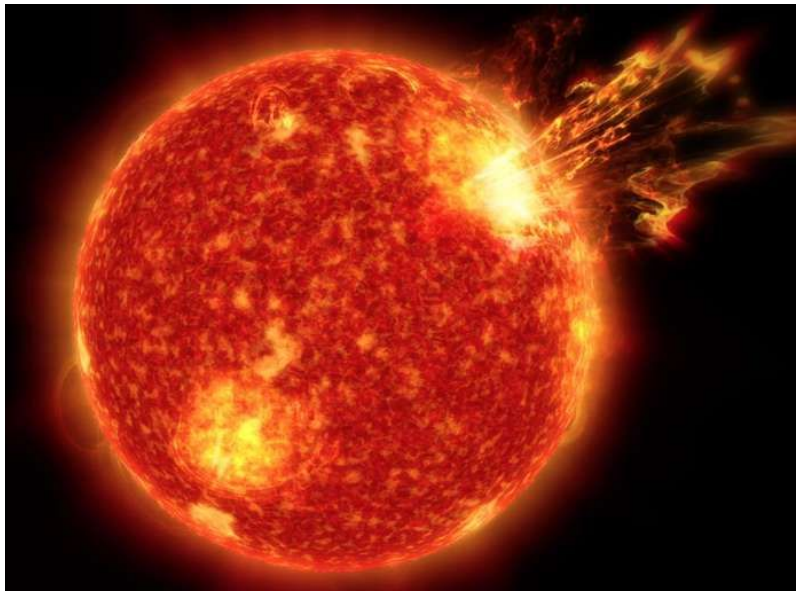
The Sun's layers (the outer layers)

- The outer layers are the photosphere, the chromosphere, the transition region, and the corona.
- **Photosphere:** This is the Sun’s deepest layer, and the layer visible to human eyes directly from the Earth. It has an appearance of bright cells with dark edges. Photosphere's temperature varies from roughly 6500 degrees Kelvin at the bottom of it to 4000 degrees Kelvin to the top.
- **Chromosphere:** This layer of the Sun is located between 250 miles and 1300 miles above the photosphere. The chromosphere has temperatures around 4000 degrees Kelvin at the base, and 8000 degrees Kelvin at the top. As a result, in this layer and other higher layers of the sun, the temperature increases if one moves away from the Sun, unlike in lower layers where it gets hotter if one gets nearer to the Sun’s center.
- **Transition Region:** This layer is very thin with a size of about 60 miles, and it is tucked amidst the corona and the chromosphere. In the transition region layer, temperature rises rapidly from roughly 8000 to 500,000 degrees Kelvin. Scientists are yet to discover why this rapid temperature rise occurs.
- **Corona:** This layer is the Sun’s outermost layer. It starts at roughly 1300 miles over the photosphere and it has no upper limit. Its temperature is between 500,000 degrees Kelvin to 1 million degrees Kelvin. The corona cannot be seen with bare eyes, but during a total solar eclipse one can use a coronagraph telescope to view it.



Sun spots and Solar Flares

- **Sunspots** are areas that appear dark on the surface of the Sun. They appear dark because they are cooler than other parts of the Sun's surface. The temperature of a sunspot is still very hot though—around 6,500 degrees Fahrenheit!
- Why are sunspots relatively cool? It's because they form at areas where magnetic fields are particularly strong. These magnetic fields are so strong that they keep some of the heat within the Sun from reaching the surface.
- The magnetic field lines near sunspots often tangle, cross, and reorganize. This can cause a sudden explosion of energy called a **solar flare**. Solar flares release a lot of radiation into space. If a solar flare is very intense, the radiation it releases can interfere with our radio communications here on Earth.
- Solar flares are sometimes accompanied by a coronal **mass ejection** (CME for short). CMEs are huge bubbles of radiation and particles from the Sun. They explode into space at very high speed when the Sun's magnetic field lines suddenly reorganize.
- When charged particles from a CME reach areas near Earth, they can trigger intense lights in the sky, called auroras. When particularly strong, a CME can also interfere in power utility grids, which at their worst can cause electricity shortages and power outages. Solar flares and CMEs are the most powerful explosions in our solar system.



Missions to go to the sun

- NASA’s Parker Solar Probe will be the first-ever mission to "touch" the Sun. The spacecraft, about the size of a small car, will travel directly into the Sun's atmosphere about 4 million miles from the surface. Parker Solar Probe launched aboard a Delta IV-Heavy rocket from Cape Canaveral, Aug. 12, 2018

- https://www.youtube.com/watch?v=RT9laVHZZQo