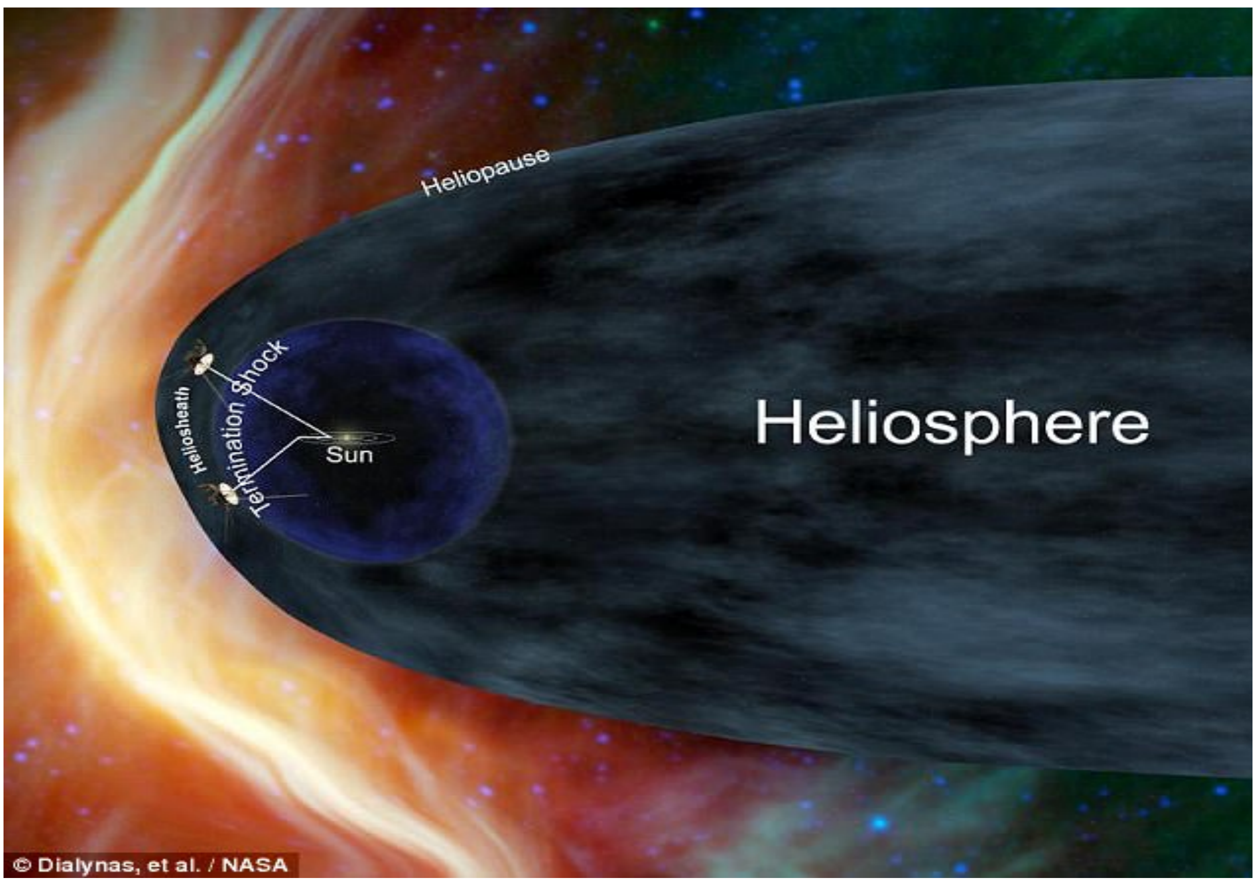
1. The heliosphere

The heliosphere is defined as the region of interplanetary space where the solar wind is flowing supersonically.

The heliosphere is the bubble-like region of space dominated by the Sun, which extends far beyond the orbit of Pluto. Plasma "blown" out from the Sun, known as the solar wind, creates and maintains this bubble against the outside pressure of the interstellar medium, the hydrogen and helium gas that permeates the Milky Way Galaxy.

The shape of the heliosphere is controlled by the interstellar medium through which it is traveling, as well as the Sun and is not perfectly spherical. The limited data available and unexplored nature of these structures have resulted in many theories. The word "heliosphere" is said to have been coined by Alexander J. Dessler, who is credited with first use of the word in the scientific literature.



1.2 Solar wind

Spacecraft in interplanetary space have encountered streams of highly energetic charged particles originating from the Sun. These streams, called the solar wind, flow radially outward from the Sun's corona through the solar system and extend beyond the orbits of the planets. These particles are continuously released, but their numbers increase greatly following solar flares and other eruptions.

The solar wind is a plasma consisting chiefly of a mixture of protons and electrons plus the nuclei of some heavier elements in smaller numbers. The solar wind may be formed when the hot coronal plasma expands. The particles are accelerated by the corona's high temperatures to speeds great enough to allow them to escape from the Sun's gravitational field.

The fastest streams of the solar wind come from particles that flow from the coronal holes. These particles travel as fast as about (800 kilometers) per second. Other streams of the solar wind reach speeds as high as about (400 kilometers) per second. These streams usually originate in regions near the solar equator.

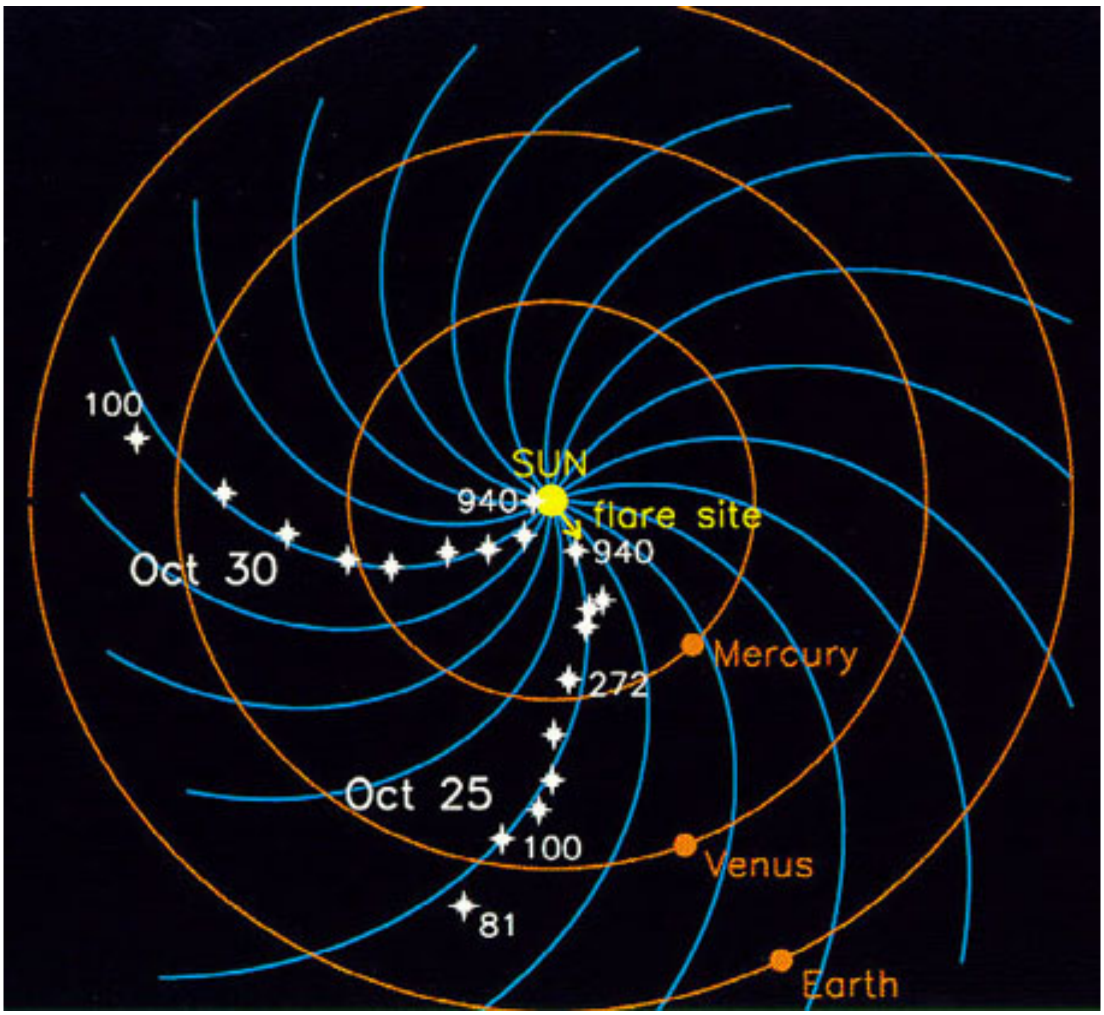
As they flow outward, the particles of the solar wind carry part of the Sun's magnetic field along with them. Because of the Sun's rotation and the steady outflow of particles, the lines of the magnetic field carried by the solar wind trace curves in space. The planet's magnetic field shields it from the radiation of the solar wind. When the streams of particles encounter Earth's magnetic field, a shock wave results.

1.3 The interplanetary magnetic field (IMF)

IMF stands for Interplanetary Magnetic Field. It is another name for the Sun's magnetic field. The Sun's magnetic field is huge! It goes beyond any of the planets. The Sun's magnetic field got its name because of that. called the Sun's magnetic field the Interplanetary Magnetic Field meaning it has all of the planets within it.

The part of the Sun's magnetic field that is pulled out into the heliosphere by the solar wind is called the interplanetary magnetic field (IMF). Its characteristic spiral configuration when viewed from above or below the equatorial plane is due to the Sun's rotation.

The magnetized solar wind expands radially (directly away from the Sun), pulling the solar magnetic field along with it. As the Sun rotates, the position or foot point of where the solar wind stream leaves its surface moves counter-clockwise when viewed from above the Sun. This causes the magnetic field to start to spiral as it moves farther from the Sun. This is called an Archimedian spiral after the Greek scientist Archimedes, who first described it mathematically. It is analogous to a stream of water being shot out of a rotating sprinkler head. Even though each individual drop or parcel of water moves radially away, since the sprinkler is rotating, the stream appears to curve or spiral out.



The IMF is represented by the blue arcs in the picture above. This picture shows the spiral nature of the IMF.

1.4 Cosmic rays

Earth is constantly bombarded from every direction by highly ionized atoms and other subatomic particles known as cosmic rays. Cosmic rays are further divided into two components: particles that originate outside our heliosphere (called galactic cosmic rays) and those that originate from our Sun (called solar energetic particles). Cosmic rays travel at nearly the speed of light, and most are nuclei of atoms. The composition of cosmic rays spans the periodic table, from the lightest particles, such as hydrogen and helium, to the heaviest, such as iron. Cosmic rays also include electrons, positrons (the mirror particle of an electron – essentially a positively-charged electron), and other sub- atomic particles. The energy of cosmic rays is usually measured in MeV (mega-electron-volt or a million eV) or GeV (giga-electron-volt or a billion eV). Typical energies of galactic cosmic rays are between 100 MeV and 10 GeV. To put this in perspective, if the galactic cosmic ray is a proton, it has a velocity between 43% and 99.6% the speed of light.

When high-energy cosmic rays hit Earth's atmosphere, they collide with atmospheric particles and cause showers of secondary particles to hit the surface. Each collision takes energy from the original cosmic ray, creates new particles, and energizes the atmospheric gas particles that are hit. These in turn can hit other particles, energizing them. They then can hit new particles, etc. Depending on the energy of the incoming cosmic ray, large fluxes of secondary particles can reach Earth.

1.4.1 cosmic rays formation

The current theory is that galactic cosmic rays originate in super- novae (stellar explosions). It is estimated that one supernova happens every 50 years in a galaxy like the Milky Way. One type of supernova is the death-throes of a massive star. After the star has consumed all of its fuel by thermonuclear fusion, its outer layers collapse and cause a huge explosion that expels stellar material into space and causes shock waves to form. The explosion and shock waves then produce particles of very high energy. The shock waves continue to propagate away from the progenitor star (or the star that went supernova), continuously accelerating particles for many years after the explosion.

Since cosmic rays are charged particles, their motion is deflected by galactic magnetic fields as they propagate through interstellar space. Therefore, it is not directly possible to identify their source since their path is a "random walk" from their source to us. The Sun's magnetic field (the IMF) and Earth's magnetic field also influence the motion of cosmic rays through our Solar System and to Earth's surface.