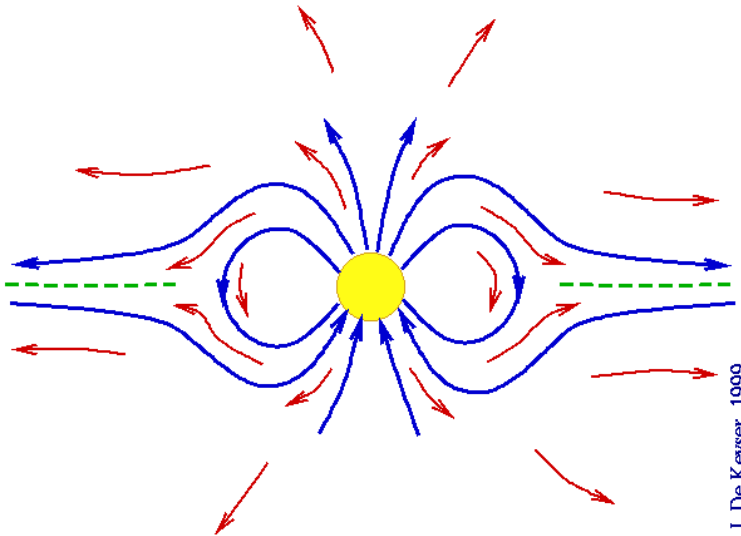


The interplanetary magnetic field

By J. De Keyser

The Sun possesses a magnetic field. There are not only strong local magnetic fields (for example near sunspots), but a global magnetic field exists as well. In a first approximation one can consider the Sun as a simple bar magnet. It turns out that the polarity of this bar magnet changes every 22 years (magnetic north and south pole change places), so that 22 years pass before the same pattern returns.

Because the escaping solar wind carries the magnetic field, the interplanetary magnetic field (IMF) slightly differs from a bar magnet, as shown in the figure alongside. Strictly speaking, this figure is only valid for low solar activity. The blue lines represent the magnetic field lines. These are "closed" in the equatorial regions of the Sun and "open" near the poles. The border between them is formed by the heliospheric current sheet, further called HCS.

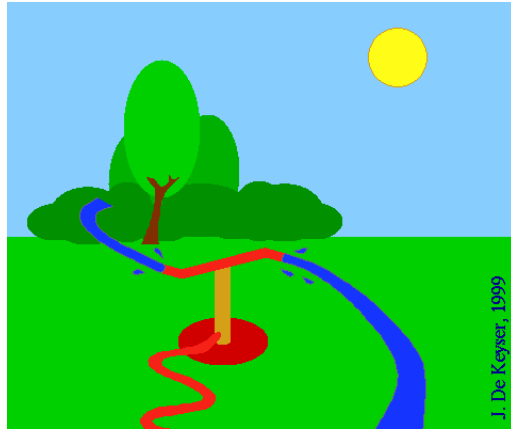


This surface forms a contact layer between the solar wind and the north-south polarity (meaning: the direction of the magnetic field on both sides of the HCS is opposite) and is indicated by the light blue dashed line on the figure. The HCS starts on a distance of about 3 times the radius of the Sun and stretches beyond the orbits of the planets. The charged particles follow the magnetic field lines; the stream of plasma in the solar corona (red arrows) is so that normally only plasma from the polar regions (the coronal holes) escapes: It is this plasma that forms the solar wind and flows almost radially away from the Sun.

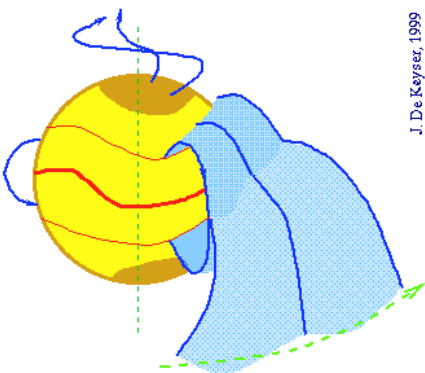


Everybody knows these spinning sprinklers most often switched on in the summertime to keep the lawn's healthy green colour.

The water is sprayed out almost radially from the spinning sprinkler. The form of the jets of water is a spiral. In exactly the same manner, the solar wind that originates from one point in the solar atmosphere (spinning along with the Sun) will find itself on a spiral line - this line is at the same time a magnetic field line. One calls this structure the Parker Spiral.



The figure alongside sketches the three-dimensional structure of the interplanetary magnetic field. The structure of open and closed field lines in the corona and the spiral shape of the outward field lines are clearly demonstrated. The field lines are represented in blue. Moreover the figure shows that the coronal holes (in ochre) around the northern and southern pole do not have to be symmetric, as a result of which the heliospheric current sheet (light blue) is wavy. To be clear, the sketch only shows a segment of the HCS. The undulations of the HCS that are formed outward have the typical spiral shape. This is why it is sometimes called "the ballerina skirt".



The figure also shows a piece of the Earth's orbit around the Sun (green dashed line). Because of the small angle between the rotation axis of the Sun and the orbital plane of the Earth (about 7 degrees) and because of the undulations of the HCS, the Earth is situated alternately above and under the HCS during each solar rotation (about 28 days). The polarity of the IMF near the Earth changes regularly. The periods of constant polarity are called "sectors".

During low solar activity the global magnetic field of the Sun only changes slowly. The sector pattern is therefore repeated almost unaltered during several solar rotations.



The above description can give the impression that the solar wind is a rather static phenomenon. Nothing is further from the truth! The Sun and the solar wind change continuously. Changes on a time scale of seconds, hours, days and years exist. It is especially during high solar activity that the simple representation mentioned above is no longer correct: Coronal holes with an irregular shape can appear on all latitudes and continuous explosive gas eruptions occur near the active areas on the Sun (mostly near sunspots) - we could call it a rather violent boiling soup!

