

# SUN'S MAGNETIC FIELD

A magnetic field is a vector field that describes the magnetic influence on magnetic materials, electric currents, and moving electric charges. Magnetic fields can be represented by continuous lines of force or magnetic flux, which is the flux of a magnetic field through a surface. In the SI, the magnetic flux is measured in weber (Wb) which is equivalent to the magnetic flux through a loop producing an electromotive force equal to 1 volt when uniformly reduced to zero in 1 second. An important derivative of weber is flux density measured in tesla (T).

## SOLAR MAGNETIC FIELD

The Sun is a **magnetic star** and its magnetic field is generated by the movement of **conductive plasma** in a part of the Sun called the convective zone. This motion is a result of convection, a form of energy transport that entails the physical movement of material. The convective motion of plasma works like a **dynamo** and is generated both a global and some localized magnetic fields. In addition the circulation of plasma creates the star's primordial magnetic field and generates a global magnetic field. As the star rotates with different velocities at various latitudes, the magnetism wraps itself around a toroidal field of **flux ropes** that surrounds the star.

As magnetism, it creates a surface and when, when creates a dipole.

There are two different magnetic zones in the solar corona (which is an area of plasma that surrounds stars).

**Open field regions**, which connect the solar surface with the interplanetary field and are the source of the fast solar wind.

**Closed field regions**, which open up at higher altitudes and then connect to the heliosphere.

The sun's magnetic field **changes polarity about every 11 years**, which brings a diminished magnitude of the field for some time. During this, we have the maximum sunspot activity and massive eruptions of high-energy plasma take place in the corona and in the interplanetary space. An important thing in the solar field reversal is the heliospheric **coronal sheet** which is the surface projecting outward from the sun's equator where a magnetic field (stronger) flows than other parts of the surface produces an electrical current and where the polarity of the Sun's magnetic field varies from north to south, becoming very easy. The current sheet is small and thin, but extends billions of kilometers beyond Pluto, in the distances of interstellar space. The changing of polarity can cause stormy space weather around the Earth. In addition, the current sheet acts as a barrier to cosmic rays when they attempt to go inside the solar system.

The Sun's magnetic fields store a large amount of energy that can be released in a gradual or explosive way. Explosive energy release takes place through:

- Flares**, that are powerful eruptions of radiation at all wavelengths that happen in the sun's atmosphere.

- Coronal mass ejections (CMEs)**, which are the release of plasma and magnetic field from the Sun's outer layer (corona). They happen in active regions of the solar surface like groups of sunspots which have closed magnetic field lines. When these field lines are broken they suddenly release energy, which causes a CME, usually accompanying a solar flare. CMEs directed towards Earth cause geomagnetic storms.

Along the structure of the magnetic field line solar **prominences**, gaseous structures extending outward from the surface of the sun. The eruption of a prominence takes place when the structure gets unstable and bursts outward, making plasma that is more turbulent and dense than coronal plasma.

## EFFECTS ON EARTH

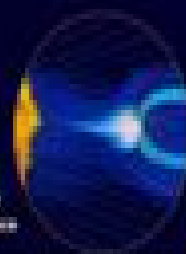
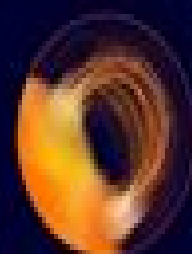
The sun's magnetic field is responsible for the solar eruptions that create **space weather** on Earth.

When the field breaks, it releases a small quantity of energy, shown as a flare. Many flares are too small to be seen, resulting in the emission of X-ray and ultraviolet radiation that can change the state of satellites and disturb communications, navigation, and surveillance systems.

The **solar wind** is generated in the solar corona. It is a continuous stream of charged particles accelerated to near the Sun. The solar wind carries the **interplanetary magnetic field (IMF)** while flowing through interplanetary space. When it comes to Earth and other planet eruptions of radiation into a planet's magnetic field, it can cause the **magnetic reconnection** that is a process where the field on the Earth side joins together. Charged particles then stream back to the planet's magnetic poles causing the aurora borealis in the upper atmosphere.

When magnetic fields **strange** through the photosphere, they form:

- Sunspots**, which are dark areas we can observe on the sun's surface. The reason why they are darker is that they are relatively cooler because there the magnetic fields are particularly intense and because they keep some of the heat within the Sun from reaching the surface.
- Coronal loops**, which are bright arc structures above the sun's surface made of hot plasma. They form around curving magnetic field lines and are usually associated with surfaces of opposite magnetic polarity.



# Solar Magnetic Fields

**IM Harris**



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## **Table of Contents Solar Magnetic Fields**

1. Understanding the eBook Solar Magnetic Fields
  - The Rise of Digital Reading Solar Magnetic Fields
  - Advantages of eBooks Over Traditional Books
2. Identifying Solar Magnetic Fields
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Solar Magnetic Fields
  - User-Friendly Interface
4. Exploring eBook Recommendations from Solar Magnetic Fields
  - Personalized Recommendations
  - Solar Magnetic Fields User Reviews and Ratings
  - Solar Magnetic Fields and Bestseller Lists
5. Accessing Solar Magnetic Fields Free and Paid eBooks
  - Solar Magnetic Fields Public Domain eBooks
  - Solar Magnetic Fields eBook Subscription Services
  - Solar Magnetic Fields Budget-Friendly Options
6. Navigating Solar Magnetic Fields eBook Formats

- ePub, PDF, MOBI, and More
- Solar Magnetic Fields Compatibility with Devices
- Solar Magnetic Fields Enhanced eBook Features
- 7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Solar Magnetic Fields
  - Highlighting and Note-Taking Solar Magnetic Fields
  - Interactive Elements Solar Magnetic Fields
- 8. Staying Engaged with Solar Magnetic Fields
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Solar Magnetic Fields
- 9. Balancing eBooks and Physical Books Solar Magnetic Fields
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Solar Magnetic Fields
- 10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
- 11. Cultivating a Reading Routine Solar Magnetic Fields
  - Setting Reading Goals Solar Magnetic Fields
  - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Solar Magnetic Fields
  - Fact-Checking eBook Content of Solar Magnetic Fields
  - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
- 14. Embracing eBook Trends
  - Integration of Multimedia Elements
  - Interactive and Gamified eBooks

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