

Glossary

Caution please: Links marked * will take you **out of this directory**, into the rest of the world-wide web. They will not work if you use this glossary off an internal directory.

(2) The items linked to extensive descriptions when listed as glossary **headings** may only be linked to shorter ones when mentioned **inside** a glossary entry.

Click on the item whose definition you want

Acceleration	Alpha processes	Amplification
Anti-dynamo theorem	Auroral oval	Auroral zone
Aurora, polar	Basalt	Chromosphere
Coition	Continent	Continental drift
Core (Earth's)	Corona	Coronal hole
Coronal mass ejection	Coronal streamers	Crust (of Earth)
Declination (magnetic)	Dip angle	Dipole
Dynamo	Dynamo process	Dynamo theory
Dynamo, fluid	Electric charge	Electric current
Electricity	Electron	Ferromagnetic
Field	Field, Electric	Field, electromagnetic
Field line, closed	Field line, open	Field line preservation
Field lines, magnetic	Field, magnetic	Flare, solar
Flux, magnetic	Hard materials (magnetic)	Inclination (magnetic)
Inner core	Inverse squares law	Ion
Kinematic dynamo	Lava (magma)	Lightning
Line of force	Lithospheric plates	Lobe, tail
Lodestone	Magnetic Bode's Law	Magnetic induction
Magnetic pole	Magnetic potential	Magnetic storm
Magnetization, induced	Magnetize	Magnetometer
Magnetometer, ___ fluxgate	Magnetometer, ___ proton precession	Magnetometer, ___ Overhauser effect
Magnetometer, alkali vapor	Magnetopause	Magnetosphere
Magnetotail	Main field	Maunder minimum

MHD	MHD dynamo theory	Mid-ocean ridge
North-seeking pole	Orb of virtue	Photosphere
Plasma	Plasma sheet	Plate tectonics
Polar wandering	Poloidal field	Radiation belt
Radiation Belts (inner, outer)	Reconnection, magnetic	Reversals, magnetic
Ring current	Seafloor spreading	Secular variation
Soft materials (magnetic)	Solar activity	Solar cycle
Solar flare	Solar wind	South seeking pole
Spherical harmonics	Substorm, magnetic	Sunspot
Sunspot cycle	Terrella	Toroidal field
Torsion balance	Trapping	Trenches, oceanic
Variation	Versorium	Verticity

Acceleration In mechanics (e.g. in the [*description of free fall](#) or in [*Newton's laws](#), acceleration is a change in the velocity of a moving object. In studies of magnetospheres, of the Sun and in astrophysics, "acceleration" often implies the energization of ions or electrons, imparting great velocities to (for instance) electrons of the [polar aurora](#) or ions of the [radiation belts](#).

Alpha processes In [dynamo theory](#), a class of fluid flows which make possible feedback from [toroidal modes](#) of the magnetic field to its [poloidal modes](#).

Amplification (of a magnetic field) The process by which fluid motions in a conducting fluid can make a weak magnetic field become stronger. On the Sun, stretching of the [field lines](#) of a magnetic field, coupled with [field line preservation](#), will amplify the field.

Anti-dynamo theorem, an informal name for Cowling's theorem, by which a self-sustaining kinematic dynamo cannot have axial symmetry.

***Auroral oval**, the region in which aurora is observed at any given time, typically a circular band centered about 3 degrees nightward of the magnetic pole. With a typical radius of 2500 kilometers, it expands during magnetic storms and contracts during "magnetically quiet" times.

***Auroral zone** The region in which aurora is likely to be seen, on the average. A band centered on the magnetic pole with a radius of about 3000 km, the auroral zone is defined by collected auroral observations over many years. It is the average of many auroral ovals of different sizes.

***Aurora, polar** (also known north of the equator as **northern lights** or **aurora borealis** ["northern dawn"], and south of it as **aurora australis**) A glow seen in the sky, usually in the [auroral zone](#), caused by electrons hitting atmospheric atoms and causing them to emit light. The typical aurora is produced at altitudes around 100 km (60

miles), by [electrons](#) of 3-15,000 [*electron volts](#). Most aurora is greenish, caused by light emitted from oxygen, or red, also from oxygen. Electrons producing auroral arcs seen from the ground have usually undergone acceleration in the [magnetosphere](#) by electric currents that connect Earth to space. Electrons observed by satellite imagers, often as rings around the [auroral oval](#), are usually escaping from the Earth's [magnetotail](#). Their glow is too dim to be seen by eye from the ground.

Basalt A black rock, formed when a common type of volcanic lava cools and hardens. Basalt is faintly magnetized, in the direction of the magnetic field existing when it first cools.

[* Chromosphere](#) The layer in the Sun's atmosphere just above the light-emitting photosphere. About 5000 km high, it is visible to the unaided eye as a reddish layer (chromo- means color-) during a total eclipse. On the face of the Sun its light is completely swamped by that of the photosphere, but it can be observed through filters that isolate narrow color bands (spectral "lines") emitted by specific elements. The chromosphere is of interest because flares and other active solar phenomena occur in it and because it is the transition to the hotter solar [corona](#)

Coition Term invented by William Gilbert, obsolete today, to describe the attraction between magnets. Gilbert wanted to stress the mutual symmetry of the attracting force, not realizing that (by Newton's 3rd law) **any** attraction is mutually symmetric.

[Continent](#) A large land-mass on Earth, formed by slabs of granite floating on the denser, deeper layers of the lithospheric plates.

[Continental drift](#) The name given by Alfred Wegener to his 1915 theory, by which continents not only floated on top of deeper layers, but were able to slowly move ("drift") the way ice-floes do in the arctic ocean.

[Core](#) (of Earth) The dense spherical region surrounding the center of the Earth. By studying the propagation of earthquake waves, geophysicists concluded that the core was fluid, and from its estimated density proposed that it consisted of molten iron. Later studies showed that inside the fluid core was a smaller solid "inner core." A fluid core, generating heat and able to conduct electricity, is one of the necessities of the dynamo theory of the Earth's magnetic field.

[* Corona](#) The outermost layer of the Sun's atmosphere, starting about 5000 km above the photosphere, its outermost layers merging with the [solar wind](#). The corona is extremely hot, as originally evidenced by the light of atoms from which many electrons have been torn (e.g. iron missing 13 electrons), suggesting they were buffeted in a gas of 1 million deg. centigrade or more. The source of this heat is still being debated. Because of the high temperature, the corona can be observed from space in x-rays and extreme ultraviolet, showing many features. From the ground the full corona is only seen

(for a few minutes) during a total eclipse of the Sun, though the inner corona can also be observed through appropriate color filters.

***Coronal hole**--an area in the Sun's corona that appears dark when viewed in the far UV or in the long-wavelength end of the x-ray range. Coronal holes seem associated with sources of fast solar wind, probably because their field lines do not curve back to the Sun. Over most of the Sun their shapes are changeable and irregular, but the Sun's polar regions seem to contain "permanent" coronal holes.

***Coronal mass ejection (CME)**--a huge cloud of hot plasma, occasionally expelled from the Sun. It may accelerate [ions](#) and [electrons](#) and may travel through interplanetary space as far as the Earth's orbit and beyond it, often preceded by a shock front. When the shock reaches Earth, a [magnetic storm](#) may result.

Coronal streamers Long streaks seen in the solar corona during total eclipses, or in photographs from space which achieve similar effects. They are believed to outline [magnetic field lines](#) of the Sun.

Crust (of Earth) The outermost layer of rock the Earth, relatively thin (about 30 km).

Declination (magnetic) The difference between magnetic north, given by the compass needle, and true north, the horizontal projection of the direction of the Earth axis.

Dip angle The local angle between the horizontal and the direction of the magnetic force. Indicated by a freely-floating magnetic needle, free to turn to any direction in space, or by a "dip circle" instrument, which has a needle pivoted around a horizontal axis aligned in the magnetic east-west direction.

Dipole--a compact source of magnetic force, with two magnetic [poles](#). A bar magnet, coil or current loop, if their size is small, create a dipole field. The Earth's field, as a crude approximation, also [resembles that of a dipole](#), located near the Earth's center.

Dynamo Also known as "generator," a machine creating electric currents by relative motions between the conductors that carry them and magnets of electromagnets. In geomagnetism the term is also used for naturally occurring fluid flows through a magnetic field, generating electric currents. A self-excited dynamo (of either kind) is one in which the generated current creates the magnetic field by which the dynamo operates.

Dynamo process The generation of magnetic field by motions of a fluid that conducts electricity, motions driven by some source of energy (e.g. heat convection).

Dynamo theory The theory of fluid dynamos. Initially, "kinematic dynamo theory" asked whether dynamo processes were at all possible, and after some decades of study, the answer was "yes." "MHD (magneto-hydrodynamic) dynamo theory" searches for

dynamos which also satisfy consistent pressure and force structures.

Dynamo, fluid A [dynamo](#) process occurring in a fluid that conducts electricity.

Electric charge--A property of [electrons](#) and [ions](#), causing them to attract each other, and to repel particles of the same kind. The electric charge of electrons is called "negative" (-) and that of ions "positive" (+). Materials such as glass, fur and cloth acquire an electric charge by rubbing against each other, a process which tears electrons off one substance and attaches it to the other. Electric charges (+) and (-) may also be separated by a chemical process, as in an electric battery. About Ben Franklin's role in studying and naming electrical charges, [*see here](#).

Electric current--a continuous flow of electric charge through a material which conducts electricity, carried by ions and/or electrons. Currents usually flow in a closed circuit, without beginning or end. In daily life a current is generally driven through wires by a voltage ("electric pressure") produced by batteries or generators. Some currents in space plasmas are also produced this way, but many are inherent to the way ions and electrons move through magnetic fields, e.g. their **drifts**.

Electricity --Colloquially, electric charge and currents, viewed as a "fluid" which may be attached to matter or flow through it. The word came from "elektron," the Greek name of amber, one of the materials which when dry and lightly rubbed can attract small objects (by "static electricity"). The Greeks and Romans already knew about such attractions, but William Gilbert, who [studied them](#), called such materials "electricks," and from that came the modern term.

***Electron**--a lightweight particle, carrying a negative electric charge and found in all atoms. Electrons can be energized or even torn from atoms by light and by collisions, and they are responsible for many electric phenomena in solid matter and in plasmas. (About the discovery of the electron in 1897, click [here](#).)

Ferromagnetic --A material which like iron ("ferrum" in Latin) can become strongly magnetized, temporarily or permanently. William Gilbert named such materials "magneticks."

***Field** --The region in which a particular type of force can be observed; depending on the force, one can thus speak of a gravity field, magnetic field, electric field (or when the two are linked by fast oscillations, electromagnetic field) and nuclear field. The laws of physics suggest that fields represent more than a **possibility** of force being observed, and that they can also transmit energy and momentum, e.g. a light wave is a phenomenon completely defined by fields. For that reason a field is often viewed as a space which was modified by the sources of the force which the field represents.

Field, electric--the region in which electric forces can be observed, e.g. near an electric charge.(see [field](#)).

Field, electromagnetic(EM field)--the regions of space near electric currents, magnets, broadcasting antennas etc., regions in which electric and magnetic forces may act (see [field](#)). Unchanging magnetic or electric phenomena can often be handled by just considering the magnetic or the electric field alone; however wave phenomena such as radio and light involve a tight interplay of time-varying electric and magnetic fields, viewed as manifestations of their [*electromagnetic fields](#).

Field line, closed In magnetospheric physics, field lines which are **not** open, but have both ends attached to Earth. The field lines reaching most locations on Earth are closed and can trap charged particles.

Field line, open --In magnetospheric physics, a field line whose one end reaches Earth (specifically, the conducting ionosphere layer in the high atmosphere) but whose other end extends into the solar wind. Presumably, such lines have undergone [magnetic reconnection](#). Because plasma and energy easily flow along magnetic field lines, these lines offer an easy pathway by which energy and plasma can flow from the solar wind to the Earth's magnetosphere.

[*Field line preservation](#)--A predicted property of fluids which are perfect conductors of electricity (including "ideal plasmas"), fairly closely obeyed in much of the space environment. By this property, two particles which initially share the **same** field line, continue to do so into the future, even if the line is deformed. The opposite also holds for such fluids: two particles which start out on **different** field lines will **always** be on different field lines (but see [magnetic reconnection](#)).

[*Field lines, magnetic](#)--imaginary lines in space used for visually representing magnetic fields (just as lines of latitude and longitude are used to represent locations on Earth). At any point in space, the local field line points in the direction an ideal compass needle would assume, if it were free to rotate in 3 dimensions. It is also the direction of the magnetic force--the force which an isolated magnetic pole at that point would experience. In a plasma, magnetic field lines guide the motion of [ions](#) and [electrons](#), are sometimes able to [trap them](#) and direct the flow of some electric currents.

Field, magnetic The region where magnetic forces can be observed. See [field](#).

[* Flare, solar](#) (Solar flare)--a rapid outburst on the Sun, usually in the vicinity of an active sunspot. A sudden brightening (only rarely seen without special filters, e.g. ones that isolate the red light of hydrogen) may be followed by the signatures of particle acceleration to high energies--x-rays, radio noise and occasionally, a bit later, the arrival at Earth of high-energy ions from the Sun. Flares appear to be associated with rapid energy releases high above the photosphere, apparently from the magnetic fields of sunspots. Their link to coronal mass ejections, which may also be powered by magnetic energy, is still unclear.

Flux, magnetic A measure of the amount of magnetic energy contained in a bundle of magnetic field lines. The magnetic flux in the bundle is found by multiplying its perpendicular cross section area by the average magnetic intensity on that cross section.

Hard materials (magnetically) Materials which can retain permanent magnetization.

Inclination (magnetic) The scientific name to the magnetic [dip angle](#).

Inner core (of the Earth) While the Earth has a spherical fluid core, the inner core is a solid sphere in the middle of the fluid core, about 3/4 its width. It may have formed by the solidification of the liquid iron of the fluid core, and since such solidification releases heat, this may be one source of energy for the fluid motions which sustain the Earth's inner dynamo.

Inverse squares law The mathematical formula by which a force decreases with distance from its source like the inverse of the square of the distance R from the source, that is like $1/R^2$. Gravity decreases at this rate, also the electric force due to an isolated electric charge and the magnetic force due to an isolated magnetic pole. Here a "source" is assumed to be pointlike and small, but it may be shown that a sphere with even distribution of source material also acts like a point source at its center.

***Ion**--usually, an atom from which one or more [electrons](#) have been torn off, leaving a positively charged particle. Ions carry much of the large-scale currents in the Earth's magnetosphere. "Negative ions" are atoms which have acquired one or more extra electrons, and molecules can also become such ions.

Kinematic dynamo --In the theory of fluid dynamos, a self-sustaining dynamo process based on a certain flow pattern, without requiring the flow pattern to be consistent with force balance and other physical considerations.

Lava (magma) --Molten rock issuing from a volcano or volcanic vent.

Lightning --A discharge of static electricity, generated (usually) by a thunderstorm cloud.

Line of force --Michael Faraday's original term for what is now known as [magnetic field line](#).

Lithospheric plates --Large plates of dense rock, supporting the continents and oceans. The entire surface of the Earth is divided among them, and their relative motion is the basic driver of [plate tectonics](#).

Lobe, tail --One of two bundles of magnetic field lines, starting at the Earth's polar caps and stretching into the [magnetotail](#)--one linked to

the region around the northern magnetic pole, the other to that around the southern one. The tail lobes contain very rarefied plasma and appears to store magnetic energy released in [substorms](#) .

Lodestone (also spelled Loadstone) --A rare mineral, found to have strong permanent magnetization. For many centuries, lodestones provided humanity with its only known source of magnetism. The mineral is a rare form of fine-grained magnetite and is believed to acquire its magnetic properties when struck by lightning.

Magnetic Bode's law --Bode's law is an approximate formula giving the distances of planets from the Sun; it fits observations, but has no theory behind it. "Magnetic Bode's Law" suggested a similar regular dependence of the strength of a planet's magnetic source on the size of the planet. Some regularity exists--the largest and second largest planets (Jupiter and Saturn) have the largest and second largest magnetic sources. However, Venus, only slightly smaller than Earth, is not magnetized, while Mercury, much smaller, is; thus this guess is unconfirmed.

Magnetic induction --This term may refer to one of two phenomena, either [induced magnetism](#) or **electromagnetic induction**. The latter may be loosely defined as the ability of a substance that conducts electricity to develop a circulating current, if it senses a changing magnetic field. The change might come either from variation of the strength of the magnetic source, or from the motion of the conductor relative to that source. The dynamo process is based on such currents.

Magnetic pole-- (1)A magnetic pole of a bar magnet is a compact source of magnetic force near the end of the bar. Magnetic poles always come in matched pairs, north-seeking (N) and south-seeking (S). Magnetic poles are just an observed consequence of the way magnetic field lines are channeled by the bar: actually, the bar's magnetization is evenly spread inside it and is not concentrated at its ends.

(2) The magnetic pole of Earth is one of the two points on Earth towards which the compass needle seems to point. At the pole, the magnetic force is vertical. The magnetic poles of Earth are near the geographic poles, the points where the Earth's surface intersects its rotation axis; however the two are not the same, and on Uranus and Neptune are quite widely separated.

Magnetic (scalar) potential --The magnetic force at a point in space is a **"vector"** quantity, one which has both direction and strength. To specify it, **three** numbers are required--for instance, one specifying its strength and two its direction. However, the magnetic field near the surface of the Earth (and at any other location where electric currents are absent) is of a relatively simple kind, describable by a single varying quantity--an ordinary number or "scalar", as distinct from a vector. A similar simplified representation exists for the force of gravity, even when its sources are complicated.

The magnetic scalar potential was introduced for describing the Earth's magnetic field by [Gauss](#) and is described in terms of

"[spherical harmonics](#)." It is still being used.

***Magnetic storm**--A large-scale disturbance of the [magnetosphere](#), often initiated by the interplanetary shock marking the arrival of a plasma cloud originating at the Sun.

A magnetic storm is marked by the injection of an appreciable number of [ions](#) from the tail regions of the magnetosphere into the near-Earth magnetosphere, increasing the [ring current](#). The stronger ring current shifts the region of the [polar aurora](#) equatorward, so such storms offer a rare opportunity to residents in middle latitudes to see auroral displays. The injected particles cause a world-wide drop in the equatorial magnetic field, taking perhaps 12 hours to reach its greatest intensity, followed by a more gradual recovery.

Magnetization, induced The magnetization of iron and similar "[ferromagnetic](#)" materials, when placed near a magnet or lodestone. In magnetically "[soft](#)" materials this magnetization is only temporary.

Magnetize --Cause to become magnetic. This can happen by placing the material in the strong magnetic field produced by a permanent magnet or by an electric current, or when heated material which can become magnetic (e.g. iron or basaltic lava) cools down in the presence of a magnetic field.

Magnetometer--an instrument for measuring the direction and/or intensity of [magnetic fields](#). Spacecraft often carry fluxgate magnetometers, which measure components of the magnetic field (3 of them are combined to provide all three, giving both strength **and** direction of the field) but they need to be calibrated.

Instruments using rubidium vapor measure only the field strength, but their reading is absolute, related to atomic constants.

Magnetometer, Fluxgate-- An electronic magnetometer based on the saturation of certain magnetizable materials. Can be made very sensitive.

***Magnetometer, proton precession** --An electronic magnetometer based on the resonance between protons (hydrogen nuclei) and an oscillating electromagnetic signal. Protons are small magnets, and the magnetic strength of each (like the proton's mass) always has the same value, which is well known. Because of this, the resonance frequency has a simple relation to the strength of the magnetic field. By measuring that frequency, the magnetic field strength can be immediately calculated, and no calibration of the instrument is needed.

Magnetometer, Overhauser effect --A greatly improved version of the proton precession magnetometer (preceding item), using an added chemical to enhance performance.

Magnetometer, alkali vapor--A magnetometer which, like the proton precession type, is based on an atomic resonance process and therefore requires no calibration. A glass chamber containing the vapor of an alkali metal (e.g. rubidium or caesium) becomes slightly

more opaque to a specific light frequency when exposed to a radio signal of resonant frequency. That frequency gives the strength of the surrounding magnetic field.

Magnetopause--The boundary of the magnetosphere, separating plasma attached to Earth from that of the flowing solar wind.

Magnetosphere -- The outermost environment of Earth, dominated by the Earth's magnetic field. The magnetosphere is a cavity carved in the solar wind by the planetary magnetic field, and is the site of the radiation belts and of many intricate phenomena. Magnetized planets other than Earth also have magnetospheres.

Magnetotail--The long stretched-out nightside region of the magnetosphere, the region in which **substorms** begin. It starts about 8 Earth radii (R_E) nightward of the Earth and has been observed to distances of at least $220 R_E$. See [plasma sheet](#), [tail lobes](#),

Main field (of Earth)--A term frequently used by scientists for the internal magnetic field of the Earth, in distinction from fields originating outside its surface.

Maunder minimum--A period between 1646 and 1715 in which (for unknown reasons) sunspots grew scarce and astronomers lost interest in them. First noted by E. Maunder around 1900, the Maunder minimum may have been associated with a colder climate observed in those years, at least in Europe.

MHD --Short for "magneto-hydrodynamics, " the theory of fluids which conduct electricity. MHD is applicable to the Earth's fluid core and also to many [plasmas](#).

MHD dynamo theory --The theory of dynamo action in conducting fluids, including force balance and other physical effects.

Mid-ocean ridge The volcanic ridge in the ocean floor between two [lithospheric plates](#), at which lava oozes out and builds up the plates, which are slowly pulled away from it. The [Mid-Atlantic Ridge](#) is the best known example.

North seeking pole--The [pole of a bar magnet](#) which, if the magnet is freely suspended (or is placed on a "boat" floating on water) tends to point northward. Also known as the "north pole" (or "N pole") of the bar magnet. However, it should be noted that if a bar magnet at the center of the Earth were the source of the Earth's field, the N-pole of that bar would be directed **southward**, because it tends to repel another N-pole, not attract it.

Orb of virtue (of the Earth). --William Gilbert's term for the region in which the Earth's magnetic attraction can be observed--for what we now might call the Earth's magnetic field. Since "orb" means sphere, in modern terms this would translate to "sphere of influence."

Photosphere--The layer of the Sun's atmosphere from which almost all visible light reaches us. The Sun is too hot to have a solid surface and the photosphere consists of a [plasma](#) at about 5500 degrees centigrade.

***Plasma**--a gas containing free [ions](#) and [electrons](#), and therefore capable of conducting electric currents. A "partially ionized plasma" such as the Earth's ionosphere or the gas inside a fluorescent lamp is one that also contains neutral atoms.

Plasma Sheet --The region in the [magnetotail](#) of relatively denser plasma and rather weak magnetic field, stretching tailwards from the Earth's magnetic equator. It separates the two [tail lobes](#) and is the site of [substorms](#) and the source region of most of the [polar aurora](#).

Plate tectonics. The theory according to which the changes of oceans and continents are dictated by the [lithospheric plates](#) being built up at [mid-ocean ridges](#) and consumed at [oceanic trenches](#).

Polar wandering A theory popular in the early 1950s but now discredited, which tried to explain the different directions of fossil magnetic fields recorded in ancient basalts. It proposed that the magnetic poles of the Earth did not reverse or change, but that the entire crust of the Earth slowly slid over its interior.

Poloidal field One of two classes of magnetic field (mainly in a near-spherical configurations). A dipole field, and more generally, the internal field of the Earth observed near its surface, is poloidal. (The field in the core, however, may also contain some field of the [toroidal mode](#)).

Radiation belt --The region of high-energy particles trapped in the Earth's magnetic field.

***Radiation belts (inner, outer)** High energy particles (loosely, "radiation") trapped by the Earth's magnetic field consist of two populations, of different energies, locations and sources. The **inner radiation belt** contains energetic protons, typically of energy 10-50 Mev (10-50,000,000 electron volts) and is a secondary product of the [*cosmic radiation](#). When a cosmic ray ion hits an atom on the atmosphere, an assortment of fragments fans out from the collision, and if the ion moved in a direction near the horizontal, some of these fragments may be splashed out to space. Among them may be neutrons, similar to protons but without electrical charge, and therefore moving in straight lines, unaffected by magnetic forces.

Neutrons decay radioactively with an average lifetime of about 10 minutes, into a proton (which takes most of the energy), an electron and a neutrino. Ten minutes, however, is the average: a few will already decay within a fraction of a second, and in such cases the proton will materialize close to Earth. Since it carries an electric charge, the proton is affected by magnetic fields, and may be trapped by them. Obviously, only a small fraction of cosmic ray ions contribute such a trapped proton. However, orbits crossing the equator 3000-6000 km above ground are very stable, and such

protons can accumulate for years, producing a dense radiation belt.

The **outer radiation belt** consists of ions and electrons accelerated in the Earth's magnetosphere; its field lines cross the equator between 2 and 5 Earth radii from the center of the Earth.. Some electrons can reach 1-2 MeV and their origin is not yet clear. The ions can reach 1 MeV, but most of them (and of the electrons) are of lower energy. Besides acceleration of particles from the [magnetotail](#), outer belt particles may also be accelerated when [*interplanetary shock fronts](#) hit the magnetosphere.

***Reconnection, magnetic**--In a plasma, the process by which plasma particles attached to two different field lines can be made to share the same field line (see [field line preservation](#)). For instance, following reconnection, solar wind particles on an interplanetary field line, and magnetospheric ones on a field line attached to Earth, may find themselves sharing the same "open" field line, which has one end anchored on Earth and the other extending to distant space.

Magnetic reconnection can occur when plasma flows through a neutral point or a neutral line, locations at which the intensity of the magnetic field is zero and its direction is not defined. It is an important concept in the theories of energy transfer from the solar wind to the magnetosphere and of energy release in substorms, and requires a non-zero resistivity near the neutral point, or some process with equivalent properties.

Reversals, magnetic --Episodes of changes in the Earth's magnetic field which result in the polarity of the north and south magnetic poles being interchanged. Reversals have occurred in the geological history of the Earth at typical intervals of 500,000 years. The Sun's global magnetic polarity seems to reverse every 11-year sunspot cycle.

Ring current--A very spread-out electric current circling around the Earth, carried by trapped ions (peak energy about 65,000 electron volt) and electrons.

Seafloor spreading --The movement of the ocean floor away from [mid-ocean ridges](#).

Secular variation --The observed slow variation of the magnetic field from sources inside the Earth.

Soft materials (magnetically) --Materials such as soft iron which become temporary magnets when placed near permanent magnets or electric currents, but lose their magnetization when taken away again.

***Solar activity** A general term for the class of processes and changes on the Sun that rise and fall with the sunspot cycle, e.g. [solar flares](#).

Solar cycle (or **sunspot cycle**)--an irregular cycle, averaging about 11 years in length, during which the number of sunspots (and of their associated outbursts) rises and then drops again. Like the sunspots, the cycle is probably magnetic in nature, and the polar magnetic field

of the Sun also reverses in each cycle.

Solar flare See [flare, solar](#)

Solar wind -- A fast outflow of hot gas in all directions from the upper atmosphere of the Sun ("solar corona"), which is too hot to allow the Sun's gravity to hold on to its gas. Its composition matches that of the Sun's atmosphere (mostly hydrogen) and its typical velocity is 400 km/sec, covering the distance from Sun to Earth in 4-5 days. The solar wind confines the Earth's magnetic field inside a cavity known as the [magnetosphere](#) and supplies energy to phenomena in the magnetosphere such as the [polar aurora](#) ("northern lights") and [magnetic storms](#).

South seeking pole The magnetic pole (for example, on a bar magnet) which, when freely suspended in space, tends to point south. See [north-seeking pole](#).

Spherical harmonics Mathematical expressions (functions) that depend on location in space, used in expressing the [magnetic \(scalar\) potential](#). One such expression (in coordinates lined up with the magnetic axis) can describe the [dipole](#) component of the field, describing fields whose intensity decreases with distance R like $1/R^3$. Others can give the [4-pole](#) (quadrupole) component, for fields whose intensity decreases like $1/R^4$, and still others give more complex parts that decrease even faster. The results of global surveys are usually given as the magnitudes of various spherical harmonics (typically 100 or more, most differing in structure rather than rate of decrease), and the [secular variation](#) is usually expressed through the rate at which each of these changes with time.

***Substorm, magnetic**--a process by which plasma in the magnetotail becomes rapidly energized, flowing earthward and producing bright auroras and large Birkeland currents, for typical durations of half an hour.

***Sunspot**--An intensely magnetic area on the Sun's visible face. For unclear reasons, it is slightly cooler than the surrounding [photosphere](#) (perhaps because the magnetic field somehow interferes with the outflow of solar heat in that region) and therefore appears a bit darker. Sunspots tend to be associated with violent solar outbursts of various kinds, and their numbers rise and fall with the [solar cycle](#).

Sunspot cycle See [solar cycle](#).

Terrella--a small magnetized sphere, used as laboratory model of the Earth. The first terrellas are described by William Gilbert in "De Magnete" (1600). About Birkeland's terrella experiments (~1900), [*see here](#)

Toroidal field One of two modes of magnetic fields (particularly in spherical configurations), the other being the [poloidal field](#). A typical toroidal field is the one created by a current in a long straight wire,

with ring-shaped ("torus shaped") field lines around the wire. A general magnetic field has a toroidal part and a poloidal part. On the Sun, the uneven solar rotation (faster near the equator) amplifies only the toroidal part, though the poloidal field is essential to the process.

Torsion balance --A sensitive instrument invented in 1776 by [Charles Augustin Coulomb](#), measuring small forces by the twist of a flexible thread or wire from which a magnet is suspended. Introduced by Coulomb to observe small variations of the magnetic field, it also allowed Coulomb to confirm the [inverse squares law](#) for magnetic and electric forces.

***Trapping**--The process which allows electrically charged particles (such as protons and electrons) to be confined by magnetic fields for long stretches of time. Such particles, if their energy is not too high, tend to spiral around magnetic field lines and be guided by them.

Trapping is made possible by the fact that the progress of a particle guided along a field line is slowed down or even reversed when the particle is led into regions of stronger magnetic field. Because both ends of a [closed field line](#) extend to the surface of the Earth, where the field is stronger than where the line crosses the equator, ions and electrons can be trapped on such lines near the equator. They never reach the atmosphere and become lost there (by collisions with air molecules) because, whenever they approach the ends of the field line, their advance along the field line is slowed down and then reversed.

Trenches, oceanic --The deepest parts of the ocean floor, shaped like long deep valleys. Oceanic trenches mark locations where spreading lithospheric plates descend again into the Earth. They generally parallel shorelines or strings of islands, often ones lined with volcanoes, e.g. Japan, the Aleuts or South America. It is believed the lava of such volcanoes comes from the lighter material in the plates, which separates and floats upwards.

Variation --In William Gilbert's book, the difference (in degrees) between magnetic north and true north. Nowadays known as "magnetic declination." "Variation" was preferred by sailors in Gilbert's time, because "declination" is also used for one of the two angles which define a position in the sky, on the celestial sphere.

Versorium--In William Gilbert's book, a needle on a vertical pivot--either the magnetic needle of a compass, or a [non-magnetic](#) lightweight needle designed to indicate the direction of electric attraction.

Verticity--In William Gilbert's book, the ability to acquire magnetic poles (e.g., in an iron bar).

[Back to the Master List](#)

Author and Curator: [Dr. David P. Stern](#)

Mail to Dr.Stern: [earthmag\("at" symbol\)phy6.org](mailto:earthmag(at)phy6.org)

Last updated 25 November 2001 </htm