Magnetic Planet

A compass needle points approximately north because of Earth's magnetic field. What else does Earth's magnetic field do? Is it important? Would Earth be any different without a magnetic field?

A compass needle points to Earth's magnetic north pole.

Earth's magnetic field results from the movement of liquid metals in the outer core of the planet. Deep in the center of Earth, liquid metal moves in circular convection currents. The circular movements of electrons in the metals create a magnetic field, much like electricity running through wire coils creates an electromagnet. However, the currents in Earth's core involve over 900 billion billion metric tons (that's 900,000,000,000,000,000,000) of iron. The magnetic field generated by the movement of this much material is huge. In fact, it makes the entire Earth behave like a giant magnet.

How is Earth like a magnet? Like other magnets, Earth has magnetic poles and a magnetic field. Earth's magnetic poles are located in the same general area as the rotational North and South Poles, although they move constantly. Earth's magnetic north is currently about 450 kilometers from what we normally consider to be the North Pole, the rotational north pole. (The rotational poles are the points at which Earth's rotational axis intersect with the planet's surface.)


Electricity running through wire coils creates an electromagnet, like the kind found in doorbells, headphones, and other common devices.

What exactly is a magnetic field? Basically, a magnetic field is a space in which a magnet exerts force. Earth's magnetic field extends beyond the solid part of the planet. Remember that all magnets have this property. That is why one magnet can move another without actually touching it. Earth's magnetic field extends high into the atmosphere. It turns out that this is a very important property for life on Earth.

The extension of Earth's magnetic field into space protects our planet from dangerous radiation and space "weather." Many people think of space as empty, but that is not the case. "Winds" of radiation and charged particles move through space and, if

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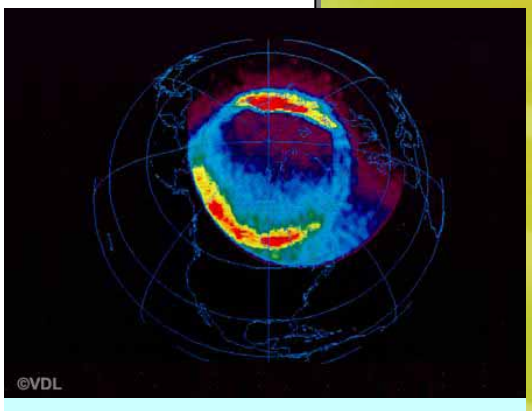
not for the magnetic field, would bombard Earth. The radiation comes from distant areas of the galaxy. Some of the most dangerous forms of radiation come from exploding stars. Winds of charged particles come from our own Sun. These solar winds come from solar flares, or sudden bursts of energy in the Sun's atmosphere. Solar winds sometimes get so intense that they can interfere with communication satellites. However, Earth's magnetic field protects us from most of the radiation from space and from charged particles in solar winds.

Interactions of solar winds and Earth's magnetic field produce the amazing light displays called auroras.

Colorful, glowing auroras are visible effects of Earth's protective magnetic field at work. Auroras are mainly visible at very northerly and very southerly latitudes. During periods of intense solar winds, the charged particles build up enough to interact with gases in the atmosphere and produce the amazing light displays.



Auroras are concentrated around Earth's magnetic poles.

Without a magnetic field, Earth's surface would be constantly struck with harmful radiation and charged particles from space. Living things on Earth's surface would be harmed directly by the radiation and the particles. Also, without a magnetic field, life on Earth may not have had a chance to evolve in the first place. If a planet is not protected by a magnetic field, rapidly moving charged particles can literally bounce gas molecules out of its atmosphere. Over millions of years, the solar wind could literally erode an atmosphere away. In fact, scientists hypothesize that this happened on Mars. Mars is made up of the same materials as Earth, so it likely has an iron core. But Mars is smaller, so its iron core is also smaller. Both planets are cooling. Since Mars is smaller, its iron core is cooling faster than Earth's. In fact, Mars' iron core is likely frozen solid. The iron is not moving in currents, so it does not produce a magnetic field on the planet. Instruments on board

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the Mars Global Surveyor confirmed that the planet does not have a magnetic field. Mars also has a very thin atmosphere that is unable to support life. Mars' thin atmosphere may be explained by erosion from solar wind in the absence of a magnetic field.

The lack of a magnetic field on Mars may have resulted in the planet's lack of a life-sustaining atmosphere.

So, Earth's magnetic field protects life and the atmosphere. But is our magnetic field here to stay?

Earth's magnetic field will go away for good when its iron core cools, just as Mars' did. Scientists have calculated the amount of material in the iron core and the rate of cooling. Based on these calculations, Earth should sustain a magnetic field for billions more years. In fact, even if the metal currents in the core were shut down today, it should still take hundreds of thousands if not millions of years for the magnetic field to wind down. However, scientists have also discovered that the strength of Earth's magnetic field is decreasing. It is decreasing so fast that it may be gone in a couple thousand years.

So, what is happening to Earth's magnetic field? Why does it appear to be declining so quickly? The answer may be surprising. In fact, even scientists were surprised when they searched the rock record for answers.

Certain minerals, such as iron oxides, are sensitive to magnetic fields. When rock is molten, the minerals in it align with Earth's magnetic field at the time. Their positions are preserved when the rock solidifies. Rocks of different ages form a record of Earth's changing magnetic field. By looking at this magnetic rock record, the scientists found that the direction of Earth's magnetic field actually reverses from time to time. That means Earth's north magnetic pole changes places with the south magnetic pole. The rock record also revealed that the strength of Earth's magnetic field declines rapidly in the centuries leading up to these reversals. Records of the period we are in now are similar to records of Earth's magnetic field before previous reversals. Scientists think this may be an indication that a

reversal could happen within the next couple thousand years. How will a reversal affect people?

While Earth's magnetic field is low, solar storms could damage satellites, disrupting communications and research.

The main danger to humans and life on Earth will occur during the transition from one direction to the other. When the strength of our protective magnetic field is low, heavy solar winds could damage satellites. Earth's surface will see an increase in harmful radiation. This could lead to an increase in diseases such as cancer. However, because this decline will happen over centuries, scientists will have time to develop solutions to these problems. After the poles reverse, the magnetic field should quickly regain its strength and our protective shield will be restored.