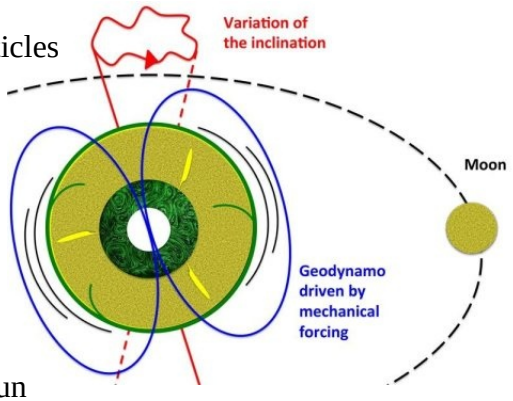
THE MOON AND THE EARTH'S MAGNETIC FIELD



The Earth's magnetic field permanently protects us from the charged particles and radiation that originate in the Sun. This shield is produced by the geodynamo, the rapid motion of huge quantities of liquid iron alloy in the Earth's outer core. To maintain this magnetic field until the present day, the classical model required the Earth's core to have cooled by around 3000 °C over the past 4.3 billion years. Now, astronomers suggest that, on the contrary, its temperature has fallen by only 300 °C. **The action of the Moon, overlooked until now, is thought to have compensated for this difference and kept the geodynamo active.**

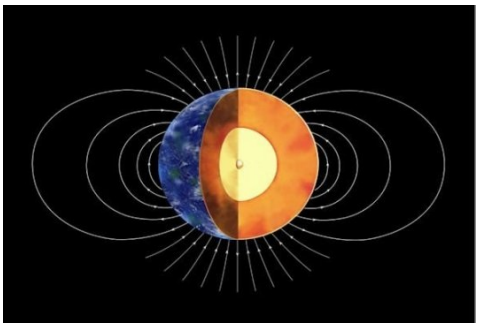
The gravitational effects associated with the presence of the Moon and Sun cause cyclical deformation of the Earth's mantle and wobbles in its rotation axis. This mechanical forcing applied to the whole planet causes strong currents in the outer core, which is made up of a liquid iron alloy of very low viscosity. Such currents are enough to generate the Earth's magnetic field.

The classical model of the formation of Earth's magnetic field raised a major paradox. For the geodynamo to work, the Earth would have had to be totally molten four billion years ago, and its core would have had to slowly cool from around 6800 °C at that time to 3800 °C today. However, recent modeling of the early evolution of the internal temperature of the planet, together with geochemical studies of the composition of the oldest carbonatites and basalts, do not support such cooling. **With such high temperatures being ruled out, the researchers propose another source of energy in their study.**

The Earth has a slightly flattened shape and rotates about an inclined axis that wobbles around the poles. Its mantle deforms elastically due to tidal effects caused by the Moon. The researchers show that this effect could continuously stimulate the motion of the liquid iron alloy making up the outer core, and in return generate Earth's magnetic field. **The Earth continuously receives 3,700 billion watts of power through the transfer of the gravitational and rotational energy of the Earth-Moon-Sun system, and over 1,000 billion watts is thought to be available to bring about this type of motion in the outer core.** This energy is enough to generate the Earth's magnetic field, which together with the Moon, resolves the major paradox in the classical theory. The effect of gravitational forces on a planet's magnetic field has already been well documented for two of Jupiter's moons, Io and Europa, and for a number of exoplanets.

Since neither the Earth's rotation around its axis, nor the direction of its axis, nor the Moon's orbit are perfectly regular, their combined effect on motion in the core is unstable and can cause fluctuations in the geodynamo. This process could account for certain heat pulses in the outer core and at its boundary with the Earth's mantle and may have led to peaks in deep mantle melting and possibly to major volcanic events at the Earth's surface. **This new model shows that the Moon's effect on the Earth goes well beyond merely causing tides.**

The inner core is Earth’s deepest layer. It is a ball of solid iron just larger than Pluto which is surrounded by a liquid outer core. The inner core is a relatively recent addition to our planet and establishing when it was formed is a topic of vigorous scientific debate with estimates ranging from 0.5 billion to 2 billion years ago. Increases in magnetic field residue in rocks at that time is a likely indication of the first occurrence of solid iron at Earth's centre and the point in Earth's history at which the solid inner core first started to "freeze" out from the cooling molten outer core. Confirmation of this finding could change our understanding of the Earth's interior and its history. **The timing of the first appearance of solid iron or "nucleation" of the inner core is highly controversial, but is crucial for determining the properties and history of the Earth's interior and has strong implications for how the Earth's magnetic field -- which acts as a shield against cosmic radiation, as well as a useful navigational aid -- is generated.**



The Earth's magnetic field is generated by the motion of the liquid iron alloy in the outer core, approximately 3,000 km beneath the Earth's crust. These motions occur because the core is losing heat to the overlying solid mantle that extends up to the crust on which we live, producing the phenomenon of convection. Once the inner core started to freeze, this convection received a strong boost in power because light, non-metallic elements remained molten in the outer core and were buoyant relative to the overlying liquid. **The process continues today and is thought to be the main source of "fuel" for generating the Earth's magnetic field**.

This contrasts sharply with Mars, which seems to have had a strong magnetic field early in its history that died after half a billion years.

AK from Science Daily News