Earth's anisotropic inner core structure driven by dipole geomagnetic field, reveals study

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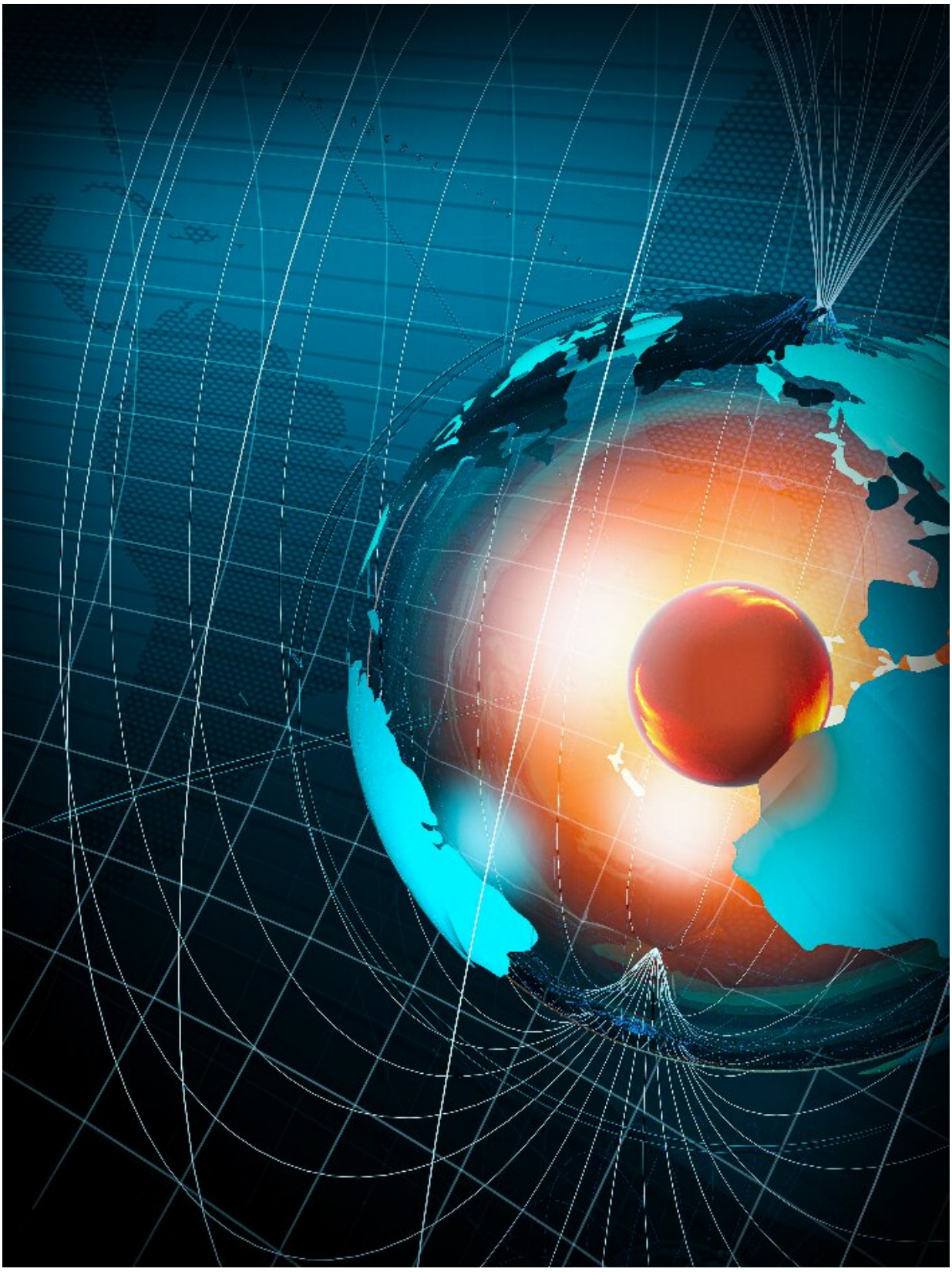

Earth's inner core and geomagnetic field. Credit: IGCAS

A geomagnetic field is generated in Earth's interior and extends into outer space to protect Earth from cosmic radiation and the charged particles of solar wind. The magnetic field is generated by the convection of charged molten iron fluids in Earth's outer core.

In contrast to the convective homogenous outer core, Earth's inner core is inhomogeneous and anisotropic. The seismic velocity in the polar direction is ~2–3% faster than that in the equatorial direction.

Recently, researchers led by Profs. Li Heping and He Yu from the Institute of Geochemistry of the Chinese Academy of Sciences (IGCAS) have revealed that Earth's anisotropic inner core structure is driven by the dipole geomagnetic field.

The study was published in *Nature Communications* on March 24.

Last year, a study published in *Nature* revealed that Earth's inner core is not a normal solid but a composition of solid iron and liquid-like light elements (hydrogen, oxygen, and carbon), which is also known as a superionic state.

In the current study, the researchers found that hexagonal-close-packed (hcp) Fe-H alloy exhibited both seismic anisotropy and H-ion diffusion anisotropy under high pressure-temperature conditions in Earth's inner core.

In the presence of an external electric field, the alignment of the Fe-H lattice with the c-axis pointing in the field direction was energetically favorable. Due to this effect, the alignment of the Fe-H lattice could be

driven by an electric field.

Considering the electric-magnetic field distribution in the inner core, an interaction between the inner core and geomagnetic field was established. The aligned texture driven by the geomagnetic field exhibited significant seismic anisotropy, which explains the anisotropic seismic velocities in the inner core.

"It's intriguing! The mobile hydrogens inside the Earth's inner core may correlate with the geomagnetic field and thus form anisotropic texture, which should give us a new perspective to understand the mysteries of the Earth's inner core and Earth's magnetic field," said Dr. He Yu, corresponding author of the study.

"Beyond the geoscience implications, unique physical properties of superionic effect are also vital for us to further understand the behaviors of superionic matter under extreme conditions of exoplanets' interior," said Dr. Sun Shichuan, first author of the study.

More information: Shichuan Sun et al, Superionic effect and anisotropic texture in Earth's inner core driven by geomagnetic field, *Nature Communications* (2023). DOI: 10.1038/s41467-023-37376-1

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