NEWS FEATURE

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Sun mimics rotating machinery

Two centuries-long mystery solved: the Sun acts as a magnetic alternator, not dynamo

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"The most important discovery of 2023: an excentral wobbling core (really) runs the Sun and trillions of Sun-like stars"

Key words— Sun global vibration; Sun engine; Sun core; stellar dynamo; standard stellar models; solar wind; space weather; Rieger period.

In the most important scientific discovery of 2023 and the most significant solar physics find of all time—published last week in the oldest geophysics periodical in the world, the *Journal of Geophysics*, a global dynamicist Dr. Mensur Omerbashich has shown that the Sun acts as an ordinary engine instead of an elusive dynamo (a model often considered in solar physics but one never proven to hold in reality). Instead of a star classically seen as a nuclear furnace with impulsively alternating polarity, the Sun continuously behaves as a **typical revolving-field motor** with an eccentrically placed rotor (core) and no stator. The discovery ends two centuries of efforts to grasp the true nature of the global dynamics of our host star, including past partial results based on theories and hints instead of *in situ* data.

In the same research, Dr. Omerbashich has achieved the first-ever conclusive **detection of the solar core and its global dynamics**. The core does not share a common center of mass with the rest of the Sun but lays instead off-center and towards the south pole (or, away from the apex) as the thrice-as-massive Sun shell tugs it along while traversing the Milky Way galaxy. The eccentric core then naturally **wobbles once every ~2 years**, causing the Sun to resonate like any operating motor engine would. But unlike in engines, which are firmly caged to prevent vibrational damage, the **cageless Sun vibrates** both freely and completely—constructively (resonance) and destructively (antiresonance).

The incessant global decadal resonance causes our host star to spin (differentially) and thus emit its excess mass into space as gas jets of magnetized hot plasma called the **solar wind**. Magnetization in the wind—called the Interplanetary Magnetic Field (IMF)—permeates the solar system and affects its planets in the most dramatic ways, such as by causing seismicity—as Omerbashich showed in a related study earlier this year.

Dr. Omerbashich has now looked into the 1-mo-13-yr dynamics of the Sun as captured by the Ulysses spacecraft high-resolution data—the only *in situ* IMF magnetic variations ever collected over the polar regions (at >70° solar latitudes). The polar regions are the source of the overall fastest solar wind, with ejection speeds exceeding 700 km/s, representing the ideal Sun (that is to say, as it would be with its core centered and the Sun thus interference-free and thereby turbulence-free). However, while orbiting the Sun, Ulysses could have visited the polar regions only intermittently, resulting in patchy data sets. Using the Gauss-Vaníček spectral analysis, as the only rigorous method for detecting periodicities in incomplete measurements, has for the first time enabled analysis of the decadal dynamics of the northerly and southerly winds separately, and of the polar fast and slow winds separately as well. Indeed, they all **preserve the global decadal vibration of our star**, with the fast winds doing it significantly better to the point of virtually theoretical perfection (image).

But the Sun does not just release the winds under global decadal vibrations triggered by the core wobble every ~2 years: it also gives in to them cyclically by **flipping its core** (and thus magnetic polarity) every ~11 years—an interval known as the Schwabe period and observed in sunspot number variations since times ancient. This interval also marks one solar cycle of variation in the global magnetic activity of our star. Just as the father of solar physics, **Hannes Alfvén**, proposed it back in the 1940s, this period is, in fact, a global mode (forcer) of solar vibration.

However, due to complex nonlinear dynamics involved, including differentially rotating and contrarily (out-of-phase-) vibrating "conveyor" belts and layers, the Schwabe is not the only global mode of vibration but the equilibrium period of the core wobble-triggered yet the whole Sun-self-sustained vibration, resulting in **three global modes** in total. Thus, the

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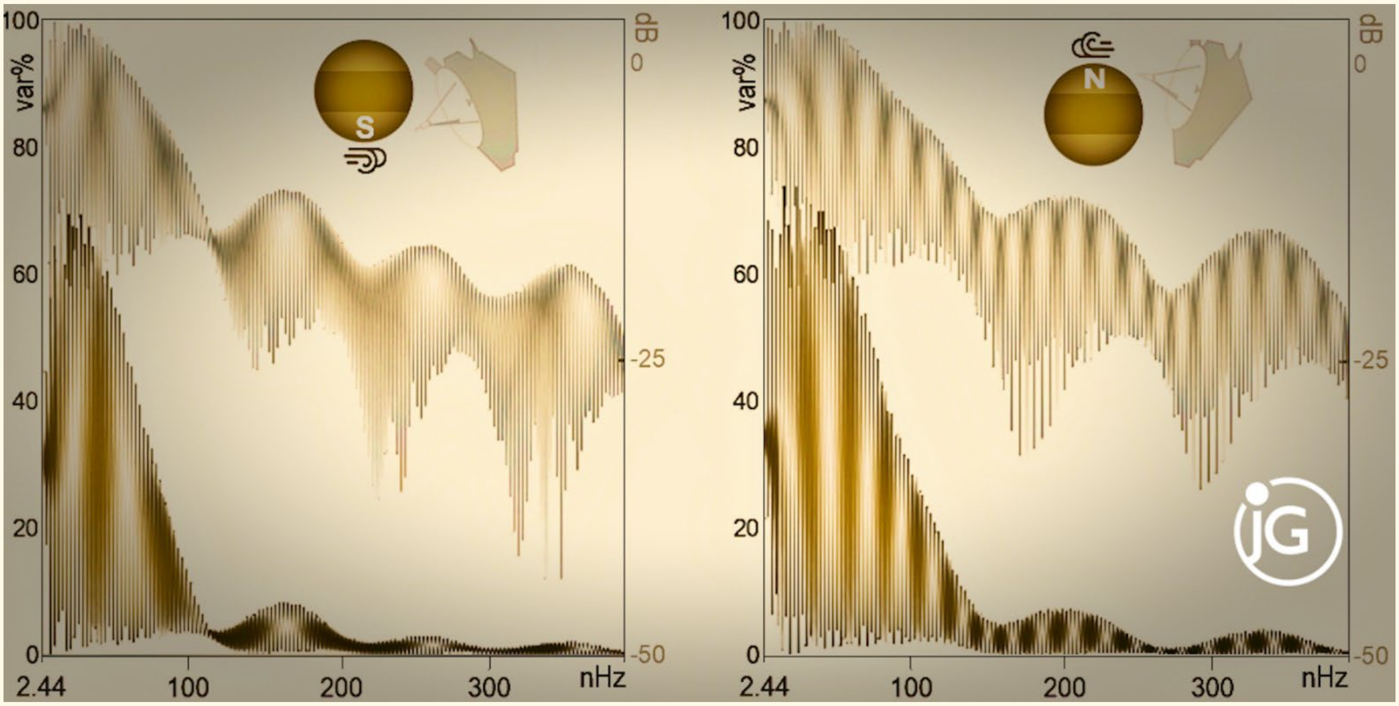

northern, equatorial, and southern polar regions oscillate under different modes: 11-years, 10-years, and 9-years, respectively. Such N-S gradual attenuation of global decadal vibration reveals progressive degeneration of the forcing towards the south pole—damping expected from a solar core offset towards the south and whose relative proximity there creates the long-known but previously never deciphered high turbulences in the south—the highest anywhere on the Sun.

By extension, while acting as a real engine, the Sun also does something we are all accustomed to seeing in rotating machinery: sparks. We commonly observe the continuous surface sparking on such grand scales as incessant firing events called nanoflares and occasional explosions called coronal mass ejections (CMEs). The interior sparking manifests on the surface as dimmer (less magnetic) regions, popularly called sunspots.

The discovery is in excellent agreement with sunspot historical records, remote data from the Wilcox observatory telescope at Stanford, and the experiment—thus instantly replacing the elusive dynamo concept with the magnetic alternator well known from mechanical engineering. The results are based on reproducible computations and are conclusive and impossible to question since the study directly analyzed the only record of in situ polar magnetic variations (as the Sun created them) rather than proxies and remote data or based on modeling as done by some. In addition, the study reported and explained well-known periodicities, such as the 154-day Rieger period that permeates the solar system and at which seismicity on rocky worlds occurs (see the previous related paper). The strength and vigor of this period, which now undoubtedly is solar in origin, stem from it being a folded offshoot of the solar winds (emitted from both the northern and southern polar regions).

This first-ever conclusive detection of the solar core and the newly gained understanding of its dynamics, while exposing the majestically regular decadal global vibrations of the Sun as snapped by the polar wind (turbulence-free and therefore the most reliable data type for studies of this type), painted for the first time a complete picture of the macroscopic dynamics of our star that regularly lead to magnetic polarity reversals every ~11 years.

Since our Sun serves as the standard for stars and stellar systems, these discoveries have tremendous implications for astrophysics and cosmology, as the results of this study also apply to most of the estimated >10 billion trillions of little-understood solar-type stars in the observable universe (most stars, not counting dwarfs).

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