Atomic Heat Saturation of the Sun's Corona: A Geometric Explanation for the Coronal Temperature Inversion

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Abstract

This paper presents a novel geometric model to explain the persistent mystery of the solar corona's temperature inversion - why the outer atmosphere of the Sun reaches millions of degrees Kelvin, far hotter than its surface. The hypothesis is based on the field-of-view saturation experienced by atoms in the corona. When hydrogen gas near the Sun's surface is immersed in a sky dominated by the solar disk, outgoing photon emission paths are constrained, resulting in radiative saturation. Only when the Sun fills less than half of the sky do photons escape efficiently, allowing the gas to cool. This geometric constraint aligns strongly with observed temperature peaks in the corona.

Background Context

The solar corona, extending millions of kilometers into space, exhibits a puzzling thermal structure. While the Sun's surface (photosphere) maintains a temperature of about 5,800 K, the surrounding corona reaches temperatures exceeding 1 to 2 million K. This sharp inversion violates intuitive thermodynamic gradients and has puzzled physicists for decades.

Multiple theories have been proposed, including magnetic reconnection, plasma wave heating, and nanoflares, but none offer a universally accepted, mechanistic, and geometry-based explanation that aligns precisely with observational data.

This paper proposes that the root cause of this inversion lies in photon field saturation due to limited sky visibility. In the dense inner corona, atoms are surrounded by intense solar radiation with few angular escape paths for their own emissions. This geometric constraint leads to heat accumulation. Once atoms reach an altitude where the Sun takes up less than half of the sky, photon escape becomes efficient, and temperatures begin to decline - mirroring observed patterns.

Implications and Forward View

This model presents a physically grounded and geometrically verifiable explanation for the coronal temperature profile, one that does not depend on speculative plasma events or unknown forces. It invites experimental validation through simulation and satellite data review.

If confirmed, it reshapes our understanding of stellar atmospheres, photon emission dynamics, and could influence broader astrophysical thermodynamics. Future studies should examine if this saturation geometry plays a role in other stellar types or in accretion disk environments where radiation density and sky coverage are similarly extreme.

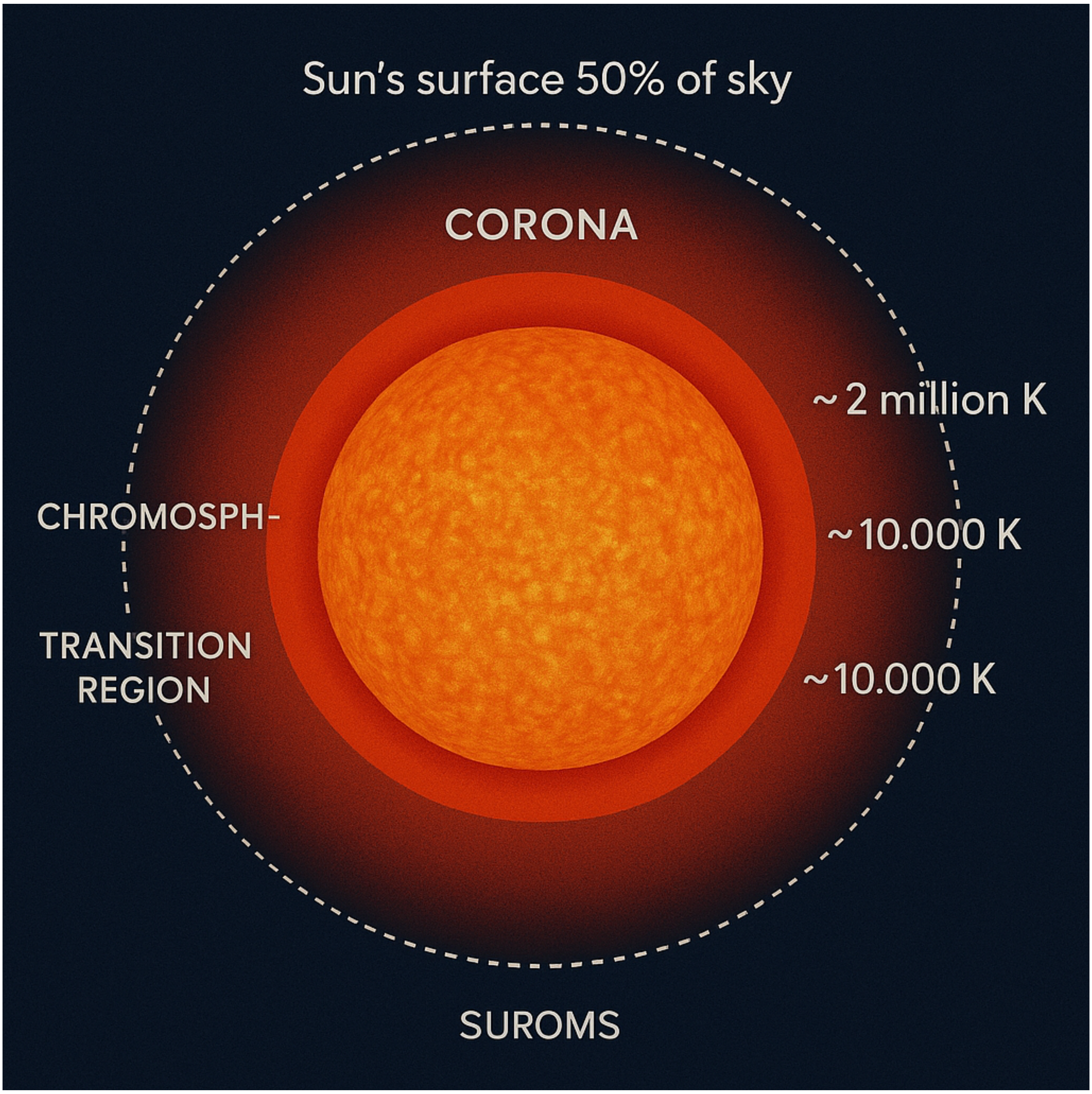

Figure 2: Solar atmosphere and corona showing 50% sky-view boundary and approximate temperature zones.

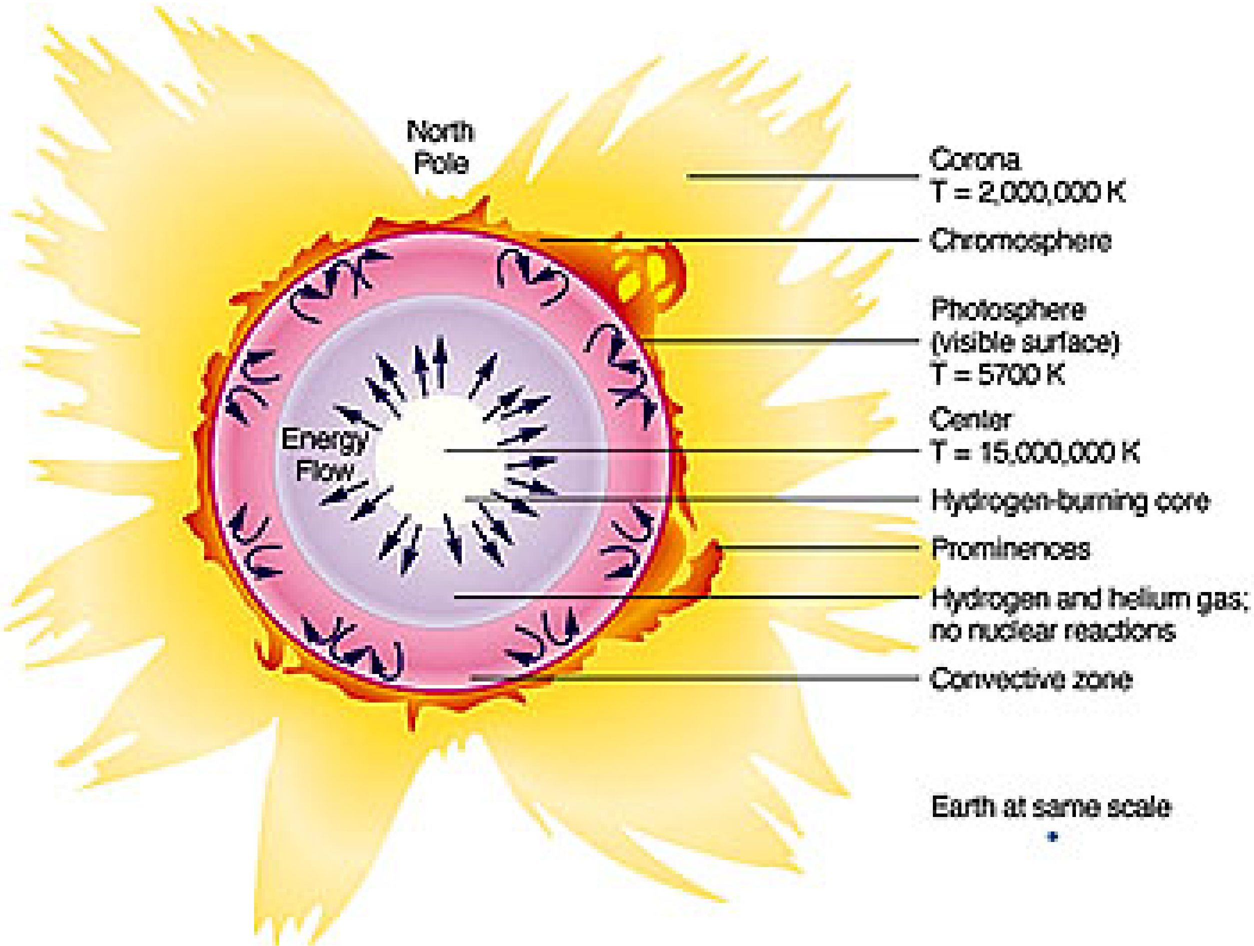

Figure 3: NASA-style solar structure cutaway showing internal and external temperature distribution.

References

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