Magnetosphere Formation of a Tidally Locked Planet or Satellite.

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Introduction: The magnetosphere, a crucial defense mechanism against harmful solar winds, has long been thought to be absent in tidally locked planets due to the absence of convection currents in their cores. However, recent studies on exoplanets suggest that tidal heating can lead to core melting, potentially resulting in the formation of a magnetosphere. This paper explores the conditions necessary for the formation of a magnetosphere in a tidally locked planet or satellite. The study proposes that a highly eccentric orbit and close perihelion are essential for achieving the required high velocity, leading to a changing electric field.

The research examines four points on the orbital path, considering aphelion, perihelion, and two diametrically opposite points. Tidal forces cause the planet to expand and contract, generating heat within the core. The ionization of iron in the core, driven by the high temperature, produces a partially charged core. As the planet moves, charge separation occurs, generating a changing electric field. According to Ampere-Maxwell law [1][2], this varying electric field results in the formation of a magnetic field around the planet.

The intensity and direction of the magnetic field are influenced by the planet's rotational velocity and eccentricity. The study provides equations predicting the magnetic field strength, highlighting its proportionality to the square of the core radius. Contrary to common belief, tidally locked planets may possess a magnetic field, challenging previous assumptions about their habitability. The study opens avenues for understanding how planets generate magnetic fields, despite their proximity to host stars.

Figures:

Figure 1. Here blue arrows denote the direction of motion of the planet.

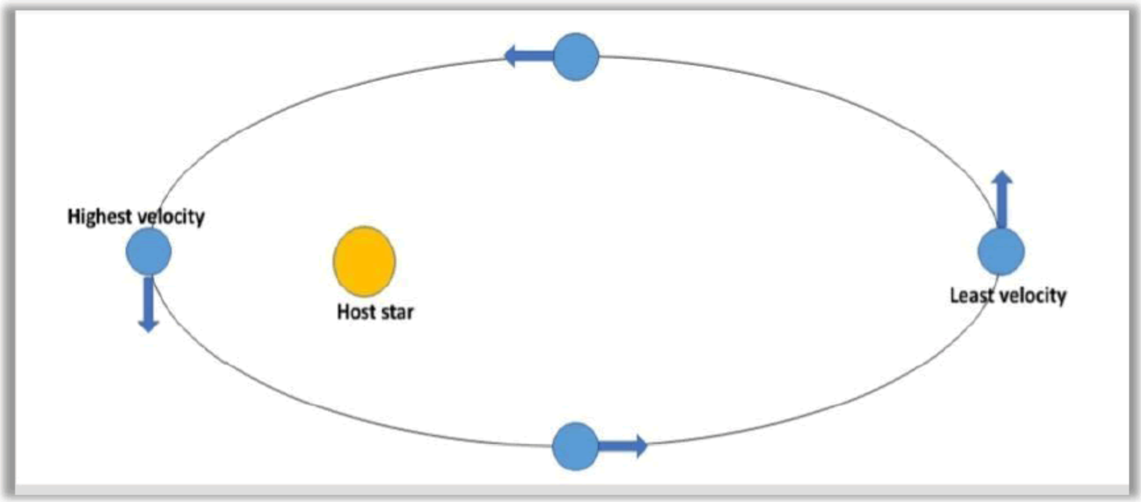


Figure 2. Due to motion core separation of charges takes place.

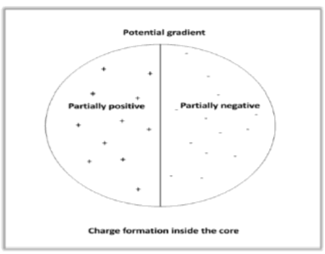
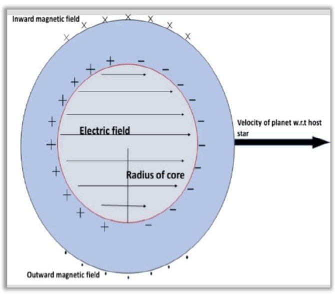


Figure 3. Direction of magnetic field, electric field and velocity of the planet.



References:

[1] James Clerk Maxwell et al. 1865

[2] Andre-Marie Ampere et al. 1820.

[3] Ludwig Boltzmann et al. 1870.

[4] Bruce HM. College of Chemistry, University of California Berkeley; 1962.