



Ambipolar Electric Field

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Why in News?

Recently, the [National Aeronautics and Space Administration \(NASA\)](#) has, for the first time, detected **Earth's hidden ambipolar electric field**, which plays a crucial role in driving the "**polar wind**" that propels charged particles into space at supersonic speeds.

- The discovery, published in the *journal Nature*, marks a significant advancement in our understanding of [Earth's ionosphere](#) and its interactions with space.

What is the Ambipolar Electric Field?

- **Definition:** The ambipolar electric field is a **weak, planet-wide electric field** that affects the movement of **charged particles in Earth's atmosphere**. It was proposed to be as fundamental as [gravity](#) and [magnetism](#). The ambipolar field was first hypothesized in the 1960s.
- **Mechanism:** The electric field, generated at about **150 miles altitude**, interacts with charged particles (ions and electrons). It prevents the separation of charges and helps lift some ions high enough to escape into space.
 - The ambipolar field is **bidirectional**, meaning it works in both directions (lifting ions into space while pulling electrons downward), effectively tethering them together and the net effect of the ambipolar field **extending the height of the atmosphere**.
- **Detection:** The discovery was made using a NASA suborbital rocket launched as part of the **Endurance mission** that confirmed the existence of the ambipolar field and quantified its strength.

How does the Ambipolar Field Affect Earth's Atmosphere?

- **Increased Scale Height:** The ambipolar field increases the "scale height" of the ionosphere by 271%. This means the **ionosphere remains denser at greater altitudes than it would without the field**. The increased density contributes to the polar wind, driving charged particles into space.
 - **Ionosphere**, a layer of the upper atmosphere where charged particles are abundant.
 - The polar wind is an **ambipolar (bidirectional) outflow of thermal plasma** from the high-latitude ionosphere to the **magnetosphere (region around a planet dominated by the planet's magnetic field)**, consisting primarily of Hydrogen, Helium, and Oxygen ions and electrons.
- **Effect on Hydrogen Ions:** The field **exerts a force 10.6 times stronger than gravity** on hydrogen ions. This significant force propels them into space at supersonic speeds, enhancing atmospheric escape.
- **Broader Implications:** Understanding this field provides insights into Earth's **atmospheric evolution and can be applied to other planets with atmospheres**, such as [Venus](#) and [Mars](#). It may also help to understand which planets could be hospitable to life.

Endurance Mission

- It was a NASA-funded mission conducted through the Sounding Rocket Program at NASA's Wallops Flight Facility in Virginia.
- The primary goal is to measure Earth's global electric potential, which is believed to be very weak. This electric potential is crucial for understanding why Earth can support life, unlike other planets such as Venus.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. What is 'Greased Lightning-10 (GL-10)', recently in the news? (2016)

- (a) Electric plane tested by NASA
- (b) Solar-powered two-seater aircraft designed by Japan
- (c) Space observatory launched by China
- (d) Reusable rocket designed by ISRO

Ans: (a)

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