



## **The Alfvén Mission: A possible ESA M4 Mission Candidate**

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The Alfvén mission was proposed to the ESA M3 call for missions in 2010. Its scientific objective was to study the Auroral Acceleration Region (AAR), the most accessible laboratory for investigating plasmas at an interface where ideal magneto-hydrodynamics does not apply. Alfvén was designed to teach us where and how the particles that create the aurorae are accelerated, how and why they emit auroral kilometric radiation, what creates and maintains large scale electric fields aligned with the magnetic field, and to elucidate the ion outflow processes which are slowly removing the Earth's atmosphere.

The auroral regions are the interface connecting the solar wind-driven collisionless magnetosphere to the collisional ionosphere at the top of Earth's atmosphere. Solar wind energy, transmitted via the magnetosphere, is dissipated in this interface, often explosively during magnetic substorms. The plasma organizes itself on a hierarchy of spatial and temporal scales, manifesting as auroral structures ranging from huge long-lived arcs to tiny flickering filaments.

The only way to make substantial further progress in auroral plasma science and to elucidate the fundamental physics of the acceleration processes at the heart of magnetosphere-ionosphere coupling is to combine the advantages of high-time resolution in situ measurements (as pioneered by the FAST mission), with the advantages of multi-point measurements (as pioneered by Cluster) in one mission. The mission concept also envisages continuous auroral imaging from the spacecraft, guaranteeing an understanding of the context (auroral morphology and motion) within which the in situ plasma measurements are made, and strong coordination with the existing dense network of ground based observatories, for more detailed ionospheric and auroral information when Alfvén overflights occur.

We will review the ESA M3 Alfvén concept, consider recent scientific progress in this area, and discuss possible developments of the concept for a possible ESA M4 proposal.