Auroral Emissions Radio Observer (AERO)

Active Technology Project (2018 - 2022)

Project Introduction

Auroral Emission Radio Observer (AERO) Phil Erickson, PI MIT Haystack Observatory ABSTRACT Earth's aurora has a deep complexity and richness in both energetics and spatial / temporal structuring that is of intense interest for our understanding of space physics, and yet it still has many unknown or ill-defined features. Auroral radio emissions from the terrestrial ionosphere in the LF and HF frequency range are a particularly powerful way to investigate space physics processes because 1) they provide methods to remotely sense auroral ionospheric plasma conditions and processes; 2) they provide a near-Earth laboratory for investigating wave processes, including nonlinear ones, that operate in a broad range of heliospheric, planetary and astrophysical plasmas; and 3) through wave-particle interactions and other mechanisms, they can play a significant role in determining plasma conditions or plasma boundaries. The Auroral Emission Radio Observer (AERO) is a one-year CubeSat mission in polar orbit that will significantly advance our knowledge of these key features. In particular, AERO's radio frequency capabilities will unlock a deep and vital scientific investigation space. Auroral kilometric radiation (AKR) is the most important energetic radio source in Earth's aurora, as it radiates up to 1% of the entire energy input. While it was formerly believed that AKR is beamed away from the Earth, recent observations suggest that AKR might couple to the whistler mode and penetrate to low altitudes, even to ground level. One objective of AERO is in fact to settle the issue of whether AKR indeed penetrates to low altitudes, a significant question given the power of AKR and its usefulness for remotely sensing the auroral acceleration region. Additionally, a host of other auroral emissions occur that can be targeted by AERO observations. These include auroral "roar" emissions which are closely analogous to magnetospheric continuum radiation, and medium frequency bursts which are poorly understood. Some of these bursts may be analogous to solar type III emissions, and auroral hiss, but even after years of study it is still not known how and where the waves are scattered to small wave normal angles that allow them to propagate to ground level. AERO aims to solve this last mystery and other related topics using thorough plasma wave characterization and direction finding. AERO's technical approach uses a unique electromagnetic vector sensor (VS) to study AKR at LF and HF frequencies. The VS consists of six orthogonal dipole and loop antennas that provide angle of arrival and polarization information within a single unit. The mission's data acquisition strategy will store many orbits of compressed data on board, then select segments for download based either on analysis of "thumbnail" dynamic spectra on the ground, or on automatic detection of the extremely bright AKR events and other auroral radio emissions of opportunity. From a heliophysics technology perspective, AERO is also a stepping stone to a novel spaceborne high capability remote sensing platform that will provide new characterization opportunities for diverse scientific targets such as radio emission from the solar corona and inner heliosphere, and anisotropic turbulence properties of interplanetary medium plasma within the heliosphere.

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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Lead Organization	Academia	Cambridge, Massachusetts
Dartmouth College	Supporting Organization	Academia	Hanover, New Hampshire
Merrimack College	Supporting Organization	Academia	
MIT Haystack Observatory	Supporting Organization	Academia	Westford, Massachusetts
Morehead State University	Supporting Organization	Academia	Morehead, Kentucky
University of Tromsø	Supporting Organization	Academia	

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

Massachusetts Institute of Technology (MIT)

Responsible Program:

Heliophysics Technology and Instrument Development for Science

Project Management

Program Director:

Roshanak Hakimzadeh

Program Manager:

Roshanak Hakimzadeh

Principal Investigator:

Philip J Erickson

Co-Investigators:

Mary Knapp
Allan Weatherwax
Kerri Cahoy
Frank D Lind
Dennis Burianek
Michael Hecht
Juha Vierinen
Ryan Volz
Frank C Robey
Benjamin K Malphrus
Stacey Sullaway
Geoffrey B Crew
James W Labelle

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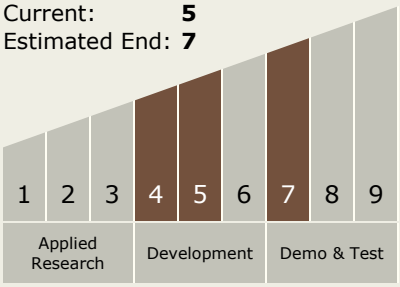
Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **7**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination

The Sun