Project Title: Investigating Storm-time Plasma Bubbles using CHAMP and SWARM Langmuir Probe Observations

Project Reference Code: Dey-USA

Name of Project Leader: Soumyajit Dey

Host Facility: University of South Alabama

Internship Location: Shelby Hall, 150 Student Services Drive, Mobile, AL 36688

Host Facility Location: 307 N University Blvd, Mobile, AL 36688

Project Description (roughly 300 words):
Equatorial Plasma Bubbles (EPBs) are regions of depleted plasma density in the F-region (150-500 km) of Earth's ionosphere that form at low latitudes after sunset. EPBs are caused by the Rayleigh-Taylor instability, in which low-density plasma from the bottom of the F-region rises into the denser plasma above, much like a light fluid rising through a heavier one. EPBs are considered localized ionospheric disturbance structures that disrupt radio signals passing through them, degrading GPS navigation and satellite communication. As a result, EPBs have become one of the most actively studied topics in space weather research, with the goal of understanding their driving conditions and predicting their occurrence. The intern will investigate plasma bubbles using in situ electron density from the CHAMP and Swarm Langmuir probes. A Langmuir probe measures the current collected from the surrounding plasma as its voltage is swept over a range; the resulting I–V curve provides electron density and temperature. The intern will:

1. Process raw I–V curves to derive electron density and temperature, and validate the results against published datasets. This work will contribute to the active development of the CADENCE instrument designed for the NASA Orbital Clarity Challenge.
2. Identify plasma bubble events during selected geomagnetic storms and classify them by storm phase. Using other satellite data, ground observations, and solar wind and geomagnetic indices, the intern will then investigate the background conditions that drive bubble formation in each phase.
3. Contribute to the hardware development of CADENCE and JagSat, a CubeSat mission that is also in development. This may include circuit design, board fabrication, embedded systems, and antenna development.

Through this project, the intern will learn Langmuir probe data processing, ionospheric physics, and space instrument development. The results will be carried forward towards conference presentations and peer-reviewed publications.

Disciplines: Space Physics, Plasma Physics, Electrical Engineering, Data Science

Importance:

Plasma bubbles cause scintillation of radio signals, degrading GPS navigation, satellite communication, and HF radio links that aviation, maritime navigation, and many other systems depend on. This is a worldwide problem: bubbles occur routinely over equatorial and low-latitude regions, and geomagnetic storms can push them to much higher latitudes. Locally, the Gulf Coast relies heavily on GNSS for port operations, offshore activity, and aviation, so storm-time bubbles reaching higher latitudes pose a risk. Understanding the conditions that drive bubble formation during storms is therefore a necessary step toward forecasting and mitigating their impacts.

Requirements:

- Preferred Major
  - Computer Engineering, Electrical Engineering, Aerospace Engineering, Physics, Mathematics
- Class work
  - NA
- Programming knowledge
  - Basic data analysis in any programming language (e.g., C/C++, Fortran, Python, MATLAB)
- Software knowledge
  - NA
- Other

Biography (roughly 100-150 words):

Dr. Edmund Spencer is an Associate Professor in the Department of Electrical and Computer Engineering at the University of South Alabama. His research areas include space plasma physics, space weather, geomagnetic storms and substorms, and space plasma instrumentation. Dr. Soumyajit Dey, a postdoctoral researcher in his group, will supervise this project.

Is U.S. citizenship required to participate in this project? No

Contact information:

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Dr Soumyajit Dey (email: soumyajit.dey@southalabama.edu)

Internship Coordinator/ HR manager:

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