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"Terrestrial Gamma-ray Flashes (TGFs) are very brief (sub-ms) and Extremely Intense Pulses of Gamma-rays Emitted by Thunderstorms and Generally Only Observed by Space Based Instruments"

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Project Summary

Terrestrial Gamma-ray Flashes (TGFs) are very brief (sub-ms) and extremely intense pulses of gamma-rays emitted by thunderstorms and generally only observed by space based instruments. There are many aspects of TGFs that are poorly understood and we have an active research program in this field. TGFs were first discovered here in Huntsville in the early 1990's with the Burst and Transient Source Experiment (BATSE) on NASA's Compton Gamma-ray Observatory and are currently being monitored with the Gamma-ray Burst Monitor (GBM) on board NASA's Fermi spacecraft. UAH played an important role in the development of BATSE and GBM and is a world leader in TGF science. We are currently investigating how the next generation of space-base instruments will expose the mechanism behind TGF production.

We are developing instrumentation for a novel NSF funded CubeSat mission that will enable unique measurements of TGFs. Our methods require multiple CubeSats to be flown in Earth orbit at controlled distances of a few tens of kilometers. This will allow us to make simultaneous measurements of a TGF across the beam profile which has never been accomplished before. This is the most direct way to constrain models of TGF production. We have teamed up with Prof. Jean-Marie Wersinger of Auburn who is experienced in CubeSat development. Auburn will provide the spacecraft and flight controls while we at UAH will provide the instrumentation.

Currently we are finalizing the design for the detector and have begun to build and test hardware. Over the summer we will be constructing an engineering model of the detector that will need to go through rigorous testing and calibration. Students will be responsible for the optimization, fabrication and integration of the detectors. This is a critical and most exciting stage of development where the hardware moves from conception to reality.

The student will learn valuable laboratory skills as well as gain experience with common tools used in the gamma-ray and X-ray community. The student will learn a great deal about the detection of gamma-rays and hard X-rays that has useful application in many fields including astrophysics, medical imagery and nuclear physics. At the end of the program, the student will gain confidence in the lab environment and be able to design and execute his/her own experiments in X-ray and gamma-ray detection.

Student Prerequisites

The successful applicant will have a good academic record and demonstrate the ability to manage a complex schedule. The applicant should be detail oriented and be able to work with hand tools. Experience with electronics, fast logic circuits and programming skills is a plus.

Student Duties

1) The student will first learn the fundamentals of gamma-ray scintillator detectors and scintillation light collection.
2) The student will be instructed in laboratory safety gear and the safe use of power supplies, laboratory tools and handling weak (microCurie) radioactive sources.
3) The student will learn how to use signal digitizers and be tutored in the proper use of digital oscilloscopes and data acquisition software.
4) The student will learn the basics of Si photomultiplier detectors and build a simple circuit to operate and test.
5) The student will optimize the developed discriminator circuitry and integrate it with the front end electronics provided by GSFC.
6) The final project, which will occupy the majority of the summer, will be building and testing the engineering unit gamma-ray detector that will be identical in function to the flight units that will be on the CubeSats. The student will integrate, test and calibrate the engineering unit and oversee environmental testing (evacuation and shake testing) in preparation for building two flight units.

Mentor Supervision and Interaction

The lab is near my office in Cramer Hall. For the first week of the program, I will devote most of my time tutoring the student and teaching him/her basic lab skills as well as specific skills associated with our application. After that, the student will be working under a senior student with my assistance being available at any time. Each morning we will review what the student has accomplished and what he/she hopes to accomplish during the day. I will guide the student in order to ensure the student understands his/her current tasks and the project proceeds at a reasonable pace. The student will present the results of each step for evaluation. Once suitable results are obtained, I will assist in setting up the next phase for the student. Dr. Michael Briggs, a UAH research scientist, also located in Cramer Hall, has also volunteered his time to help the prospective student and will be available in my absence. He is a senior scientist who helped developed the Gamma ray Burst Monitor currently on board the Fermi gamma ray observatory.