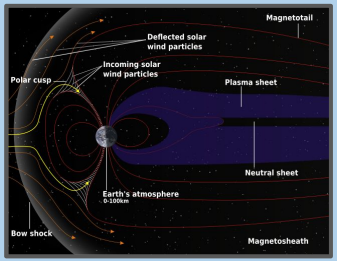
Particle Detector Safeguard for 2U CubeSat

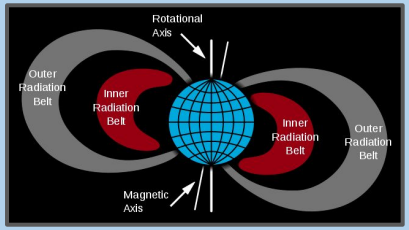
Alexander M. Vasquez

The IMAP Student Collaboration between Sonoma State University, Howard University, and the University of New Hampshire, intends to construct a 2U Cube Satellite. The IMAP Cube Satellite will observe the phenomena in the Earth's magnetic field near the cusp.

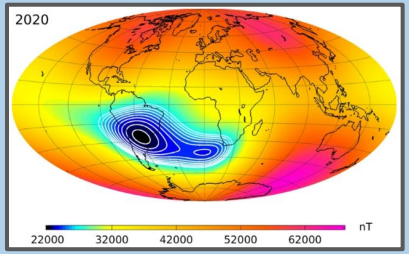


Solar wind particles being blocked by the magnetosphere

The Sun produces a steady stream of solar wind, an outflux of high-energy particles radiating out into the solar system, and multiple wavelengths of electromagnetic waves. These waves and particles follow the Earth's magnetic field and travel along its magnetic field lines, then are either deflected around the Earth and sent further out into the solar system, or travel to Earth along the magnetic field lines.



The Van Allen radiation belts surrounding Earth contain high-energy particles



The South Atlantic Anomaly where the Van Allen belt is closest and the Earth's magnetic field is weakest.

In order to detect high-energy particles in the Van Allen belts and South Atlantic Anomaly, I am constructing a particle detection board which will warn the satellite of particles which may harm other instruments on the satellite. The board works by the use of a special particle sensor, capable of detecting thermal electrons and short wavelength waves.

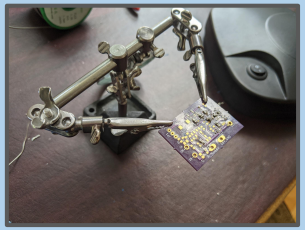
Parts List

KEMET 399-1104-2-ND - x1 1 pF Capacitor
Taiyo Yuden 587-6337-2-ND - x4 10 uF Capacitor
Würth Elektronik 732-12216-1-ND - x1 3.3 pF Capacitor
TDK Corporation 445-9196-1-ND - x1 0.1 uF Capacitor
KEMET 399-10059-1-ND - x1 10000 pF Capacitor
Pomona Electronics 501-2347-ND - Banana Jack
Würth Elektronik 732-13518-1-ND - x1 1 mH Inductor
ON Semiconductor 2SK2394-7-TB-EOSCT-ND - x2 JFET Transistor
ON Semiconductor MMBTH81CT-ND - x2 BJT Transistor
Yageo YAG4461CT-ND - x1 5.6K OHM Resistor
Yageo 13-AC0603JR-07820RLCT-ND - 820 OHM Resistor
Yageo YAG2127CT-ND - x1 2.2K OHM Resistor
Yageo 13-AC0603FR-076M8LCT-ND - x1 6.8M OHM Resistor
Vishay MCT0603-4.7K-MDCT-ND - x1 4.7K OHM Resistor
Vishay 749-1520-1-ND - x2 10 OHM Resistor
Yageo YAG2112CT-ND - x2 2K OHM Resistor
Yageo 311-47.0HRCT-ND - x1 47 OHM Reisstor
Yageo 311-1MLECT-ND - x1 1M OHM Resistor
Stackpole HMC0603JT100MCT-ND - x1 100M OHM Resistor
Analog Devices Inc. ADA4805-2ARMZ-ND - x1 Dual Op Amp
Si PIN photodiode S3588-08

Cube satellite skeleton, 10 cm x 10 cm x 20 cm.

The Si PIN photodiode S3588-08 sensor

During the Spring semester 2021, I was introduced to the IMAP team and assigned the project of assembling the Charge Amplifier board, which the Si PIN photodiode will be attached to. Assembly of the board is underway, with twenty unique components helping the board function.



The charge amp board under construction. Each added part is smaller than a grain of rice, ~ 2.00 mm on the longest side

In the future, the components of the board will be combined with the uStar board, which controls instrumentation on the IMAP satellite. The boards will be tested by raising them into low-earth orbit using balloons while we observe the incoming data from the ground.

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Dr. Garrett Jernigan	-	Advising
Dr. John Doty	-	Board Design
Gary Stofer	-	PC Board Layout
IMAP Student Collab.	-	CubeSat Development

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