State of the Lab

September 2014
Research Overview

Characterizing the Space Environment

- Meteors
- Space Debris
- Atmosphere/Ionosphere

Characterizing Environmental Effects on Spacecraft

- Hypervelocity Impact Plasma
- Hypersonic Plasma

Space Exploration

- Trajectory Design
- Novel Propulsion
Research Projects

• Characterizing Environment
  • Meteors
  • Space Debris
  • Atmospheric Properties
  • Ionospheric Properties

• Characterizing Environmental Effects
  • Hypervelocity Impacts
  • Hypersonic Plasma

• Space Exploration
  • Trajectory Design
  • Novel Propulsion Concepts
Characterizing Environment

• Team
  • Dr. Bob Marshall, Dr. Alex Crew
  • Alan Li
  • Lorenzo Limonta
  • Steven Pifko
  • Austin Sousa
  • Glenn Sugar
  • Ana Tarano
  • Ryan Volz
  • Jonathan Yee

• Facilities
  • SAAMER (Argentina), ALTAIR (Kwajalein Islands), Arecibo Observatory (Puerto Rico), MIT Millstone Hill (MA), MU (Japan), Jicamarca Observatory (Peru), EISCAT (Sweden), PFISR (Alaska)
  • Cameras
  • VLF receivers
Characterizing Environment

• Projects
  • Orbit Determination and Interstellars
  • Compressed Sensing and Signal Processing
  • Diffusion and Polarization
  • Ionization and Luminous Efficiency
  • Neutral and Plasma Densities

• Funding
  • NASA Marshall (prior and pending)
  • JPL CubeSat (pending)
  • NSF Lightning (pending)
  • NDSEG Fellowship (current)
  • NSF CAREER (current)
  • NSF CEDAR (current)
  • SRI (current)
  • NSF CubeSat (current)
  • FAA (“current”)
  • CoRA (prior)
Characterizing Environment: Meteors

Non-specular trail

Head Echo

Day 140, 2007, 18:00 UT: LC
Characterizing Environment: Space Debris

Cumulative Number of Debris

Filtered Frequency Plot

Cumulative number

Frequency [Hz]

Time [h]

Range [km]

Diameter (m)

NASA Exponential model
NASA Linear Model
Representative Sample for Comparison
Characterizing Environment: Ionosphere

Questions:
- What is the prevalence of thunderstorm-driven gravity and acoustic waves (GAWs) propagating from to troposphere into and through the lower ionosphere?
- What are the mechanism for GAW coupling to the lower ionosphere?
- How much energy is transported to the lower ionosphere by GAWs?

Approach:
- VLF subionospheric remote sensing of GAW signatures: 24-hour, weatherproof detection method
- GPS TEC measurements of GAW signatures
- Statistical analysis of GAW occurrence; diurnal, seasonal variations
- Numerical modeling of GAW propagation to assess quantitative effect

Left: From Marshall and Snively [2014]: Acoustic wave observed by VLF-SRS at the time of two thunderstorms in Florida. Modeling was used to estimate the body force required to produce these events.
Characterizing Environment: Atmosphere

Silicon-based particle detector.

QB50

ERDOS
Research Projects

• Characterizing Environment
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• Characterizing Environmental Effects
  • Hypervelocity Impacts
  • Hypersonic Plasma

• Space Exploration
  • Trajectory Design
  • Novel Propulsion Concepts
Characterizing Environmental Effects

• **Team**
  - Dr. Dave Laubcn, Dr. Ivan Linscott
  - Jesse Coffey
  - Alex Fletcher
  - Ashish Goel
  - Monica Hew
  - Theresa Johnson
  - Siddharth Krishnamoorthy
  - Andrew Nuttall
  - Paul Tarantino

• **Facilities**
  - Max Planck Institute
  - LASP
  - NASA Ames Vertical Gun Range
  - DLR
Characterizing Environmental Effects

- **Projects**
  - Plasma theory
  - PIC/CFD simulation
  - Sensor and target design
  - Data analysis

- **Funding**
  - NSF CubeSat (pending)
  - Lockheed Martin (pending)
  - Ames AVGR (pending)
  - Ames CubeSat Reliability (pending)
  - AFOSR (arriving)
  - DoE CAREER (current)
  - NSF Fellowship (current and prior)
  - NASA Ames (prior)
  - LANL (prior)
  - Hellman (prior)
Characterizing Environmental Effects: Hypervelocity Impacts (Ground)
Characterizing Environmental Effects: Hypervelocity Impacts (Space)
Characterizing Environmental Effects: Hypersonic Plasma
Research Projects

• Characterizing Environment
  • Meteors
  • Space Debris
  • Atmospheric Properties
  • Ionospheric Properties

• Characterizing Environmental Effects
  • Hypervelocity Impacts
  • Hypersonic Plasma

• Space Exploration
  • Trajectory Design
  • Novel Propulsion Concepts
Space Exploration

- **Team**
  - Dr. Alex Crew, Dr. Dave Lauben, Dr. Ivan Linscott, Dr. Bob Marshall
  - Ivan Ravlich
  - Travis Swenson

- **Facilities**
  - VASIMR

- **Projects**
  - Trajectory Design
  - Warp Drive

- **Funding**
  - NASA Fellowship (current)
Space Exploration

![Image of space exploration equipment]

Diagram showing LUNAR L_1 and LUNAR L_2 Halo Orbits with a "GATEWAY."
Future Research ??

- Energetics in Space Environment

- Space Energy Harvesting

- Asteroids

- Space exploration/CubeSats
Student Honors/Awards

- A. Fletcher, NSF Postdoctoral Fellow 2014 (MIT/BU)
- M. Hew, Student Poster Competition 2014 (CEDAR)
- A. Fletcher, 1st Place Student Paper Competition 2014 (URSI)
- N. Lee, 1st Place Student Paper Competition 2013 (URSI)
- N. Lee, Postdoctoral Fellow 2013 (Caltech)
- A. Tarano, Outstanding Poster Award 2013 (Stanford)
- T. Johnson, Best Student Award 2012 (Spacecraft Charging)
- A. Fletcher, Student Poster Competition 2012 (CEDAR)
- J. Yee, Outstanding Student Paper Award 2012 (AGU)
- T. Johnson, Outstanding Poster Award 2012 (Stanford)
- R. Volz, 3rd Place International Student Paper Competition 2011 (URSI)
- S. Pifko, Outstanding Student Paper Award 2011 (IAASS-SGAC Space Safety Competition)
- N. Lee, NSERC Fellowship
- A. Goel, Stanford Fellowship
- S. Krishnamoorthy, Stanford Fellowship
- M. Hew, Stanford Fellowship
- I. Ravlich, Stanford Fellowship and Top GPA Award
- S. Pifko, NASA Fellowship
- R. Volz, NDSEG Fellowship
- T. Johnson, NSF Fellowship
- G. Sugar, NDSEG Fellowship
- A. Nuttall, NSF Fellowship
- T. Swenson, NASA Fellowship
Live Long and Prosper