2022 Inaugural NASA Sounding Rocket Symposium

Full Agenda & Abstracts

https://sites.wff.nasa.gov/code810/Symposium/Sounding-Rocket-Symposium.html

August 17 - 19, 2022

Contents

1 Block Agenda

PDT	EDT	Wednesday, August 17	Thursday, August 18	Friday, August 19
6:00 AM	9:00 AM	**Introduction & Welcome**	Morning Welcome **Vehicles & Capabilties** Charles Brodell	Morning Welcome **Oral Session #4: Geo II**
6:15 AM	9:15 AM			
6:30 AM	9:30 AM	**Agency Overview** Nicky Fox, Dan Moses		
6:45 AM	9:45 AM		**Subsystems** Shane Thompson	
7:00 AM	10:00 AM			
7:15 AM	10:15 AM			Break
7:30 AM	10:30 AM	**NASA SR Program Science Overview** Robert Pfaff	**Launch Support Advancements** Catherine Hesh, Nick Cranor	**Oral Session #5: Astro**
7:45 AM	10:45 AM			
8:00 AM	11:00 AM	Break & Posters / Booths	Break & Posters / Booths	
8:15 AM	11:15 AM			
8:30 AM	11:30 AM	**NASA SR Program Overview** Giovanni Rosanova	**Oral Session #2: Solar**	
8:45 AM	11:45 AM			Break
9:00 AM	12:00 PM	**NASA Ranges & Facilities** Scott Bissett, Jeff Reddish		**PI Development Forum**
9:15 AM	12:15 PM			
9:30 AM	12:30 PM	**Commercial Sub-orbital** John Kelly		
9:45 AM	12:45 PM			
10:00 AM	1:00 PM	Lunch	Lunch	**Closing Remarks / Adjourn**
10:15 AM	1:15 PM			Cafeteria Open for Grab & Go Lunch
10:30 AM	1:30 PM			
10:45 AM	1:45 PM			
11:00 AM	2:00 PM	**Geospace Keynote** Kristina Lynch	**Oral Session #3: Poker Flat Facilities**	
11:15 AM	2:15 PM			
11:30 AM	2:30 PM	**Solar Keynote** Amy Winebarger	**On-site Attendees** **EXCURSION** Tour of Wallops Launch Facilities: Wallops Island, Blockhouse, Launch Rail, Range Control Center **Virtual Attendees** **Commercial Sub-orbital Q&A**	
11:45 AM	2:45 PM			
12:00 PM	3:00 PM	**Astro Keynote** Dan McCammon		
12:15 PM	3:15 PM			
12:30 PM	3:30 PM	Break		
12:45 PM	3:45 PM			
1:00 PM	4:00 PM	**Oral Session #1: Geo I**		
1:15 PM	4:15 PM			
1:30 PM	4:30 PM			
1:45 PM	4:45 PM			
2:00 PM	5:00 PM			

7:00 - 9:00 PM

MIXER: Rocket Club (on-base)

Suggested off-base location:
Ropewalk in Chincoteague

2 Wednesday, 2022 August 17

All times in ET.

9:00 - 9:30	**Introduction & Welcome**	
	Robert Pfaff	NASA GSFC, SR Program, Project Scientist
	Sabrina Savage	NASA MSFC, Organizing Committee Chair
	David Pierce	Wallops Flight Facility (WFF), Director
9:30 - 10:30	**Agency Overview**	
	Nicky Fox	NASA Heliophysics Division, Director
	Dan Moses	NASA SR Program, Program Scientist
10:30 - 11:00	**NASA SR Program Science Overview**	
	Robert Pfaff	NASA GSFC, SR Program, Project Scientist
11:00 - 11:30	**Break & Posters / Booths**	
11:30 - 12:00	**NASA SR Program Overview**	
	Giovanni Rosanova	NASA SR Program Chief
12:00 - 12:30	**NASA Ranges & Facilities**	
	Scott Bissett	NASA WFF, Deputy Chief
	Jeff Reddish	NASA WFF, Program Manager
12:30 - 1:00	**Commercial Sub-orbital**	
	John Kelly	NASA AFRC, STMD Flight Opportunities Program, Manager
1:00 - 2:00	**Lunch**	

2:00 - 2:30	**Geospace Keynote**	
	Kristina Lynch	*Multipayload sounding rockets for Geospace: from hockey pucks to Cowboys to Bobs*
2:30 - 3:00	**Solar Keynote**	
	Amy Winebarger	*A History of Heliophysics Science and Technology Development Through the Sounding Rocket Program*
3:00 - 3:30	**Astrophysics Keynote**	
	Dan McCammon	*Sounding rocket impacts on astrophysics from an X-ray perspective*
3:30 - 4:00	**Break**	
4:00 - 5:15	**Oral Session #1: Geo I** Chair: John Bonnell	
	Paul Bernhardt	*A Standard Radio Beacon Section for Sounding Rockets*
	Dominic Puopolo	*Despun Platform - Mechanical Image Stabilization for Auroral Imaging Camera*
	Carl L Siefring	*Space Measurements of A Rocket-Released Turbulence (SMART) and the Future of High-Speed Releases from Sounding Rockets*
	Rafael Luiz, Araujo de Mesquita	*Hailstorm Part I: A rocket mission to study the role of neutral winds in MIT coupling using a modernized falling spheres technique*
	Glyn Collinson	*The Endurance Rocket Mission*
7:00 - 9:00	**Mixer:** **Rocket Club** (on-base) Suggested off-base location: Ropewalk in Chincoteague	

3 Thursday, 2022 August 18

All times in ET.

9:00 - 9:45	**Vehicles & Capabilities**	
	Charles Brodell	NASA WFF, Vehicles Systems Manager
9:45 - 10:30	**Subsystems**	
	Shane Thompson	NASA WFF, Payload Systems Manager
10:30 - 11:00	**Launch Support Advancements**	
	Catherine Hesh	NASA WFF, SR Program Office, Assistant Chief
	Nicholas Cranor	NASA WFF, Engineering Manager
11:00 - 11:30	**Break & Posters / Booths**	
11:30 - 1:00	**Oral Session #2: Solar** Chair: Rob Pfaff	
	Sabrina Savage	*The First Solar Flare Sounding Rocket Campaign*
	Phillip Chamberlin	*Solar eruptioN Integral Field Spectrograph (SNIFS), Part 1: Science*
	Vicki Herde	*Solar eruptioN Integral Field Spectrograph (SNIFS), Part 2: Technical Implementation*
	Juliana Vievering	*Real-Time Solar Flare Predictions for Triggered Flare Observations*
	Bennet Schwab	*Overview of the SDO EVE Calibration Program*
	Subramania Athiray Panchapakesan	*Preliminary Results from the Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)*
	K. D. Kuntz	*The DXL and LXT Sounding Rocket Programs*
1:00 - 2:00	**Lunch**	

2:00 - 2:30	**Oral Session #3: Poker Flat Facilities** Chair: Phillip Chamberlin	
	Bob McCoy	*Space Science from Alaska*
	Donald Hampton	*Beyond the aurora: capabilities of the Poker Flat Research Range launch facility.*
2:30 - 5:00	**Parallel Events**	
	On-site Attendees	**EXCURSION** Tour of Wallops Launch Facilities: Wallops Island, Blockhouse, Launch Rail, Range Control Center
	Virtual Attendees	**Commercial Sub-orbital Q&A Session**

4 Friday, 2022 August 19

All times in ET.

9:00 - 10:15	**Oral Session #4: Geo II** Chair: Carl Siefring	
	Peter Delamere	*Sounding rocket active experiments to probe fundamental plasma dynamics*
	Miguel Larsen	*Passive chemical tracer techniques: an overview*
	Oleksiy Agapitov	*Ionosphere Dynamics from VLF Transmitter Signal Measured by the 3-components Magnetic Loop VLF/HF Detector*
	John Bonnell	*First Results and Intriguing VLF and HF Observations from the VIPER Campaign*
	Marc Lessard	*The "Loss through Auroral Microburst Pulsations" (LAMP) mission*
10:15 - 10:30	**Break**	
10:30 - 11:45	**Oral Session #5: Astro** Chair: Michael Zemcov	
	Nicholas Kruczek	*Planets to Galaxies: Studying Diverse Science Cases with Far Ultraviolet Instruments*
	Brian Fleming	*INFUSE and MOBIUS - New far- and near-ultraviolet integral field spectrographs for mapping feedback in galaxies.*
	Emily Witt	*The DEUCE Sounding Rocket: Stellar Observations in the EUV*
	Serena Tramm	*The Cosmic Infrared Background ExpeRiment-2: First Flight Findings and Status*
	Amanda Steinhebel	*A Hosted Payload for AstroPix – A Novel Pixelated Silicon CMOS Detector for Space-Based Gamma-ray Telescopes*
10:15 - 10:30	**Break**	

12:00 - 1:00	**PI Development Forum**

This discussion session is intended to benefit students and scientists who want to become new Principal Investigators. The forum will go through the basics about sounding rockets and cover some of the material found in the Sounding Rocket Handbook located at https://sites.wff.nasa.gov/code810/files/SRHB.pdf. The PI Development Forum will also feature a segment on best practices for subsystems and have a Q&A session with experienced sounding rocket principal investigators.

1:00 - 1:15	**Closing Remarks & Adjourn**

5 Oral Abstracts

Alphabetical listing by first author.

Ionosphere Dynamics from VLF Transmitter Signal Measured by the 3-components Magnetic Loop VLF/HF Detector

Session Time

Oleksiy V. Agapitov, University of California Berkeley
John W. Bonnell, University of California Berkeley
Amanda Slagle, University of California Berkeley
Scott Karbashewski, University of California Berkeley
Robert Wright, Hawai'i Institute of Geophysics and Planetology University of Hawai'i at Mānoa

We present the 3-components Magnetic Loop VLF/HF Detector capable for fully autonomous operation (30 hours of autonomous measurements from the battery) with the GPS log to control the 3D antennas orientation and time synchronization tested for sessions up to a month of duration (with changing batteries). The field session to record the 3-components wave magnetic signal simultaneously with the VIPER rocket launch on May 26, 2021. The 1 day before and 1 day after measurements were recorded (May 25-27, 2022). The measurements sessions were carried out in Berkeley, CA (April-May 2021, January-March 2022) and in Honolulu, HW (August 2021). The daily dynamics of the lower ionosphere and the solar flares effects to the lower ionosphere has been processed making use of the signal from VLF transmitters.

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A Standard Radio Beacon Section for Sounding Rockets

Session Time

Paul A. Bernhardt, Geophysical Institute, University of Alaska Fairbanks, AK
R. Nikoukar, Johns Hopkins University/Applied Physics Laboratory, Laurel, MD

Ionospheric studies with sounding rockets have several requirements that can be satisfied with a dual frequency radio beacon payload. The Coherent Electromagnetic Radio Tomography (CERTO) have been developed using two frequencies at VHF (150.012 MHz) and UHF (400.032 MHz) with a frequency ratio of 3/8. The CERTO beacon was first developed in 1998 by JHU/APL for use on the DMSP/F15 satellite for precise 1-m location accuracy, high resolution (0.1 TECU) total electron content and radio diffraction measurements of both phase and amplitude scintillations. The CERTO beacon is currently available as an attachment to a Black Brandt or Nihka rocket motor section. This section can also house a tracking GPS with telemetry for experiments comparing the accuracy for GPS with the trajectory determine using Doppler Beacon technology. The rocket borne radio beacon yields

absolute electron density at the rocket using range differenced total electron content. A linear array of ground software defined receivers is being set up on the Poker Flat Rocket Range (PFRR) by the University of Alaska and the Johns Hopkins Applied Physics Laboratory to make tomographic images of electron density inside the parabolic trajectory of the two GIRAFF rocket launches scheduled for 2024. The standard CERTO dual frequency beacon system is available for any sounding rocket launch from PFRR.

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First Results and Intriguing VLF and HF Observations from the VIPER Campaign

Session Time

John W Bonnell, UCB SSL
Oleksiy V. Agapitov, UCB SSL
Roger Roglans UCB SSL
Marilia Samara, GSFC
ConnorDiMarco, UMich
Adam Schoenwald, GSFC
Ellen Robertson, USRA
Chrystal Moser, Dartmouth College, UNH
George B Hospodarsky, U Iowa
Robert A. Marshall, Univ. of Colorado, Boulder
Wei Xu, Univ. of Colorado, Boulder
James M. Cannon Univ. of Colorado, Boulder
Jacob Bortnik, UCLA
Ning Kang, UCLA

The NASA VIPER (Bonnell 46.028 UE) sounding rocket flew to an altitude on 160 km off the US Atlantic coast after a successful launch at 0115 UT, 27 May 2021 (2115 local time 26 May) in order to probe the reflection, absorption, and transmission of natural and artificial VLF waves. The payload carried three-axis VLF E and B field receivers (0-50 kHz), a three-axis DC MAG (0-1 kHz), a LP (0-1 kHz), a one-axis HF E field receiver (0.1-4 MHz), asnd a dual orthogonal ion gauge (0-1 kHz). It was also supported by a set of ground-based two- and three-axis VLF magnetic loop receivers at locations along the eastern seaboard (Machias, ME (NAA transmitter site); Dover, DE; WFF, VA).

Initial comparisions of the ground-based VLF and HF observations have allowed for modeling of the D region density profiles; detection and fine-scale investigation of HF propagation in and around a spradic E-layer; and initial models of the altitude profile of density using the dense thicket of commercial AM radio sations along the eastern seaboard, along with local neutral density and ram velocity.

We'll present a summary of these results, the instrumentation used to obtain them, and future plans spured by these observastions and analyses.

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Solar eruptioN Integral Field Spectrograph (SNIFS), Part 1: Science

Session Time

Phillip C. Chamberlin, U. of Colorado, Laboratory for Atmospheric and Space Physics
Vicki Herde, U. of Colorado, Laboratory for Atmospheric and Space Physics
Don J. Schmit, U. of Colorado, CIRES
Adrian N. Daw, Solar Physics Laboratory, NASA Goddard Space Flight Center
Ryan O. Milligan, Queens University Belfast
Vanessa Polito, Bay Area Environmental Research Center

The lower solar atmosphere is temporally dynamic, and it is becoming increasingly clear that this complex activity must be measured and quantified at high cadence, as well as over a range of activity from the smallest through largest of energy releases, if we are to fully understand how mass and energy are transported into the corona. The Solar eruptioN Integral Field Spectrograph (SNIFS) is designed to continuously observe the lower solar atmosphere from the chromosphere through the transition region. SNIFS will observe not only the full spectral profile of the chromospheric Hydrogen Lyman-alpha (Ly-α, 1216Å), the brightest line in the solar UV spectrum, but also Si III and O V, two transition regions lines that allow us to observe how the chromosphere connects with the upper atmosphere. The two optical channels of SNIFS have individual targets and science goals, one to look at the small-scale dynamics in Rapid Blue/Red shifted Excursions (RBEs/RREs) and possibly nanoflares, while the other will observe the footpoint of an erupting solar flare. This last target is made possible through the participation of SNIFS in the first NASA Sounding Rocket Solar Flare Campaign in March 2024. This presentation will focus on the science questions to be addressed by SNIFS.

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The Endurance Rocket Mission

Session Time

Glyn Collinson, The Catholic University of America / NASA Goddard Space Flight Center
Alex Glocer, NASA Goddard Space Flight Center
Rob Pfaff, NASA Goddard Space Flight Center
Robert Michell, NASA Goddard Space Flight Center
Aroh Barjatya, Embry Riddle Aeronautical University
Robert Michell, NASA Goddard Space Flight Center
Jim Clemmons, University of New Hampshire
Francis Eparvier, Laboratory for Space and Atmospheric Physics
David Mitchell, University of California at Berkeley, Space Science Laboratory
Suzie Imber, University of Leicester, UK

NASA's Endurance sounding rocket (yard No. 47.001) launched from Ny Ålesund, Svalbard on May 11th 2022 on a solid fueled Oriole III-A launch vehicle. Its 19 minute flight carried it to an altitude of

767 km above Earth's sunlit polar cap. Its objective is to make the first measurement of the weak "'ambipolar" electric field generated by Earth's ionosphere. This field is thought to play a critical role in the upwelling and escape of ionospheric ions, and thus potentially in the evolution of Earth's atmosphere. The results will enable us to determine the importance to ion escape of this previously unmeasured fundamental property of our planet, which will aid in a better understanding of what makes Earth habitable. Endurance carried six science instruments (with 16 sensors) to measure the total electrical potential drop below the spacecraft, and the physical parameters required to understand the physics of what generates the ambipolar field. The mission was supported by simultaneous observations of solar and geomagnetic activity.

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Sounding rocket active experiments to probe fundamental plasma dynamics

Session Time

P. A. Delamere, University of Alaska Fairbanks
D. L. Hampton, University of Alaska Fairbanks
M. Conde, University of Alaska Fairbanks
K. Lynch, Dartmouth College
R. Pfaff, NASA Goddard Space Fight Center
M. Lessard, University of New Hampshire
M. Larsen, Clemson University
R. Michell, NASA Goddard Space Flight Center

Active plasma experiments can be used to strongly perturb the space plasma environment. During the early phase of a chemical release (e.g., few to several seconds), the injected plasma cloud can excite a variety of waves rather than acting as "inert" tracer particles. It is during this early phase of the release that fundamental plasma processes can be studied. For example, the Trigger [Holmgren et al., 1980] and recent Kinetic-scale energy and momentum transport experiment (KiNET-X) missions were both designed to study processes related to auroral electron energization. Early experiments relied primarily on ground-based optics to diagnose the plasma interaction, but advances in optical sensors have dramatically improved imaging capability of both the ion and neutral components of the injected cloud. In addition, advances in plasma (fields and particles) instruments have enabled a new generation of possible experiments from the sounding rocket platform. In this presentation, we will discuss previous sounding rocket (and orbital) active experiments, the related science objectives, and new pathways for future experiments.

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INFUSE and MOBIUS - New far- and near-ultraviolet integral field spectrographs for mapping feedback in galaxies.

Session Time

Brian Fleming, University of Colorado
Emily Witt, University of Colorado

The INFUSE (Integral Field Ultraviolet Spectroscopic Experiment) instrument is nearing completion at the University of Colorado with a nominal launch date in April 2023 from WSMR to observe the Cygnus Loop supernova remnant in the far-ultraviolet. The Cygnus loop is one of the closest and best studied laboratories for understanding how the death of massive stars in supernovae shape the interstellar medium of galaxies, and has been the targets of several sounding rocket flights over the years. INFUSE is designed to generate a spectral map of the XA region of the Cygnus Loop, where there is active interaction between the expanding blast wave and the ambient ISM, for the first time by using a new form of integral field spectrograph - the first for the UV. INFUSE is funded to continue studying feedback processes in galaxies by also observing the Vela remnant (2025), and the intense catastrophic cooling in galaxy NGC 2366 (2026), the nearest possible "green pea" analog galaxy. After these flights, INFUSE will be modified to add near-UV capability simultaneously, being renamed MOBIUS (The Multi-Octave Bandpass Integral-field Ultraviolet Spectrograph), to observe the active core of galaxy NGC 1068 in 2027. In this talk, we present the INFUSE and MOBIUS instrument and science program, and look forward to possible future applications.

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Beyond the aurora: capabilities of the Poker Flat Research Range launch facility.

Session Time

Donald Hampton, Geophysical Institute, University of Alaska Fairbanks
Kathe Rich, Poker Flat Research Range, University of Alaska Fairbanks
Robert McCoy, Geophysical Institute, University of Alaska Fairbanks

Poker Flat Research Range (PFRR) is located at 65 deg. N and 147 deg W, about 40 km north of Fairbanks Alaska. In addition to the obvious advantages of launching into aurora and associated phenomena in the arctic, PFRR also offers some advantages that make it attractive for a wide range of applications. With multiple launchers PFRR can launch a volley of rockets in a single launch window. The down-range impact zones cover over 31 million acres of state, federal and tribal lands with land-based impact zones as far as 420 km from the launch site. This enables high apogee flights and extends in flight operational times to as long as 10 minutes. The extensive impact area also enables land-based recovery of payloads. Recovery of payloads remains at 100% for soft-landing recovery and a high percentage for missions not planned for payload recovery. Instrumented down-range observatories with significant power and network capabilities enable observation with optical or RF instrumentation underneath the flight trajectories. The launch facilities are located only 45 minutes from Fairbanks, which provides full services and multiple daily direct flights to Seattle and Minneapolis. In this talk we will discuss these capabilities and how they can enhance capabilities for science missions.

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Solar eruptioN Integral Field Spectrograph (SNIFS), Part 2: Technical Implementation

Session Time

Vicki Herde, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder
Phillip C. Chamberlin, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder
Don J. Schmit, CIRES University of Colorado, Boulder
Adrian N. Daw, Solar Physics Laboratory NASA Goddard Space Flight Center
Ryan O. Milligan, Queens University Belfast
Vanessa Polito, Bay Area Environmental Research Center, Moffett Field, C

The Solar eruptioN Integral Field Spectrograph (SNIFS) is a novel type of solar EUV spectrograph instrument that will fly on a sounding rocket in 2024. It will be able to take spectral images of the sun with a 1-second temporal resolution, 0.44 arcsec plate scale, and 33 mÅ spectral resolution. It will have two 32x32 arcsecond fields of view measuring the 1.5 nm around Ly-α 1216Å (observing Si III, and O V lines as well) and will be observing both the footpoint of a flare as well as nearby active network. Unlike a slit spectrograph which can only measure one row at a time and must raster across an image, this new spectrograph design will be able to record the entire 2D image with a spectrum for each spatial pixel in one measurement. In this poster, we discuss the new technology which enables these capabilities as well as engineering design for the SNIFS rocket. The SNIFS sounding rocket will be launching as part of a the first coordinated solar flare observation campaign alongside Hi-C Flare and FOXSI-4.

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Planets to Galaxies: Studying Diverse Science Cases with Far Ultraviolet Instruments

Session Time

Nicholas Kruczek, University of Colorado Boulder
Kevin France, University of Colorado Boulder
Nicholas Nell, University of Colorado Boulder
Brian Fleming, University of Colorado Boulder
Fernando Cruz Aguirre, University of Colorado Boulder
Keri Hoadley, University of Iowa
Patrick Behr, University of Colorado Boulder
James Green, University of Colorado Boulder
Matthew Beasley, Southwest Research Institute
Robert Kane, Blue Canyon Technologies

The ultraviolet bandpass (10 – 320 nm) contains a host of strong atomic and molecular transitions of astronomically abundant species, making it a crucial bandpass for studying the physics of stars, planets, and galaxies. We describe our recent and upcoming sounding rocket payloads that span a wide range of science investigations and technology developments at far ultraviolet wavelengths (100 – 180 nm). The Colorado High-resolution Echelle Stellar Spectrograph (CHESS) was an echelle spectrograph

designed to study the atomic-to-molecular transitions within diffuse molecular and translucent cloud regions. The Suborbital Imaging Spectrograph for Transition region Irradiance from Nearby Exoplanet host stars (SISTINE) was a moderate resolution spectrograph used to observe the FUV radiation environment around low-mass stars and the effects of that UV on potential exoplanet atmospheres. Beyond science results, we will discuss lessons learned from these payloads and technology demonstrations facilitated through them. We will additionally provide details on our upcoming instrument, the Far- and Lyman-Ultraviolet Imaging Demonstrator (FLUID), a four-channel imager designed to study galaxy morphology and stellar populations. It includes novel Lyman-alpha (121.6 nm) rejection filters that open a short wavelength bandpass that has historically been unreachable due to prohibitively high airglow.

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The DXL and LXT Sounding Rocket Programs

Session Time

K. D. Kuntz, Johns Hopkins University GSFC
Massimiliano Galeazzi, University of Miami
Jose Adorno, University of Miami
Nico Cappelluti, University of Miami
Renata Cumbee, University of Maryland GSFC
Gabriel Loftus, Space Dynamics Laboratory
Dimitra Koutroumpa, LATMOS-IPSL/CNRS
Roberto Moncada, University of Miami
F. Scott Porter, GSFC
David Sibeck, GSFC
Nicholas E. Thomas, MSFC
Brian Walsh, Boston University

The Diffuse X-rays from the Local galaxy (DXL) is a sounding rocket mission dedicated to the study of solar wind charge exchange (SWCX) and local hot bubble properties (LHB). It was successfully launched four times, with the last launch in January 2022 from Wallops Flight Facility (WFF) using a sealed payload and water recovery.

The Lobster-eye X-ray Telescope (LXT) is a proposed mission that uses micropore (or lobster eye) optics coupled with CCD detectors in a compact, wide field telescope. Micropore optics have already been flown as piggyback instrument (coupled with microchannel plates) and tested on the ground as part of the previous DXL program. LXT will be the first instrument to fly them coupled with CCD detectors to provide energy resolution.

In this paper we will present results from last DXL launch, including preliminary science results and technical details associated with a water recovery out of WFF. We will also discuss the science goals, technical details, and instrument design of the new LXT instrument.

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Passive chemical tracer techniques: an overview

Session Time

M. F. Larsen, Clemson University

Passive chemical tracers are one of the most extensively used techniques for sounding rocket measurements of atmospheric and ionospheric properties. The technique was used already in the earliest sounding rocket probes of the upper atmosphere starting in 1958. The techniques and types of information that can be obtained from them have evolved significantly over the past six decades, leading up to the fairly sophisticated current capabilities. The various types of tracers will be described, including special applications for each.

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The "Loss through Auroral Microburst Pulsations" (LAMP) mission

Session Time

Marc Lessard, University of New Hampshire
Alexa Halford, NASA Goddard Space Flight Center
Kazushi Asamura, Japan Aerospace Exploration Agency
Niharika Godbole, University of New Hampshire
Don Hampton, University of Alaska
Keisuke Hosokawa, The University of Electro-Communications
Allison Jaynes, University of Iowa
Hyomin Kim, New Jersey Institute of Technology
Kristina Lynch, Dartmouth College
Maya Mandyam, US Air Force Academy
Matthew McHarg, US Air Force Academy
Yoshizumi Miyoshi, Institute for Space-Earth Environmental Research, Nagoya Univ.
Taku Namekawa, University of Tokyo
SungJun Noh, New Jersey Institute of Technology
Masahito Nosé, Institute for Space-Earth Environmental Research, Nagoya University
Nikolaos Paschalidis, NASA Goddard Space Flight Center
Takeshi Sakanoi, Tohoku University
Mykhaylo Shumko, NASA Goddard Space Flight Center
Emma Spanswick, University of Calgary
Riley Troyer, University of Iowa
Paulo Uribe, NASA Goddard Space Flight Center
Jules Van Irsel, Dartmouth College
John Williams, US Air Force Academy

The "Loss through Auroral Microburst Pulsations" (LAMP) mission was designed to explore connections between electron microburst precipitation from Earth's radiation belts and pulsating aurora. The

specific goals were to characterize the optical signature of electron microburst precipitation, to acquire a comprehensive measurement of precipitating electrons from 10 eV to 2 MeV and to explore the mechanism that causes high frequency modulations in pulsating aurora. The strategy included the use of multiple ground- and rocket-based imagers (the latter using a despun platform) to support the mapping of onboard plasma and field measurements to specific features in the aurora. The payload was launched into an energetic pulsating aurora event at Poker Flat on March 5, 2022 with all of the instruments on the payload and on the ground working well. In this presentation, we will describe the payload and ground support, as well as the launch. We will also show preliminary results to highlight some of the ongoing studies from LAMP.

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Multipayload sounding rockets for Geospace: from hockey pucks to Cowboys to Bobs

Session Time

Kristina A. Lynch, Department of Physics and Astronomy, Dartmouth College

A reprise of the use of multipayload sounding rockets for Geospace studies, focussing on auroral flights. Recently these missions have been not only multipayload, but also multiplatform, increasingly incorporating heterogenous data sources such as groundbased imagery, radars, and other sensor networks; and increasingly involving modern assimilative tools for interpreting the system-science-level data that result.

The design, developement, and engineering iteration of a number of different types of deployable arrays provides a rich set of possibilities for scientists working to disentangle spatial and temporal variations in a variety of science question settings. While nobody would substitute d/dx for d/dt in a homeowrk problem, we do it all the time with single-spacecraft data; those of us who have had the opportunity to work with multipoint sensor data rarely return to the use of single-point observations.

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Sounding rocket impacts on astrophysics from an X-ray perspective

Session Time

Dan McCammon, University of Wisconsin

A brief and very incomplete history of sounding rocket's contributions to X-ray astronomy, and some speculation on what the future might bring.

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Space Science from Alaska

Session Time

Bob McCoy, Geophysical Institute, University of Alaska Fairbanks

Because of its high latitude location and vast size, Alaska offers multiple advantages for access to space and space research. Alaska is home for two spaceports – one in the interior used for suborbital sounding rocket flights, the Poker Flat Research Range (PFRR), owned and operated by the Geophysical Institute of the University of Alaska Fairbanks (UAF/GI); and a second on Kodiak Island, the Pacific Spaceport Complex-Alaska (PSCA) owned and operated by the Alaska Aerospace Corporation (AAC) and used for commercial and military launch, both suborbital and orbital. These two spaceports in the sub-Arctic provide low-cost access to space for a wide-range of scientific, commercial and military applications. Some of the advantages of launch from both ranges will be presented, and new concepts for space test and space science from Alaska's rocket ranges will be presented.

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Hailstorm Part I: A rocket mission to study the role of neutral winds in MIT coupling using a modernized falling spheres technique

Session Time

Rafael Mesquita, The Johns Hopkins Applied Physics Laboratory
Spencer Hatch, University of Bergen, Bergen, Norway
Ian Cohen, The Johns Hopkins Applied Physics Laboratory
Jesper Gjerloev, The Johns Hopkins Applied Physics Laboratory

The altitude range between 80 and 200 km encompasses the transitional region of ion demagnetization and is where most magnetospheric energy is deposited in Earth's thermosphere. Up to now very few missions have been able to provide concurrent, in situ, co-located direct measurements of winds and electrojet currents, limiting investigations of magnetosphere-ionosphere-thermosphere (MIT) coupling to non-simultaneous observations at night. Measurements of vertical profiles of electrojet currents are also sparse. We present a modernization of the falling sphere technique, with current technology (GPS, magnetometers, accelerometers, etc.) to concurrently probe vertical profiles of winds and currents in the auroral region. The falling sphere technique was developed in the 1950s [Bartman et al. 1956] to determine mass density and temperatures, but a recent study showed the framework for 3D winds (including vertical winds) by using two spheres with different area to mass ratio. By releasing dozens of spheres ("*Hailstones*") over a large area and utilizing an inversion technique to produce infinite sheets of current from scalar magnetometer measurements, we can produce unprecedented 3D volumetric MIT coupling results from co-located observations. In this work we will focus on the technique to derive wind measurements and different observing strategies in the rarefied region above $\sim$100 km.

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Preliminary Results from the Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)

Session Time

Subramania Athiray Panchapakesan, University of Alabama-Huntsville
Amy Winebarger, NASA Marshall Space Flight Center
Sabrina Savage, NASA Marshall Space Flight Center
Ken Kobayashi, NASA Marshall Space Flight Center
Dyana Beabout, NASA Marshall Space Flight Center
Steven Bradshaw, Rice University
Patrick Champey, NASA Marshall Space Flight Center
Peter Cheimets, Smithsonian Astrophysical Observatory
Jonathan Cirtain, BWXT
Ed DeLuca, Smithsonian Astrophysical Observatory
Giulio Del-Zanna, University of Cambridge
Leon Golub, Smithsonian Astrophysical Observatory
Helen Mason, University of Cambridge
David McKenzie, NASA Marshall Space Flight Center
Brian Ramsey, NASA Marshall Space Flight Center
Katharine Reeves, Smithsonian Astrophysical Observatory
Paola Testa, Smithsonian Astrophysical Observatory
Genevieve Vigil, NASA Marshall Space Flight Center
Robert Walsh, University of Central Lancashire
Harry Warren, Naval Research Laboratory

The Marshall Grazing Incidence X-ray Spectrometer (MaGIXS) is a sounding rocket mission designed to observe the soft x-ray solar spectrum (6 – 25 Angstrom) with both spatial and spectral resolution over a substantial field of view. This wavelength range has several high temperature and abundance diagnostics that can be used to assist/constrain in diagnosing the frequency of heating events in solar active regions. The first mission MaGIXS-1, launched from White Sands Missile Range on July 30, 2021 and successfully observed the Sun through a 5' x 33' effective slot, producing "overlappograms", where the spatial and spectral information are overlapped and must be unfolded. The follow-up MaGIXS-2 mission, scheduled for 2023 launch will have improved optical design, which offers higher spatial/spectral resolution, easier optical alignment and higher throughput than its predecessor. In this presentation, I will report on the MaGIXS-1 observations, provide preliminary analysis and results of MaGIXS-1 data and discuss the design and development of MaGIXS-2 mission.

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Despun Platform - Mechanical Image Stabilization for Auroral Imaging Camera

Session Time

Dominic Puopolo, University of New Hampshire
Marc Lessard, University of New Hampshire
Mark Widholm, University of New Hampshire
Takeshi Sakanoi, Tohoku University
Miki Kawamura, Tohoku University

The “Loss through Auroral Microburst Pulsations” (LAMP) sounding rocket mission aimed in part to study the optical signature of auroral microburst precipitation and its spatial distribution with respect to pulsating aurora. The DeSpun Platform (DSP) was designed as a mechanical image stabilization method for a rocket-borne Auroral Imaging Camera (AIC). The AIC featured two cameras, one pointed down and one at a 45-degree angle targeting the southwest. A compact motor and gear assembly, which underwent extensive testing, was used to spin the platform. The electronic controls used a closed-loop feedback system to counter the spin-stabilization of the rocket and to point the AIC away from interfering sunlight. The first use of the DSP on the LAMP mission allowed the AIC to successfully capture stable video of pulsating aurora from above.

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The First Solar Flare Sounding Rocket Campaign

Session Time

Sabrina Savage, NASA Marshall Space Flight Center
Amy Winebarger, NASA Marshall Space Flight Center
Lindsay Glesener, University of Minnesota
Katharine Reeves, Harvard Smithsonian Center for Astrophysics
Ken Kobayashi, NASA Marshall Space Flight Center
Leon Golub, Harvard Smithsonian Center for Astrophysics
Philip Chamberlin, University of Colorado

Solar flares are an essential driver of space weather as they account for the rapid release of powerful amounts of energy (10$\hat{3}$2 ergs) in a matter of seconds to hours. Observations from the past several decades have yielded a wealth of understanding of these events while at the same time presenting countless new questions. Key gaps in our knowledge remain that cannot be satisfactorily answered with available instrumentation, and we are now at the precipice of the value of incremental improvements in technology versus the need for design breakthroughs. The latter requires exceptional testing in order to justify vast investments within Explorer-class mission programs. High energy instrumentation often invokes the additional requirement of testing above the absorption layer of the Earth’s atmosphere. The NASA sounding rocket program has been an invaluable pathway for developing such cutting-edge technologies. However, these suborbital missions have been severely limited for the development of flare-specific instrumentation due to the current inability to remain in a holding pattern until a flare occurs at the White Sands Missile Range ($\sim$1 hour) compounded by the short duration of a flight ($\sim$5 minutes of science observations) in which it is nearly impossible to capture a flare per chance. In response to this deficiency, a pilot solar flare campaign has been established to test the ability to launch at least two sounding rockets with instrumentation optimized to observe flares from the Poker Flats Research Range in Alaska, taking advantage of the site’s ability to accommodate a long holding pattern ($\sim$4 hours per day for several weeks). This capability has been utilized extensively by the geospace communities. We will present the first payloads selected for this solar pilot program, Hi-C Flare, FOXSI 4, and SNIFS, and discuss how this new technology development paradigm could enable the next wave of exploratory flare missions.

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Overview of the SDO EVE Calibration Program

Session Time

Bennet Schwab, Laboratory for Atmospheric and Space Physics
Thomas N. Woods, Laboratory for Atmospheric and Space Physics
Phil Chamberlin, Laboratory for Atmospheric and Space Physics
Frank Eparvier, Laboratory for Atmospheric and Space Physics
Andrew Jones, Laboratory for Atmospheric and Space Physics
Rick Kohnert, Laboratory for Atmospheric and Space Physics
Robert Sewell, Laboratory for Atmospheric and Space Physics

The Solar Dynamics Observatory (SDO) sounding rocket program is an underflight calibration for the Extreme ultraviolet Variability Experiment (EVE) instrument. These EVE channels include the Multiple Extreme ultraviolet Grating Spectrographs (MEGS)-A, -B, and -P instruments as well as the Solar Aspect Monitor (SAM) and the Extreme ultraviolet SpectroPhotometer (ESP). The EVE underflight calibrations have been launched every 1-2 years since 2004 out of White Sands Missile Range (WSMR), New Mexico, as a critical component to quantify the degradation of the SDO/EVE instrument in order to meet its accuracy success criteria. Throughout this program, additional instruments have been flown as secondary payloads on the rocket to mature their TRL. Examples of secondary payloads include various version of the X123, an X-ray spectrometer, that eventually lead to the Miniature X-ray Solar Spectrograph (MinXSS-1 and MinXSS-2) CubeSats, and currently the Dual Aperture X-ray Solar Spectrometer (DAXSS) on the INSPIRESat-1 CubeSat. The next sounding rocket launch targeted in June 2023 will include a more compact version of DAXSS as well as several other experimental science payloads. This talk will focus on the EVE payload, including its past results, as well as results from the secondary payloads and how these rocket flights led to orbital missions.

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Space Measurements of A Rocket-Released Turbulence (SMART) and the Future of High-Speed Releases from Sounding Rockets

Session Time

Carl L Siefring, US Naval Research Laboratory, Plasma Physics Division
Gururdas Ganguli, US Naval Research Laboratory, Plasma Physics Division
George Gatling, US Naval Research Laboratory, Plasma Physics Division
Joe Coombs, US Naval Research Laboratory, Plasma Physics Division
Chris Crabtree, US Naval Research Laboratory, Plasma Physics Division
Alex Fletcher, US Naval Research Laboratory, Plasma Physics Division
Bill Amatucci, US Naval Research Laboratory, Plasma Physics Division
Christopher Netwall, US Naval Research Laboratory, Spacecraft Engineering Division
Nicholas Falcone, Naval Surface Warfare Center – Indian Head Division
William Ferrrell, NASA Goddard Space Flight Center, Solar System Exploration Division
Robert Holzworth, University of Washington

Michael McCarthy, University of Washington

Space Measurements of A Rocket-Released Turbulence (SMART) is a sounding rocket experiment to explore the role of the weak turbulence process known as nonlinear (NL) scattering in space plasmas. The experiment is modeled after similar high-speed Barium releases conducted since the mid-1970s that generated high-speed Barium (Ba) atoms using a shaped charge explosion. A fraction of Ba is atomized and ejected at velocities around 8 km/s. Such releases have been used to study multiple physical processes in the ionosphere. One example are Critical Ionization Velocity (CIV) experiments such as NASA CRIT II experiment flown in 1989. The technological expertise to generate such high-speed releases have largely been lost and in general they were not well documented. One of the goals of the SMART program is to revive this technology. In developing the SMART experiment, a number of issues concerning range safety have occurred, limiting available launch sites, trajectories, and times.

In SMART, the Ba atoms are fired perpendicular to the Earth's magnetic field in sunlight. The Ba atoms then photoionize forming an ion ring velocity distribution of heavy Ba+ that is unstable and known to generate LH turbulence. Theoretical analyses indicate that weak turbulence processes causes NL scattering of LH waves into whistler waves. Previous experimental Ba explosive releases measured large amplitude electric fields, indicate possible generation of electromagnetic waves and, in one case, resulted in energetic particle precipitation. However, none of these experiments had sufficient measurements to separate the EM contribution to the electric field and confirm NL scattering. For SMART, simultaneous measurements are made of electrostatic lower-hybrid (LH) waves in the ionosphere and the scattered electromagnetic (EM) waves (e.g., whistlers) with both the sounding rocket in the ionosphere and remotely with a satellite in the magnetosphere. The effect of Very Low Frequency whistler turbulence (e.g., lightning generated whistler waves) is of particular importance to the dynamics in the inner magnetosphere and the radiation belts, but also has more global relevance, e.g. in solar wind turbulence.

We will discuss the SMART experiment, progress in rediscovering the technology of creating high-speed Ba releases from sounding rockets, and some of the pit-falls that currently limit launching similar payloads.

This work was supported by Defense Advanced Research Projects Agency and the NRL Base Program
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A Hosted Payload for AstroPix – A Novel Pixelated Silicon CMOS Detector for Space-Based Gamma-ray Telescopes

Session Time

Amanda Steinhebel, NASA Goddard Space Flight Center, NASA Postdoctoral Program Fellow
Regina Caputo, NASA Goddard Space Flight Center
Henrike Fleischhack, Catholic University of America
Lindsey Seo, NASA Wallops Flight Facility

This presentation introduces the use of a monolithic CMOS active pixel silicon sensor – AstroPix – as a novel technology for use in future gamma-ray telescopes. Space-based gamma-ray telescopes such as the Fermi Large Area Telescope have used single sided silicon strip detectors to measure the position of incident gamma-rays with high resolution, but at lower energies two-dimensional position information within a single detector is required. AstroPix has the potential to maintain the high energy and angular resolution required of a medium-energy gamma-ray telescope while reducing noise with the dual detection and readout capabilities of a CMOS chip. Plans for a hosted payload will be presented, allowing for the continued advancement of this novel technology in-situ.

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The Cosmic Infrared Background ExpeRiment-2: First Flight Findings and Status

Session Time

Serena Tramm, Rochester Institute of Technology
Michael Zemcov, Rochester Institute of Technology
Jamie Bock, California Institute of Technology
Yun-Ting Cheng, California Institute of Technology
Asantha Cooray, University of California Irvine
Richard Feder-Staehle, California Institute of Technology
Ryo Hashimoto, Kwansei Gakuin University
Grigory Heaton, California Institute of Technology
Viktor Hristov, California Institute of Technology
Yuya Kawano, Kwansei Gakuin University
Arisa Kida, Kwansei Gakuin University
Phil Korngut, California Institute of Technology
Alicia Lanz, Carnegie Observatories
Daehee Lee, Korea Astronomy and Space Science Institute
Simon Liu, California Institute of Technology
Chika Matsumi, Kwansei Gakuin University
Shuji Matsuura, Kwansei Gakuin University
Tomoya Nakagawa, Kwansei Gakuin University
Chi Nguyen, California Institute of Technology
Kazuma Noda, Kwansei Gakuin University
Mikey Ortiz, Rochester Institute of Technology
Won-Kee Park, Korea Astronomy and Space Science Institute
Kei Sano, Kyushu Institute of Technology
Koji Takimoto, Kyushu Institute of Technology
Kohji Tsumura, Tokyo City University

The Cosmic Infrared Background ExpeRiment-2 (CIBER-2) is a sounding rocket experiment designed to distinguish the Epoch of Reionization from intra-halo light by characterizing fluctuations in the Extragalactic Background Light. CIBER-2 comprises a 28.5-cm telescope coupled through a cryogenic optical chain to three HAWAII-2RG detectors filtered to image over 0.5-2.5 um in six wavebands simultaneously. CIBER-2's successful first flight from White Sands Missile Range took place on June 7th, 2021.

During flight, the instrument generally demonstrated good sensitivity, pointing, and data acquisition performance. Though the flight was an engineering success, the image data did not meet our science quality goals in 2 of the 3 science channels due to challenges with electrical pickup, light leaks, and other more minor issues. Over the past year we have fully diagnosed these problems and designed solutions to mitigate them. We are currently refurbishing the payload hardware to implement the solutions and fully expect science-quality data in our next flight scheduled for early 2023. This talk will present the science case for CIBER-2, review the performance of the instrument from the first flight, and discuss the improvements that will lead to a successful second flight of the payload.

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Real-Time Solar Flare Predictions for Triggered Flare Observations

Session Time

Juliana Vievering, Johns Hopkins Applied Physics Laboratory
Brent Smith, Johns Hopkins Applied Physics Laboratory
P. S. Athiray, University of Alabama Huntsville
Juan Camilo Buitrago-Casas, Space Sciences Laboratory
Phillip Chamberlin, Laboratory for Atmospheric and Space Physics
Lindsay Glesener, University of Minnesota
Säm Krucker, Space Sciences Laboratory
Janet Machol, CIRES at the University of Colorado Boulder
Courtney Peck, CIRES at the University of Colorado Boulder
Marianne Peterson, University of Minnesota
Katharine Reeves, Harvard-Smithsonian Center for Astrophysics
Sabrina Savage, NASA Marshall Space Flight Center
Amy Winebarger, NASA Marshall Space Flight Center

Understanding when and where solar flares and eruptive events will occur continues to be an important goal for the heliophysics community, from both fundamental science and space weather perspectives. Currently available flare forecasts typically fall into two main categories: (1) long-term probabilistic forecasts (e.g., probability that a flare of a certain magnitude is going to occur over the next 24 hours), and (2) flare alerts (e.g., notification when GOES X-ray flux reaches a high threshold). For a wide variety of operations and research purposes, there is an additional need for flare predictions that are more actionable than long-term forecasts and provide earlier notice of extreme events than current flare alerts. To address this need, we seek to develop a tool using machine learning that rapidly aggregates near-real-time signatures of flare onset, including X-ray and EUV irradiance measurements, to provide early prediction of the magnitude and duration of ensuing solar eruptive events. Such a tool will enable triggered observations of the early stages of solar flares, a crucial capability for demonstrating novel instrumentation optimized for solar flares via sounding rocket. A version of this tool will be developed for the first solar sounding rocket flare campaign in March 2024, which will feature the FOXSI-4, Hi-C Flare, and SNIFS experiments. Here we present our concept for real-time solar flare predictions.

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A History of Heliophysics Science and Technology Development Through the Sounding Rocket Program

Session Time

Amy Winebarger, NASA Marshall Space Flight Center

Ultraviolet, Extreme-ultraviolet, and X-ray observations of the Sun have revolutionized our understanding of our closest star. The first observations of the Sun in these wavelengths were made in the early years of the sounding rocket program. Technologies developed through sounding rocket program were then folded into space-based instrumentation. This cycle continues today. In this talk, I will give a few examples of some of the first data ever obtained of the Sun in this wavelengths, and how these early observations continue to drive technology developments in the present day.

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The DEUCE Sounding Rocket: Stellar Observations in the EUV

Session Time

Emily Witt, University of Colorado-Boulder
Brian Fleming, University of Colorado-Boulder
James Green, University of Colorado-Boulder
Nicholas Erickson, Southwest Research Institute

After the Extreme UltraViolet Explorer (EUVE) ceased operations in 2001, no astrophysics observing platform existed to observe the lambda ¿ 500 angstrom extreme ultraviolet (EUV) until the Dual-channel Extreme Ultraviolet Continuum Experiment (DEUCE), a sounding rocket, was built at the University of Colorado. Composed of a Wolter-II telescope feeding a Rowland circle spectrograph, DEUCE served as a platform for technology development by flying a 20 cm x 20 cm delay line microchannel plate (MCP) detector, the largest MCP ever flown. The telescope, on the other hand, had flown on twelve sounding rocket flights prior to the first DEUCE launch. The DEUCE payload itself launched four times. Its original mission, to place limits on ionizing radiation from B-type stars, was accomplished by launching from White Sands Missile Range in December 2018 (epsilon CMa) and November 2020 (beta CMa). After the original observations were completed, DEUCE was repurposed to observe potential exoplanet host-stars and determine whether or not EUV radiation from those stars is conducive to supporting habitable planets. The target chosen for that mission, alpha Centauri A+B, was observed in July 2022 from the Arnhem Space Center in Australia. This launch was part of a successful campaign to reopen the southern sky to sounding rockets after a twenty-seven year hiatus. DEUCE has now been retired after five years of service.

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6 Poster Abstracts

Alphabetical listing by first author.

Local scale ionospheric modeling in support of sounding rocket campaigns

Meghan Burleigh, Naval Research Laboratory

The Geospace Environment Model for Ion-Neutral Interactions with Transverse Ion Acceleration (GEMINI-TIA) is a 2.5D multi-fluid ionospheric model based on a bi-Maxwellian distribution that incorporates all of the ionospheric chemistry and collisional terms needed to simulate ionospheric dynamics (¿80km), including possible effects of low-altitude wave-particle interactions. GEMINI-TIA is an offshoot of the isotropic model GEMINI (Zettergren and Semeter, 2012) and accepts, as inputs, the main drivers of ion upflow and outflow: particle precipitation, electric fields, ELF wave power, and neutral winds and densities. It is well suited for ingesting sounding rocket campaign data for investigations of ionospheric dynamics. GEMINI-TIA has been used to model the impacts of forcing from above (e.g. auroral precipitation, local convection patterns) and below (e.g. gravity waves) through data-driven and data-inspired simulations. The recommended hysteresis necessary to reproduce data measurements with model outputs has also been explored.

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Overview of the Integrated Design Center (IDC) and Mission Planning Lab (MPL)

Will Mast, NASA Wallops Flight Facility
Ben Cervantes, NASA Wallops Flight Facility

GSFC's Integrated Design Center (IDC) and WFF's Mission Planning Lab (MPL) both provide an environment that facilitates multi-disciplinary, concurrent, collaborative, space system engineering design and analysis activities, to enable rapid development of science instrumentation, mission, and mission architecture concepts. The IDC collaborates with and supports science teams by providing studies with three facilities: the Mission Design Lab (MDL), Instrument Design Lab (IDL), and Architecture Design Lab (ADL). The Mission Planning Lab (MPL) operates similarly to the MDL, but with a focus on supporting Principal Investigators exploring CubeSat, Small Sat, and Suborbital platform mission concepts.

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SpEED Demon: A tech demo mission for simultaneous multipoint measurements of electrodynamics and neutral dynamics

Robert Clayton, Embry-Riddle Aeronautical University
Aroh Barjatya, Embry-Riddle Aeronautical University

Henry Valentine, Embry-Riddle Aeronautical University
Nathan Graves, Embry-Riddle Aeronautical University
Josh Milford, Embry-Riddle Aeronautical University
Peter Ribbens, Embry-Riddle Aeronautical University
Anthony Oreo, NASA Wallops Flight Facility

SpEED Demon is a technology demonstration mission scheduled to be launched from Wallops Flight Facility in August 2022. The main payload consists of a Sweeping Langmuir Probe for plasma density and electron temperature, a pair of multi-Needle Langmuir Probes for 5KHz electron density, Positive Ion Probe for relative ion density, ionization gauges and sensitive accelerometers for background neutral density, a suite of sensitive magnetometers and a pair of electric field measurements. Each main payload ejects four sub-payloads, each carrying ion density measurement along with a sensitive magnetometer and an accelerometer capable of performing 'falling sphere' analogous neutral density measurements. We present the instrument salient features as well as the expected performance characteristics.

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Hailstorm Part II: A rocket mission to study the role of closure currents in MIT coupling using a modernized falling spheres technique

Ian J. Cohen, The Johns Hopkins University Applied Physics Laboratory
Rafael L.A. Mesquita, The Johns Hopkins University Applied Physics Laboratory
Spencer M. Hatch, University of Bergen
Jesper W. Gjerloev, The Johns Hopkins University Applied Physics Laboratory

The altitude range between 80 and 200 km represents the transition region between Earth's magnetosphere and the upper atmosphere and is key for the processes that are critical for enabling the transport of energy and momentum in geospace. Up to now very few missions have been able to provide concurrent, in situ, co-located direct measurements of electrojet currents, limiting investigations of magnetosphere-ionosphere-thermosphere (MIT) coupling to non-simultaneous observations at night. Measurements of vertical profiles of electrojet currents are also sparse. We present a modernization of the falling sphere technique, with current technology (GPS, magnetometers, accelerometers, etc.) to concurrently probe vertical profiles of winds and currents in the auroral region. By releasing dozens of spheres ("Hailstones") over a large area and utilizing an inversion technique to produce infinite sheets of current from scalar magnetometer measurements, we can produce unprecedented 3D volumetric MIT coupling results from co-located observations. In this work we will focus on the inversion technique and magnetic field measurements to determine the closure currents in this region.

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Preliminary Sweeping Langmuir Probe Results from the Endurance Rocket Mission

Rachel Conway, Embry-Riddle Aeronautical University
Aroh Barjatya, Embry-Riddle Aeronautical University

Shantanab Debchoudhury, Embry-Riddle Aeronautical University
Robert Clayton, Embry-Riddle Aeronautical University
Henry Valentine, Embry-Riddle Aeronautical University
Nathan Graves, Embry-Riddle Aeronautical University
Glyn Collinson, NASA Goddard Space Flight Center

On May 11, 2022 NASA launched the Endurance sounding rocket from Ny-Alesund, Svalbard, Norway. The mission is designed to make the first measurements of Earth's weak ambipolar electric field. Amongst a whole suite of instruments onboard the rocket, there is a cylindrical Sweeping Langmuir probe (SLP). The SLP will provide plasma densities and electron temperatures, as well as measurements of the spacecraft floating potential. Every 5 seconds, a sweeping voltage from -5 to +5 Volts was applied to the gold-plated needle probe (diameter = 1.5mm, length = 7cm) at a sweep rate of 15.64 Hz. In between sweeps the probe was fixed bias in the ion saturation region at -5 Volts. In total, the SLP provided over 150 sweeps covering 200 to 768km in altitude. This work presents a first look at the SLP data. We look into contamination effects on the SLP and provide preliminary results for plasma densities, temperatures, and spacecraft floating potentials.

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Overview of the Integrated Design Center (IDC) and Mission Planning Lab (MPL)

Will Mast, Wallops Flight Facility
Ben Cervantes, Wallops Flight Facility

GSFC's Integrated Design Center (IDC) and WFF's Mission Planning Lab (MPL) both provide an environment that facilitates multi-disciplinary, concurrent, collaborative, space system engineering design and analysis activities, to enable rapid development of science instrumentation, mission, and mission architecture concepts. The IDC collaborates with and supports science teams by providing studies with three facilities: the Mission Design Lab (MDL), Instrument Design Lab (IDL), and Architecture Design Lab (ADL). The Mission Planning Lab (MPL) operates similarly to the MDL, but with a focus on supporting Principal Investigators exploring CubeSat, Small Sat, and Suborbital platform mission concepts.

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The Rockets for Extended-source X-ray Spectroscopy (tREXS)

Drew M. Miles, California Institute of Technology
James H. Tutt, Penn State University
Ross McCurdy, Penn State University
and Randall L. McEntaffer, Penn State University
on behalf of the tREXS collaboration

The Rockets for Extended-source X-ray Spectroscopy (tREXS) are a funded series of sounding rocket instruments to detect diffuse soft X-ray emission from astrophysical sources. The first iteration of tREXS,

scheduled for launch in Q3 2022 and currently going through integration and testing at Wallops Flight Facility, will target the Cygnus Loop supernova remnant. The tREXS payload houses a multi-channel grating spectrograph that uses passive, mechanical focusers, modules of reflection gratings, and an extended focal plane based around Teledyne CIS 113 CMOS sensors. Each mechanical focuser consists of a series of 45 plates, each populated with 241 slits that converge in size and position over the length of the modules. The sculpted beam exiting each mechanical focuser channel is intercepted by a module of 38 reflection gratings initially fabricated at Penn State University and replicated by Philips SCIL Innovation. The relatively large ($\sim$10 sq. deg.) field of view is captured on an array of 11 sensors butted to form a $\approx$75 mm x 350 mm focal plane. In addition to the multi-channel grating spectrograph, tREXS utilizes a pull-away rail pumping system, a custom vacuum-compatible shutter door that isolates the detector chamber from the telescope, and will flight qualify a Stanford Photonics, Inc. secondary star-tracking camera to allow for experiment-controlled fine guidance during future flights. We present here an update on the instrument design, build, alignment, and calibration in advance of the launch later this year, including expected performance.

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Multipoint Thermal Ion Measurement Technique and Data from KiNET-X

Magdalina Moses, Dartmouth College
Kristina Lynch, Dartmouth College
Grace Kwon, Dartmouth College
Katherine Pommerening, Dartmouth College
Peter Delamere, University of Alaska Fairbanks
Nathan Barnes, University of Alaska Fairbanks

Observations of ambient ions in the auroral ionosphere can provide a more complete understanding of the underlying physics. In-situ observations of the aurora are often conducted with sounding rockets, which require an instrument package that can fit a small platform and be replicated for multiple sub-payloads. Petite-Ion Probes (PIPs) are small retarding potential analyzers (RPAs) whose data consists of a series of measured anode current vs applied screen voltage (IV) curves over time.

The Kinetic-scale energy momentum transport experiment (KiNET-X) investigated kinetic-scale ionospheric plasma transport for a known input energy and momentum by measuring ionospheric perturbations from two sounding rocket barium releases. The KiNET-X diagnostic payload, launched May 2021 from Wallops, carried eight main-payload-mounted PIPs onboard as well as two small, deployable sub-payload instrument packages (Bobs) that each carried two PIPs, one viewing in the ram direction and one looking out the side of each Bob. The two Bobs were each ejected forward of the main diagnostic payload at different times during the ascent, forming a line of measurements perpendicular to the separation line to the Barium release events. released at different times during the ascent. Thus, thermal ion plasma measurements were collected at three different points in the two plasma plumes.

We determine the scalar thermal ion properties of the measured plasma by finding the modeled IV curve for a PIP on a (sub-)payload charged to some potential (Vs) in Maxwellian plasma, with ion temperature (Ti) and density (ni), that best approximates the measured PIP IV curve. Additionally, (near-)simultaneous IV curve measurements from two main-payload-mounted PIPs, separated azimuthally by

a fixed angle, can be used to solve for the flow vector, given constraints from the scalar parameters. In order to model a PIP's IV curves, we must know the attitude of the PIP with respect to the ambient plasma at the time of measurement. We can determine the attitude of main-payload-mounted PIPs using the provided rocket attitude solution from the attitude control system (ACS) and the known orientation of the PIPs on the rocket payload. In contrast, as the Bobs plasma measurements are made once the instrument has separated from the main payload, we must use the onboard IMU magnetic field data to determine a Bob's attitude. Here we demonstrate the process of determining plasma parameters from PIP IV curves with the KiNET-X data as well as determining the Bobs' attitudes from the measured magnetic field referenced the the IGRF. Finally, we will discuss how to get the most information out of the PIPs measurements while minimizing the uncertainty in the optimized fitting process.

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Opportunistic Science Exploiting Existing Sounding Rocket Programs

Andrew ONeill, The Pennsylvania State University
James Tutt, The Pennsylvania State University
Timothy J Kane, The Pennsylvania State University

Flagship sounding rocket experiments present the chance to conduct opportunistic science that supports the development of new payload concepts in a low stakes environment, furthers understanding of the near earth space environment, and provides for the training of new scientists and engineers. For example, the Off-plane Grating Rocket for Extended Source Spectroscopy (OGRESS) was a mission to measure the soft X-ray spectra of diffuse sources such as the Cygnus Loop supernova remnant (SNR). Analysis the mission data post flight showed no discernable spectral features, nor expected artifacts from the system's support structure. Through laboratory experiments post-flight, it was determined that the issue stems from electrons accelerated within the payload striking the instrument and releasing secondary X-rays. The issue of induced X-ray fluorescence in OGRESS experiment presents the necessity and opportunity to measure the electron energy spectrum of the ambient environment and within the payload body. With the impending launches of The Rockets for Extended-Source X-ray Spectroscopy (tREXS) campaign there are specific cases in which this particular example of opportunistic science can be used to train new researchers while testing equipment and broadening our understanding of the near space environment. Future campaigns will yield new and exciting opportunities, such as the release of specific integrated drop sondes and semi-autonomous sensors.

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Kratos Sounding Rocket Hypersonic Research History

Kevin Schoonover, Kratos Space Missile Defense Systems
Wayne Montag, Kratos Space Missile Defense Systems
Emily Rose Hickey, Kratos Space Missile Defense Systems

Reliable, responsive, affordable sounding rocket systems provide industry, scientists, students and government an opportunity to explore innovative technology in hypersonic regimes. Kratos Space and Missile Defense Systems is committed to hypersonic research through its past international sounding rocket flight tests. In an ongoing regime of offering cost effective booster systems and in-situ flight testing, the Kratos team continues to further NASA and industries' knowledge in hypersonic research. Kratos has designed and developed, sometimes even resurrected, new and legacy booster stacks that have opened the door to a broad range of opportunities for critical environmental measurements, scramjet inlet material and flow-path design using both lofted and suppressed trajectory profiles. Kratos has supported hypersonic flight programs that include, HyShot [1, 2, 3 4], FASTT [3 flights], HYCAUSE, HIFiRE [0, 1 2] for the University of Queensland, Australian Ministry of Defense, DARPA, ONR, NASA Langley Research Center and the AFRL. Kratos will highlight the history and importance of knowledge and "firsts" achieved in many of these programs.

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The Swarm Communication system: a standard platform utilized to acquire simultaneous, multipoint, in-situ measurements in a geospace region of interest.

Joshua Yacobucci, NASA Goddard Space Flight Center
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This presentation provides a description of the Swarm communication system, as developed by the NASA Sounding Rocket Program (SRP) and NASA Engineering and Technology Directory (ETD) engineers, in addition to its flight history, future planned flights, and overall system capabilities. The Swarm Communication system was designed as a platform to support a science payload approximately 5.8" long, with a 3.4" outer diameter, and with a set electrical interface. Utilizing a standard sub-payload geometry for sounding rockets, Swarm has been deployed from a previously developed spring and rocket ejection system at around 8 and 390 fps respectively, on two missions thus far. Swarm Communication telemeters data from each deployed sub-payload to the main payload via S-band at rates up to 1 Mbps per sub-payload. The main payload receiving system compiles the multiple sub-payload links into a single synchronous serial data stream that is transmitted to the ground via the main payload telemetry downlink, negating the need for a separate ground asset to receive each sub-payload downlink. Ultimately, Swarm provides a standard platform for principal investigators to utilize to acquire simultaneous, multipoint, in-situ measurements in their geospace region of interest.

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