



An Introduction to the Lowell Center of Space Science and Technology

Supriya Chakrabarti
SHOE-PRE-OH CHALK-ROW-BORE-TEA

and the LoCSST Team
<https://www.uml.edu/Research/LoCSST/>

The Team (active members only)

Core Faculty

- Supriya Chakrabarti (Physics)
- Dimitris Christodoulou (Math)
- Ofer Cohen (Physics)
- Timothy Cook (Physics)
- Christopher Hansen (Mech. Eng.)
- Silas Laycock (Physics)

Research Staff

- Mr. Samuel Fingerman
- **Dr. Susanna Finn**
- Dr. Ivan Galkin
- Mr. Jason Martel
- Dr. Christopher Mendillo

Administrative Staff

- Ms. Lynne Schaufenbil

Ph.D. Students

- Qusai Al Shidi
- **Saurav Aryal**
- Rigel Cappallo
- **George Geddes**
- Chrstopher Emma
- Kuravi Hewawasam
- Glenn Howe
- Chen Li
- Sunip Mukherjee

Undergraduate Students

- 9 Capstone (physics & engineering) students
- 6 Co-op scholars (physics & engineering projects)
- Many (>50) SPACE HAUC students
- 7 Independent study

LoCSST

One of about 10 University Research Centers

- ▶ It is a research Center with the three primary goals:
 - **Train** next generation of space scientists, technologists, teachers, business leaders and policy makers
 - Provide a home for space science and technology **research** activities on UMass Lowell campus
 - Involve university, industry and government **partners** in curriculum, research as well as in proposal development

What do we do?

Science and technology for space exploration

▶ **Science about space**

- Astrophysics from Earth to exoplanet to extragalactic studies

▶ **Science from space**

- Things that cannot be done from the ground

▶ **Tools to accomplish both**

- Engineering and technological tools
- Theoretical and modeling tools
- Computational tools

Our research interests involve science AND technology

SCIENCE

- **Astrophysics**
 - High energy astrophysics
 - Neutron star – Black Hole binaries
 - Pulsars
 - Time-domain astrophysics
 - Stellar astrophysics
 - Interstellar medium
 - Intergalactic medium
- **Exoplanet**
 - Theory
 - Observations
- **Heliophysics**
 - Space Weather
 - Upper atmosphere
 - Ionosphere
- **Solar-System Science**
 - Planetary atmospheres
 - Interplanetary medium

TECHNOLOGY/TOOLS

- **Materials**
 - Materials processing
 - Structural composites
 - Fiber-reinforced composites
 - Multifunctional materials
 - Self-healing materials
 - Additive manufacturing
- **Modeling Techniques**
 - Novel methods of statistical inference
 - Radiative transfer
 - Image processing, Tomography
 - High performance computing
- **Observational techniques**
 - Ground-based, sub orbital, orbital
 - From soft X-ray to near-infrared
 - High-contrast imaging, photometry, spectroscopy, interferometry, spectral imaging, LIDAR
 - Photon counting detectors
 - Custom optical configurations

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Example: SPACE HAUC

Undergraduate student-led CubeSat mission

- ▶ Demonstrate the practicality of high-data rate, high frequency communications on a CubeSat
- ▶ Achieve rapid beam steering for dynamic pointing of **X-band** uplink/downlink
- ▶ Use **phased array** of patch antennas
- ▶ Camera will take high-res images of Sun to transmit back to Earth
- ▶ **Launch 2018**



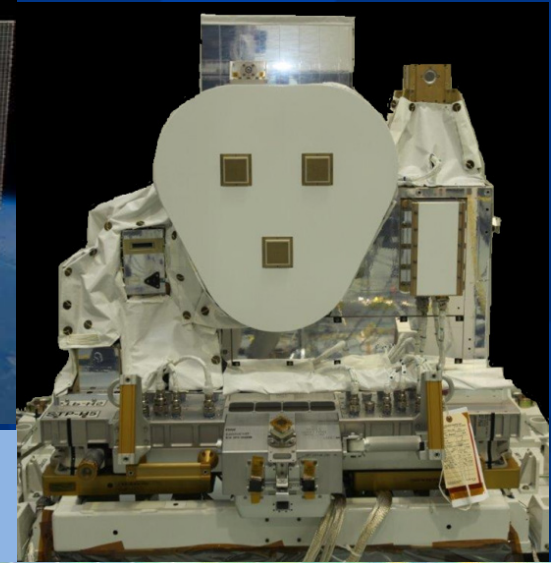
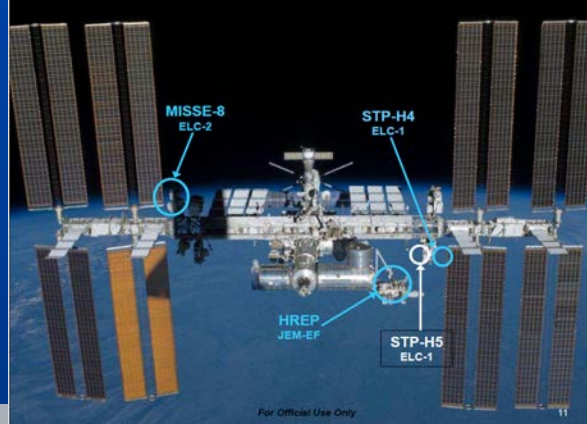
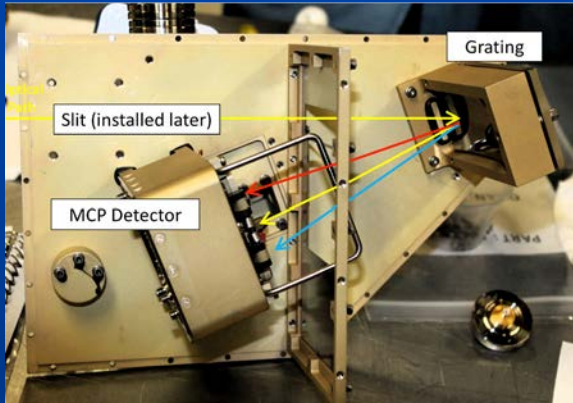
See: <https://www.uml.edu/Research/LoCSST/Research/spacehauc/about.aspx>

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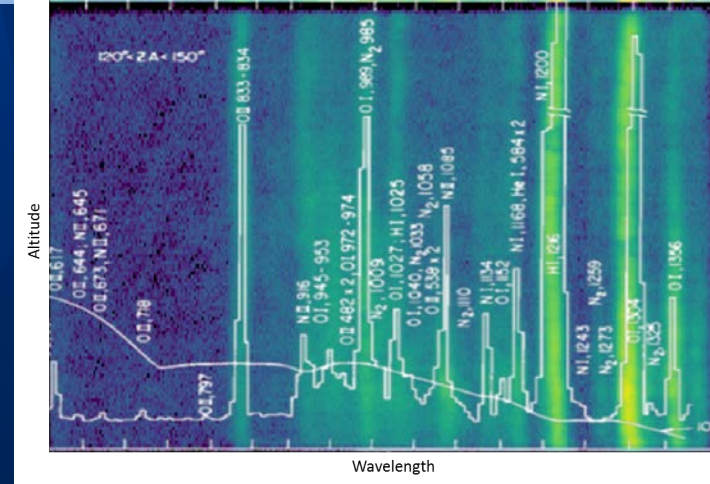
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Example: LITES on ISS

A Precursor to ICON's UV observations



Launch: 19 February 2017
Payload Installed: 27 February 2017
LITES First Light: 6 March 2017



LITES: Limb-imaging Ionospheric and Thermospheric Extreme ultraviolet Spectrograph

Ph.D.: Geddes – check out his poster

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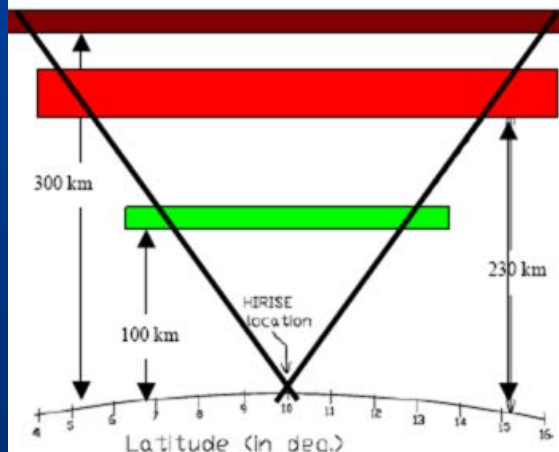


Example: Ground-based aeronomy

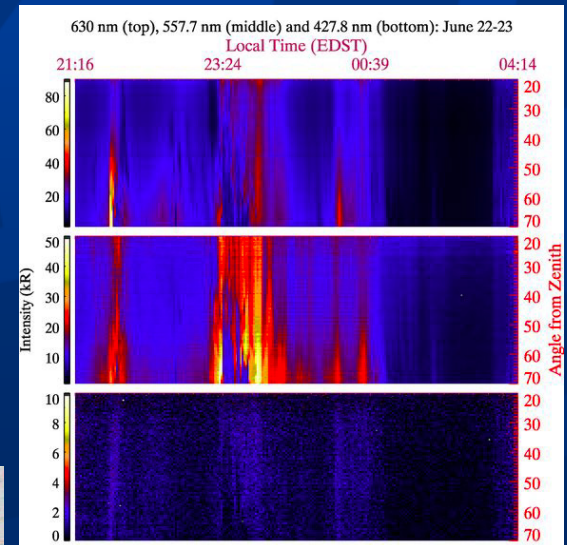
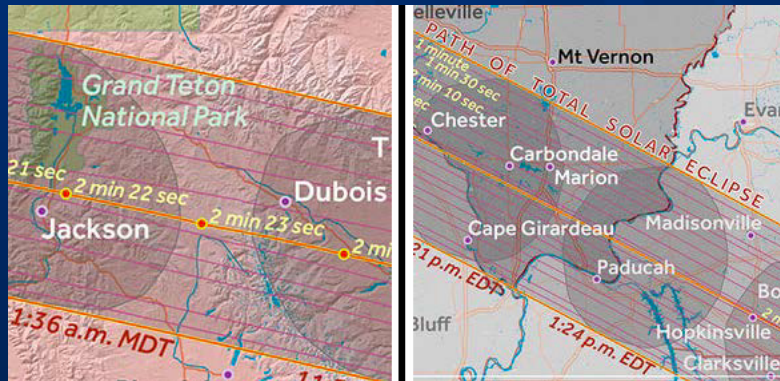
Round-the-clock optical observations from Haystack



HiT&MIS: High Throughput & Multi-slit Imaging Spectrograph



7774 Å
6300 Å
5577 Å



Ph.D.: Aryal – check out his poster

Example: High energy astrophysics

We work on a variety of science areas

Pulsars, Black Holes and Accretion: High Energy Astrophysics in the Time Domain

- Accretion lights up the **Neutron Star or Black hole**
- Direct access to fundamental astrophysical quantities (Mass, Spin, B-field, Age, Equation of state).
- X-rays probe large distances and dark corners
- Companion bright at optical and infrared wavelengths

Accretion Disk

Black Hole or
Neutron Star

Massive O/Be/WR star
Mass loss = 10^{-7} - $10^{-4} M_{\odot} \text{yr}^{-1}$
 $V_{\text{wind}} = \text{few } 10^3 \text{ km s}^{-1}$

- 100 galactic examples, similar number known in other galaxies
- Many more NS than BH formed
- Set by the initial mass function and the binary fraction

Christodoulou and Laycock's article on retrograde accretion disks of Neutron stars received attention from the world-wide science community including the LIGO team, in what was probably the year's "most read" astrophysics paper.

<http://faculty.uml.edu/u/slaycock/>

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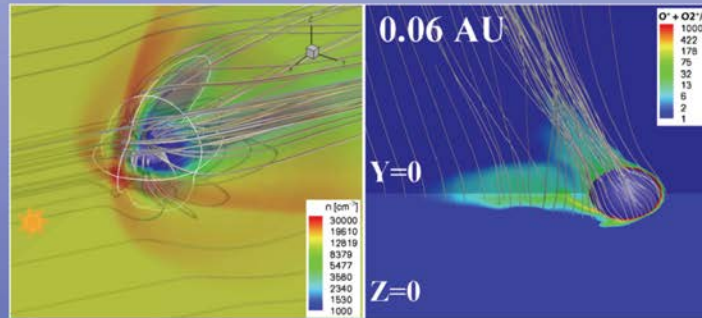
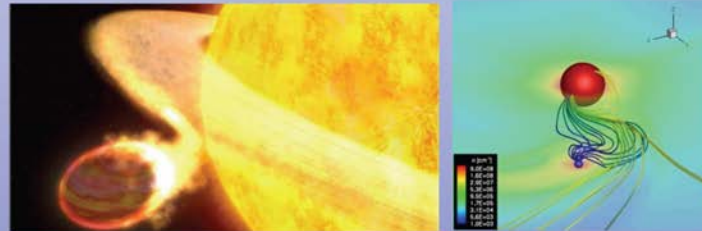
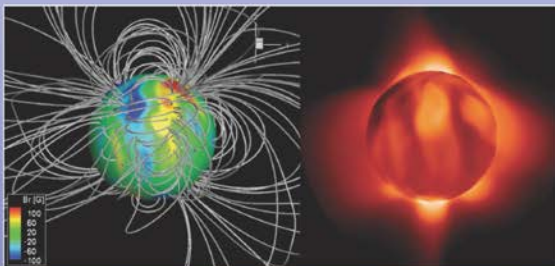
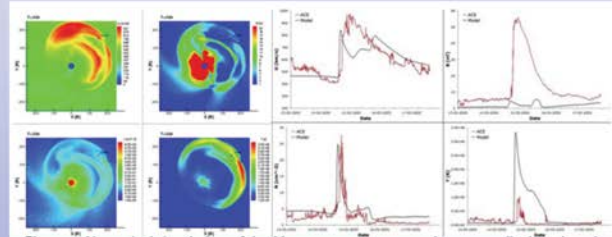
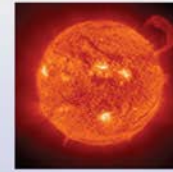


More examples

Computational studies with diverse applications

Applications of computational plasma physics:

1. Solar Physics
2. Space Weather and Heliophysics
3. Stellar Astrophysics
4. Extra-solar Planets
5. Planetary Atmospheres



Professor Cohen's work on habitability exoplanets have been highly cited in popular press such as the National Public Radio and the Forbes magazine.

<https://sites.google.com/site/ofercohenuml/group>

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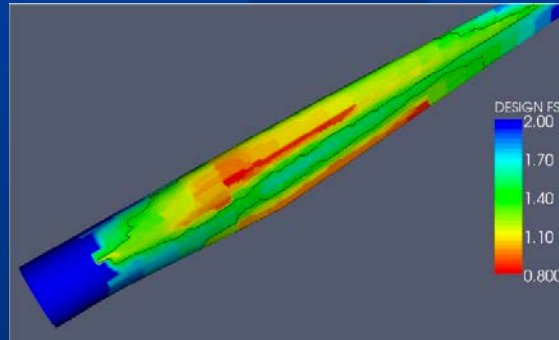
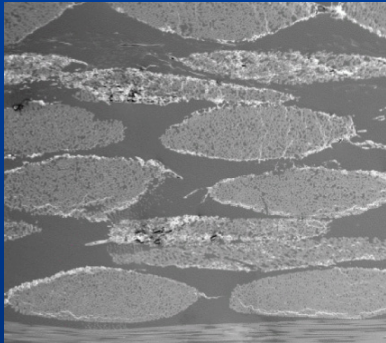
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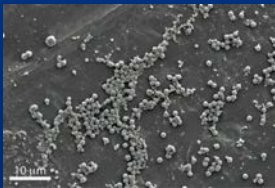
and for the technology minded

Multifunctional composite materials world of Prof. Hansen

SELF-HEALING MATERIALS FOR WIND BLADES



One of seven NASA Early Career Faculty Space Technology Research Grant.winner in 2014

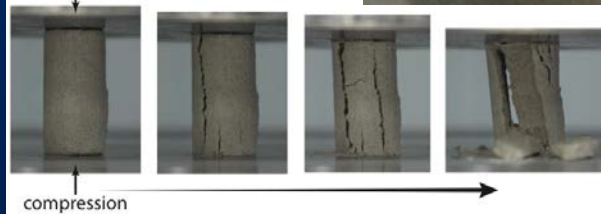


Micro-capsules containing healing liquid are able to slow or reverse damage

3D PRINTING FOR COMPOSITES



Extruded fiber for 3D Printing, ATP



... and other aerospace applications see: http://faculty.uml.edu/Christopher_Hansen/

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What else do we do?

Example: We gathered great thinkers to campus last April

To commemorate 60 years of space exploration and...

to plan our role in the future of space exploration

<https://www.uml.edu/Research/LoCSST/symposium/default.aspx>

UNIVERSITY OF MASSACHUSETTS LOWELL SPRING 2017



Space Exploration in the Upcoming Decade:
THE DOMESTICATION OF SPACE

To commemorate the 60th anniversary of the launch of Sputnik 1 and the dawning of the Space Age, UMass Lowell's Lowell Center for Space Science and Technology (LoCSST) and the Massachusetts Space Grant Consortium are hosting a two-day symposium that features NASA and space industry experts and researchers. Invited speakers include:

APRIL 21 3-9 p.m.
APRIL 22 8 a.m.-6:30 p.m.
UMass Lowell Inn & Conference Center
50 Warren Street, Lowell, MA
Open to the public

| | |
|---|--|
|  <p>Catherine (Cady) Coleman, former NASA astronaut</p> |  <p>James A. Abrahamson, former associate administrator of NASA and former director of President Ronald Reagan's Strategic Defense Initiative</p> |
|  <p>Robert D. Cabana, former NASA astronaut and current director, NASA Kennedy Space Center</p> |  <p>John Connolly, Mars Study Capability Team Lead, NASA Johnson Space Center</p> |
|  <p>Kenneth R. Sembach, astronomer and director, Space Telescope Science Institute</p> | <p>Panelists will include experts from OmniEarth, KinEX Aerospace, BAE Systems, L-3 Communications-SSG, Raytheon, Axiom Research, BoldyGo Institute and many more.</p> |

This event is open to the public.
For UML registration, contact Lynne Schaufenbil at Lynne_Schaufenbil@uml.edu.

For more information, go to www.uml.edu/Research/LoCSST/symposium.



Engineering, College of Technology of

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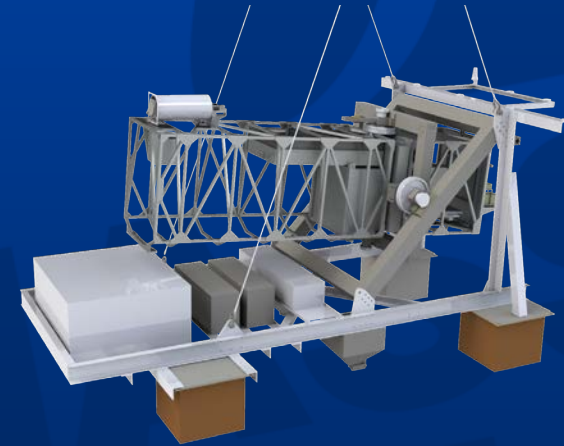
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Training and Research

Interesting problems involving our students

- ▶ New academic programs
 - Aerospace engineering minor
 - Astrophysics options
- ▶ We are still young
 - Expect faculty growth to continue
- ▶ Our next flight mission
 - A balloon experiment for exoplanetary studies
- ▶ New tools
 - A $<1 \text{ U}$ imaging spectrograph (with Jeff Baumgardner/BU)



Partnerships

Continue, strengthen and expand



- ▶ Other Universities and academic institutions
 - BU, UNH, Harvard (CfA)
 - Boston Area Exoplanet Science Meeting on December 4
 - <https://sites.google.com/view/bostonareaexoplanets/>
- ▶ MIT/Haystack
 - LITES
 - HiT&MIS and SPACE HAUC host site
 - 2018 ISR Summer school
- ▶ Industry
 - BAE
 - Helping with an instrument validation
 - BoldlyGo
 - Project Blue
- ▶ NASA Centers
 - Ames Research Lab, Wallops Flight Facility



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In summary

Lets get into trouble together

- ▶ A lot of good stuff happening
- ▶ The students are learning amazing things and doing things that we could not imagine
- ▶ In a few years we have established a thriving research center
- ▶ We are always looking for ways to work together – please come visit