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

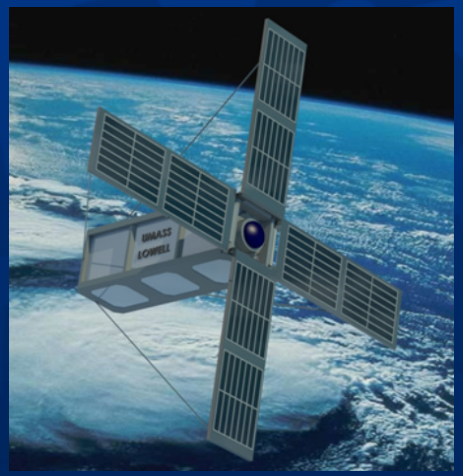
TECHNOLOGY/TOOLS

- 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

Example: SPACE HAUC

Undergraduate student-led CubeSat mission

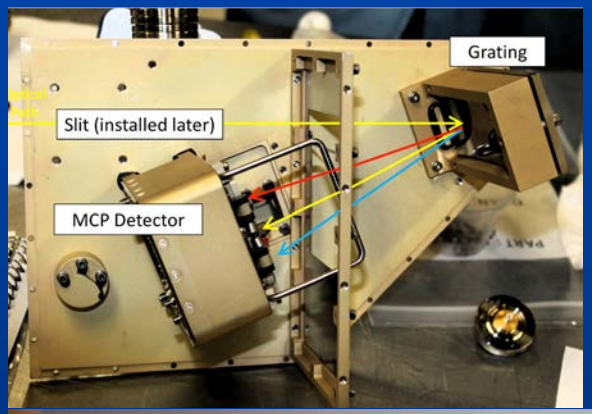
- Demonstrate the practicality of high-data rate, high frequency communications on a CubeSat
- Achieve rapid beam steering for dynamic pointing of X-band uplink/downlink
- Use phased array of patch antennas
- Camera will take high-res images of Sun to transmit back to Earth
- Launch 2018

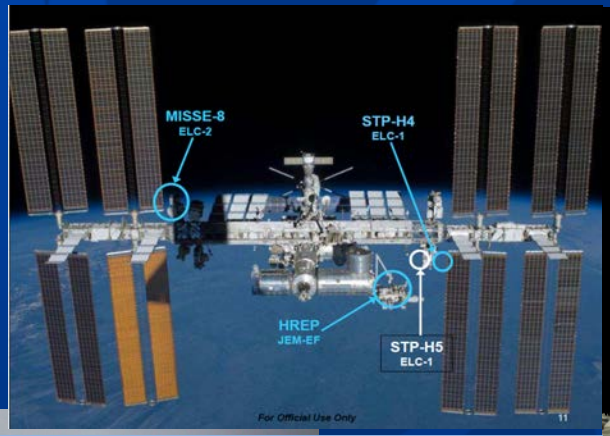


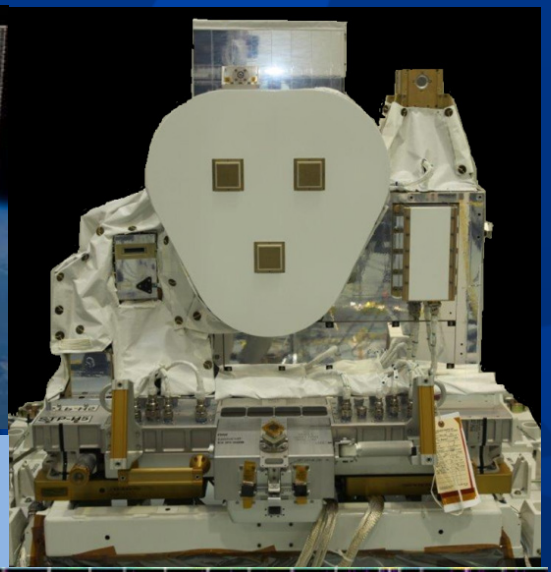
See: https://www.uml.edu/Research/LoCSST/Research/spacehauc/about.aspx

Example: LITES on ISS

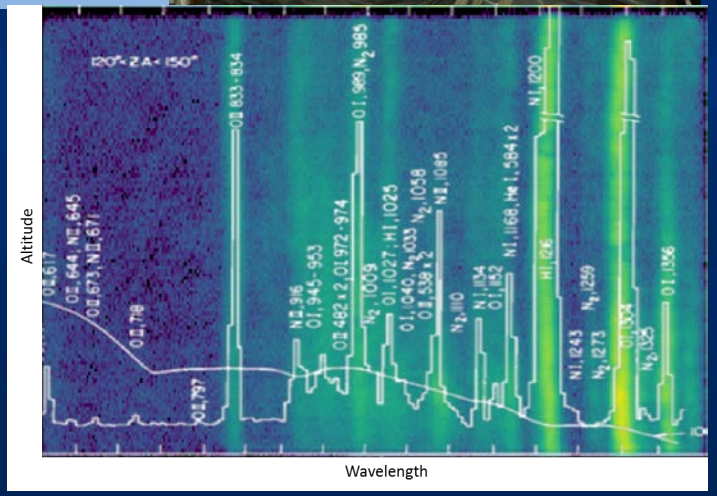
A Precursor to ICON's UV observations







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



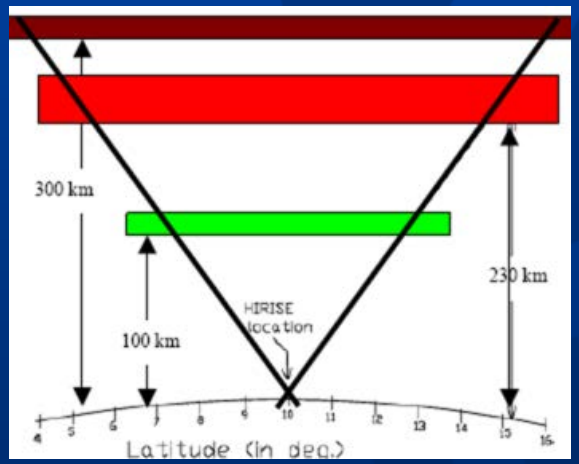
LITES: **L**imb-imaging **I**onospheric and **T**hermospheric **E**xtreme ultraviolet **S**pectrograph

Ph.D.: Geddes – check out his poster

Example: Ground-based aeronomy

Round-the-clock optical observations from Haystack

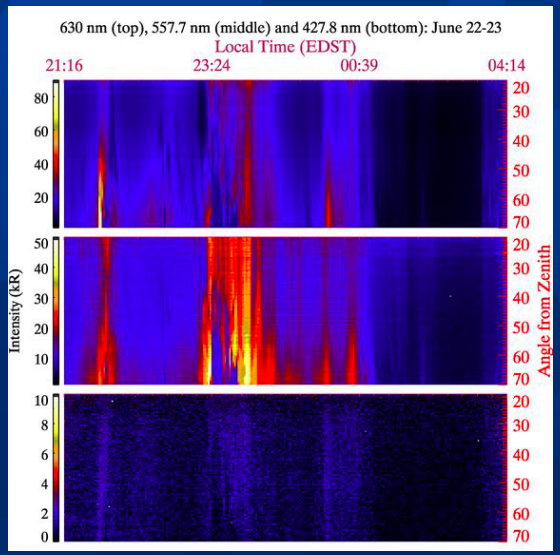
HiT&MIS: High Throughput & Multi-slit Imaging Spectrograph

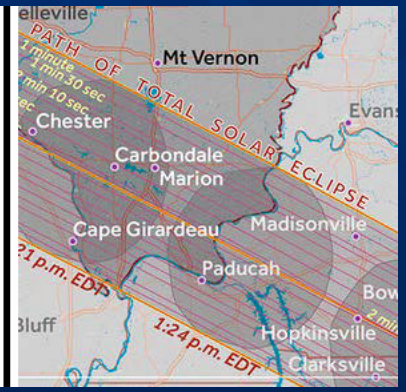


7774 Å

6300 Å

5577 Å

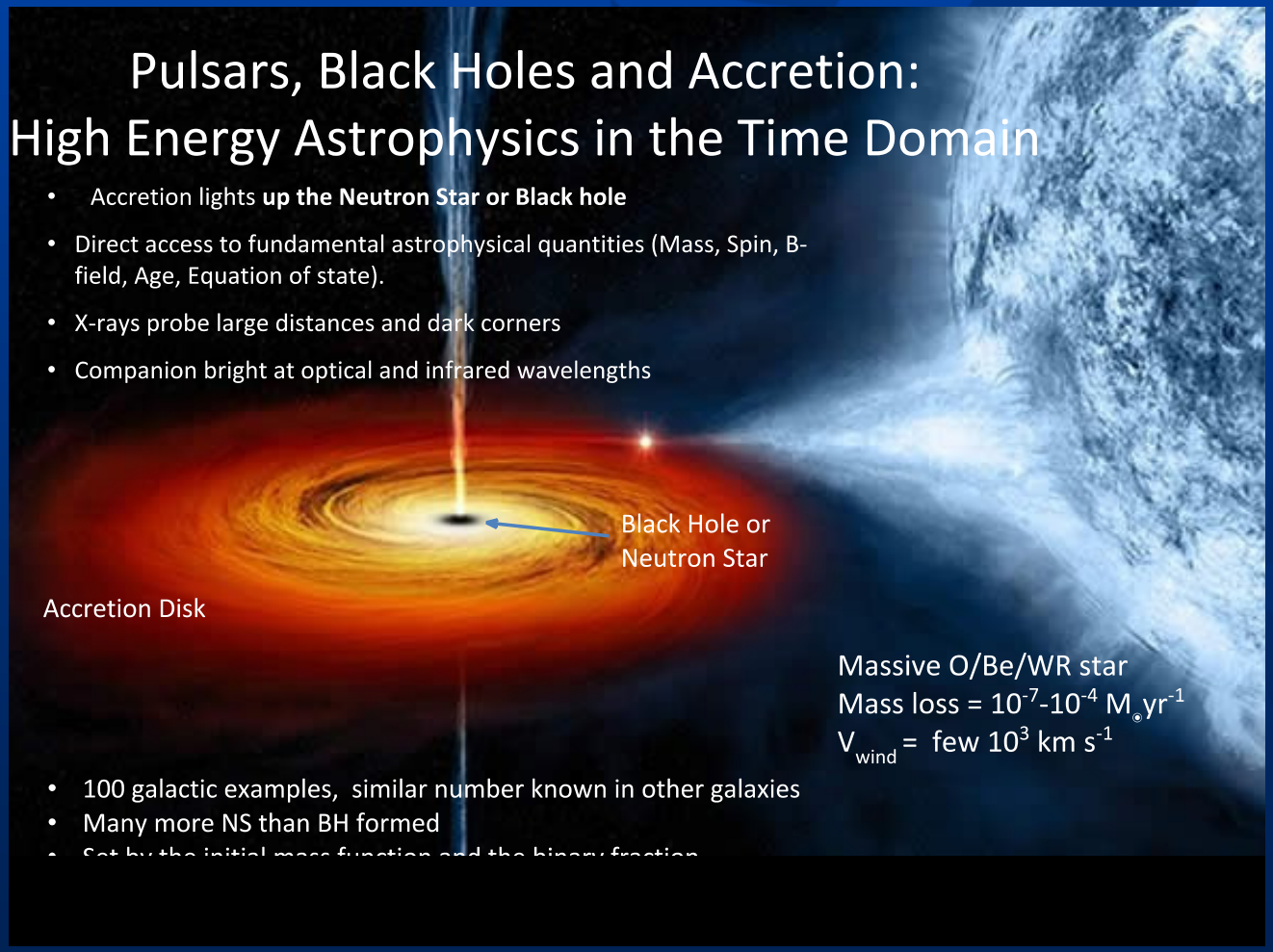




Ph.D.: Aryal – check out his poster

Example: High energy astrophysics

We work on a variety of science areas



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.

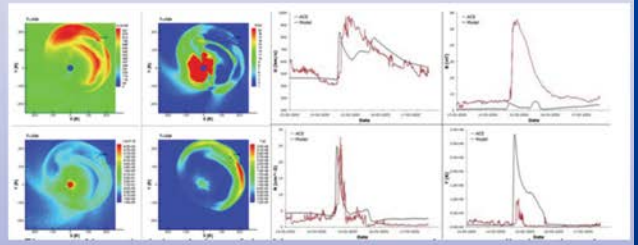
http://faculty.uml.edu/slaycock/

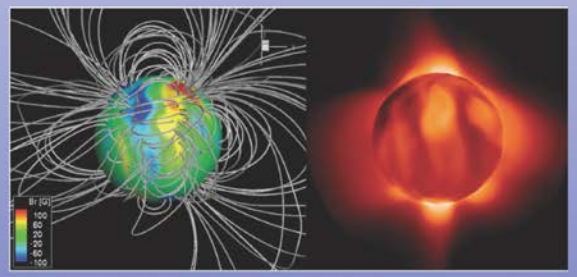
More examples

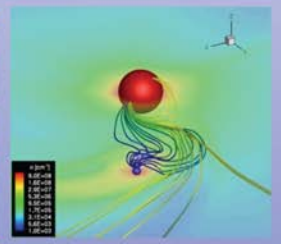
Computational studies with diverse applications

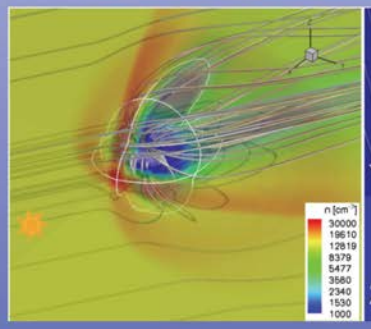
Applications of computational plasma physics:

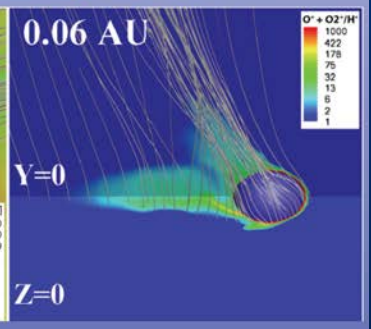
1. Solar Physics
2. Space Weather and Heliophysics
3. Stellar Astrophysics
4. Extra-solar Planets
5. Planetary Atmospheres











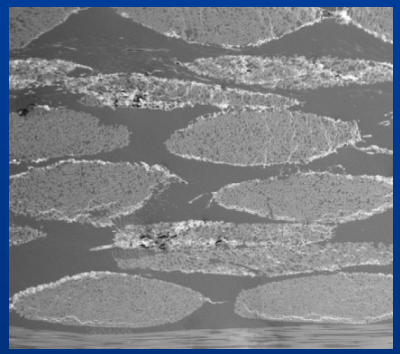
Professor Cohen's work on habitability exoplanets have been highly cited in popular press such as the National Public Radio and the Forbes magazine.

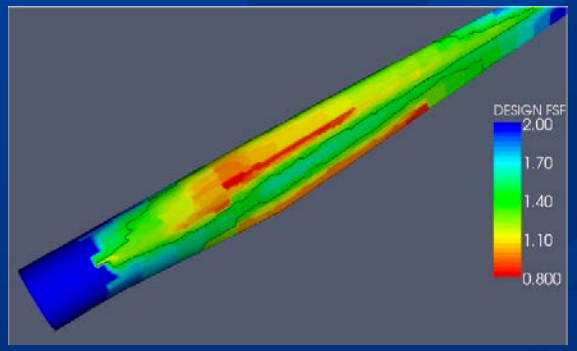
https://sites.google.com/site/ofercohenuml/group

and for the technology minded

Multifunctional composite materials world of Prof. Hansen

Self-Healing Materials for Wind Blades

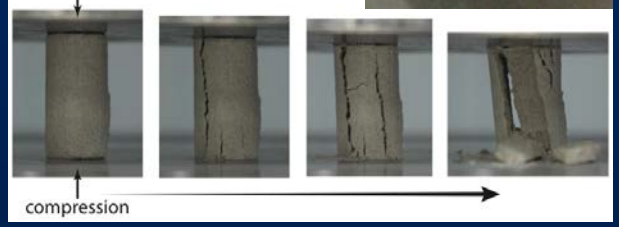




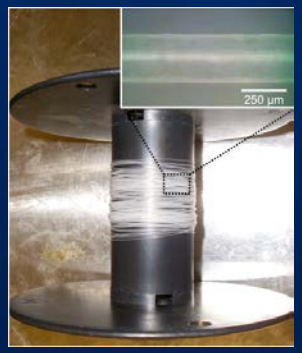
Micro-capsules containing healing liquid are able to slow or reverse damage

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

3D Printing for Composites



Extruded fiber for 3D Printing, ATP



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

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

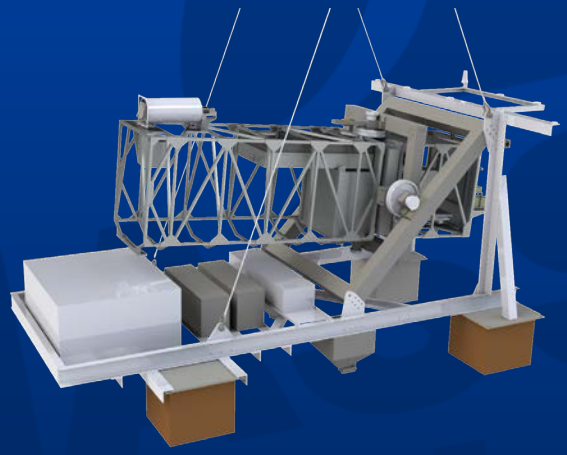
https://www.uml.edu/Research/LoCSST/symposium/default.aspx

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 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

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