Astronomy Town Hall Meeting
Nov. 2016

Topics of Discussion

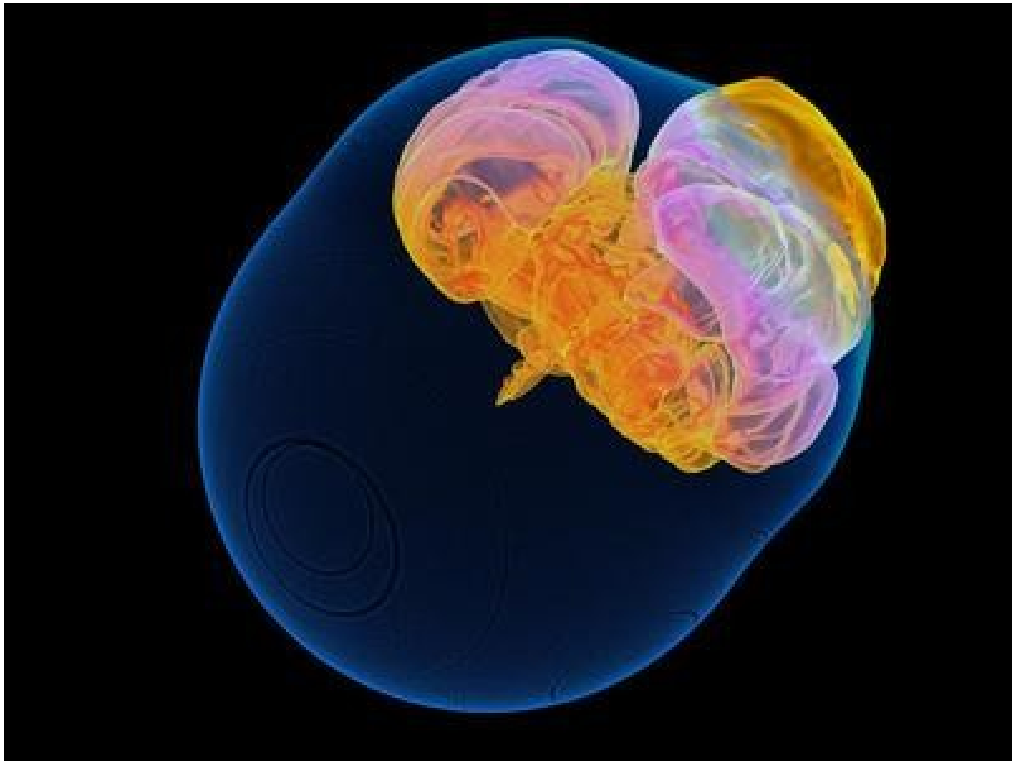
- Astronomy courses / degree requirements
- Research opportunities
- Astronomy club
- Graduate School
- Whatever is on your mind

Introduction

- The Astronomy group has 10 regular faculty + a number of active research and emeritus faculty

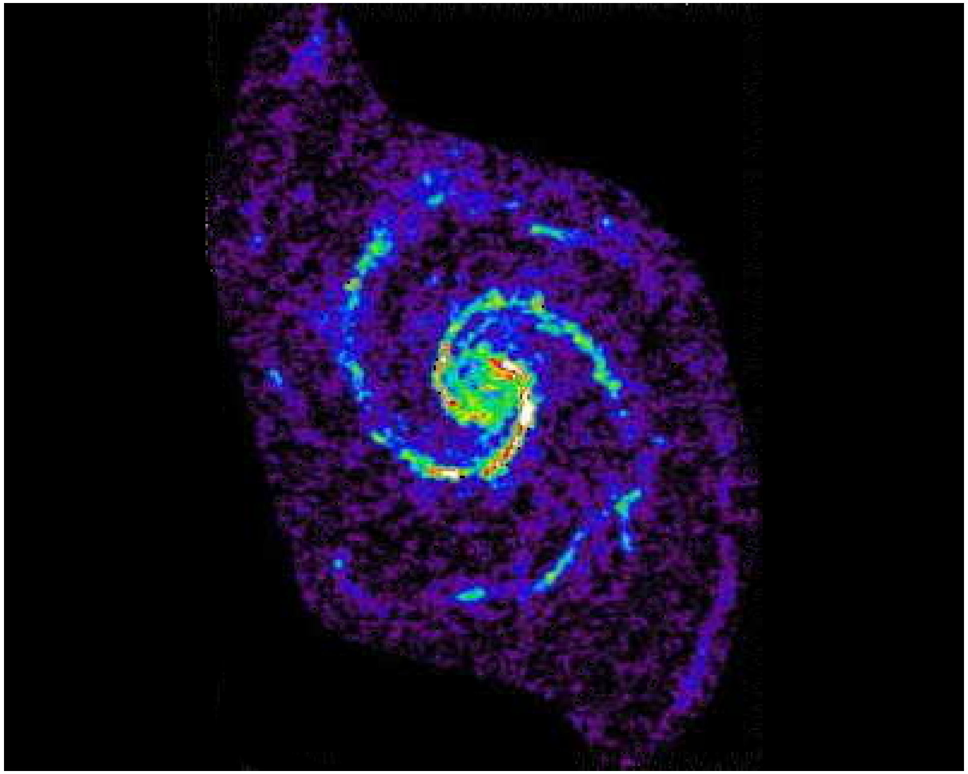
Alan Calder

Alan Calder studies a variety of nuclear astrophysics problems as well as the basic physical processes involved in these problems. He has investigated core collapse supernovae and coalescing neutron stars, events thought to be sites of r-process nucleosynthesis, and problems involving thermonuclear explosions, classical novae and thermonuclear runaway (Type Ia) supernovae in particular. Calder is also interested in the challenging problem of radiation hydrodynamics, which has numerous applications in astrophysics. His research involves large-scale, multi-physics simulations of astrophysical events, and he is very interested in the validation of codes and simulations by comparing simulations to actual laboratory experiments.



Jin Koda

The primary goal of Jin Koda's research is to understand the gas dynamical evolution of galactic disks, with an emphasis on star formation and interstellar medium (ISM) evolution. He employs both observational and theoretical approaches to explore gas structure, dynamics, and star formation over galactic disks. Jin Koda uses numerical hydrodynamic simulations and predicts the dramatic evolution of ISM structures in galactic dynamics (e.g. Wada & Koda 2004). The growth of such structures triggers star formation, controlling the formation and evolution of galactic disks. He also observes the evolutionary links among dynamics, ISM structures, and star formation. Recent and upcoming instruments are providing exciting opportunities in resolving ISM structures over global galactic disks.

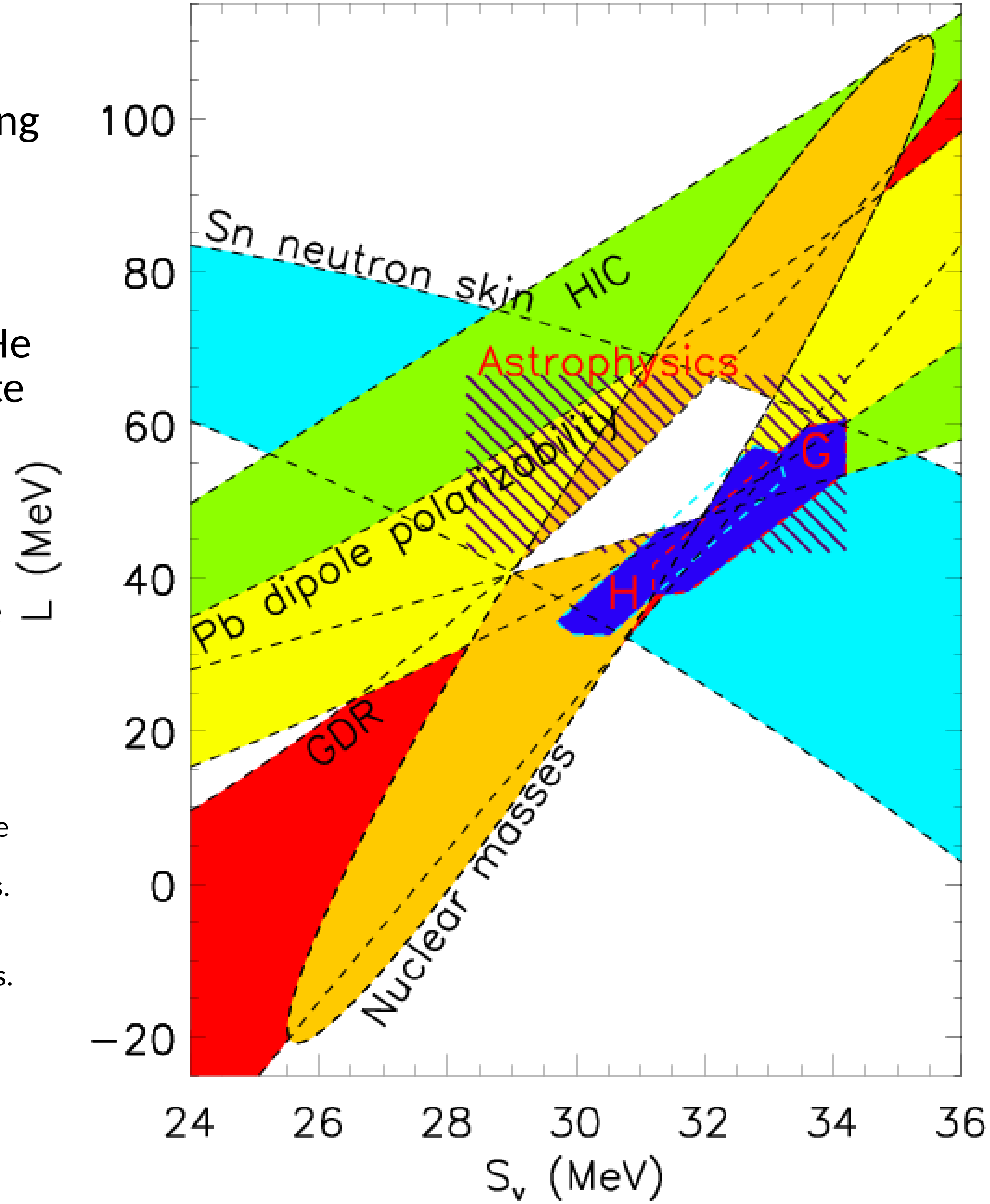


The figure shows an example—a new image of molecular gas in the Whirlpool galaxy M51 observed with the Combined Array for Research in Millimeter Astronomy (CARMA) and Nobeyama 45m telescope (NRO45). This new map reveals the ISM evolution driven by galactic dynamics: strong shear motions on spiral arms pull apart massive molecular gas associations as they cross the spiral arms, producing filamentary/spur structures in interarm regions (Koda et al. 2009). He is now leading the CARMA & NRO45 survey of nearby galaxies to establish more general picture of ISM evolution and star formation in galaxies. He is also a member of the Herschel key science project (KINGFISH -- Key Insights on Nearby Galaxies: a Far-Infrared Survey with Herschel), which will unveil the immediate sites of star formation that are hidden deeply in the dense ISM.

Jim Lattimer

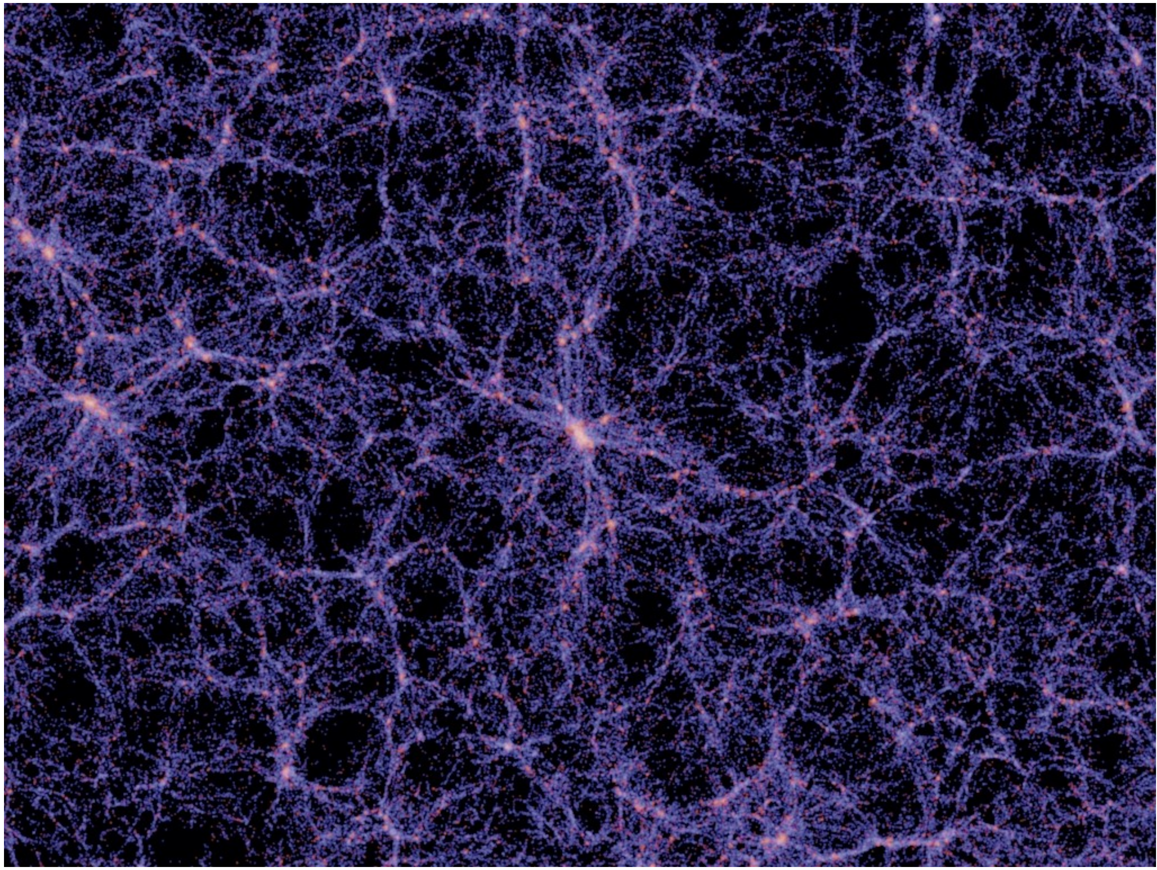
Jim Lattimer studies the structure, composition, formation and evolution of neutron stars by working at the crossroads between nuclear theory and astrophysics. He also researches gravitational collapse supernovae, the mergers of neutron star-neutron star and neutron star-black hole binaries, and neutrino emission from proto-neutron stars. He is interested in the nuclear matter equation of state and the constraints that can be placed on it by laboratory nuclear measurements as well as by pulsar-timing observations and optical and X-ray studies of neutron stars. He has published, and continues to develop, tabulated equations of state that are frequently used throughout the world in large-scale computational simulations of supernovae and neutron star mergers.

This figure shows the experimentally constrained region of parameter space for symmetry energy coefficients, showing remarkable agreement with neutron matter theory and astrophysical measurements from neutron stars. The nuclear constraints come from nuclear binding energies, dipole polarizabilities, giant dipole resonance energies, and neutron skin thickenesses, and from the composition of fragments in heavy ion collisions. The astrophysical measurements come from neutron star X-ray bursts and from thermal radiation from of recently-accreting and now-cooling neutron stars in binary systems.



Marilena Loverde

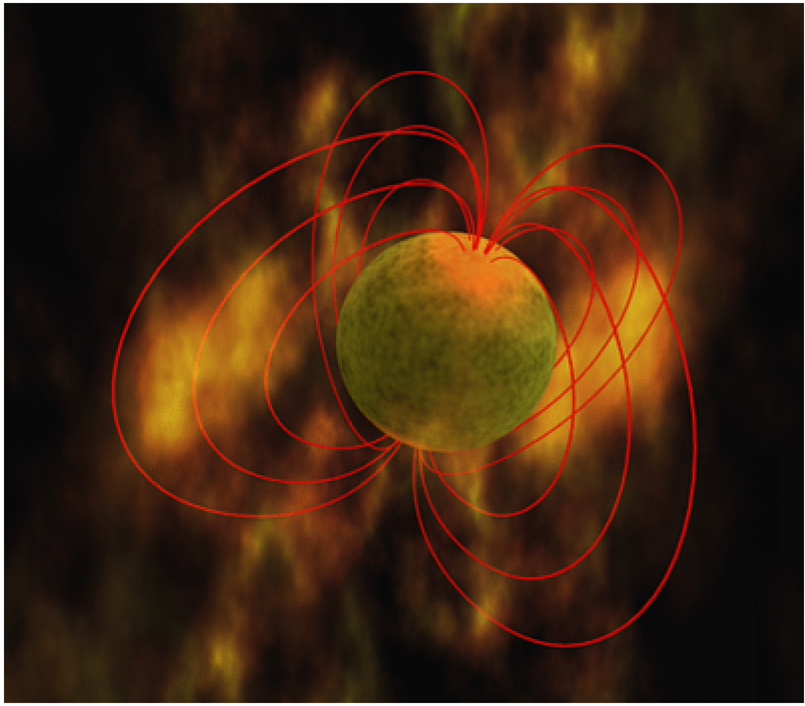
Marilena Loverde is a theoretical astrophysicist working in cosmology. Her primary interests are developing tools to use astrophysical datasets to learn about the fundamental physics of dark matter, dark energy, and inflation and to learn about the history and evolution of structure in the universe. She has worked extensively on weak gravitational lensing in galaxy surveys, primordial non-Gaussianity as a test of inflation, and massive neutrinos in cosmology (Image credit: Springel et al. 2005).



Rosalba Perna

Rosalba Perna is a theorist with eclectic research interests, including gamma-ray bursts, neutron stars, gravitational lensing, accretion phenomenena, the growth of supermassive black holes, foregrounds for CMB experiments, axions, exoplanets. In the last few years, her research has partly focused on using gamma-ray bursts as cosmological tools, to probe the physical conditions (i.e. metallicity, clumping, dust content) in high-redshift galaxies, and to put constraints on warm dark matter models for structure formation.

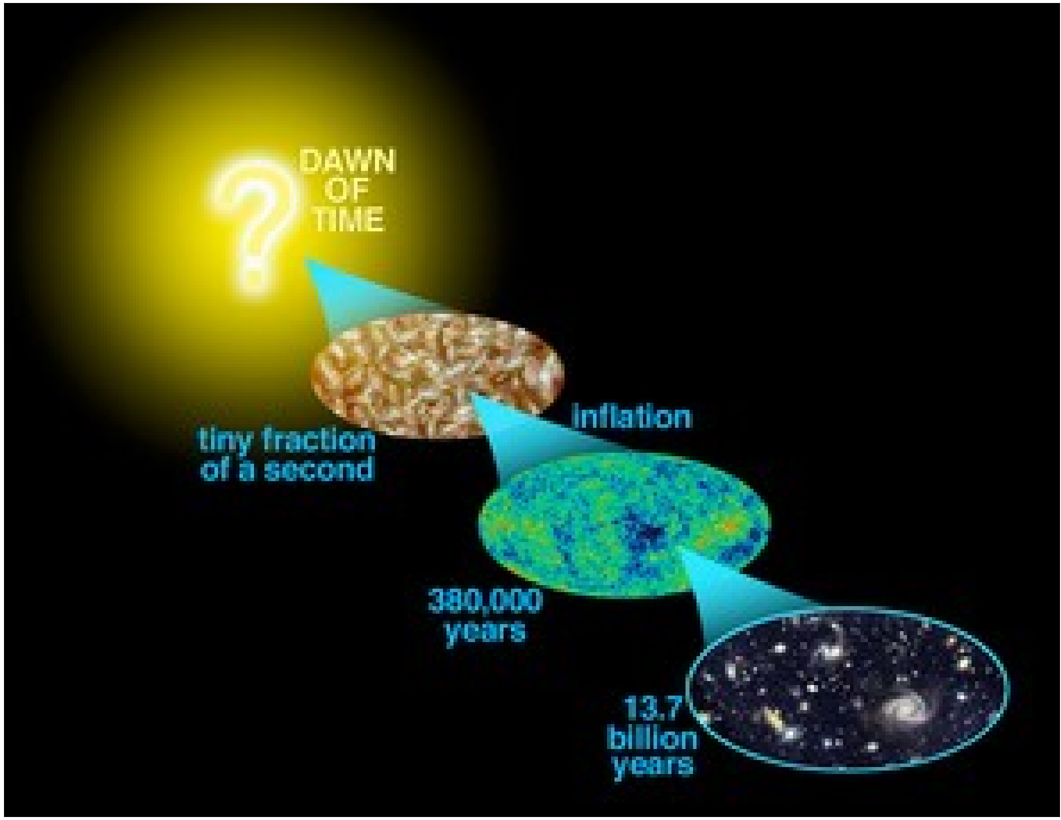
Another currently active line of research is in the area of the so-called *magnetars*, a class of neutron stars characterized by very strong magnetic fields, on the order of 10^{14}-10^{15} G. These are the most intense fields ever measured in the Universe. As the magnetic field evolves in the interior of these stars, magnetic stresses can occasionally become strong enough to break the crust, yielding *starquakes*, which trigger outbursts in gamma and X-rays. Rosalba's research aims at understanding, by means of simulations of the coupled thermal and magnetic field evolution within the neutron star crust, the role played by the magnetic field strength and topology on the observed phenomenology of these sources, and in particular on their temperature and timing evolution, and on their outburst statistics.



(image credit: NASA)

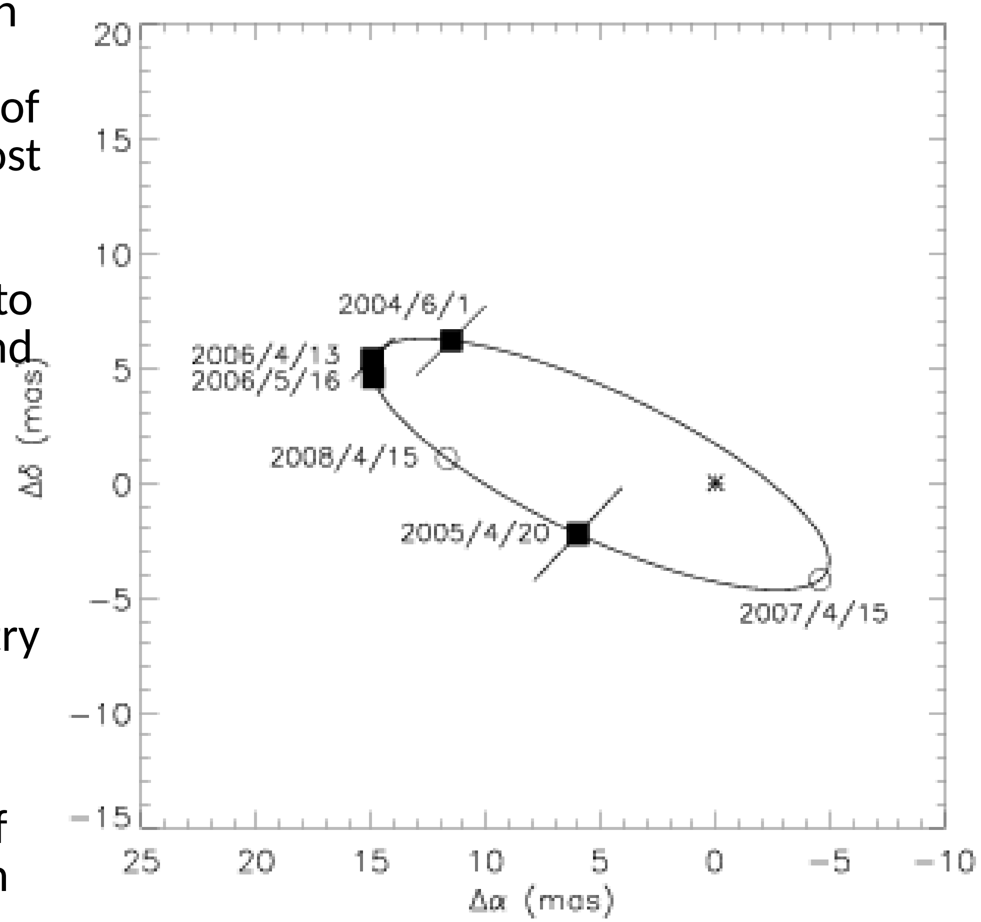
Neelima Sehgal

Neelima Sehgal's research focuses on using cosmological data to understand the nature of dark energy and dark matter, the properties of neutrinos, and the physics of the early Universe, including inflation. This is done primarily using measurements of the Cosmic Microwave Background (CMB), and Stony Brook is actively involved in the ACTPol Collaboration, which measures the CMB from a ground-based telescope in the Atacama Desert in Chile. Neelima's group is primary interested in exploiting the gravitational lensing signal in the CMB to measure the mass of neutrinos, and in measuring the polarization signal in the CMB to look for signatures of inflation.



Michal Simon

Mike Simon is interested in the formation of stars, brown dwarfs, and planets, and more specifically in the processes and circumstances that govern the formation of binaries and higher order multiples. At present, he is most involved in using dynamical methods to measure the masses of young stars to measure the masses of very young stars with high precision. The goal of this work is to calibrate calculations of pre-main sequence evolution and thus to improve the accuracy of mass and age estimates of young stars from their location in the HR diagram. Increasingly, this work is leading to similar studies of brown dwarfs. His research uses state-of-the-art instrumentation in several areas of astronomy (e.g. IR spectroscopy, adaptive optics imaging, and interferometry at Gemini and Keck Observatories, mm-wave interferometry at IRAM and ALMA). This research is almost always collaborative and offers students the opportunity to work with instruments at the forefront of modern astronomy and with scientists who are expert in their use.



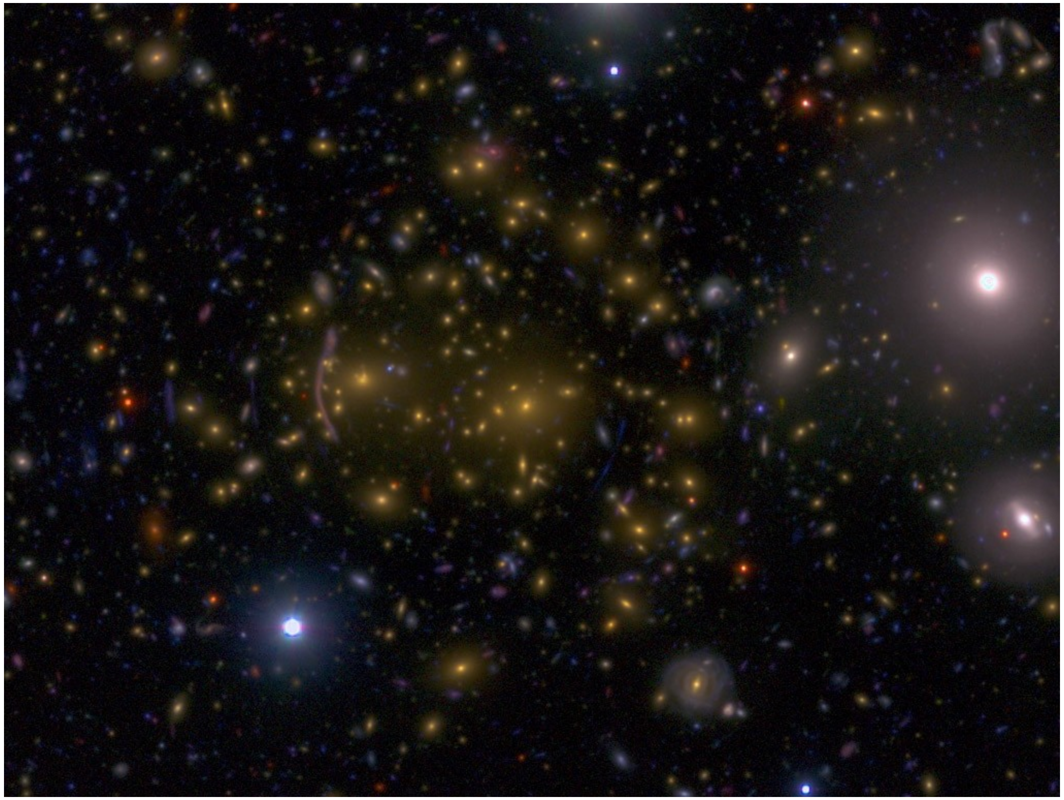
Doug Swesty

Doug Swesty is interested in a variety of nuclear astrophysical and radiation-hydrodynamic phenomena. He is working on neutrino radiation-hydrodynamic models of stellar core-collapse and type II supernova explosions. This work utilizes large-scale parallel computers to carry out high-resolution models of the neutrino-radiating fluid that is present in proto-neutron stars formed at the endpoint of the collapse of a massive stellar core.

His research also focuses on the role of the equation of state of hot, dense matter in facilitating the supernova explosion associated with the stellar core collapse. Swesty also actively works with colleagues at national laboratories, such as Lawrence Livermore National Laboratory, on the development of new radiation transport and radiation-hydrodynamic algorithms and codes. This includes the development of verification tests as well as validation testing strategies using data from high energy density laboratory experiments.

Anja von der Linden

Anja von der Linden uses observations of galaxy clusters, the largest gravitationally bound objects in the Universe, to help answer fundamental questions about our Universe: What is it made of? What are dark matter and dark energy? How do galaxies evolve? She specializes in using weak gravitational lensing to accurately calibrate cluster mass measurements, a crucial step in using clusters as cosmological probes. Her Weighing the Giants project enabled the highest precision cosmology constraints from clusters to-date, including some of the tightest constraints on the nature of dark energy from a single probe. She continues this work within the LSST Dark Energy Science Collaboration, where she is currently co-convener of the Clusters working group, and a member of the Collaboration Council. von der Linden is also interested in the physics of galaxy clusters, such as the dynamics of merging clusters, as well as the properties and evolution of cluster galaxies.



Fred Walter

Fred Walter has eclectic interests in galactic astronomy. His main interests are in star formation in the Galaxy, stellar coronae and chromospheres, and compact objects. The overarching theme to his present research is the astrophysics of accretion, from star formation (T Tauri stars), to white dwarfs (polars and novae). He is a multiwavelength observer, working in X-rays (Chandra and XMM), UV (FUSE), optical (HST; SMARTS) and the near-IR (IRTF). Current projects include: Accretion and activity in the T Tauri stars S CrA and RU Lupi, The eruptive pre-main sequence stars (EXORs) V1118 Ori and V1647 Ori, Spectrophotometry of recent novae, including YY Dor and N LMC 2005, Coronal structure in rapidly rotating stars: XY UMa and V471 Tau, Star formation in OB associations, concentrating on the low mass stars and brown dwarfs in the Orion OB1 association, properties of isolated neutron stars, activity cycles in magnetic cataclysmic variables (POLARS)

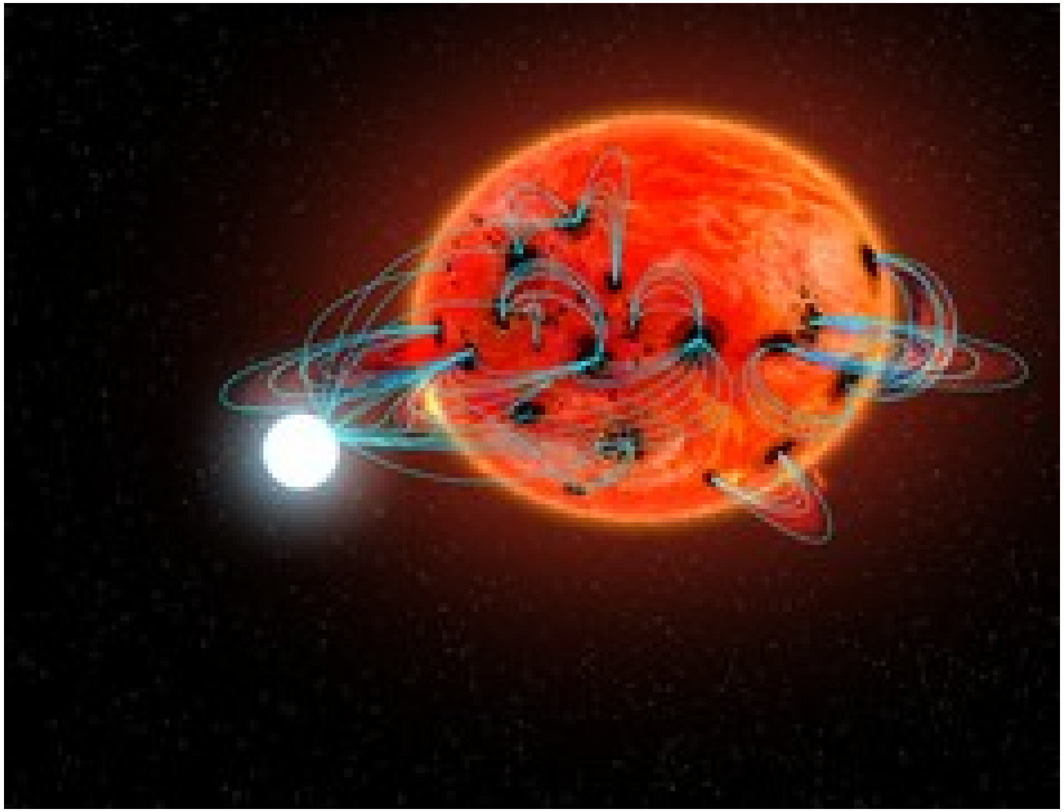
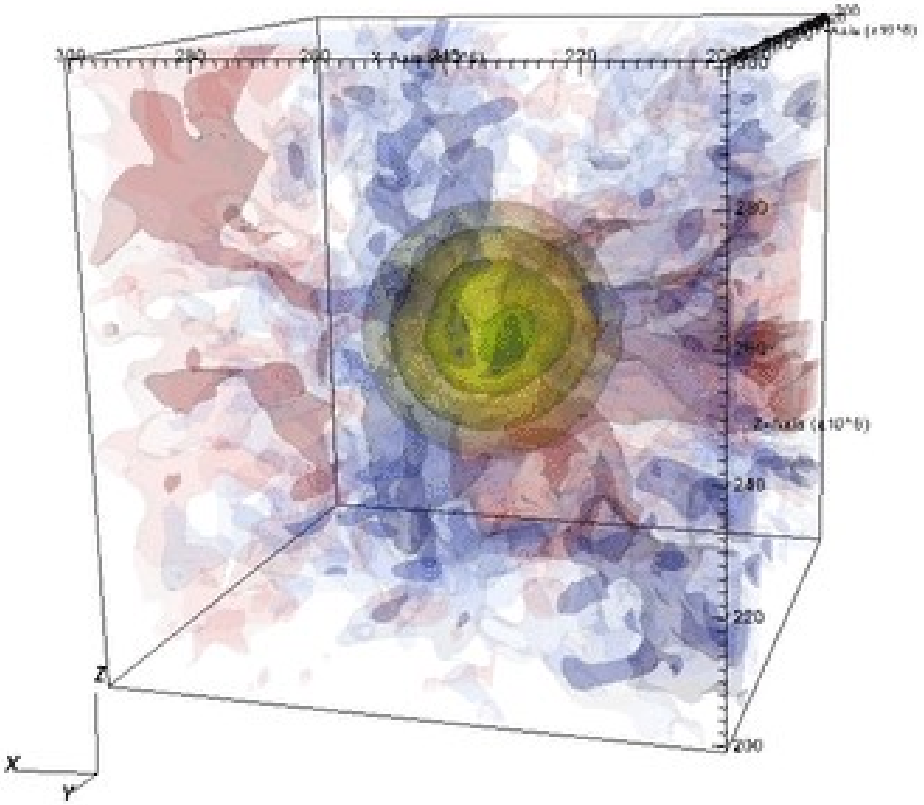


image credit: Stella Kafka/CTIO)

Michael Zingale

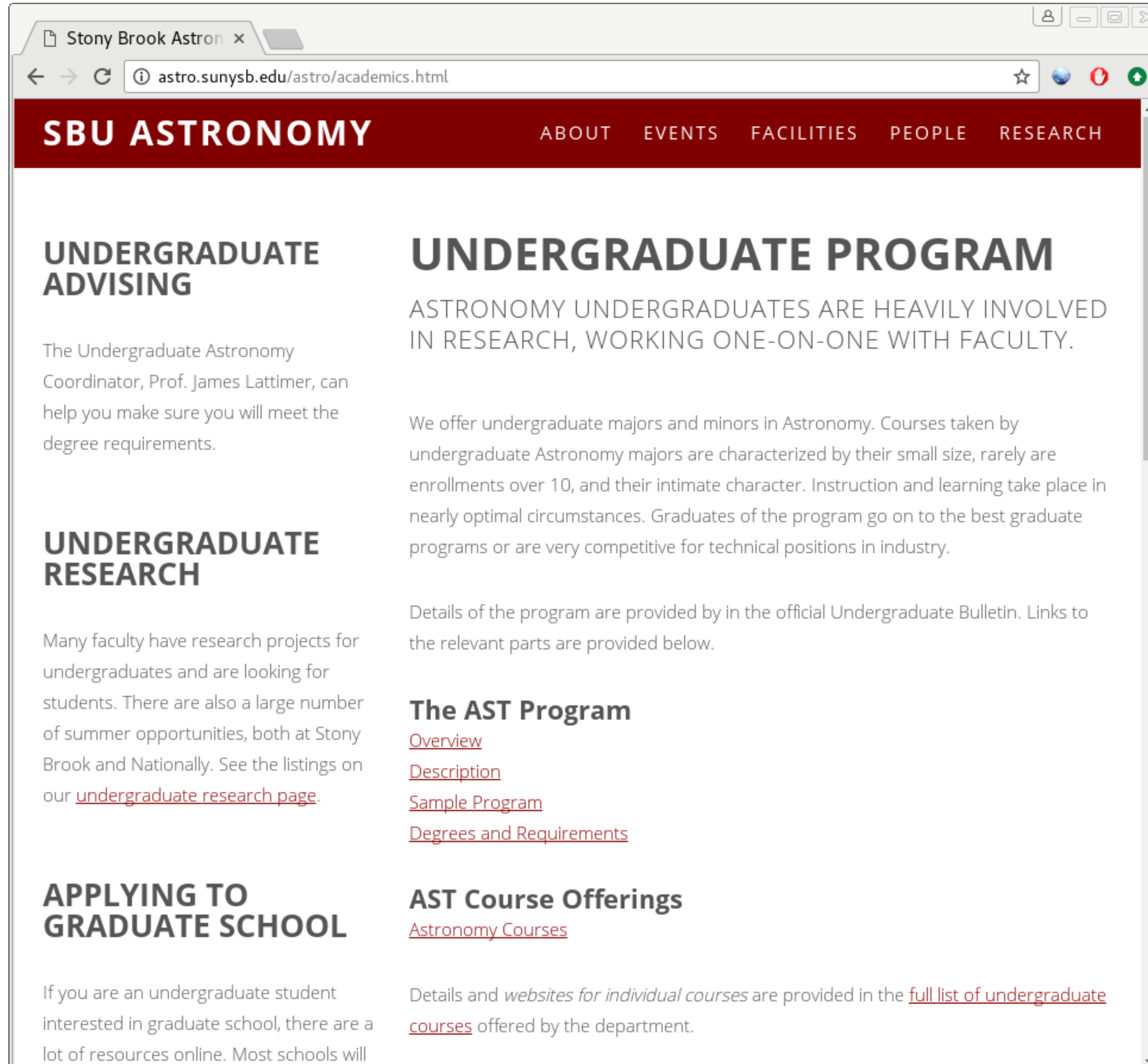
Mike Zingale is interested in computational and nuclear astrophysics, in particular the development of computational methods appropriate to modeling Type Ia supernovae, Type I X-ray bursts, and Classical novae. Type Ia supernovae are the largest thermonuclear explosions in the Universe. The physical processes leading up to the explosion involve a wide range of length and timescales, making these events extremely challenging to simulate. Working with colleagues at LBL, Zingale has developed a low Mach number hydrodynamic code, Maestro and compressible radiation hydrodynamics code, Castro. Together these codes can model both the subsonic and explosive phases that arise in these system. Maestro filters soundwaves from the system, allowing for the efficient simulation of long timescale processes, such as astrophysical convection. This method was recently used to model the final hours of 'smoldering' preceding the explosion of a Type Ia supernovae. This type of calculation is critical to determining the distribution of the initial flames for the subsequent explosion. Current applications include the convection in sub-Chandra models of SNe Ia and X-ray bursts. Castro is the main code for our merging white dwarf studies. Both codes are freely available for use.



UG Astro Program

http://astro.sunysb.edu/astro/academics.html

- Links to the UG bulletin with degree requirements
- Links to research opportunities
- Information about graduate school



Astronomy Courses

- AST 203 offered every Spring; is the prerequisite for most classes
- AST 205 offered every Fall (order with AST 203 doesn't matter)
- AST 34x-level classes offered on a 2-year cycle—plan ahead
- Many students take AST 443 (Observational Techniques) to satisfy major requirements
  - *Can be used in place of the senior Physics lab* (PHY 445) if you are a double major (note: if you plan to later do the MAT in Physics, then you will need to take the Physics lab)
- Many students also do research or reading classes to satisfy major requirements—plan ahead
  - You need to find an advisor who agrees to mentor you for this.
  - You may not find someone willing to do 3 credits in one semester.
- Physics major and Astronomy major are closely related—many students double major
- Talk to Prof. Lattimer for information about the major

Astronomy Degree

- Major requirements:
  - AST 203
  - AST 341 (stars and radiation); AST 346 (galaxies); AST 347 (cosmology)
  - 6 credits from AST 205 or higher (except: AST 248, PHY 277, AST 301, AST 389, AST 475)
    - Popular combinations: AST 443 (observational techniques) + AST 205 (planetary science)
    - Either AST 443 or AST 205 + 3 credits/semesters of research
    - We will also accept PHY 408 (Modern Relativity) here
  - PHY intro sequence
  - PHY 251/2 (modern physics)
  - PHY 277 (computation)
  - PHY 300 (waves)
  - PHY 306 (thermal physics)
  - 8 credits from advanced physics courses
  - MAT 131 and 132 or similar sequence
  - MAT 203 or 205 or 307 or AMS 261 (calc III)
  - MAT 303 or 305 or 308 or AMS 361 (calc IV)
- Note: no more than 3 classes with a grade of C− may be applied to the major
- Practical note: you need AST 203 by Spring of your sophomore year to finish in 4 years

34x Sequence

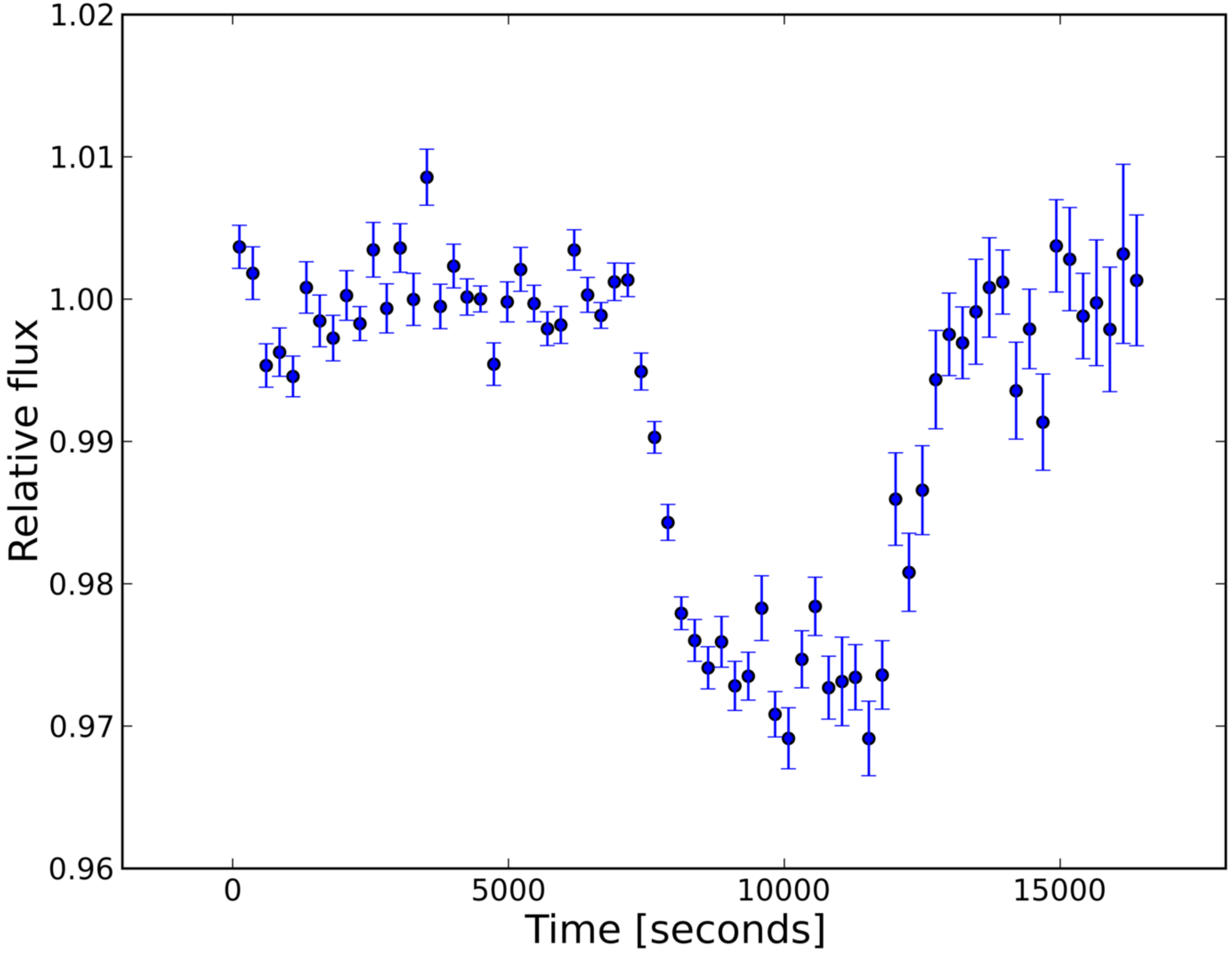
- AST 341 (Stars & Radiation):
  - Fall 2016
  - Fall 2018
- AST 346 (Galaxies):
  - Spring 2017
  - Spring 2019
- AST 347 (Cosmology):
  - Fall 2017
  - Fall 2019
- AST 349 (special topics):
  - Spring 2018
  - Spring 2020

proposed

34x Sequence

- AST 349: Special Topics
  - This course could substitute one of the other AST 34x courses
  - Potential topics:
    - Black Holes and Neutron Stars
    - Computational Astrophysics (follow-on to PHY 277)
    - Exoplanets
    - Gravitational Wave Astrophysics
    - Radio Astronomy
    - …
  - Thoughts?

Observational Techniques



Lightcurve of transiting exoplanet around HD189733—data taken by students in AST 443 from our rooftop telescope!

PHY 277 as a Prereq?

- It has been proposed to make PHY 277 a prereq for the upper level AST classes—thoughts?

Astronomy Degree

- In addition to the courses, there is a writing requirement

Students are certified as satisfying the upper-division writing requirement by registering for the 0-credit AST 459 and completing writing projects within their major. All students majoring in Astronomy/ Planetary Sciences must submit two papers (term papers or independent research papers) to the Astronomy coordinator for Department evaluation by the end of the junior year. If this evaluation is satisfactory, the student will have fulfilled the upper- division writing requirement. Papers should be written in the form of a journal article. All papers must consist of an abstract, introduction, main content, and references. References should be cited throughout the text. Any figures should be numbered and have an appropriate caption. If you are using a lab report for the basis of this requirement, you should expand upon the introduction and describe the connection to topical scientific research.

A typical length should be 10 pages (double spaced, 11-point font) plus references, preferably written in LaTeX.

Students should consult with the department advisor to ensure that their plan for completing the Upper Division Writing Requirement is consistent with university graduation requirements for General Education. Students completing the Stony Brook Curriculum (SBC) must complete a course that satisfies the "Write Effectively within One's Discipline" (WRTD) learning objective to graduate. The Upper Division Writing Requirement is consistent in most cases with the SBC learning outcomes for WRTD.

  - Don't wait until the very last semester just before graduation to turn these in...

SBC Requirements

- We require 2 upper-level writing papers. To get credit, you must register for AST 449 and then AST 459
  - One for each requirement
  - AST and PHY+AST double majors should register for AST 449 when they submit their first paper, and then register for AST 459 or PHY 459 to complete their second paper.
  - This ensures all University requirements (WRTD) are fulfilled
- You really should complete these *before* your senior year
  - Often changes are requested to the papers
  - Waiting until the last minute can put your graduation in jeopardy
- Students can take the 1-credit AST 100 to satisfy the SPK requirement

Honors

- In your Junior year, you can apply to become a candidate for Departmental honors
  - Need to complete a thesis as part of your research coursework
  - Need to register for AST 447 or AST 487
    - You will want to have an faculty mentor lined up at this point.
  - Need a GPA of 3.3 or higher in math/natural sciences
- Note: in order for your thesis to count as part of your writing requirement you have to submit it separately as a writing requirement paper. This is not automatic.

Research Opportunities

- AST 200 (Current Astronomical Research at Stony Brook) is a good way to see what research is taking place here
- PHY 277 (Computation for Physics and Astronomy) provides a good basis for the tools you will need to do research
- Local opportunities
  - Knock on doors
  - Talk to fellow students
  - Look at the UG section of the Astro Group webpage
- UG student office (back of ESS 437) available to research-active students
- Course credit:
  - AST 287: Introductory Research
  - AST 345: Undergraduate Research
  - AST 447: Senior Tutorial
  - AST 475: Teaching Practicum (not for major credit though)
  - AST 487: Senior Research

External Research Opportunities

- NSF REU program
  - Provides stipend and travel expenses for ~10 week research experience at a University in the US.
  - Previous SBU students went to Hawaii, Harvard, Texas, SF, …
  - Highly competitive
  - applications due in Dec./Jan.
- Many other summer opportunities exist—look at the UG webpage
- Typically application requires: transcript, 2 – 3 letters of recommendation, statement of interests

Graduate School

- Apply during senior year
- Both Physics and Astronomy programs and Astronomy/Astrophysics program
- Strong application:
  - GPA
  - Letters of reference
  - Research experience
  - Physics GREs + general GREs are not as important to all programs
- PhD graduate students are fully supported
  - Teaching/research assistant with annual stipend (~$29,000) + tuition waiver
- ~ 4 – 6 years to get degree (sometimes shorter, sometimes longer)
- If you think you might be interested in graduate school, talk to some of our grad students—they're friendly!

Timeline

- Applications are due in winter of your senior year
  - You'll hear in March-ish
  - Deadline to make a choice is typically April 15th of your senior year

Physics GREs

- Dates (https://www.ets.org/gre/subject/register/centers_dates/)
  - 09/27/14
  - 10/25/14
  - 04/18/15
- Content (https://www.ets.org/gre/subject/about/content/physics)
  - Classical mechanics: 20%
  - E&M: 18%
  - Optics and waves: 9%
  - Thermo and stat mech: 10%
  - Quantum: 12%
  - Atomic physics: 10%
  - Special relativity: 6%
  - Laboratory methods: 6%
  - Specialized topics: 9%

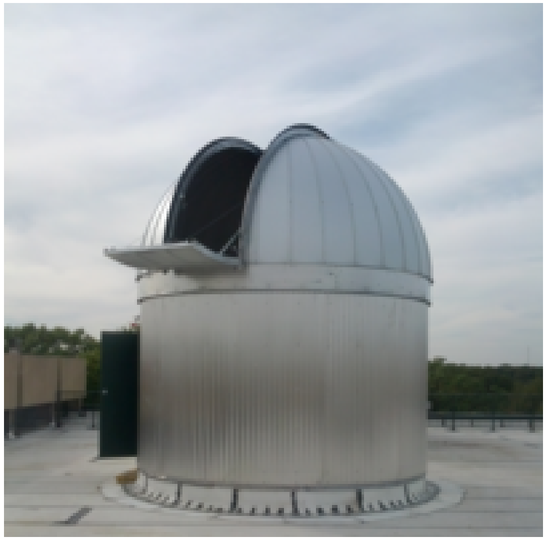
You may not have had all the upper level courses on these topics by the time you take the exam. Plan your schedule as best as you can and look over the practice exams.

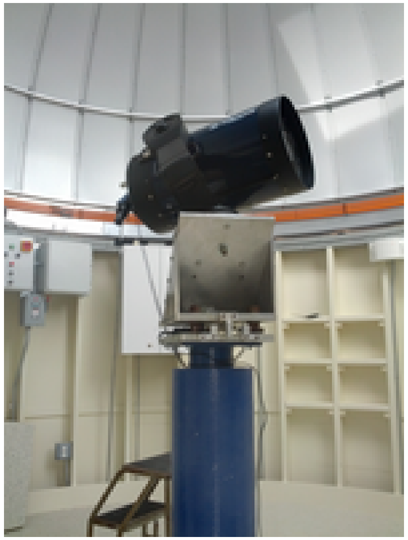
Careers

- Astronomy research provides students with the skills to do data analysis, software/algorithm design, and problem solving
  - Not every path requires a graduate degree
- Career paths
  - Academic (all levels: grade school through high school, college & university)
  - Industry
    - Astro related
    - Software
    - Financial
    - …
  - National observatories
  - National Laboratories
  - Museums/Planetariums
  - Journalism
  - …

Undergraduate Astronomy Club

- Revived ~2010
- Run observing sessions
- Use rooftop telescope (and know how to use it better than the faculty)
- Help with open nights
- Annual AstroFest



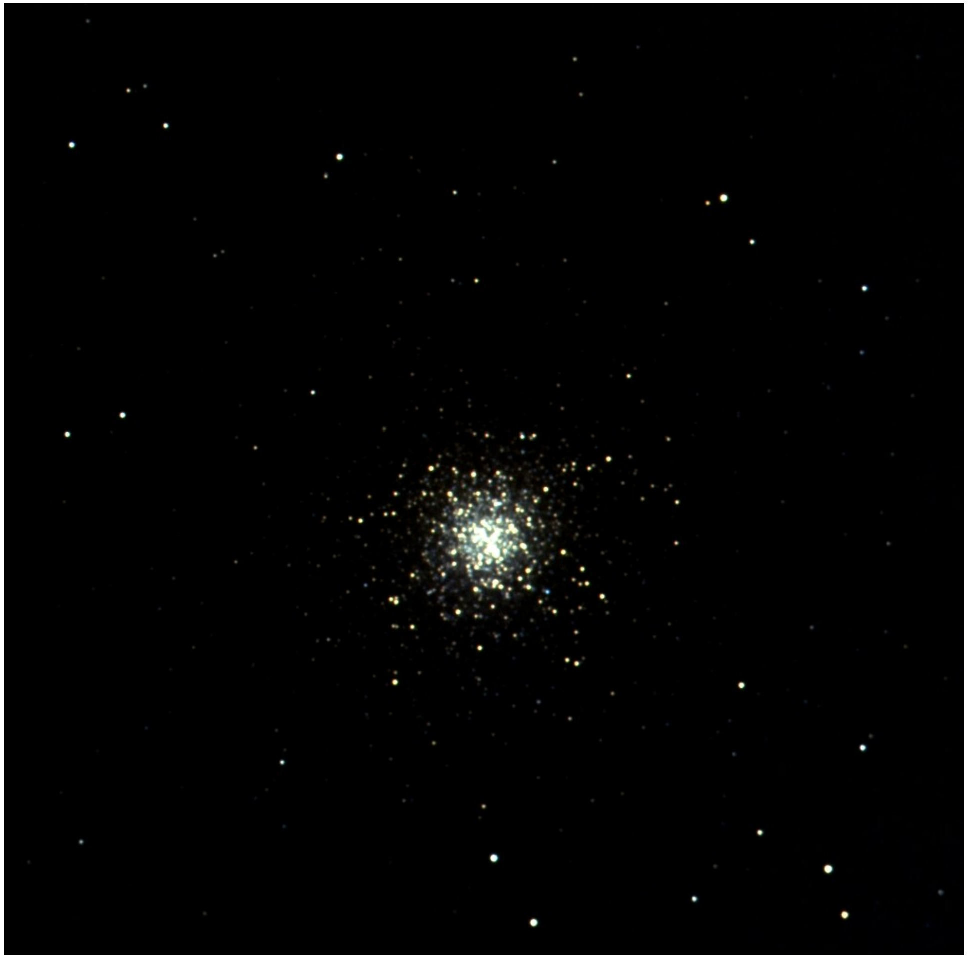



Mt. Stony Brook Observatory

Bodes Galaxy (M81), exposed for roughly 40 minutes combined in B, V, and H_alpha filters. (image: Matt Wahl)

M42: the Orion Nebula (image: Matt Wahl)

Mt. Stony Brook Observatory



M13: a globular cluster made up of roughly half a million stars, notice the different color stars within the cluster (image: Matt Wahl)

M57: The Ring Nebula—a planetary nebula formed when the exterior layer of a red giant star expands out into space. (20mins each in B V and H_alpha filters; image: Matt Wahl)