SCHEDULE and Abstracts: ASNY Session Saturday, Nov 11

12:30 -1:30	**ASNY Poster Session II (Olin Rotunda)**

ASNY Talks	Olin 115
1:30 - 2:00	**ASNY Graduate Student Prize Talk** Sarah Pearson Columbia ***The Milky Way's Galactic bar can punch holes in stellar streams***
2:00 – 2:30	**ASNY Undergraduate Student Prize Talk** Briley Lewis Columbia ***Direct Imaging of Exoplanets with Project 1640***
2:30- 2:45	Break
2:45-3:00	Yashashree Jadhav RIT ***Monsters on the move: Gravitational wave recoiling supermassive black hole candidates***
3:00 – 3:15	Joe Patterson Columbia ***Gravitational radiation as the driver in ultracompact binaries***
3:15 – 3:30	Kevin Cooke RIT ***Ancestors of the Brightest Cluster Galaxies***
3:30 – 3:45	Chi Nguyen RIT ***Cosmic Background Infrared ExpeRiment 2: Probing Structure Formation with Near-Infrared Fluctuations***
3:45 - 4:00	Phil Nicholson Cornell **Cassini's Grand Finale**

The Milky Way's Galactic bar can punch holes in stellar streams

Sarah Pearson
Columbia University

As clusters of stars orbit our own Milky Way, a gravitational tidal interaction unfolds and the clusters tear apart into distinct morphological and kinematic structures. From our detailed understanding of gravity, the distribution and motions of these stellar structures enable us to work backwards in time and thereby study our Milky Way's past and evolution. Palomar 5 is an old cluster of stars orbiting our Galaxy, while disrupting into thin leading and trailing stellar arms. It is located ~16 kpc (~52000 light years) above the Galactic plane. In this talk, I will show that a previous encounter between the stream and the Milky Way's Galactic bar (which is a collection of billions of stars coherently rotating in the plane of our Galaxy) has punched a hole in the stream which can explain why the leading arm of Palomar 5 appears to be a lot shorter than the trailing arm. The discovery that the bar can punch holes in stellar streams has important implications for cosmology, which predicts that our Galaxy should be filled with dark matter subhalos of various sizes. One proposed method to detect the dark matter subhalos, is to search for them through disturbances in the structure of stellar streams. My work demonstrates that the Galactic bar can create holes of very similar appearance to those created if dark matter subhalos pass through or close by stellar streams. I therefore caution that we should not necessarily interpret the holes in stellar streams as evidence of the existence of dark matter subhalos. Additionally, I will demonstrate how the Galactic bar's interaction with the Palomar 5 stream provides an intriguing methodology for studying our own Milky Way's Galactic bar in more detail.

Direct Imaging of Exoplanets with Project 1640

Briley Lewis
Columbia

Project 1640 (referred to as P1640) is a suite of instrumentation and software focused on high-contrast imaging of exoplanets, probing the parameter space of companion size $> 1M_J$ and distance 5-50 AU around the host stars. The instrument consists of an apodized Lyot coronagraph, with a Mach-Zender interferometer and an integral field spectrograph, forming data cubes of dimensions right ascension, declination, and wavelength. P1640 is operated at Palomar Observatory in Southern California, in conjunction with their PALM-3000 adaptive optics system. Data reduction models out remaining speckle noise using principle component analysis and produces a residual cube, which can then be manually inspected for possible companions. For this project, data reduction using the Karhunen-Loéve Image Projection (KLIP) algorithm was completed on many of the survey stars and inspected, in an effort to search for more candidates. At this time, one candidate object and multiple previously undiscovered binary systems have been discovered and are undergoing further analysis to characterize them based on their spectra, photometry, and astrometry.

Monsters on the move: Gravitational wave recoiling supermassive black hole candidates

Yashashree Jadhav
RIT

There is compelling evidence that supermassive SMBH (SMBH) reside at the centers of all large galaxies and are the gravitational ‘engines’ of Active Galactic Nuclei (AGN). Mergers between galaxies are thought to have played a fundamental role in the growth and evolution of the largest galaxies in the nearby universe. A galaxy merger leads to the formation of an SMBH binary, which eventually coalescences through the emission of gravitational waves and receives a gravitational recoil kick (up to several 1000km/s). This recoil in turn causes the merged SMBH to oscillate (up to ~1 Gyr) in the gravitational potential well of the galaxy. During this time, the recoiling SMBH may be observed as a ‘displaced’ AGN. These events are a strong test of gravitational physics and merger frequency of binary SMBH. Recoiling SMBH can be detected via electromagnetic signatures. As a result of residual oscillations, displacements ~10 – 100pc may be expected even in nearby elliptical galaxies and can be measured as spatial offsets of AGN in high resolution optical or infrared images. In a preliminary study, isophotal analysis was conducted on a sample of 96 galaxies to obtain the photocenter of the galaxies using mostly Hubble Space Telescope (HST) archival images (mostly in the visual filters). The position of the nuclear point source (AGN) was also measured to obtain a displacement vector. Analysis of this initial sample reveals 18 candidates that show a significant displacement. Of these, 14 are hosted by core ellipticals while the rest have a cuspy light profile. A majority of the galaxies analyzed have galactic and nuclear dust structures that interfere with the isophotal analysis. We will also present preliminary results from new HST infrared images (in filters F110W and F160W) of 2 of the 18 candidates.

Gravitational radiation as the driver in ultracompact binaries

Joe Patterson
Columbia

The "ultracompacts" are very close binaries in which a white dwarf transfers matter to an accretion disk around a white dwarf, neutron star, or black hole. Mass transfer is thought to be powered by the loss of angular momentum by gravitational radiation... and, perhaps paradoxically, this should lead to a period increase as the binary widens. Yet no such period increase has ever been seen - until now. This paper reports such a period increase in the WD-WD binary ES Ceti, on a timescale of 6 Myr.

Ancestors of the Brightest Cluster Galaxies

Kevin Cooke
RIT

The most massive galaxies in the universe are the Brightest Cluster Galaxies (BCGs), which formed through a complex series of mergers and star formation episodes not fully understood. The extreme size of their stellar populations hints toward intense star formation episodes long ago, with the further delivery of additional stars through mergers with other galaxies. To investigate when the most mass growth occurs, I identify galaxies using the constant and evolving number density method to identify progenitors of low redshift BCGs. I retrieve observations from the COSMOS Hubble Space Telescope survey to construct a SED for each ancestor candidate, which is then fit to stellar, dust, and sometimes AGN models simultaneously. By tracing the specific star formation and stellar mass of BCG ancestors in the early universe, we gain a new understanding of when the largest individual structures in the universe developed.

Cosmic Background Infrared ExpeRiment 2: Probing Structure Formation with Near-Infrared Fluctuations

Chi Nguyen
RIT

The extragalactic background light (EBL) in the near-infrared is the integrated emission from all objects outside of the Milky Way. Imprinted by the history of stellar emission, theEBL traces light back to the birth of the first stars during the Epoch of Reionization and places tight constraints on star formation models. Characterizing the EBL by the absolute count of photons has been historically difficult due to the presence of local foreground emission. A successful new technique is to map the variations from the mean intensity (“fluctuations”) of the observed emission on different spatial scales and at various wavelengths. The fluctuations can then be decomposed spectrally and spatially to probe the underlying faint EBL emission. Recent work from Spitzer and the first Cosmic Infrared Background ExpeRiment (CIBER-1), among others, show that the EBL fluctuations exceed the contribution from known galaxy populations. Built on the success of CIBER-1, CIBER-2 aims to identify the sources of the EBL fluctuations by tracing their spectral signatures from the optical to near infrared. The experiment uses a 28.5-cm telescope capable of obtaining images in six wavebands covering 0.5-2.5 microns, and will be launched four times on a NASA sounding rocket with the first flight projected in 2018. In this talk, I will present the current status of the CIBER-2 payload integration and how its design addresses the scientific questions found in CIBER-1, as well as outline the plan for future CIBER-2 data analysis.

Cassini's Grand Finale
Philip Nicholson
Cornell University

NASA's Cassini spacecraft was in orbit around Saturn from July 2004, having been launched in October 1997. During this time, it completed over 290 orbits around the ringed planet and returned hundred of thousands of images and spectra, as well as data on the planet's magnetic field, its plasma and dust environment, and on its retinue of satellites. The latter include Titan, the only satellite known to have an atmosphere and lakes on its surface, and Enceladus with its active plumes of water vapor and ice particles. On September 15 of this year, having exhausted its fuel for orbital trim manoeuvres, Cassini completed its mission with a final plunge into the planet's atmosphere. I will summarize what went into the planning of this final phase of the mission and some of the unique science that was accomplished during this period. This includes the highest-resolution images and spectra ever obtained of the rings and small satellites as well as in situ sampling of the ring environment and the planet's upper atmosphere.

ASNY Poster Abstracts

Measuring Cosmic Velocity Field Evolution with a Novel Millimeter-wave Spectrometer

Victoria Butler
RIT

The Tomographic Ionized Carbon Mapping Experiment (TIME) is a novel millimeter-wave imaging spectrometer designed to make the first high speed kinetic Sunyaev-Zeldovich (kSZ) effect survey. TIME is a heritage instrument in that it improves upon several previous instruments attempting to measure this affect. Its most important advances include atmospheric monitoring channels for noise reduction, and measurements in a waveband of roughly 200-300 GHz, where the tSZ signal is at a null and the kSZ signal is at a peak. This high significance kSZ signal can then be used to compute the peculiar velocities of hundreds of galaxy clusters, and lead to a mapping of the cosmic velocity field at various epochs. This also correlates to the cosmic gravitational field, and is a direct tracer for the effect of dark matter on large scale structure evolution.

An Analysis Using H-alpha to Probe Star Formation in the Filament Behind the Virgo Supercluster

Natasha Collova
Siena College

After imaging a filamentary structure behind the Virgo Supercluster at Kitt Peak National Observatory in May, we obtained radial profiles for several galaxies indicating star formation. In doing so, we compared the spatial distribution of this star formation in the filament to a nearby group of galaxies. Galaxies in filaments have been known to funnel into denser environments thereby sometimes depleting star formation.The goal of this project was to compare galaxies in the denser group, to galaxies in the filament to confirm and probe the various mechanisms that are possible culprits of diminishing star formation. The Virgo Supercluster is a highly studied environment, and we look forward to comparing our results to previously published data.

Analysis of Dark Frames and the Consistency of Flat Field Frames

Sean Dempsey-Gregory
Fredionia

A 17 inch PlaneWave Instruments telescope with a SBIG STT-8300M CCD camera was recently installed on the State University of New York at Fredonia campus, for use in education, outreach, and research. Our current goal is to characterize the noise properties of the camera, in particular the noise added by calibration procedures, so that we are able to minimize the noise added by calibration to our science images. In order to achieve this goal we have analyzed the relationship between the number of dark frames used and the noise in the combined master dark frame. We have also performed a preliminary analysis on the stability and consistency of flat field frames across different nights.

Molecular Line Emission in the Disk Orbiting the Young, Close Binary V4046 Sgr" and the abstract is as followed:

Annie Dickson-Vandervelde
RIT

We present analysis of a suite of subarcsecond ALMA Band 6 (1.1 - 1.4 mm) molecular line images of the circumbinary, protoplanetary disk orbiting V4046 Sgr. The ~20 Myr-old V4046 Sgr system, which lies a mere ~73 pc from Earth, consists of a close (separation ~10 Rsun) pair of roughly solar-mass stars that are orbited by a gas-rich crcumbinary disk extending to ~350 AU in radius. We summarize the insight into the physical and chemical processes within this evolved protoplanetary disk that can be obtained from comparisons of the various emission-line morphologies with each other and with that of the continuum (large-grain) emission on size scales of tens of AU.

Quasi-normal modes of black holes in scalar-tensor theories with non-minimal derivative couplings

Ruifeng Dong, Jeremy Sakstein, and Dejan Stojkovic
SUNY Buffalo

We study the quasi-normal modes of asymptotically anti-de Sitter black holes in a class of shift-symmetric Horndeski theories where a gravitational scalar is derivatively coupled to the Einstein tensor. The space-time differs from exact Schwarzschild-anti-de Sitter, resulting in a different effective potential for the quasi-normal modes and a different spectrum. We numerically compute this spectrum for a massless test scalar coupled both minimally to the metric, and non-minimally to the gravitational scalar. We find interesting differences from the Schwarzschild-anti-de Sitter black hole found in general relativity.

Evolution of Protostellar Outflows

Kassidy Howard
Fredonia

Protostellar outflows, which are ubiquitous in the star formation process, remove mass and angular momentum from the forming star and trace the underlying mass accretion process. In an effort to better understand how outflows evolve and how they regulate star formation, we have previously measured the dynamical properties for a large sample of isolated protostellar outflows. The goal of this present research project is to assemble complete spectral energy distributions for each protostar, calculate evolutionary signatures for each object, and place them into a relative evolutionary sequence, so that we may study how outflows evolve as protostars evolve.

New Algorithm Identifies Tidal Streams Oriented Along our Line-of-Sight

Ziyi Lin, Heidi Jo Newberg, Paul Amy, Charles Martin, and Keighley Rockcliffe
Rensselaer Polytechnic Institute

The known dwarf galaxy tidal streams in the Milky Way are primarily oriented perpendicular to our line-of-sight. That is because they are concentrated into an observable higher-surface-brightness feature at a particular distance, or because they tightly cluster in line-of-sight velocity in a particular direction. Streams that are oriented along our line-of-sight are spread over a large range of distances and velocities. However, these distances and velocities are correlated in predicable ways. We used a set of randomly oriented Milky Way orbits to develop a technique that bins stars in combinations of distance and velocity that are likely for tidal streams. We applied this technique to identify previously unknown tidal streams in a set of blue horizontal branch stars in the first quadrant from Data Release 10 of the Sloan Digital Sky Survey (SDSS).
This project was supported by NSF grant AST 16-15688, a Rensselaer Presidential Fellowship, the NASA/NY Space Grant fellowship, and contributions made by The Marvin Clan, Babette Josephs, Manit Limlamai, and the 2015 Crowd Funding Campaign to Support Milky Way Research.

Don't Be Blinded By the Light

Courtney Maki, Joshua Thomas, Mike Ramsdell
Clarkson University

The August 21, 2017 solar eclipse sparked an interest in science. Many people viewed the Sun with eyewear approved by NASA with the ISO 12312-2:2015 standard printed on them, while others purchased potentially unsafe eyewear, or used homemade eyewear with commonly available items. We present a relatively simple experiment that can be done in a classroom setting to demonstrate why it is unsafe to look at the Sun with non-approved eyewear. This experiment can connect students with real-world events and perhaps spark a deeper interest in STEM. Students compare spectra of the Sun taken through various eyewear to the officially approved eyewear. The students also learn about light that is not perceived by the eye, but let through the eyewear that can cause irreparable damage to the human eye.

Analysis of micrometeorites at the National Synchrotron Light Source II; Introducing secondary education teachers to beamline science

Lauren Osojnak(1), Bernadette Uzzi(2)
(1) Vassar College
(2) Brookhaven National Laboratory

A group of high school science teachers from Long Island were granted beam time on the Submicron Resolution X-Ray Spectroscopy (SRX) Beamline at the National Synchrotron Light Source II (NSLS II) at Brookhaven National Laboratory to analyze micrometeorites. I collaborated with this group to facilitate the data analysis of their micrometeorite samples and to introduce secondary education teachers to the NSLS II. This project has both a scientific and educational purpose. Scientifically, analyzing micrometeorites with the NSLS II may provide insight into the origin of our universe. Educationally, this was an opportunity to demonstrate how to conduct a science research project to teachers and students using the NSLS II. Spatially resolved X-ray Absorption near edge Structure (XANES) and X-Ray fluorescence spectroscopy were used to dentity specific elements in micrometeorites in this experiment. The beam used during this experiment was an undulator beamline that enables x-ray fluorescence and nanometer spatial resolutions. Micrometerorites (MMs) are 2-100µm in diameter and slowly fall to the Earth trapped in atmospheric wind and rain. These teachers, along with their students, created their own experiments to collect these MMs and the samples were brought to the NSLS II to be analyzed. I used PyXRF, a python based analysis package, to analyze the data from the beamline. I also used the Athena Program which has the capabilities to process data from X-Ray Absorption Spectroscopy. This data analysis is still in process, but should confirm that some of the samples collected are MMs and provide more comprehensive data analysis of the composition of MMs in general. This was both an educational and scientific opportunity for me as I worked with high school science teachers and beamline scientists. I added new data analysis programs to my repertoire and

spent time with science teachers who were eager to continue experimenting as well as sharing that passion with their students.

Challenges and Joy of Teaching an Undergraduate Course in Gravitational Astronomy

Manju Prakash
Hofstra University

Hundred years after the prediction by Albert Einstein, the gravitational waves were detected directly on September 14, 2015 at 5:51 a.m. Eastern Daylight Time by the twin LASER Interferometer Gravitational Wave Observatories (LIGO) detectors located in Livingston, Louisiana and Hanford, Washington. These gravitational waves are ripples in the fabric of space-time and originated when a 36 solar mass black hole merged with its binary companion of 29 solar mass black hole, nearly 1.3 billion light years away. These observations confirm the dawn of gravitational astronomy and have opened whole new frontiers for understanding exciting phenomena occurring in the cosmos, such as collision of black holes, dense matter inside neutron stars, and early universe. Electromagnetic waves that are currently used as a tool in astronomy are inadequate to shed light on these phenomena. Gravitational Astronomy holds the potential to bring a paradigm shift in how we view and understand our universe.
This presentation will discuss different teaching approaches, strategies, and curriculum modulesto teach Gravitational Astronomy to undergraduates students. These efforts will train a next generation of scientists and teachers who will advance the field of gravitational astronomy through education, novel experimental, and theoretical ideas.

Mapping the circumnuclear gas of NGC 4180 and MCG-06-30-015

Trent Seelig
RIT

The growth process of supermassive black holes (SMBH) in the centers of galaxies has been observed to influence the stellar evolution of the host galaxy by radiative and kinematic feedback mechanisms. At distances of tens of parsecs from the nucleus, how does the inwards flow of material fueling the growth process relate to the luminosity and the kinematic power of the Active Galactic Nuclei (AGN) and associated outflows? As part of a larger team studying AGN spanning a broad range of powers we are analyzing two galaxies MCG-06-30-015 and NGC 4180. Observations were performed with the GEMINI Multi Object Spectrograph Integral Field Units(GEMINI GMOS IFU) located in Hawaii and Chile. Our goal is to map the gas flows and disentangle the non circular motions from the circular rotation patterns to determine the rates of mass inflow and outflow. We search for evidence of structures that may be feeding the AGN as well as feedback resulting from the SMBH growth. IFU datasets allow us to produce maps of the motion of the gas, as well as its temperature and density, in the central region of these galaxies to determine these parameters. The results of our study will eventually be included with those of similar studies to understand the relation of galactic host properties and the properties of their AGN.

Tracing the Origin of Black Hole Accretion Through Numerical Hydrodynamic Simulations

Sandy Spicer
Siena College

It is now widely accepted that supermassive black holes co-evolve with galaxies, and may play an important role in galaxy evolution. However, the origin of the gas that fuels black hole accretion, and the resulting observable radiation, is not well understood or quantified. We use high resolution "zoom-in" cosmological numerical hydrodynamic simulations including modeling of black hole accretion and feedback to trace the inflow and outflow of gas within galaxies from the early formation period up to present day. We track gas particles that black holes interact with over time to trace the origin of the gas that feeds supermassive black holes. These gas particles can come from satellite galaxies, cosmological accretion, or be a result of stellar evolution. We aim to track the origin of the gas particles that accrete onto the central black hole as a function of halo mass and cosmic time. Answering these questions will help us understand the connection between galaxy and black hole evolution.

Resolved Stellar Populations in High Redshift Galaxies

Meaghann Stoelting
RIT
I aim to investigate individual stellar populations within galaxies from the COSMOS survey between $1 < z < 3$. Using the relationship between global and local galaxy properties, one can study galaxy evolution on a small, resolved scale for an individual galaxy. To achieve this, I am fitting spectral energy distributions (SEDs) per resolution element for a sample of galaxies in order to derive galaxy properties such as, star formation rate (SFR), stellar mass, stellar age, and dust content. From these SEDs, we can define particular regions in each galaxy that have differing local properties and

compare these regions to the overall integrated galaxy properties. Defining these properties locally can tell us how galaxy structure evolves internally, which in turn, we can relate to overall the evolutionary sequence

---

Time Delay Orbiting Around A Schwarzschild Black Hole

Yifan Tang
Ithaca College

Imagine a spaceship starting from very far away in flat spacetime region and travels towards a Schwarzschild black hole. I am interested in finding how much the time dilates in the reference frame of the spaceship with respect to the one of the observer located at far away. In this project, Schwarzschild metric is used in all my calculations. I investigated the time delays for various initial conditions determined by energy of the spaceship per unit mass and angular momentum of the spaceship per unit mass. The results are presented in both bar graphs and physical orbits.

Order or Disorder? A Kinematic Analysis of Starburst Galaxies at z ~ 1.5
Brittany Vanderhoff
RIT

Abstract: Luminous infrared galaxies are gas-rich, starburst galaxies that are common around redshift 2-3. Understanding the dynamics of these unique objects gives insight into the major contributing processes that shape the galaxies we observe today. Using H alpha measurements from Keck telescope, I conduct a kinematic analysis of the bulk motion of these galaxies to determine the role of mergers in the morphology and extreme luminosity of these objects.

Making Lemonade out of LEMON: Improved Photometry Processing Software

Mackenna Wood, Joshua Thomas
Clarkson University

Photometry is the measurement of the brightness of stars. This information can be useful in the study of stars, and particularly the study of variable stars, the brightness of which changes over time. When studying variable stars it is often necessary to view the brightness of the star over a period of time spanning multiple observations. While there is software available for the analysis and plotting of photometric data, it is not capable of combining the data from multiple observation sets. The goal of this research is to create a program which will work with existing software to combine multiple observational sets,

do long term photometric analysis of stars, and flag potentially variable stars. By being able to easily view the photometry of stars over extended periods of time it will be easier to notice changes in brightness over long periods, or confirm changes in brightness over short periods. The additional ability of the program to remove noisy stars and mark potentially variable stars will allow the astronomer to narrow the number of stars which require personal attention. This will then be used as a tool to locate and analyze variable stars.

Measuring the Mass of a Supercluster with the Arecibo Pisces-Perseus Supercluster Survey

Zihui Zeng, Rebecca Koopmann, Undergraduate ALFALFA Team
Union College

The Arecibo Pisces-Perseus Supercluster Survey (APPSS) aims to determine the total mass of the Pisces- Perseus Supercluster by measuring the peculiar velocities of a large sample of galaxies that are falling into it. By using emission from atomic hydrogen (HI), we measure the Hubble distance, HI mass, and total mass of galaxies in the vicinity of Pisces Perseus which will be compared to the Tully- Fisher distance to determine peculiar velocities. In this project, we mainly focused on analyzing the galaxies in a slice of sky at 35 degrees declination. Many of the galaxies are lower mass galaxies that were too faint to be detected by the ALFALFA HI survey. This work has been supported by NSF AST – 1637339.