Transient & Variable Universe 2023 Abstracts

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Invited Speakers

Black Hole Demographics from Extragalactic Transient and Variable Phenomena – Vivienne Baldassare, Washington State University

Transient and variable extragalactic phenomena can reveal otherwise hidden supermassive black holes (BHs) and give unique insight into their properties and accretion physics. The results from BH variability studies have a broad impact and can be used to constrain the occupation fraction, estimate BH masses, and infer accretion disk properties. In this talk, I will present an overview of our current understanding of BH variability and tidal disruption events and describe recent impactful discoveries. I will also discuss exciting future prospects for this field with upcoming facilities such as the Vera Rubin Observatory and the Nancy Grace Roman Space Telescope.

Cosmology with Gravitational Waves - Patrick Brady, University of Wisconsin-Milwaukee

I will review approaches to studying cosmology with gravitational-wave observations emphasizing the use of compact object mergers to measure the Hubble constant. After reviewing the latest results, I give a personal perspective on plans and opportunities for the field over the next decade.

The Era of Supermassive Black Hole Binaries – Sarah Burke-Spolaor, West Virginia University

Gravitational-wave facilities are set to build an era where we have a thorough census of binary black holes at the full range of masses and a broad range in distances. In the meantime, much theoretical development has set predictions for electromagnetic signatures of binary black holes, and electromagnetic instruments across the spectrum are reporting hundreds of candidate systems. This talk will discuss exciting updates from pulsar timing arrays, and the impacts that upcoming instruments can make in terms of massive black hole binary observation.

The transient and variable VHE galactic sky – Masha Chernyakova, Dublin City University

The 21st century was marked by the start of the operation of VHE Cherenkov (HESS, MAGIC, VERITAS), and Air Shower (HAWC, LHAASO) telescopes that allow us to study the universe in its most extreme and non-thermal form. A wide range of sources in our Galaxy exhibit transient and variable emission via accretion/ejection processes and interactions between jets, outflows and/or strong winds. These processes accelerate particles up to relativistic energies, leading to the production of high-energy radiation. In some systems both the rate at which the particles are accelerated and the amount of total energy released appear to be close to the maximum theoretically allowed level. In my talk, I will review what we have learned during the last two decades of observations of our Galaxy at very high energies and discuss the progress that can be expected in the nearest future with the start of CTA observations.

Supernovae! – Ryan Foley, UC Santa Cruz

Supernovae, the explosive deaths of stars, enrich the Universe with heavy elements, shape the interstellar medium, participate in the reionization of the Universe, and create compact objects. They are used to measure the expansion history of the Universe and may soon be detected at redshifts above 10. With new facilities and instruments combined with large dedicated time-domain surveys, transient astrophysics will be a key research area over the next decade. I will review the physics of supernovae and how the ever-growing number of supernova classes are produced by different progenitor systems and explosion mechanisms. I will also provide a perspective on how the community can best leverage new data to make new discoveries.

The Landscape of Relativistic Stellar Explosions – Anna Ho, Cornell

A wide range of questions, from galaxy evolution to compact-object formation, hinge on the lives and deaths of massive stars: how a star's zero-age main sequence properties translate to the physics of the explosion and the nature of the remnant. The story used to be simple—a star's fate depends on its mass, and the highest-mass stars form black holes—but recent developments have shown that poorly understood processes (e.g., binary interaction, late nuclear burning phases) strongly influence a star's evolution and internal structure at the time of collapse, which in turn determines the remnant—and even whether there is any explosion or remnant at all. In this talk, I will review developments in the study of relativistic stellar explosions, systems in which a newborn compact object drives a transient powerful outflow. For decades, the only firmly established example was long-duration gamma-ray bursts, thought to represent the special case of a narrow ultra-relativistic jet lasting seconds. However, in recent years the landscape has broadened dramatically because discovery methods have expanded from solely γ-ray satellites to include time-domain surveys at other wavelengths. The observed diversity likely arises from variations in end-stage stellar evolution, compact-object accretion, and jet physics.

Crystal Ball Gazing of Time Domain Astronomy – Shri Kulkarni, California Institute of Technology

Time domain astronomy especially in optical bands is now a mature field. It consists of three different areas, partitioned by methodology: moving objects (solar system), photometric light curves (stellar and AGN) and explosive objects (novae, supernovae). My crystal ball gazing is guided by two maxims: (1) progress is greatest when new phase is explored and (2) technological advances (not just hardware but also software) matter the most. In explosive objects, the frontier lies with the shortest and longest timescale phenomena because they are the least explored. The emerging area of GW astronomy is another very rich frontier, albeit paced entirely by the very slow improvement of GW facilities. The poorly explored UV frontier (both imaging and spectroscopy) is likely to offer rich returns. Finally, advances in sensors (inexpensive CMOS) and cost reduction in electro-optical systems favor distributed telescopes for time domain astronomy. CMOS will open up the 1-second frontier of the night sky.

Gravitational Wave Cosmology – Tyson Littenberg, NASA Marshall Space Flight Center

Gravitational waves (GWs) are a direct probe of dynamical space-time and are emitted from sources at cosmologically relevant distances. Naturally that means that GWs serve as a valuable resource for studying cosmology on their own, and especially in the context of multimessenger observations. This talk will update you on the state of the art, and boldly speculate about the near and medium term future of the field.

Novel Metrics for Time Series Analysis of Accreting Systems – Rebecca Phillipson, Villanova University

TBA

Accretion disk instabilities in compact binaries – Liliana Rivera Sandoval, UTRGV

Accretion disks in binaries that harbor stellar remnants (or compact binaries) are crucial to understand how the binary components interact and evolve. They can also provide insights into the nature of the objects involved. However, these disks are not necessarily stable. They can develop instabilities which arise due to various physical mechanisms, including thermal, viscous, tidal, and magnetic processes that produce observables at different wavelengths. In this talk, I will review the current understanding of accretion disk instabilities and the mechanisms that drive them in compact binaries. In particular, in accreting white dwarfs. I will show observations that challenge current models for some types of binaries and how these observations have enhanced our comprehension of the underlying physical mechanisms occurring within accretion disks. I will emphasize how further studies can work as a foundation for developing more accurate models that allow us to deepen our understanding of the complex interacting process in compact systems.

Multimessenger studies with high-energy neutrinos – Marcos Santander, University of Alabama

The discovery of TeV-PeV astrophysical neutrinos and the recent identification of evidence for the first high-energy neutrino sources offer new opportunities to perform multimessenger studies involving neutrinos and electromagnetic observations. I will present a brief summary of recent results and the status of the field, as well as introduce opportunities for further multimessenger studies over the coming decade.

Gamma-ray shocks -- opening a new window on novae - Jennifer Sokoloski, Columbia University

Over the past decade, the discovery that many, if not most, novae produce GeV gamma-rays has revolutionized our understanding of these common major stellar eruptions. Powerful shocks generated as slow and fast outflows collide are now thought to play a key role in numerous aspects of nova eruptions, from accelerating particles to relativistic speeds, to helping eject the white dwarf's envelope, powering the optical emission, and possibly triggering catastrophic cooling and dust formation. Multiwavelength observations on a wide range of timescales are vital for diagnosing these shocks. In this talk, I will briefly review the current state of nova research. Looking forward, I'll argue that observational and theoretical studies of novae will provide insight into physics that is important for many types of transients.

Contributed Speakers

Rubin and DSA-2000: A winning synergy to unveil populations of elusive transients – Igor Andreoni, University of Maryland & NASA/Goddard

We are living in a golden era for time-domain astronomy. New world-class survey instruments, such as the Vera C. Rubin Observatory in the optical and DSA-2000 in the radio, will enable the systematic exploration of large sky volumes. Synergies between Rubin and DSA-2000 can be particularly valuable to discover populations of rare transients that provide us with unique insights about the physics of compact objects. I will use data obtained by current surveys and follow-up facilities to discuss the case of electromagnetic counterparts to gravitational-waves, "orphan" gamma-ray burst afterglows, and relativistic tidal disruption events.

White Dwarfs Binaries across the H-R Diagram- Borga Anguiano, Notre Dame Department of Physics & Astronomy

We created the APOGEE-GALEX-Gaia catalog to study white dwarf (WD) binaries. This database aims to create a minimally biased sample of WD binary systems identified from a combination of GALEX, Gaia, and APOGEE data to increase the number of WD binaries with orbital parameters and chemical compositions. We identify 3414 sources as WD binary candidates, with nondegenerate companions of spectral types between F and M, including main-sequence stars, main-sequence binaries, subgiants, sub-subgiants, red giants, and red clump stars. Among our findings are (a) a total of 1806 systems having inferred WD radii $R < 25\ R_\oplus$, which constitute a more reliable group of WD binary candidates within the main sample; (b) a difference in the metallicity distribution function between WD binary candidates and the control sample of most luminous giants ($M_H < -3.0$); (c) the existence of a population of sub-subgiants with WD companions; (d) evidence for shorter periods in binaries that contain WDs compared to those that do not, as shown by the cumulative distributions of APOGEE radial velocity shifts; (e) evidence for systemic orbital evolution in a sample of 252 WD binaries with orbital periods, based on differences in the period distribution between systems with red clump, main-sequence binary, and sub-subgiant companions and systems with main-sequence or red giant companions; and (f) evidence for chemical enrichment during common envelope (CE) evolution, shown by lower metallicities in wide WD binary candidates ($P > 100$ days) compared to post-CE ($P < 100$ days) WD binary candidates.

A fast-rising tidal disruption event from an intermediate mass black hole – Charlotte Angus, DARK, University of Copenhagen

Intermediate mass black holes (IMBHs), the link between stellar black holes and the supermassive black holes we see at the hearts of local galaxies, are an elusive population. Thought be hidden within the hearts of most dwarf galaxies, their small masses make them difficult to find. To date, only a handful of IMBHs have been discovered. Our limited understanding of the number and density of these events currently hinders our understanding of SMBH growth, galaxy evolution mechanisms and the gravitational wave background.

Tidal disruption events (TDEs) provide a direct way to probe black holes of all masses. In this talk I will present AT2020neh, a fast-rising TDE located at the heart of a passive dwarf galaxy. With early observations from the Young Supernova Experiment constraining the rise time down to 3% of its peak brightness, this remarkable event reached peak luminosity in just 13 days. Best described by the tidal disruption of a main sequence star by an IMBH, I will present the properties of this rare event. I will discuss the role fast-TDEs can play in distinguishing between different models of black hole growth and how we can harness the power of upcoming surveys to find them.

Searching for radio counterparts to Tidal Disruption Events (TDEs) using multi-epoch ASKAP RACS data – Akash Anumarlapudi, University of Wisconsin-Milwaukee

Tidal Disruption Events (TDEs) are a transient phenomenon in which a star orbiting a massive black hole gets tidally disrupted leading to broadband electromagnetic signatures. TDEs observed at radio wavelengths so far are broadly classified into two categories based on their radio energetics -- emission from a nascent relativistic jet, and emission from a mildly relativistic/non-relativistic outflow. However, not all the TDEs detected at higher energies (X-ray/optical/UV) are expected to have radio counterparts with roughly 10% of the TDEs expected to be radio loud. Recent years have found an increasing number of radio events from TDE candidates ~ years after the actual disruption event. Using data from the Variable and Slow Transients (VAST) project and Rapid ASKAP Continuum Survey (RACS) from the ASKAP telescope, in this talk, we present the results of a search for radio counterparts to all known TDEs, in RACS/VAST footprint (south of +51 declination). Using RACS and archival data we find that the radio emission is detected in a number of TDEs on a timescale of ~ years, suggesting such delayed radio emission is more common than previously expected. Based on our detections, we discuss the rates of such events and prospects of independently detecting TDEs at radio wavelengths.

Investigating Dynamics of Active Galactic Nuclei Jets Using FERMI and TESS Observations - Banafsheh Beheshtipour, Washington University in St. Louis

Relativistic jets from active galactic nuclei (AGNs) are observed from radio to gamma-ray energies and influence the evolution of their host galaxies by changing the interstellar medium. Flux variability is a defining property of these jets, with the observed luminosity changes in timescales of years to minutes seen across the electromagnetic spectrum. To obtain a comprehensive understanding of the radiation mechanisms of the particles in these jets, it is crucial to conduct simultaneous observations of the jets at different wavelengths. Therefore, our research focuses on investigating the flux variability of relativistic jets in AGNs by analyzing their behavior at two distinct wavelengths, namely optical and gamma-ray. We combine the time-domain observations from the TESS and Fermi telescopes to quantify the variability of gamma-ray flux based on the variability of optical flux. In this presentation, I will present our analysis of TESS and Fermi observations for selected AGN sources, explain our methodology for quantifying the variability, and present the results of mapping the variability to the energy flux for these sources. This study can help us to develop data quality metrics to quantify AGNs variability in gamma-ray and to optimize observing strategies that maximize the scientific return of time-domain data.

Transient and Variable Science Opportunities with Early Alerts from the Rubin Observatory – Eric Bellm, Rubin Observatory / University of Washington

When it reaches steady state operations, the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST) will provide a real-time view of the dynamic universe at unprecedented scale, with ten million alerts flowing to community alert brokers each night. However, during 2024-25 substantial effort will be needed to commission this system and to build appropriate templates across the Southern Hemisphere sky. In this talk I will provide a detailed overview of Alert Production during LSST commissioning and early operations. I will discuss plans for special commissioning surveys and describe the expected timeline and ramp-up of public alerts. Finally I will highlight potentially unique transient and variable science opportunities during this early phase of the survey.

Multi-band look at the black hole X-ray transient Swift J1357.2-0933 and discovery of the Millihertz Variability in the X-ray light curves – Aru Beri, IISER Mohali, India

Swift J1357.2-0933 is a black-hole candidate X-ray transient, and several multi-wavelength observations have been made during its outbursts. This source has previously shown intense dips in the optical light curve, a phenomenon linked to the existence of a "unique toroidal structure" in the inner region of the disc, seen at a high inclination. This talk will present the analysis results using X-ray data from the Neil Gehrels Swift, NICER, NuSTAR observatories, and radio data from AMI. A substantial X-ray variability in the X-ray light curves is seen for the first time, structures varying at timescales of ∼200–700s. Millihertz quasi-periodic X-ray oscillations are found in all observations with frequencies varying between $\sim 1 - 5$ mHz. An absorbed power-law model could well describe the broadband spectra without any signatures of the cut-off at energies above 10 keV or any reflection from the disc or the putative torus. Our multi-wavelength study using the data of X-ray telescope and Ultraviolet/Optical Telescope aboard Swift showed a correlation with X-ray measurements, indicating that most of the reprocessed flux must be coming out in the ultraviolet.

The Millimeter Transient Sky – Emily Biermann, University of Pittsburgh

CMB surveys now have sufficient resolution, sensitivity, and sky coverage to study the millimeter transient sky. Synchrotron radiation associated with strong magnetic fields is the likely source of many millimeter flares. Studying these flares can provide insight into the mechanisms behind this radiation as well as constraints on statistical properties of the transients. In this talk, I will present the current state of millimeter transient astronomy and its possible applications to studying gamma ray bursts, fast radio bursts, flaring stars, and other synchrotron transient events. In particular, I will focus on my work completing a blind search of millimeter transients in data from the recently decommissioned Atacama Cosmology Telescope (ACT). These data will help prepare us to do millimeter transient science with upcoming CMB surveys such as Simons Observatory and CMB-S4. Lastly, I will highlight other time domain science done with ACT data such as AGN and pulsar studies.

GRBs and the ISM – Andrew Blain, University of Leicester

GRBs have a potentially huge impact on the ISM of the galaxy in which they occur. In particular, the short lifetime of their progenitors suggest that they will take place in regions of active star formation, and thus their observation could give insights into the physical conditions of star-forming regions out to the epoch of "first dust", and beyond to "first light". The stellar explosion should be insensitive to the properties of the surrounding ISM, but the surrounding ISM will strongly affect the appearance of the burst, providing insights into the astrophysics of star-formation regions on subparsec scales at redshifts out to above 10.

Evidence for Magnetar Powering from Late-time Observations of Hydrogen-Poor Superluminous Supernovae – Peter Blanchard, Northwestern/CIERA

Superluminous supernovae (SLSNe) have been studied for over a decade, yet our understanding of the physical mechanisms responsible for their enormous luminosities remains incomplete. While energy from magnetar spin-down explains the UV/optical properties of hydrogen-poor SLSNe and is consistent with their similarities with long-duration gamma-ray bursts, a smoking gun signature of a central engine has proven elusive. Here I will discuss one of the most convincing observational signatures found to date, the power-law light-curve decline at late times seen in two SLSNe with deep HST imaging. They decline much slower than radioactive decay and show no signs of circumstellar interaction. Moreover, these events suggest that a substantial fraction of the magnetar's energy leaks out at late times, highlighting the need for complementary high-energy observations. I will also discuss late-time spectroscopic observations of the largest sample to date, which reveal signs of ejecta ionization driven by a central engine. Together, these unprecedented late-time observations provide the best evidence to date that magnetars power the majority of SLSNe. Excitingly, these data allow us to tease out which objects may result from more complex scenarios, such as magnetar input combined with circumstellar interaction, perhaps due to mass loss from the pulsational pair-instability.

Correlation between emission-line luminosity and gamma-ray dominance in the blazar 3C279 – Markus Boettcher, North-West University

Despite numerous studies, the origin of the gamma-ray emission from blazars is still debated, in particular whether it is produced by leptonic or hadronic processes. In this study, we are testing the leptonic model for the Flat Spectrum Radio Quasar (FSRQ) 3C279, specifically the scenario in which the gamma-ray emission is generated by inverse Compton scattering of external target photons from Broad Line Region (IC-BLR scenario). For this purpose we use a 10-year data set of the source consisting of the optical spectroscopy data from the Steward Observatory blazar monitoring program and Fermi-LAT gamma-ray data. We search for a possible correlation between the Compton dominance and the emission line luminosity using the discrete correlation function (DCF) analysis. We find no significant correlation between these two quantities at any time lag value, while the emission line luminosity displays a moderate correlation with the gamma-ray flux at a zero time lag. We also reveal that the optical synchrotron continuum flux shows a pronounced correlation with the gamma-ray flux, and therefore we interpret these results within the leptonic IC-BLR scenario where the Compton dominance variations are primarily induced by changes in the magnetic field, rather than in the emission line luminosity.

Hydrogen rich luminous supernovae: looking into the unexplored regime - Subhash Bose, The Ohio State University

Supernovae are produced from a wide range of progenitors and environments, and so their observed and physical properties are also diverse. With the emergence of all-sky and untargeted surveys, we are now able to find several extreme and unusual types of supernovae that were previously unknown and challenge our present understanding, which is mostly based on normal types of supernovae. One such extremely rare group is luminous hydrogen-rich supernovae (LSNe-II) which is in between superluminous supernovae and regular core-collapse supernovae. The lack of interaction signatures makes these intrinsically energetic explosions. Their progenitor system, explosion mechanisms, and the processes driving the luminous light curve are unknown. They fill in the gap in the supernova luminosity distribution and so are important in understanding the complete picture of supernovae diversity. In this talk, I will discuss the few candidates we identified in this rare group, the unique features shared by them, and a few possible mechanisms we propose that may explain these exotic objects.

Gathering Early UV Observations of Type II Supernovae – Azalee Bostroem, University of Arizona

Early in their evolution, Type II supernovae (SNe) emit much of their light at ultraviolet (UV) wavelengths, however, this wavelength range remains relatively unstudied, especially the far ultraviolet (FUV). We present five FUV and near ultraviolet (NUV) spectra of the low luminosity type IIP SN~2022acko, obtained 5-21 days after explosion, earlier than any other type IIP/L SN in the FUV. Unlike the relatively featureless early optical spectra, our first three epochs of UV spectra are dominated by strong metal lines. With these spectra we create a time-series of Type II SNe in the UV, hinting at diversity of Type II SNe in the UV which can only be explored with a larger dataset. In addition to understanding the UV components that will be missing from time-domain surveys such as those from the Rubin Observatory and Roman Space Telescope, interpreting the physics underlying UV spectra and disentangling the effects of extinction, temperature, and CSM interaction are critical for understanding Type II SNe at high redshift. I will discuss the role of discovery and rapid follow-up with current facilities such as Swift, planned UV time domain surveys with Ultrasat and UVEX, and the need for FUV capabilities.

Using X-Shooter to reveal the explosion, progenitor, and host of a very nearby superluminous Type IIn supernova – Sean Brennan, Stockholm University

Type IIn superluminous supernovae (SLSNe-IIn) are a rare subclass of supernova (SN) that exhibit extremely high luminosities and strong interaction with the surrounding circumstellar medium (CSM). The origin of interacting SLSN remains elusive, however its origins likely result from massive stars ejecting large amounts of material before core-collapse. We present our observational campaign of the SN2021adxl, the closest type IIn since the SN2010jl. A long rise time, peak magnitude of -20.5 mag, and narrow emission lines, places SN2021adxl into the class of super luminous interacting SN. The host of SN2021adxl is a “tadpole” galaxy, with a region of high star formation rate and a low brightness tail. We model the HOST SED, providing insight into the age and metallicity the environment and place an upper limit on the progenitor mass. Although the evolution of SN2021adxl is similar to the Type IIn SLSN 2010jl, the observed slow decay of only ~3 mag since discovery makes this supernova's persistent and luminous light-curve a unique opportunity for conducting late-time observations. Utilizing the X-shooter instrument on the VLT, high-quality data was acquired to conduct detailed late-time follow-up and nebular phase analysis. This will shed light on its underlying physical processes and circumstellar environment.

LINCC - developing software for large-scale analysis of time domain data – Neven Caplar, University of Washington

LINCC (LSST Interdisciplinary Network for Collaboration and Computing) is an ambitious effort to support the science community by developing cloud-based analysis frameworks for LSST science. The goal is to enable the delivery of critical computational infrastructure and code for petabyte-scale analyses, mechanisms to search for one-in-a-million events in continuous streams of data, and community organizations and communication channels that enable researchers to develop and share their algorithms and software.

Analysis of time-domain data is a high priority for the project. We are currently developing tools to
i) efficiently cross-match catalogs, as well as renormalize lightcurve from different surveys to enable analysis on long lightcurves
ii) provide functions that can be efficiently executed on large amounts of data (such as structure function and periodogram calculations)
iii) enable large-scale calculation of continuous auto-regressive moving average models.

LINCC is already supporting the community through an incubator program and a series of technical talks. I will present our broad efforts but then focus on time-domain science - show our current status, results and code; and illustrate how we can collaborate and be helpful for your research!

Emission properties of supermassive black hole binaries heading for merger - Chi-Ho Chan, Georgia Institute of Technology

Simultaneous detections of electromagnetic (EM) and gravitational wave (GW) signals from coalescences of supermassive black hole (SMBH) binaries will provide transformative understanding of the evolution and growth of these massive objects in the universe. Such detections are not foregone conclusions, however; their feasibility depends sensitively on the properties of accretion flows near these binaries. Motivated by this, we use radiative magnetohydrodynamics simulations of accreting binaries to investigate their EM signatures. In this talk, we will describe a simulation of the minidisks in an equal-mass binary, whose separation is wider than in most earlier simulations but nevertheless in the regime where inspiral is governed by GW emission. Our simulation predicts spatially compact minidisks, characterized by episodic accretion and strongly anisotropic EM emission. The timescale of the luminosity variation is ideally suited to EM transient surveys. We will discuss extrapolations of these observational predictions to the Laser Interferometer Space Antenna (LISA) and the Pulsar Timing Arrays (PTAs) binaries.

A Transient UV Source at the Location of AT 2018cow Years Post-Explosion – Yuyang Chen, University of Toronto

The exact progenitors and explosion mechanisms of the recently discovered class of luminous Fast Blue Optical Transients (FBOTs) are still not clear. AT 2018cow, being the closest luminous FBOT discovered, allowed for late-time monitoring of the field by the Hubble Space Telescope (HST), which revealed an underlying source at the precise location of AT 2018cow. We analyzed the latest HST observations of AT 2018cow and discovered that the underlying source faded extremely slowly in the UV over 2-4 years post-explosion. Being exceptionally blue (close to the Rayleigh-Jeans tail) and surprisingly bright (only about 20 times fainter than AT 2018cow at day 60), the spectral energy distribution of this underlying source is difficult to explain with stellar objects and places significant constraints on possible remnants of AT 2018cow. Most notably, we found that a highly-inclined precessing accretion disk can explain the spectral evolution of the underlying source, but with significant uncertainties in the type of central black hole (stellar-mass vs. intermediate-mass) and accretion (super-Eddington vs. sub-Eddington). Linking this underlying source to AT 2018cow may provide crucial information on the progenitor and explosion mechanism of Luminous FBOTs.

Shock cooling of a red-supergiant supernova at redshift 3 in lensed images – Wenlei Chen, University of Minnesota, Twin Cities

The core-collapse supernova of a massive star rapidly brightens when a shock, produced following the collapse of its core, reaches the stellar surface. As the shock-heated star subsequently expands and cools, its early-time light curve should have a simple dependence on the progenitor's size and therefore final evolutionary state. Measurements of the progenitor's radius from early light curves exist for only a small sample of nearby supernovae, and almost all lack constraining ultraviolet observations within a day of explosion. The several-day time delays and magnifying ability of galaxy-scale gravitational lenses, however, should provide a powerful tool for measuring the early light curves of distant supernovae, and thereby studying massive stellar populations at high redshift. Here we analyze individual rest-frame ultraviolet-through-optical exposures taken with the Hubble Space Telescope that simultaneously capture, in three separate gravitationally lensed images, the early phases of a supernova at redshift 3 beginning within 6 hours of explosion. The supernova is strongly lensed by an early-type galaxy in one of the Hubble Frontier Field clusters. We constrain the pre-explosion radius to be about 500 solar radii, consistent with a red supergiant.

Asteroid Measurements at Millimeter Wavelengths with the South Pole Telescope – Paul Chichura, University of Chicago

Observing asteroids at multiple wavelengths is useful for constraining their surface properties, but measurements at millimeter and longer wavelengths are historically lacking. Typically, astronomers study asteroids with radar, optical, and thermal infrared measurements, but measurements at longer wavelengths provide information that measurements at shorter wavelengths cannot. Asteroid surfaces become more transparent at longer wavelengths, so longer wavelength emission originates from deeper under the asteroid's surface. By modeling asteroid thermal emission at multiple wavelengths, astronomers can learn about asteroid properties such as surface thermal inertia, roughness, and temperature gradients.

The South Pole Telescope (SPT) is a millimeter telescope with a 10 m primary mirror. Although the SPT is used primarily to study the cosmic microwave background, we can repurpose its data to passively measure asteroids which pass through SPT sky fields while we are observing them. These data, as well as data from upcoming cosmological surveys, will help fill the relative lack of asteroid measurements at millimeter wavelengths.

The fastest transients - The need to approach things differently – Jeff Cooke, Swiniburne University

Transients with millisecond-to-hours duration have been observed and theorized to occur at all wavelengths. These events present unique observational challenges due to their rapid evolution and often their rarity. The conventional approach to transient astronomy has been 'reactive'. That is, transients are searched in one wavelength and follow-up observations are triggered after detection and identification, aimed to classify and understand the event physics. However, transients with millisecond-to-hours duration are too fast for most follow-up facilities and, thus, lack pre-burst, early/rise data, and/or full evolutionary data, with some classes having information restricted to one wavelength regime. I will discuss the Deeper, Wider, Faster (DWF) program that coordinates the world's most sensitive wide-field observatories operating at all wavelengths (radio though gamma-ray) and particle detectors to detect fast transients in large cosmological volumes. DWF operates proactively by coordinating multi-wavelength wide-field facilities to perform deep, fast-cadenced observations of the same fields at the same time, taking data before, during, and after the fast-evolving bursts to capture multi-wavelength information before the events fade away. In addition, DWF performs real-time data analysis and transient identification and triggers rapid-response (minutes later) and later-time (hours/days later) follow up with ground- and space-based spectroscopy and imaging as part of the program, as some fast transients are associated with slower-evolving events. I will discuss the DWF program strategy, some results, and future directions.

Finding the Next Kilonova – David Coulter, UC Santa Cruz

On August 17, 2017, the first binary neutron star (BNS) merger was detected in both gravitational waves (GW), GW170817, and optical light, the kilonova (KN) AT 2017gfo. Detailed follow-up observations indicated that AT 2017gfo produced a large amount of r-process material, yet questions remain about its precise composition and whether this event was typical. In 2019, the second-ever BNS system was detected, GW190425, with a total mass significantly higher than that of GW170817, suggesting a KN with a very different composition. This event was ~4x further away and with localization area ~330x that of GW170817, making a purely galaxy-targeted or a brute-force tesselating approach to searching ineffective, and no counterpart was found. I present the Gravity Collective search for GW190425 using a new tool called Teglon, which implements a novel algorithm to interpolate between these two searching strategies. With Teglon, our network of small field-of-view telescopes was able to cover 3.4% of the localization probability and allows us to combine our observations with all public data to cover ~38%. We rule out an AT 2017gfo-like blue KN to 10% and an SGRB afterglow up to 17 deg off-axis to ~35%. The fourth GW observing run has started despite the Virgo detector having a limited range, which makes Teglon a timely contribution to increase the chances of finding the next KN.

Probing pre-supernova mass loss in double-peaked Type Ibc supernovae - Kaustav Kashyap Das, California Institute of Technology

Eruptive mass loss of massive stars prior to supernova (SN) explosion is key to understanding their evolution and end fate. An observational signature of pre-SN mass loss is the detection of an early, short-lived peak prior to the radioactive-powered peak in the lightcurve of the SN. This is usually attributed to the SN shock passing through an extended envelope or circumstellar medium (CSM). Such an early peak is common for double-peaked Type IIb SNe with an extended Hydrogen envelope but is uncommon for normal Type Ibc SNe with very compact progenitors. In this paper, we systematically study a sample of 14 double-peaked Type Ibc SNe out of 475 Type Ibc SNe detected by the Zwicky Transient Facility. The rate of these events is $\sim 3-9 \%$ of Type Ibc(BL) SNe and $\sim 1-2 \%$ of core-collapse SNe. A strong correlation is seen between the peak brightness of the first and the second peak. We perform a holistic analysis of this sample's photometric and spectroscopic properties. Based on the observed CSM and progenitor properties, we discuss the various mass-loss and progenitor channels of Type Ibc SNe. We find that six SNe have ejecta mass less than 1.5\ \Msun. Based on the nebular spectra and lightcurve properties, we estimate that the progenitor masses for these are less than $\sim$ 12 \Msun. The rest have an ejecta mass $>$ 2.4\ \Msun\ and higher progenitor mass. This sample suggests that SNe with low progenitor mass undergo late-time mass transfer of binary He-stars with core mass of $\lesssim 3$ \Msun. Meanwhile, the SNe with higher progenitor masses are consistent with wave-driven mass loss or pulsation-pair instability-driven mass loss simulations.

Characterizing auroral radio emission produced by large-scale magnetospheres – Barnali Das, University of Delaware

Auroral radio emission (ARE), observed as radio pulses, is produced by objects lying towards the extreme ends of the spectral classification, such as the AB stars, and the ultracool dwarfs and brown dwarfs. This emission is often used for estimating magnetic field strength as the emission frequency is proportional to the local electron gyrofrequency. But recent works have suggested that ARE could be more useful than what had been thought before, provided we succeed in fully characterizing it. For that, the hot stars offer the perfect laboratory since their magnetic fields are extremely stable, and relatively simple in topology. In my talk, I will present our ongoing efforts, both observational and numerical, to understand the role of different stellar parameters in different properties of the emission, such as the spectral luminosity, pulse-profile, cut-offs etc.. Our strategy is two-fold: to build a large sample of hot magnetic stars producing ARE, and observing them over wide frequency ranges so as to compare their properties, and search for correlation with stellar parameters. I will present the results obtained so far, and the future directions that have emerged from them.

SN 2022ann: A type Icn supernova from a dwarf galaxy that reveals helium in its

circumstellar environment – Kyle Davis, University of California, Santa Cruz

SN 2022ann is the fifth observed type Icn supernova, a new extreme class of supernova hallmarked by interaction with a dense, H/He-poor circumstellar medium. Although massive Wolf-Rayet stars are often invoked as progenitors for these and similar objects, several properties of SN 2022ann are inconsistent with a massive progenitor star. SN 2022ann exploded in a dwarf galaxy, with a stellar mass and inferred metallicity both lower than 97% of the galaxies observed to produce core-collapse supernovae. Light curve modeling of SN 2022ann also suggests Ni56 and ejecta masses lower than typical WR masses. Lastly, the measured P-Cygni absorption line velocities (indicative of the CSM velocity) are only ~800 km/s, whereas typical WR outflow velocities are ~1000s km/s. Therefore, we favor a stripped binary progenitor scenario for SN 2022ann. NIR spectra of SN 2022ann also reveal helium, suggesting that SNe Icn may not be fully devoid of helium, and adding to the growing diversity we observe among this new and growing class of stellar explosion. Finally, recent IR observations of SN 2022ann may indicate dust formation at levels unseen before in core collapse supernovae.

SuperVRAENN+: Compressing Supernovae Light Curves into Informative Latent Features for Classification

Kaylee de Soto Pennsylvania State University, Department of Astronomy & Astrophysics

The photometric classification of supernovae using machine learning techniques is crucial for processing the massive data influx from upcoming wide-field optical sky surveys. The software SuperRAENN has shown early success in differentiating between five types of supernovae using Gaussian process interpolation followed by a recurrent autoencoder neural network to summarize each supernova's information in a lower-dimensional latent space. We modify this architecture to apply a custom non-stationary Gaussian kernel to each light curve, which better handles the evolution timescale of a typical light curve at each phase. We train a variational autoencoder with beta-cyclic annealing with a modified loss term that includes explicit invariance to supernova redshift. Additionally, our training cycle rewards clustering of the latent space based on true spectroscopic labels, which improves classification performance. We present the performance of our new method, SuperVRAENN+, trained on ZTF supernova light curves.

The Local Type Ia Supernovae Rate and Luminosity Function in ASAS-SN – Dhvanil Desai, Institute for Astronomy, University of Hawai`i

We present the volumetric rates and luminosity functions (LFs) of Type Ia supernovae (SNe Ia) from the V-band All-Sky Automated Survey for Supernovae (ASAS-SN) catalogues spanning discovery dates from 2013 to 2017. Our results are both statistically more precise and systematically more robust due to the large sample size and high spectroscopic completeness. Using standard methods, we correct for the incompleteness depending on the apparent and absolute magnitudes of the SNe. For our sample of 400 SNe Ia, we find a total volumetric rate of R = (2.03 ± 0.18) * 10^4 yr^-1 Gpc^-3 at the median redshift of our sample z=0.025. This broadly agrees with the local volumetric rates found by other studies. We compile and compare the rate of SNe Ia as a function of their absolute magnitude (i.e. LFs) for both the entire sample as well as, for the first time, for several sub-types of SNe Ia. We also compute the LFs after correcting for various amounts of average host-galaxy extinction values.

The Diversity of Gravitational-Wave Transients – Zoheyr Doctor, Northwestern University | CIERA

The growing catalog of gravitational-wave detections from merging compact objects has enabled measurements of their population-level properties. A suite of parametric and non-parametric models have been used to characterize these populations, which can be used to make predictions for other electromagnetic observables, such as explosive transients associated with neutron-star mergers. I will describe some of these population models, what they tell us about merging black holes and neutron stars in the universe, and how these results can be incorporated into electromagnetic-counterpart studies.

Unveiling a Hyperactive FRB in a Dust-obscured Environment with Star Formation- Yuxin Dong, Northwestern University

Fast Radio Bursts (FRBs) are a rising class of transients with diverse observed properties and an unknown origin. The repeating and non-repeating nature of these events combined with the rapid growth of localized FRBs to milliarcsecond precision have led to numerous potential progenitor scenarios. We present high-resolution VLA and HST observations of the extremely active repeating FRB 20201124A and its barred spiral host galaxy. The extreme activities contrast with its local environment which lacks any apparent, elevated star formation as seen in the optical band. Here, I discuss the results where we constrain the location and morphology of star formation in the host and search for a persistent radio source (PRS) coincident with the FRB. Our observations uncovered obscured star formation extending to the location of FRB 20201124A, pointing to a magnetar central engine born in-situ from the explosion of a massive young star. Finally, we use our VLA observations at 6 GHz and place deep constraints on the PRS emission associated with FRB 20201124A and find that our limits are consistent with both the magnetar wind nebula and hypernebula models. This study highlights the importance of multi-wavelength observations of the local and global environments to understand the formation channel of FRBs at large.

Shocks, jets, and emerging nebulae: ~year to decade-scale radio transients in d < 200 Mpc galaxies – Dillon Dong, NRAO

After decades of progress, all-sky radio surveys are finally at the scale where slow transients are being discovered en-masse at radio frequencies. These new transients have very different selection biases than those discovered in follow-up of optical and high energy transients, and thus they open a new window on the dynamic sky. In this talk, I will present a sample of 64 transients discovered in a search for sources present in the VLA Sky Survey Epoch 1 (VLASS, 2017 to 2019) but absent from FIRST (1990s - 2000s). The parameters of this search are most sensitive to luminous synchrotron-emitting regions at a scale of ~10^17 cm, that evolve on timescales of ~years to ~decades. Roughly 2/3 of the sources are flares from supermassive black holes, both active (likely sub-relativistic AGN outflows) and quiescent (likely TDEs). Roughly 1/3 are in active star forming regions and are consistent with being stellar explosions ~2-3 orders of magnitude more radio-luminous than the median supernova. These explosions have diverse origins, and shed new light on the late-stage evolution of stellar binaries, as well as the compact objects they leave behind.

Late-time X-ray Rebrightening vs. Early Double-peaked Balmer Emission: Investigating Disk Formation in the TDE AT2020nov – Nicholas Earl, University of Illinois at Urbana-Champaign

We present the photometric and spectroscopic analysis of the tidal disruption event (TDE) candidate AT2020nov, an event that shows properties consistent with both TDEs and active galactic nuclei (AGN).

Observations in the X-ray show late-time flaring, coincident with a minor re-brightening in the optical/UV. Optical spectroscopy taken both before and after the light curve peak show a blue continuum, with resolved double-peaked Balmer emission and possible Bowen Fluorescence features. The discrepancy between the X-ray and UV/optical photometry indicates that the radiation sources are initially uncorrelated, with emission arising from physically distinct components. This implies a scenario in which the optical/UV peak is powered by collisions in the debris streams of a circularizing accretion disk, while the late-time X-ray and optical/UV bump result from the enhanced accretion rate of the circularized disk. However, elliptical accretion disk modeling of the double-peaked Balmer features in the spectra indicates that the disk formed early and fast, inconsistent with circularization occurring at late times. We consider a pre-existing AGN disk or bi-polar outflow source for the observed emission, and discuss how this new event fits into the landscape of nuclear transients generally, and TDEs/AGN specifically.

Radio counterparts of binary neutron star mergers from present to future – Avery Eddins, Texas Tech University

The binary neutron star merger GW170817, discovered via its gravitational wave emission by LIGO and Virgo, revealed an associated gamma-ray burst, a kilonova, and a delayed radio to X-ray afterglow from an off-axis jet. Based on what we have learned so far from GW170817, unveiling radio counterparts of binary neutron star mergers requires sensitive radio arrays and follow-up observations extending from early to late times. In this talk, I will briefly summarize the results of a Jansky VLA radio follow-up campaign of short GRBs in the Swift/BAT sample aimed at uncovering GW170817-like events via their late-time radio emission from the kilonova ejecta. Then, I will discuss how the upcoming next generation Very Large Array (ngVLA) can be best utilized in similar radio follow-up observations of gravitational wave signals. Specifically, I will discuss the ngVLA potential for multi-messenger studies in light of the results of simulations performed by processing recent jet and kilonova ejecta models with ngVLA simulation tools.

Probing the Mass-loss History and CSM Density of Type II Supernovae – Tarraneh Eftekhari, Northwestern University

Despite the relative abundance of Type II supernovae (SNe) in volume-limited optical surveys, their spectral diversity and an apparent dearth of high-mass progenitors have prompted many questions relating to the processes driving mass loss from these stars. Progress in our understanding of this extreme mass loss can only be made if constraints on the full physical scale and density profile of the circumstellar material (CSM) for a large sample of Type II SNe are obtained. In this talk, I will present results from the largest systematic search for late-time radio emission from a volume-limited sample of hydrogen-rich core-collapse SNe. Our sample includes over 300 SNe on timescales of ~3-100 years post-explosion, providing constraints on the CSM density on the largest physical scales probed to date, and the mass-loss history of Type II SNe progenitors in the centuries preceding their explosion. In conjunction with early-time optical data, I will demonstrate how our results shed light on the mass-ejection mechanism which operates in the progenitors of these core-collapse SNe. I will also discuss prospects for future radio observations of SNe in the era of next-generation radio observatories.

Possible evidence for Lorentz Invariance Violation in GRB 221009A – Justin Finke, US Naval Research Laboratory

The preliminary detections of the gamma-ray burst 221009A up to 18 TeV by LHAASO and up to 251 TeV by Carpet 2 have been reported through Astronomer's Telegrams and Gamma-ray Coordination Network circulars. Since this burst is at redshift z=0.15, these photons may at first seem to have a low probability to avoid pair production off of background radiation fields and survive to reach detectors on Earth. By extrapolating the reported 0.1-1.0 GeV LAT spectrum from this burst to higher energies and using this to limit the intrinsic spectrum of the burst, we show that the survival of the 18 TeV photon detected by LHAASO is not unlikely with many recent extragalactic background light models, although the detection of a 251 TeV event is still very unlikely. This can be resolved if Lorentz invariance is violated at an energy scale E_{QG}> 49 E_{Planck} in the linear (n=1) case, and E_{QG}> 10^{-6}E_{Planck} in the quadratic (n=2) case (95% confidence limits), where E_{\rm Planck} is the Planck energy. This could potentially be the first evidence for subluminal Lorentz invariance violation.

Past AGN Activity in TDE Host Galaxies – Decker French, University of Illinois

The rates of Tidal Disruption Events (TDEs) have been shown to correlate with large-scale properties of their host galaxies, such as star formation history, color, and structure. The TDE rate is enhanced in post-starburst galaxies, which have experienced a recent burst of star formation that ended within the last billion years, as well as in green valley galaxies, suggesting a connection between the mechanisms that affect the large-scale evolution of galaxies and the orbits of stars on the small scales of the black hole sphere of influence. These trends present both a problem to solve in determining the origins of these connections, as well as an opportunity to use host galaxy correlations in identifying interesting transients in next-generation time domain surveys. We have recently found evidence for past AGN activity in post-starburst TDE host galaxies using integral field spectroscopy. I will present these results and discuss the implications for separating AGN from TDEs and selection biases in identifying TDEs in large surveys.

WINTER: a new time-domain near-IR facility – Danielle Frostig, MIT

The Wide-Field Infrared Transient Explorer (WINTER) is a new time-domain instrument which will perform a seeing-limited survey of the near-infrared sky. In this talk, I will present the design, science goals, and early results from the WINTER instrument, which was deployed recently on a dedicated 1-meter robotic telescope at Palomar Observatory. Among the many near-infrared targets of interest, WINTER is principally designed for follow-up of kilonovae detected in gravitational waves and is predicted to discover up to five kilonovae during the upcoming gravitational-wave detector run. Additionally, WINTER will conduct a wide range of time-domain surveys to a depth of J=21 magnitudes, building up a deep co-added image of the near-infrared sky and studying near-infrared transients and variables, including supernovae, tidal disruption events, and transiting exoplanets around low mass stars. WINTER is the first IR survey employing moderately-cooled Indium Gallium Arsenide (InGaAs) detectors. The custom camera combines six commercial large-format InGaAs detectors observing in Y, J, and short-H band filters (0.9-1.7 microns), and employs a novel tiled optical design to cover a >1 degree squared field of view with 90% fill factor. I will conclude with updates on early performance, initial surveys, and synergies with other time-domain facilities.

First Impressions: Early-Time Classification of Supernovae – Alexander Gagliano, UIUC/NCSA

Substantial effort has been devoted to the characterization of transient phenomena from photometric information. Automated approaches to this problem have taken advantage of complete phase-coverage of an event, limiting their use for triggering rapid follow-up of ongoing phenomena. In this talk, I will introduce my work to construct a recurrent neural network designed explicitly for early photometric classification. This classifier leverages transfer learning to account for model misspecification, host galaxy photometry to solve the data scarcity problem soon after discovery, and a custom weighted loss to prioritize accurate early classification. At both early and late phases, this model achieves comparable or superior results to the leading classification algorithms with a simpler network architecture. These results help pave the way for rapid photometric and spectroscopic follow-up of scientifically-valuable transients discovered in massive synoptic surveys.

Studying multi-wavelength properties of gamma-ray flaring blazars at redshift > 3 – Andrea Gokus, Washington University in St. Louis

High-redshift gamma-ray blazars (z>3) offer the possibility to study black hole growth, accretion processes and jet acceleration in the early Universe. However, the detection of gamma-ray emission from these sources is difficult and only about a dozen have been detected by the Large Area Telescope (LAT) onboard the Fermi satellite.

Transient blazar flares provide a unique opportunity to detect and characterize the gamma-ray emission from high-z blazars and to gather contemporaneous multiwavelength observations that are necessary to interpret their spectral energy distribution. For this reason, we designed a program to find flares in high-z blazars by using public Fermi-LAT data, which is suitable to trigger multi-wavelength observations.

In February 2022, we detected a flare by the very distant blazar GB 1508+5714 (z=4.31), whose detection at gamma-ray energies was reported in 2017. We will present the results from our multiwavelength follow-up campaign, which includes dense VLBI monitoring, and put our findings in the context of future high-energy missions.

A Census of Fast Radio Burst Host Galaxies and Implications for the Progenitor(s) – Alexa Gordon, Northwestern University

Fast radio bursts (FRBs) are bright, millisecond pulses discovered at radio wavelengths. Despite hundreds of detected FRBs, their progenitors are uncertain; one leading candidate is magnetars. With the recent ability to localize FRBs to their host galaxies, we can now leverage the information provided by local environments to place constraints on progenitor models. In this talk, I present a comprehensive catalog of stellar population properties for 23 highly secure FRB host galaxies, the largest such catalog to date. Jointly fitting their spectroscopy and photometry, I present distributions in properties such as mass, age, star formation rate, and star formation history (SFH), and investigate trends between repeating and non-repeating FRBs. Quantifying the degree of star-formation in FRB hosts, I show that while they overall trace star formation, there is a new and growing population of quiescent galaxies, possibly at odds with a single formation channel for magnetars (e.g. all formed through core-collapse supernovae). Comparing the SFHs of repeating and non-repeating FRBs, I also present noteworthy trends linking repeaters to more active star formation. The era of hundreds of localized FRBs is fast approaching; I conclude with how larger samples will address the repeater/non-repeater distinction and the origins of FRBs.

Collapsars present: zoo of transients – Ore Gottlieb, Northwestern University

One of the main challenges in studying black hole-powered explosions is the vast dynamical range between the BH and the emission site, which has prevented theoretical models from inferring the underlying physics from observations. I will present the first such models through 3D state-of-the-art GRMHD simulations that follow outflows from a newly formed black hole to the photosphere. In particular, I will demonstrate how simulations of collapsing stars (collapsars), which form black holes and relativistic jets, offer unique opportunities to study a wide range of cutting-edge astrophysical phenomena in an unprecedented way: heavy element nucleosynthesis, evolution of relativistic jets, and a variety of cosmic fireworks. I will conclude with showing how collapsars could bridge the gap between core-collapse supernovae and gamma-ray bursts through the brightest optical phenomenon in the Universe: Fast blue optical transients.

BayeSN: Scaling Bayesian Inference for Next Generation Surveys – Matthew Grayling, University of Cambridge

One of the biggest obstacles today in supernova cosmology is understanding the properties of host galaxy dust, which causes both extinction and reddening of the supernova light that we observe. Understanding the extent to which variations in the observed type Ia supernova population are driven by differences in intrinsic properties, or in host galaxy dust properties, is vital for probing the physical nature of these events. This type of analysis can help us to understand the cause of the so-called 'mass step', an effect whereby type Ia supernovae in massive galaxies appear brighter than those in lower mass hosts even after standardisation.

BayeSN is an optical-NIR SED model for fitting type Ia supernovae which uses hierarchical Bayesian modelling to treat dust and intrinsic variation separately. Using this hierarchical framework, we can constrain these two effects at the population level. However, this type of approach can be computationally expensive which poses a challenge in the era of next generation surveys. I will present recent work on efficiently scaling these Bayesian inference techniques, demonstrating that the use of BayeSN on LSST-size data sets is feasible without sacrificing functionality of the model.

A search for short-duration extragalactic millimeter-wave transients with SPT-3G - Sam Guns, University of California Berkeley

Millimeter-wave transient surveys carried out by Cosmic Microwave Background (CMB) observatories are rapidly uncovering a hitherto largely unexplored discovery space for time-domain astrophysics. The South Pole Telescope (SPT) published the results of two such surveys in 2016 and 2021, finding a substantial population of bright nearby flare stars and a small number of extragalactic flaring objects (which are likely to be dim active galactic nuclei). Recent theoretical work suggests that current and next-generation CMB experiments should be sensitive to a significant range of high-energy extragalactic transients such as gamma ray bursts (GRBs), tidal disruption events, and others. Theoretical estimates predict that GRB reverse shocks will be the most numerous extragalactic signal detected in CMB surveys, with extremely bright and brief (< 1 day) signals detectable at high significance. In this talk, I will present preliminary results from a search through 4 years of SPT data for signatures of bright extragalactic signals on hour-to-day timescales.

Quasi-Periodic Eruptions from Galactic Nuclei – Muryel Guolo, Johns Hopkins University

X-ray Quasi-Periodic Eruptions (QPEs) are a newly discovered phenomenon whereby the nuclei of some galaxies present recurrent X-ray eruptions that can be as large as a factor of 100 in time scales that vary between 3 hours to nearly a day. The origin of these QPEs remains unknown, but the proposed models can be broadly classified into two categories: accretion-driven instabilities and those related to bodies orbiting a massive black hole (MBH), the so-called extreme mass ratio inspirals (EMRIs). In this talk, I will summarize the current state of the field and report on the discovery of a new QPE source from the nucleus of a low-luminosity AGN at $\sim$ 165 Mpc, which recurs approximately every 20 days. Its recurrent soft X-ray eruptions, with no accompanying UV/optical brightening from a low-mass MBH, are properties strikingly similar to known QPE sources; however, this source shows unique characteristics: i) the eruption recurrence time is 25 times longer than the previously longest known QPE source; ii) variable ultra-fast (~ 0.1c) outflows are detected during the rise of the individual eruptions; iii) transient radio emission contemporaneous with the X-ray rise is detected.

Shock Breakout in Dense Circumstellar Material - Annastasia Haynie, University of Southern California / Carnegie Observatories

Shock breakout (SBO), the first expected electromagnetic signature of a supernova (SN), is an important probe of the progenitors of these explosions. Unfortunately, SBO is difficult to capture with current surveys due to its brief timescale ($\lesssim$1 hr). However, SBO may be lengthened when dense circumstellar material (CSM) is present. Indeed, recent photometric modeling studies of SNe, as well as early spectroscopy, suggest that such dense CSM may be present more often than previously expected. If true, this should also affect the features of SBO. We present an exploration of the impact of such CSM interaction on the SBO width and luminosity using both analytic and numerical modeling, where we parameterize the CSM as a steady-state wind. We then compare this modeling to PS1-13arp, an SN that showed an early UV excess that has been argued to be SBO in dense CSM. We find PS1-13arp is well fit with a wind of mass ~0.08 $M_\odot$ and radius ~1900 $R_\odot$, parameters which are similar to, if not slightly less massive than, what have been inferred for Type II SNe using photometric modeling. This similarity suggests that future SBO observations of SNe II may be easier to obtain than previously appreciated.

Flux Limits from a Targeted Search for Extragalactic Transients with the Atacama Cosmology Telescope - Carlos Hervias-Caimapo, Pontificia Universidad Católica de Chile

In this work, we have performed a targeted search of known, extragalactic transient events at millimetre wavelengths using 9 seasons (2013--2021) of 98, 150, and 229 GHz Atacama Cosmology Telescope (ACT) observations that mapped 40% of the sky for most of the data volume. We observe at least once 88 gamma-ray bursts (GRBs), 12 tidal disruption events (TDEs) and 203 other transients, including supernovae (SNe). We stack our ACT observations to increase the signal-to-noise ratio of the maps. In all cases but one, we do not detect these transients. The single candidate detection (event AT2019ppm), seen at ~5σ significance in our data, appears to be due to active galactic nuclei (AGN) activity in the host galaxy coincident with a transient alert. For each source in our search we provide flux upper limits. For example, the medians for the 98 GHz 95% confidence interval upper limits are 28, 15, and 16 mJy for GRBs, SNe, and TDEs respectively. While we are limited by sensitivity now, future wide-area cosmic microwave background (CMB) surveys should be good enough to detect many of these events, so we aim at developing techniques and analyses that will be relevant for the transient millimetre sky in years to come.

Limits on Simultaneous and Delayed Optical Emission from Well-Localized Fast Radio Bursts – Daichi Hiramatsu, Center for Astrophysics | Harvard & Smithsonian

In this talk, I present the largest compilation to date of optical observations during and/or following a sample of 15 well-localized Fast Radio Bursts (FRBs), including 8 repeating and 7 one-off sources. Our simultaneous optical observations of 14 bursts from the recently-discovered, highly-active FRB 20220912A provide the deepest such limits to date for any extragalactic FRBs. These simultaneous limits provide useful constraints in the context of FRB models with prompt optical emission, such as the pulsar magnetosphere and pulsar nebula models. Interpreting all available optical limits for the FRB samples in the context of the afterglow emission from the synchrotron maser model, they are generally at least an order of magnitude larger than the energies inferred from the FRBs themselves, although in the case of FRB 20220912A, our simultaneous and rapid follow-up observations severely restrict the model parameter space. I conclude by exploring the potential of future simultaneous and rapid-response observations with large optical telescopes.

Simultaneous Millimeter-wave, Gamma-ray, and Optical Monitoring of the Blazar PKS 2326-502 During a Flaring State – John Hood, University of Chicago

Including millimeter-wave (mm-wave) data in multi-wavelength studies of the variability of active galactic nuclei (AGN) can provide insights into AGN physics that are not easily accessible at other wavelengths. We demonstrate in this work the potential of cosmic microwave background (CMB) telescopes to provide long-term, high-cadence mm-wave AGN monitoring over large fractions of sky. We report on a pilot study using data from the SPTpol instrument on the South Pole Telescope (SPT), which was designed to observe the CMB at arcminute and larger angular scales. Between 2013 and 2016, SPTpol was used primarily to observe a single 500 square degree field, covering the entire field several times per day with detectors sensitive to radiation in bands centered at 95 and 150 GHz. We use SPT 150 GHz observations to create AGN light curves, and we compare these mm-wave light curves to those at other wavelengths, in particular gamma-ray and optical. In this Letter, we focus on a single source, PKS 2326-502, which has extensive, day-timescale monitoring data in gamma-ray, optical, and now mm-wave between 2013 and 2016. We find PKS 2326-502 to be in a flaring state in the first two years of this monitoring, and we present a search for evidence of correlated variability between mm-wave, optical R band, and gamma-ray observations. This pilot study is paving the way for AGN monitoring with current and upcoming CMB experiments such as SPT-3G, Simons Observatory, and CMB-S4, including multi-wavelength studies with facilities such as VRO-LSST.

The Compton Spectrometer and Imager - Alyson Joens, UC Berkeley/SSL

The Compton Spectrometer and Imager (COSI) is the next NASA Small Explorer Mission (SMEX) that will be launched into an equatorial low-earth orbit in 2027. The COSI instrument is a wide-field Compton telescope that will survey the sky in the under-explored soft gamma-ray regime (0.2-5 MeV) to provide polarizations, spectrometry, and imaging of astrophysical sources. The wide field of view, excellent energy resolution, sub-degree localizations, good background suppression, and increased sensitivity of the instrument enable COSI's four key science goals of uncovering the origin of Galactic positrons, revealing the dynamics of Galactic element formation, gaining insight into extreme environments via polarization, and probing the physics of multi-messenger events. In this presentation, we will detail the COSI mission and its vast science case with an emphasis on how COSI will propel transient science.

Type Ia supernova delay time distributions from mock galaxy surveys from the Illustris simulation – Bhavin Joshi, Johns Hopkins University

We present ongoing numerical analysis investigating the effects of sample size and selection on determining type Ia supernova (SN Ia) delay time distributions (DTDs). We explore DTDs inferred from star-formation histories (SFHs) of mock samples of galaxies generated from the Illustris simulation. The inferred DTDs employ power-law and skew-normal parametric forms as well as non-parametric forms constructed through piecewise constants. The DTDs are estimated through a MCMC exploration of the likelihood space by comparing the expected SN Ia rate within each mock galaxy, which follows a Poisson distribution, resulting from the convolution of the SFH and the DTD. This framework, put forward by Maoz et al 2011, takes into account all the SN rate information available from a survey by including host *and* non-host galaxies in a rigorous manner. We show that the parametric DTD forms usually employed can distinguish between prompt versus delayed signals but the additional flexibility afforded by non-parametric forms provides finer temporal detail in the DTD which can place further constraints on progenitor models.

Luminous Red Novae - Probes of Common Envelope Evolution in Massive Binaries – Viraj Karambelkar, Caltech

Luminous Red Novae (LRNe) are a unique class of transients that result from a stellar merger or common envelope (CE) ejection in massive stellar binaries. As such, they offer valuable insights into CE evolution, a crucial step in the formation of double compact objects (DCOs) that merge and emit gravitational waves. Despite their significance, LRNe are observationally rare due to their low intrinsic luminosities (~10-100 times lower than supernovae). In this talk, I will provide an overview of LRNe and their importance as probes of CE evolution in massive binaries. I will describe properties of the first systematic sample of LRNe compiled using the Zwicky Transient Facility, and present the first robust volumetric rate and luminosity function for extragalactic LRNe based on this sample. I will then discuss the implications of these results for CE parameters used in binary population synthesis models; understanding whether LRNe come from mergers or CE ejections in binaries; and the intriguing possibility that these LRNe could occur in progenitor binaries of DCOs that merge within the Hubble time. Finally, I will explore the role of the Vera Rubin Observatory and upcoming infrared time-domain surveys in significantly enhancing our understanding of LRNe.

Reconstructing the physics of explosion using machine learning - Wolfgang Kerzendorf, Michigan State University

Supernova explosions are some of the most energetic and luminous events in the universe, and understanding them is crucial for many areas of astrophysics. One way to gain insight into the physical processes involved in these explosions is through supernova tomography, which involves reconstructing a spatially resolved explosion model using a spectral time series. However, this requires a radiative transfer model and is computationally intractable with traditional means, requiring millions of MCMC samples.

A new solution to this problem is the use of surrogate models or emulators, which employ machine learning techniques to accelerate simulations. In this talk, we present a new emulator for the radiative transfer code TARDIS that outperforms existing emulators and provides uncertainties in its prediction. This offers the foundation for a future active-learning-based machinery that will be able to emulate very high dimensional spaces of hundreds of parameters crucial for unraveling urgent questions in supernovae and related fields. Our work provides a promising avenue for understanding the physical processes involved in supernova explosions and their progenitors, with implications for a wide range of astrophysical phenomena.

Multi-wavelength observations of fast radio bursts – Charlie Kilpatrick, Northwestern University

Fast radio bursts are millisecond pulses of MHz-GHz emission localized in galaxies from the local Universe to z=1. They present a fascinating challenge from both a theoretical and observational perspective; although they have been directly linked to magnetars, the paucity of observations outside of radio wavelengths makes it difficult to directly probe the progenitor configuration and emission mechanism. Optical observations of fast radio bursts have been mostly serendipitous or obtained by targeting repeating sources. I will discuss several of these efforts, in particular for the repeating and periodic source FRB20180916B. By targeting these events in phases of high radio activity and using imaging of varying speeds and cadences, we obtained optical observations within milliseconds to hours of multiple radio bursts, including the best constraints on their multi-wavelength counterparts to date. I will present constraints on relatively long-lived counterparts to fast radio bursts, including energetic synchrotron masers as well as traditional optical transients such as supernovae and luminous red novae. Future efforts to detect optical counterparts to radio bursts will benefit from these observing strategies and rapid follow up of nearby events.

Transient Signatures of Intermediate-Mass Black Hole Accretion from Tidal Disruption Events – Fulya Kiroglu, Northwestern University

Recent studies have shown that close encounters between stars and black hole remnants occur frequently in dense star clusters. Depending upon the distance at the closest approach, these interactions can lead to dissipating encounters such as tidal captures and disruptions, or direct physical collisions, all of which may result in multi-wavelength flares that could last for months to years. In this talk, I will present the outcomes of hydrodynamic calculations of tidal disruptions of a solar-like star by an intermediate-mass black hole (IMBH) and compare them with disruptions by a stellar-mass black hole. Depending on the black hole to star mass ratio, stellar remnant can be eventually ejected to be unbound, or completely disrupted either after the first pericenter or after many pericenter passages. If the star survives for many pericenter passages, the detection of periodic flares (with repetitions likely occurring on timescales ranging from roughly days to years) can offer insight into an accreting stellar-mass black hole/IMBH. Based on the properties of the material bound to the black hole at the end of our simulations, I will comment upon the expected accretion process and associated electromagnetic signatures that are likely to result

Transient and Variable Classification Alerts for ELAsTiCC - Rob Knop, Lawrence Berkeley National Laboratory

The ELAsTiCC campaign is a simulation of transient and variable alerts sent from LSST to brokers. The brokers apply various algorithms to classify the types of those objects, and in turn issue their own classification alerts. DESC then ingests those classification alerts, ideally so that they may be used to track live objects and direct followup resources. The first ELAsTiCC campaign ran for the last three months of 2022, and the second is slated to begin around the time of this conference. This talk will outline both the flow of simulated alerts, and the ingestion of the broker classifications. Different brokers responded to alerts at different rates, dependent largely on provisioning of resources for the campaign, but in general they demonstrated the ability to provide classifications within a day of the original alert going out. Some lessons were learned, both in terms of the design of the alert schema and classification scheme, and in terms of implementation of the system that sends alerts and monitors for classification alerts from brokers.

Near- and Mid-infrared Evolution of Type Ia Supernovae with JWST – Lindsey Kwok, Rutgers University

Type Ia supernovae (SN Ia) have important implications on our understanding of cosmology and astrophysics, yet we still lack a detailed understanding of their progenitor systems and explosion physics. Nebular phase spectroscopy at late times reveals the SN ejecta when they have expanded, allowing us to directly probe the ejecta structure, composition, ionization, and kinematics. We present the time evolution of a sample of JWST near- and mid-infrared (NIR+MIR) spectra of Type Ia SNe in the nebular phase, including new JWST data of SN 2021aefx and a spectrum of SN 2022aaiq extending out to 28 microns. The spectra reveal strong nebular iron and stable nickel emission indicative of high-density burning that suggest a high mass progenitor white dwarf. The MIR opens a new window to show stratified ejecta that are a hallmark of delayed-detonation or double-detonation SN Ia models. From the time evolution, we can measure kinematic changes in the ejecta, estimate element masses, and trace the radioactive decay. We highlight similarities and differences between the spectra, and discuss their physical implications.

Transient and Variable Signatures of Technology – Joseph Lazio, Jet Propulsion Laboratory, California Institute of Technology

The stated motivations for conducting surveys of the transient and variable Universe include constraining physical laws; exploring different channels for stellar formation, evolution, and death; and understanding the properties and physics of intervening media. However, a potential unintended consequence of such surveys is that they may reveal signatures of technology beyond the Earth (""technosignatures""). We review how intervening media can cause steady signals to appear as variable and illustrate other signals that naturally might appear as transients. We consider how future telescopes might detect such signals, with a particular focus on the Deep Synoptic Array-2000 (DSA-2000). We acknowledge the ideas and advice from the participants in the Data-Driven Approaches to Searches for the Technosignatures of Advanced Civilizations workshop organized by the W. M. Keck Institute for Space Studies. Part of this research was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

Pipeline for the systematic search of transients using ACT data – Yaqiong Li, Cornell University

The millimeter and sub-millimeter transient sky has been relatively unexplored. However, the cosmic microwave background (CMB) telescopes, such as the Atacama Cosmology Telescope (ACT) and the Simons Observatory (SO), now have high enough resolution to observe these events. ACT and the large aperture telescope (LAT) of SO are 6-meter telescopes that aim to measure CMB intensity and polarization anisotropies. Both ACT and SO scanned or will scan around half of the sky with a weekly cadence and provides arcminute resolution to study millimeter waveband transient events. We have conducted a systematic search of transients using ACT data and present here the developed pipeline. This data pipeline includes the process of initial detection using short-time maps, data cuts on spurious candidates, light curve making, and classification and identification of the final candidates.

Variability of stellar mass black hole jets - Tom Maccarone, Texas Tech University

I will discuss long wavelength variability campaigns on the jets from stellar mass black holes. These campaigns, on long timescales, can be used to determine when jets are produced and when they are not. On shorter timescales, they can be used to map out the structure of X-ray binary jets. I will discuss how this work can inform approaches for understanding the jets of active galactic nuclei, as well.

Searching for Variable Dwarf Galaxies with the Young Supernova Experiment - Alexander Messick, Washington State University

We present the initial results from a search for active galactic nuclei (AGN) in low-mass (7 <= log(M_*/M⨀)<= 10) galaxies from the Young Supernova Experiment (YSE). For decades, AGN have been known to demonstrate photometric variability at different timescales. Because their light curves can be modeled with a damped random walk, the variability of these objects have been used to identify new AGN candidates. We conduct this search using data from the YSE, a survey on the Pan-STARRS telescopes that will observe over 1500 square degrees of sky in the infrared and optical with a 3-day cadence. Although currently only partially operational, this project has already found more than a thousand transient objects since 2019. We plan to use their high cadence and large fields to construct and analyze light curves for over 55 thousand nearby dwarf galaxies. From these, we hope to discover new dwarf AGN, explore potential relationships between observed and derived parameters such as host galaxy mass and variability timescales, and help constrain the dwarf AGN occupation fraction, thus constraining the evolution of supermassive black holes.

The La Silla Southern Sky Survey - Adam Miller, Northwestern University/CIERA

The La Silla Southern Sky Survey (LS4) is a new time-domain survey to be conducted using the ESO 1m Schmidt Telescope. LS4 is upgrading the Quest camera to completely fill the 20 sq. deg. focal plane with red-sensitive LBNL deep depletion CCDs. The LS4 survey will operate for 5 years, and 90% of the open shutter time will be devoted to a wide-field survey with a ~1 day cadence. The survey will be conducted in the g, i, and z filters, and alerts for variable and transient sources identified via image subtraction will be released to the public. These observations will be strategically defined to complement the contemporaneous Legacy Survey of Space and Time (LSST) conducted by the Vera C. Rubin Observatory. The remaining 10% of the telescope time is reserved for special projects to be conducted by the LS4 partners, including ToO programs to search for electromagnetic counterparts to multi-messenger events. LS4 is uniquely sensitive to red transients in the local universe, and as such will play a unique role in the search for kilonovae, Galactic microlensing events, gravitationally lensed supernovae, and dust obscured transients.

RR Lyrae Stars as Calibrators of the Local Distance Scale - David Nataf, Johns Hopkins University

RR Lyrae variable stars are ubiquitous among ancient stellar populations, and their variations follow well-defined period-luminosity relations that can enable distance determinations of 10% per star and thus 1% per groups of stars. The photometry from the Rubin observatory and the Roman deep fields will enable detection and characterization of RR Lyrae to approximately 2 Mpc and perhaps beyond, thus charting the most precise astrometric map of the local group. In this talk, I will describe our group's attempt to calibrate RR Lyrae locally, using a combination of Gaia astrometric data and proprietary high-resolution spectroscopy. I will then describe the potential impact of our improved calibration. We are finding significant deviations between prior calibrations and our high-resolution data at the low metallicity end, and thus the changes are most impactful for the lowest metallicity, lowest mass galaxies.

Origin of Type Ia Supernovae: Infant-Phase Observations from the KMTNet Supernova Program - Yuan Qi Ni, University of Toronto

How Type Ia supernovae (SNe) explode and what companions are involved remain important outstanding astrophysical problems. The KMTNet Supernova Program (KSP) high-cadence survey has yielded the largest sample of infant SNe with multi-color observations immediately post-explosion, shedding new light on their origins. Here, we highlight results from this sample, which includes two normal Type Ia SNe (2018aoz and 2021aefx) with rapidly reddening excess emission detected <1 hour after first light. SN 2021aefx, in particular, also exhibited fast-expanding ejecta material extending to >40,000km/s—the fastest identified in Type Ia SNe to date. We show that the observations of SN

2021aefx require the presence of at least two distinct homologously-expanding ejecta components: (i) a normal-velocity component consistent with typical photospheric evolution of Chandrasekhar-mass ejecta; and (ii) a high-velocity component limited to the outer ejecta, containing unburnt carbon as well as silicon, calcium, and radioactive iron-peak elements synthesized by the explosion. We explore the implications for explosion models, noting that the partially-burnt secondary ejecta component in SN 2021aefx can originate from an off-center ignited delayed-detonation of a Chandrasekhar-mass white dwarf. Finally, we discuss these results in the context of the overall population of KSP-observed Type Ia SNe and their various early features.

The Host Galaxies of Sub-Chandrasekhar Mass Explosions – Anya Nugent, Northwestern University, CIERA

Type Ia SNe (SNe Ia) are important probes of cosmology and are thought to derive from the thermonuclear explosion of a white dwarf that approaches the Chandrasekhar mass limit. However, in recent years, there has been increasing evidence that sub-Chandrasekhar mass explosions, typically distinguished by their redder colors and higher velocities, are possible and represent a significant fraction of SNe Ia (~25%). This sub-population may bias the cosmology measurements made from SNe Ia. The host galaxy properties of such events are an important avenue to understand if these progenitors trace different environmental properties than the majority of SNe Ia and if the environment affects the observability of the SN. In this talk, I will present the first study to characterize the global stellar population properties of sub-Chandrasekhar candidate hosts, using a sample of 74 local universe SNe Ia, and infer if their environments are distinguished from Chandrasekhar mass explosions. Furthermore, I will highlight the significant evidence that the local environments of these SNe differ from those of classical SNe Ia. Finally, I will discuss how we may use this environmental information to distinguish sub-Chandrasekhar SNe in the era detecting thousands of SNe with the Vera Rubin Observatory.

Connecting Type Ia Populations with Deep-Learning Accelerated Abundance Tomography - John O'Brien, Michigan State University

Type Ia supernovae, the thermonuclear explosions of Carbon-Oxygen white dwarfs, remain poorly understood despite decades of investigation. Massive computationally intensive hydrodynamic simulations have been developed to model an ever-growing number of theoretical explosion scenarios with increasing computational fidelity. However, connecting individual supernovae observations to theoretical models through inference performed with physical simulations remains computationally intractable. To rectify the missing connection between theory and observation, we have developed a methodology to couple state-of-the-art radiative transfer simulations with deep-learning to infer physics-informed data-driven models for large samples of archival observations. In this talk, I will present reconstructions of two distinct populations of Type Ia supernovae inferred with a probabilistic deep-learning emulator for the radiative transfer code TARDIS. I will discuss the inferred internal physical differences between these two populations of Type Ia supernovae leading to their distinct observational properties.

Fermi-LAT and Swift-XRT observations of Nova Her 2021 - Tekeba Olbemo, Washington University in St. Louis

V1674 Her (Nova Her 2021) was discovered in the optical band on 2021 June 12. The nova has been observed in various energy bands thereafter. Its optical light curve showed a two magnitude decline from the peak within one day. t_2~1.0d makes V1674 Her the fastest-fading nova ever recorded. V1674

Her was also detected in the gamma-ray band by Fermi-LAT. The LAT light curve peaks on 2021 June 12 and completely fades on the same day. These rapidly declining optical and gamma-ray emissions of V1674 Her indicate that the binary system hosts a massive white dwarf. The nearly concurrent peaks in the optical and Fermi-LAT light curves can be due to a common source, possibly a shock, powering the emissions in both bands. Using Lomb-Scargle Periodogram analysis, we found a periodic modulation in SWIFT/XRT data of V1674 Her at the most probable value of 8.02 min. This value is comparable with period values reported in earlier Chandra and optical data of the nova. We discuss the origin of this period and possible reasons for the slight variations of its value among Chandra, SWIFT/XRT and optical data.

Short timescale radio variability in black hole and neutron star X-ray binary jets - Eli Pattie, Texas Tech University

Black hole and neutron star X-ray binaries host radio jets that are believed to be fed by the inner accretion disk, and then collimated and accelerated by twisting magnetic fields. General radio and jet behaviors of black holes and neutron stars are very similar, though there are some notable differences as well. It is already known that neutron star jets tend to be less luminous than black hole jets, while neutron star systems also span a much wider range in radio luminosities for a given X-ray luminosity. Currently, the reasons for these differences are not all clear, and further investigating and comparing details of black hole and neutron star jets may aid in this endeavor. Here I present preliminary short timescale variability analyses of ~2 dozen ALMA and VLA observations for both black hole and neutron star systems, performed by creating light curves and power spectra from the data, for the first time for many of the systems. We are interested to see if any potential systematic differences between back hole and neutron star jet properties such as speeds and opening angles manifest in radio power spectra characteristics.

Observing the Youngest Supernovae in the Nearby Universe – Jeniveve Pearson, University of Arizona

Despite decades of research, the properties of supernovae progenitors are not well understood. Catching supernovae early, in the hours and days immediately following explosion, can shed light on the progenitor's final moments. By surveying nearby galaxies, the Distance Less Than 40 Mpc (DLT40) survey focuses on collecting the early observational signatures key to understanding supernovae explosions and progenitors. Once a supernova is discovered, DLT40 triggers spectroscopic classification and immediately begins collecting sub-day cadence multiband photometry, creating some of the most complete datasets of young supernovae. In this talk, I will discuss a few of the exciting objects that have been followed by DLT40 in the last couple years including SN 2022xkq, a 91bg-like SN Ia with carbon features post-max light discovered by DLT40 only 21 hours after the last non-detection. These supernovae highlight DLT40’s current observational capabilities and the techniques we use to observe the youngest supernovae. DLT40 has been instrumental in growing the number of supernovae observed less than 24 hours after explosion and illustrates the importance of focused, smaller scale programs in the era of large surveys like ATLAS, ZTF, and LSST.

PG 1553+113: the case for a super-massive black hole binary, Pablo Penil, Clemson University

PG 1553+113 is a blazar exhibiting significant evidence of a 2.2-year periodic emission detected from radio to gamma rays. Here we present the first evidence of longer, 21-year periodic variability in the

>100-year optical lightcurve provided by the DASH database. The 10-to-1 relationship between these two periodicities is tantalizingly consistent with the two dominant periodicities reported in recent simulations of supermassive binaries embedded in a thin disk. In that setting, the 2.2-year period comes from the binary orbit, and the 21-year period comes from the orbit of an overdensity in the circumbinary disk called a "lump." This finding provides strong evidence that a binary of super-massive black holes resides at the core of PG 1553+113. We will also discuss physical constraints that can be placed on the putative binary.

Long duration transients with SPT-3G – Kedar Phadke, University of Illinois at Urbana-Champaign

The first results from the SPT-3G (South Pole Telescope - third generation) mm/sub-mm transient survey over an eight month period in 2020 yielded two long-duration transient (LDT) events with timescales of 2-3 weeks each. Their flare amplitudes of four and fifteen times their quiescent fluxes over the timescale of the respective events were unprecedented in the mm/sub-mm regime. I will present results from optical spectroscopic follow-up of the two transients which helped characterize those events. These two events were confirmed to be consistent with flaring AGN. I will also present a statistical report of flaring events of greater than a week timescale for all sources in the SPT-3G winter field over 4 years.

SCOVaS: Survey for Compact Objects and Variables Stars – Manuel Pichardo Marcano, American Museum of Natural History

Globular clusters (GCs) are very old group of stars. Their age and very dense stellar density lead to a higher formation rate of compact binaries (i.e. those harboring black holes, neutron stars, and white dwarfs in tight orbits), compared to the Galactic field. Of special interest are the cataclysmic variables (CVs), which are accreting white dwarfs from hydrogen-rich companions. CVs deserve special attention as they are predicted to account for a large fraction of the compact binary population in GCs and can be used to test whether GCs are in fact the efficient factories of compact binaries that we think. In this talk, I will present the first results of an ongoing survey, which uses archival Hubble Space Telescope data of globular clusters with different characteristics, to do the first search for faint Cataclysmic Variables in Globular clusters that is not biased in the X-rays. I present the first results of an ongoing survey, which uses archival Hubble Space Telescope data of globular clusters with different characteristics, to do the first search for faint cataclysmic variables in Globular clusters that is not biased in the X-rays. I will present the first results of this survey including the first candidate magnetic helium core white dwarf in the globular cluster NGC 6397.

Super-Kamiokande galactic supernova's neutrino burst monitoring – Guillaume Pronost, ILANCE (CNRS - University of Tokyo)

Since SN1987A, we know that supernovae (SNs) produce burst of neutrinos which can be detected several minutes to hours before the electromagnetic burst. Detecting this neutrino burst can provide an early warning to the astronomer community of the imminent SN.

The Super-Kamiokande experiment, with its 50 ktons water Cerenkov detector, is the world's most sensitive neutrino detector able to provide this warning. Two main interactions are expected from the neutrino bursts in a water Cerenkov detector : inverse β decay (IBD) for ~90 % and electron scattering for ~5 %, this last one providing a direct indication of the SN direction. The recent gadolinium loading in the Super-Kamiokande detector allows a quasi-background-free selection of the IBD in the detector, providing a clear signature of potential SN burst, and allowing separation between IBD and ES to improve

the SN direction pointing accuracy.
In this presentation, we will report the status of the Super-Kamiokande real-time SN monitoring system, SNWatch."

The systematic modelling the diverse type IIn supernova lightcurves using MOSFiT – Conor Ransome, Penn State

The uncommon and highly heterogenous class, type IIn supernovae are generally characterized by narrow features observed in the hydrogen Balmer series. These narrow features arise due to the interaction between fast supernova ejecta and a pre-existing, dense, slow, hydrogen rich circumstellar medium. This material must have been ejected prior to the supernova explosion by the progenitor, either dramatically through episodic mass loss and/or via massive winds. The IIn class is highly heterogenous, with a wide range of photometric and spectroscopic properties as well as environments which may indicate more than a single progenitor route. We aim to explore the parameter space (CSM mass, ejecta mass, CSM density etc.) of the largest sample (100+) of type IIn supernova lightcurves from previous work and also surveys such as the ZTF Bright Transient Survey. To do this we use the lightcurve modelling package, MOSFiT. In this talk I will discuss the derived parameters from the lightcurve fitting of this mysterious class and the links these parameters offer to possible progenitor scenarios.

Unveiling the Diversity of NS Merger Counterparts With Observations of GRBs – Jillian Rastinejad, CIERA, Northwestern University

Thanks to the landmark discovery of the first binary neutron star (NS) merger detected via gravitational waves (GWs) and its accompanying kilonova', it is widely accepted that NS mergers contribute significantly to the Universe's production of heavy elements. However, with only one well-studied kilonova to date, it remains an open question whether kilonovae are the only astronomical site of heavy element formation in our Universe. In this talk, I will discuss our work expanding our view of the diversity of kilonovae and their heavy element yields using observations following 85 short GRBs. Against this backdrop, I will present our surprising discovery of a kilonova following the long GRB 211211A (duration ~ 50s) at 350 Mpc, providing a striking counterexample to a decades-long-held GRB paradigm. I will discuss GRB 211211A's unique high-energy properties and compare our derived kilonova properties to those of GW170817 and past GRBs. Finally, I will review the exciting implications of this event for O4.

Bright transient identification with machine learning for the Zwicky Transient Facility – Nabeel Rehemtulla, Northwestern University

The Bright Transient Survey (BTS) aims to spectroscopically classify all extragalactic transients found by the Zwicky Transient Facility (ZTF) that peak brighter than 18.5 magnitude in g- or r-band. Since its inception, BTS has relied upon manual visual inspection ("scanning") to confirm candidates for spectroscopic observations. We present a new, multi-input convolutional neural network to ingest a ZTF detection's image cutouts and metadata and assign it a bright transient score. The score represents the neural network's confidence that the source in the detection is, or will become, a bright transient. This model has the ability to eliminate or dramatically reduce the need for human scanning by automatically identifying and requesting spectroscopic follow-up for new bright transient candidates. In some cases, the model can identify a bright transient while it is still faint, enabling earlier spectroscopic follow-up. On training data, the model creates a BTS sample that is >90% pure and >90% complete. We have an upcoming program with the robotic SEDMv2 spectrograph to further validate the model by automatically following-up candidates it selects.

The Historic Light Curve of Eta Car's Great Eruption from its Light Echoes – Armin Rest, STScI

The Great Eruption (GE) of Eta Carinae (Eta Car) in the mid-1800s was a spectacular astronomical event, visible to the naked eye (Smith & Frew 2011). It arose from a more than 100 solar Mass evolved star in an eccentric binary system that suddenly ejected about 20 solar Mass of material, today seen as the bipolar Homunculus nebula. The discovery of light echoes of Eta Car's GE (Rest et al. 2014) now offers us the opportunity to re-observe Eta Car's eruption with modern instrumentation. For the first time, we are able to probe the photometric asymmetry of the same event, and we find a striking diversity in the light curves derived from echoes at different viewing angles.

Presenting the Swope Supernova Survey and its first Type Ia supernova data release – César Rojas-Bravo, University of California, Santa Cruz

I will present the Swope Supernova Survey (SSS), a six-band, low-z, optical survey based in Las Campanas Observatory, Chile, and its first data release of Type Ia supernovae (SNe Ia). The Swope telescope was also used for the Carnegie Supernova Project (CSP), and thus SSS builds upon their legacy of calibration. SSS has observed over 300 transients, primarily selected from untargeted surveys, producing high-cadence, precisely calibrated uBVgri light curves. Our first data release includes over 180 SNe Ia. Combined with CSP, the Swope telescope has observed over 600 SNe Ia with high-fidelity light curves. We will present details of the survey and the SN sample. We will also present initial cosmological results.

Modeling the Reverberation Response of the Broad Line Region in Active Galactic Nuclei - Sara Rosborough, Rochester Institute of Technology

The dense gas clouds within the potential well of an active supermassive black hole (SMBH) are photoionized by the accretion disk radiation and emit spectral lines that are Doppler-broadened by several 1,000 km/s. This broad line region (BLR) provides us a way to understand the sub-parsec environment of active galactic nuclei (AGN) and infer SMBH masses by measuring BLR sizes and velocity fields. However, the distances to most AGN make spatially resolving the BLR very challenging and its structure and dynamics are uncertain. Reverberation mapping utilizes the time delay between the variability of the AGN's continuum and the emission line response to map the BLR's structure and dynamics. We have developed a new forward modeling code to simulate the reverberation response of the BLR, BELMAC (Broad Emission Line MApping Code). The result is the velocity-resolved response, which encodes the BLR's structural and dynamical information. BELMAC incorporates photoionization models to calculate the cloud luminosity for multiemission line studies. I will present the velocity-resolved responses for various BLR geometries and velocity fields, including radiatively driven outflows, Keplerian disks, and biconical winds. BELMAC provides a unique asset for interpreting the wealth of BLR reverberation data that will come from near-future large-scale time-domain surveys.

Transient Classifiers for Fink: glimpses from the ELAsTICC data challenge - André Santos, Brazilian Center for Research in Physics (CBPF)

The upcoming Vera C. Rubin Observatory and the Legacy Survey of Space and Time (LSST) will detect of the order of millions of transients every night along its ten year survey. In this context, one of the main challenges will be the robust, fast and reliable classification of these objects in order to select the most promising ones for follow-up observations. Therefore, due to the high amount of data available and the fast processing time required, machine learning (ML) algorithms are expected to play a key role. In this work, we present the methods and models developed and implemented in the Fink broker, in the context of the Extended LSST Astronomical Time-series Classification Challenge (ELAsTiCC). We study the use of hierarchical classifiers composed of broad classifiers based on state-of-art Deep Learning algorithms for time series classifications and a second set of binary classifiers optimized for specific transient science cases: fast and explosive transients, pair instability Supernovae, active galactic nuclei, supernovae and early SNI Ia. We optimize the broad classifiers both, in terms of Neural Architecture Search and also for the best outcome in the binary classifiers in terms of purity and completeness. Using a whole year of data, one of the broad models achieved over 95% true positives in all categories except for long period transients. We further present our benchmarking results and the lessons learned in the dataset.

The End of Impostor Syndrome: JWST observations of SN 1997bs - Sumit Sarbadhicary, Ohio State University

In this talk, I will discuss JWST observations of SN1997bs, one of the original SN `imposters' whose ultimate fate had been a controversy for decades. Initially, 97bs resembled a low-luminosity Type IIn SN, but subsequent HST observations instead raised the possibility of a powerful stellar eruption like η-Car, with the surviving progenitor cloaked in a shell of dust. Direct near/mid-IR signatures of such dust was needed, but not feasible until the launch of JWST, and our observations provide the much needed high-resolution (3-32 pc) information on the SN site at 2-21 micron. We do not detect any emission from the SN in the MIRI and NIRCAM filters, except at 21 micron. I will discuss how the HST+JWST observations confirm that 1997bs was indeed a terminal explosion (as the required dust would be too massive for stellar eruptions), as well as the mysterious nature of the 21 micron emission, which is also coincident with a faint blob of H-alpha emission based on IFU spectroscopy. I will finally discuss the ongoing PHANGS high-resolution multiwavelength survey of the nearby (<~20 Mpc) galaxies, and the unique constraints on progenitor properties they can provide for nearby historical and future explosive transients.

TransiNet for LSST: Two Implementations of Deep Transient Detection, towards Higher Completeness in the Unseen Domain – Nima Sedaghat, University of Washington

The original version of TransiNet, provided a novel redefinition of the detection task using fully-convolutional neural networks. In preparation for LSST, we are implementing two advanced flavours of TransiNet. First, an image-generating multi-tasked real-bogus classifier on top of the existing image differencing techniques, which aims to fullfil the minimum project requirements, while being ready for adaptation to the unseen data.

The second one is a full end2end TransiNet which encapsulates the tasks of image differencing and classification in a single unit by generating images of the sought transients, and is likewise ready to adapt to the unseen data. What makes the latter (still experimental) design is its ability to dig deeper into the space, seeking for fainter transients -- the so-called below 5-sigma area. This implementation can now handle one single science image with ~4Kx4K pixels in one forward pass which takes less than a second on a GPU, and a few seconds on CPUs. The novel self-supervised domain adaptation technique allows for training on precursor data and still be ready to generalize to real LSST data in an agile fashion.

General Coordinates Network (GCN): NASA's Next Generation Alert System for Time-domain and Multimessenger Astronomy – Vidushi Sharma, NASA GSFC/UMBC

Gamma-ray Coordinates Network (GCN) is a collaborative platform operated by NASA to facilitate the sharing of alerts and quick communications regarding high-energy, transient, and multimessenger phenomena among the astronomy research community. Over the last 30 years, GCN has enabled significant advances by disseminating observations, predictions, requests for follow-up observations, and observing plans. GCN distributes alerts between space and ground-based observatories, physics experiments, and thousands of astronomers worldwide. As new transient instruments spanning the electromagnetic spectrum and multimessenger facilities become available, coordinating efforts have become more vital and complex than ever. Introducing the General Coordinates Network (GCN), an updated version of GCN designed with modern, open-source, reliable, and secure alert distribution technologies, and deployed in the cloud. The new GCN is built on Apache Kafka, the same alert streaming technology that the Vera C. Rubin observatory uses. We will present the current status and design of the new GCN, the streaming of notices and circular alerts with Kafka, and a vision of its growth as a community resource in the future.

Piecing together the long gamma-ray burst's progenitor puzzle - Manisha Shrestha, University of Arizona

It has long been established that long gamma-ray bursts (LGRB) originate from the explosion of massive stars. Initially, the jet afterglow created by the interaction of the ejecta and the ambient medium dominates. After a few weeks, the afterglow fades, often revealing a supernova (SN) Ic-BL. Recently, LGRB221009A (z=0.151), the brightest GRB ever detected, was discovered. The proximity and brightness of this LGRB provided us with a great opportunity to explore our understanding of the progenitor of these bursts. We searched for the SN component by following the LGRB221009A using ground-based facilities such as LBT, MMT etc. Interestingly, we do not find a clear SN emission in our light curve or spectra. In this talk, I will present the photometric and spectroscopic observations and analysis we did for the LGRB221009A in search of an associated SN and the implications of our findings. This puzzling discovery along with the recent identification of r-process elements in LGRB211211A, previously associated with the merger of binary neutron stars, challenges the established progenitor scenario. Hence, I will also discuss observational strategies to search for SN/r-process emission in an unbiased sample of nearby LGRBs to better our understanding.

An Asymmetric SN Ia with a Surviving Companion: Characterizing The Unique Nebular Emission in SN 2020hvf – Matthew Siebert, Space Telescope Science Institute

Extreme thermonuclear supernovae offer unique opportunities to test Type Ia supernova (SN Ia) explosion models. Recent attention has been focused on a handful of SNe Ia that display early flux excesses in their UV/optical light curves. I will discuss nebular spectroscopy of one such SN Ia, the carbon-rich overluminous ``03fg-like" SN 2020hvf. SN 2020hvf displays strong "saw-tooth" [Ca II] emission that cannot be explained with a single symmetric Gaussian velocity component, indicating an asymmetric explosion. We find that this feature is best-modeled by two velocity components offset by 1,250 km/s. Additionally, a blueshifted, narrow (FWHM=180 km/s) component of [Ca II] is detected in our highest resolution spectrum. The extremely narrow velocity width of [Ca II] is unprecedented in normal SNe Ia and has only been observed in SNe Iax at late times. Since this event likely had a double-degenerate (DD) progenitor system, we suggest that the primary white dwarf (WD) was fully disrupted and the narrow emission is likely the result of a wind coming from a surviving companion WD. SN 2020hvf reveals additional diversity in the 03fg-like SN Ia subclass. More high-quality observations of these events are needed to constrain their progenitor scenarios.

Exploring Small-Scale Brightness Variations in Nova Vulpeculae 2021 with TESS - Kirill Sokolovsky, UIUC

Novae are explosive events occurring on white dwarfs that accrete matter from their companion stars in close binary systems. The energy generated by the re-ignition of nuclear fusion in the accreted hydrogen-rich layer drives a dramatic expansion and eventual ejection of the white dwarf's atmosphere, leading to an increase in the binary's optical brightness by 8-15 mag reaching peak absolute magnitudes of -4 to -10 mag. We present the first comprehensive examination of an erupting nova using TESS observations. We employ photometry of Nova Vulpeculae 2021, extracted from TESS full-frame images, to characterize the short-term variability of a nova with unparalleled detail. Surprisingly, our analysis reveals three distinct variability patterns:
1) the overall rise and decline of the nova lightcurve,
2) isolated mini-flares, and
3) low-amplitude periodic modulation.
The periodic variations are stable in phase and are observable both before and after the nova's peak brightness, allowing them to be attributed to the binary orbital period. The physical origin of mini-flares, remains unclear. Potential explanations include the development of shocks within the nova ejecta and/or unstable nuclear burning on the white dwarf.

tdescore: An accurate photometric classifier for TDEs – Robert Stein, Caltech

Optical surveys have become increasingly adept at identifying candidate Tidal Disruption Events (TDEs) in large numbers, but classifying these generally requires extensive spectroscopic resources. We here present tdescore, a simple photometric classifier that is trained using a systematic census of 3000 nuclear transients from ZTF. The sample is highly imbalanced, with TDEs representing 2% of the total. tdescore is nonetheless able to reject non-TDEs with 99.8% accuracy, yielding a sample of TDEs with a purity of ~85% and a completeness of ~85%. tdescore is substantially better than any available TDE photometric classifier scheme in the literature, and performs comparably well to the single-epoch spectroscopy as a method for classifying ZTF nuclear transients, despite relying solely on ZTF data and multi-wavelength catalogue cross-matching. In a novel extension, we use SHAP to provide a human-readable justification for each tdescore classification, enabling users to understand and form opinions about the underlying classifier reasoning. I will present a summary of how tdescore is aiding the search for TDEs in ZTF, and how it can serve as a model for present and future time-domain surveys, such as the upcoming Rubin observatory.

Community coordination to maximize science return in the era of Multi-Messenger Astrophysics: an ecosystem of services – Rachel Street, Las Cumbres Observatory

To understand the physics from transient and time-domain discoveries, especially from Multi-Messenger Astrophysics, we must synthesize information from many sources, combining information from Gravitational Wave and neutrino detectors with data from survey and follow-up teams across the electromagnetic spectrum. It is imperative to perform this synthesis in real-time in order to maximize the science return: efficiency is critical in order to rapidly identify high priority targets from the firehose of candidates. Streamlined sharing of information between teams in the community will be essential to realize the science.
A number of services for sharing information already exist and are being developed, including Kafka-based alert issuers (e.g. ZTF and soon LSST) and brokers (such as ANTARES, Lasair and Alerce), GCN

Notices and Circulars, and the HOPSKOTCH/Hermes system developed by SCIMMA. These services are complemented by tools for observers to coordinate follow-up programs, such as the TOM Toolkit, TreasureMap, Skyportal and more.
The scientific goals of the time-domain community are so diverse that no one single platform or tool will serve everyone's needs. Rather, these tools and services will be most effective as an ecosystem, where teams are able to use those tools that are most suitable for their science, but communicate seamlessly and efficiently across platforms when they need to.
We will review the tools and services currently available, including recent developments intended to enhance data sharing in the community, and discuss how these tools can work together with other services in the wider software ecosystem to maximize the science return.

Flaring Stars From 4 Years of the SPT-3G Transient Survey – Chris Tandoi, UIUC

Millimeter wavelength observations of stellar flares are limited when compared to those at other wavelengths such as optical, radio and X-ray. Until recently, millimeter measurements of these flares were limited to the Sun or a handful of individual stars. The South Pole Telescope (SPT) and the Atacama Cosmology Telescope (ACT) are both primarily cosmic microwave background (CMB) experiments but have also conducted millimeter transient surveys yielding flares from 3, 8, and 11 stars in recent publications. In this talk I will present results from a new flare star catalog spanning four years of the SPT-3G transient survey. A total of 111 flaring events were detected from 66 unique stars representing a wide range of spectral types from M dwarfs to early-type main sequence stars and giants, greatly increasing the number of millimeter wave flaring stars in the literature. These events can help us to understand the physics behind the impulsive particle acceleration of stellar flares.

The Keck Infrared Transient Survey: a public near-infrared spectroscopic survey - Samaporn Tinyanont, National Astronomical Research Institute of Thailand

I will give an overview of the Keck Infrared Transient Survey (KITS), a NASA Key Strategic Mission Support program with 36 half nights in 2022A, 2022B, and 2023A. KITS uses Keck/NIRES to obtain hundreds of near-infrared spectra of astronomical transients, accounting for a significant number of near-IR spectra available in the literature. With the successful launch and commissioning of the James Webb Space Telescope and the upcoming Nancy Grace Roman Space Telescope, we are entering a new era of infrared astronomy. Explosions of Population III stars may be the furthest objects JWST will observe. Accurately measuring the expansion of the Universe is one of Roman's key mission objectives; observing Type Ia supernovae in the infrared is key. KITS provides a large, publicly available sample of transient IR spectroscopy, which is essential to mine JWST data to search for primordial stellar explosions and to plan an effective survey strategy for Roman. As of March 2023, we have observed 102 unique supernovae with a total of 188 spectra. We have covered all sorts of transients spanning from the common Type Ia and Type II supernovae to the rare and exotic Tidal Disruption Events, Luminous Red Novae, and stripped interacting Type Icn supernovae. I will discuss our first data release of 2022A data and science highlights from the survey.

A Search for Millimeter-wave Transient Sources in the Galactic Plane with SPT-3G, Yujie Wan, UIUC

Transient source detection has been performed with the South Pole Telescope (SPT) survey in recent years, yielding discovery of dozens of transient events, including flare stars and variable AGN. All the previous surveys from SPT avoided the Galaxy to obtain the best measurements of the extragalactic sky.

From February 13th 2023 to March 21st 2023, SPT started its first dedicated survey towards the center of our Galaxy. This survey consists of 300 observations of 125.6 square degrees of the Galactic plane. The survey measures intensity and linear polarization in three bands centered at 95, 150 and 220 GHz, reaching a combined depth of 0.27,0.36, 1.15 mJy-arcmin, respectively. Preliminary data reduction and analysis has been made: we constructed individual maps for each observation with masking and filtering steps applied to reduce the noise, we then subtracted the individual maps by the average map to make the difference maps for transient finding. We are now in the process of applying the transient pipeline and finding the transient events and plan on presenting the first results from this survey at the conference.

Constrainting the long-living supramassive neutron stars by magnetar boosted kilonovae - Hao Wang, Purdue University

Kilonovae are optical trainsients following the merger of neutron star binaries, which are powered by the r-process heating of merger ejecta. However, if a merger remnant is a long-living supramassive neutron star supported by its uniform rotation, it will inject energy into the ejecta through spindown power. The energy injection can boost the peak luminosity of a kilonova by more than 2 orders of magnitudes, thus significantly increases the detectable volume. Therefore, even if such kind of events is only a small fraction of the kilonvae population, they could dominate the detection candidates. However, after 4 years of optical sky survey, no such event has been confirmed. In this work, we build a boosted kilonova model with rich physical details, including the description of the evolution of a proto neutron star, the energy absorption through X-ray photoionization. We also test the stability of the system. We simulate the observation prospect and find the only way to match the no-detection result is to limit the energy injection to only a small fraction of the neutron star rotational energy. Our result indicates that most supramassive neutron stars are not long-living and they must be rare events in the universe.

Flight of the Bumblebee: the early excess of SN 2023bee in UV and TESS – Qinan Wang, Johns Hopkins University

The hint for the progenitor and explosion mechanism of type Ia supernovae (SNe Ia) can lie in their early light curves. SN 2023bee is one of such SNe Ia that exhibits a mild early excess feature in its multiband light curve, including UV photometry from Swift and high cadence light curve from TESS. Compared to other SNe Ia with similar early excess, SN 2023bee has a weaker excess and redder early color, relatively similar to normal SNe Ia without excess. The early spectra of SN 2023bee have high velocity shallow absorption features, revealing a distinctive difference with normal SNe Ia as well as SN 2021aefx, another SN Ia with early excess. Current models fail to fully explain the early excess of SN 2023bee, especially the relatively flat UV light curve during the early time. That indicates that improvement in modeling is needed to fully resolve the origin of SNe Ia.

TURBO: Total-Coverage Ultra-fast Response to Binary-Mergers Observatory – Daniel Warshofsky, University of Minnesota

The Laser Interferometer Gravitational-Wave Observatory (LIGO), in coordination with a growing and global network of gravitational-wave detectors, has now detected over one-hundred mergers of compact objects . Among these detections five of them are thought to involve neutron stars and only a single example has been associated, at very high confidence, with an electromagnetic counterpart. The Total-Coverage Ultra-Fast Response to Binary Mergers Observatory (TURBO) will consist of large-format CMOS detectors mounted on two sets of sixteen 0.27-meter diameter optical telescopes installed at Skinakas

Observatory in Crete, Greece and Magdalena Ridge Observatory in New Mexico in the United States. Within two seconds of a trigger alert, TURBO will begin obtaining continuous, multi-band images of more than one hundred square degrees on the sky. Given its unique sensitivity to prompt emission, TURBO may detect novel types of counterparts and yield new insights into the poorly understood population of binary black-hole mergers. Observations of supernovae in nearby galaxies at the time of explosion (4-6 events each year) can be expected to provide new understanding of their stellar progenitor populations and explosion mechanisms. TURBO will also be able to respond extremely rapidly to alerts from additional facilities, including Fermi and Swift.

Probing Type Ia Supernova Progenitors and Local Dust Environments Using Light Echoes - Charlotte Wood, Iowa State University

Light echoes are transient reflection nebulae caused by dust scattering photons into our line of sight. The geometry of light echoes is well known and can therefore be used to map the dust distribution around a transient or variable source. In particular for type Ia supernovae, using light echoes to map the dust distribution can provide insights into the progenitor system. Single-degenerate systems should result in more circumstellar dust, which will appear as a compact, disk-like light echo. In contrast, interstellar dust creates large, ring-like light echoes. While ring light echoes do not provide insights about the progenitor, analysis of these echoes provides information about the local dust properties (e.g, grain size distribution, grain composition). As a test case, I present the newly-reported light echo around SN 2009ig and results from the dust analysis.

Photometric and Spectroscopic Analysis of SN~2022oqm: Closing The Gap Between SNe-Iax and Ic-like Calcium-Rich Transients – Karthik Yadavalli, Pennsylvania State University

In this work, we present the photometric and spectroscopic evolution of SN~2022oqm, a nearby triple-peaked Ic-like Calcium-Rich Transient (CaRT). Extensive spectroscopic coverage reveals Ic-like spectroscopic evolution, with early-time carbon and oxygen spectral features and late-time excess calcium emission consistent with other CaRTs. SN 2022oqm has relatively high peak luminosity (-17 absolute magnitude in B-band) for CaRTs, making it an outlier in the population of other observed Ic-like CaRTs, and shows other photometric discrepancies with the currently known CaRT population. We find that the first peak of the light curve is best described as a single expanding blackbody whose luminosity decays with power law index ~4.5, consistent with shock breakout. We infer an ejecta with 0.5 $M_\odot$ and Nickel Mass of 0.1$M_\odot$ with a modified Arnett-like model to describe peaks 2 and 3. Photometric and spectroscopic modeling suggests Iron-peaked elements mixing throughout the ejecta. Spectroscopy of SN 2022oqm suggests strong similarities with both SN 2007gr, a SN-Ic, and SN 2012Z, a SN-Iax. Detailed modeling of the spectral evolution of SN 2022oqm, points to an exponential density profile in the ejecta. We consider several physical origins and conclude that the disruption of a carbon-oxygen white dwarf by a helium-carbon-oxygen hybrid white dwarf presents the best progenitor scenario to explain the observed characteristics of this event.

Contributed Posters

The optical search of Fermi GRBs - Tomas Ahumada, Caltech

The Fermi Gamma-ray Burst Monitor (GBM) triggers on-board in response to ~ 40 short gamma-ray bursts (SGRBs) per year; however, their large localization regions have made the search for optical counterparts a challenging endeavour. We have developed and executed an extensive program with the wide field of view of the Zwicky Transient Facility (ZTF) camera, mounted on the Palomar 48 inch Oschin telescope (P48), to perform target-of-opportunity (ToO) observations on 10 Fermi-GBM SGRBs during 2018 and 2020-2022. Bridging the large sky areas with small field of view optical telescopes in order to track the evolution of potential candidates, we look for the elusive SGRB afterglows and kilonovae (KNe) associated with these high-energy events. No counterpart to a binary neutron star merger has yet been found in our searches, however, interesting transients have appeared in our searches.

More than 10 ground based telescopes, part of the Global Relay of Observatories Watching Transients Happen (GROWTH) network, have taken part in these efforts. The candidate selection procedure and the follow-up strategy have shown that ZTF is an efficient instrument for searching for poorly localized SGRBs, retrieving a reasonable number of candidates to follow-up and showing promising capabilities as the community approaches the multi-messenger era. Based on the median limiting magnitude of ZTF, our searches would have been able to retrieve a GW170817-like event up to ~200 Mpc and SGRB afterglows to z = 0.16 or 0.4, depending on the assumed underlying energy model. We show that future ToOs will expand the horizon to z = 0.2 and 0.7 respectively.

The disappearance of the primary blazar zone in PKS 1510-089 - Markus Boettcher - Presented on behalf of the H.E.S.S. Collaboration, North-West University

In July 2021, the blazar PKS 1510-089 exhibited a significant flux drop in the high-energy gamma-ray and optical bands and remained in this state throughout 2022. Similarly, the optical polarization degree vanished, so that the optical spectrum is fully explained through the steady flux of the accretion disk and the broad-line region without any jet contribution. Meanwhile, the very-high-energy gamma-ray and X-ray fluxes remained almost steady throughout both years. This suggests that the steady-state very-high-energy gamma-ray and X-ray fluxes originate from a different emission region than the main parts of the high-energy gamma-ray and optical jet fluxes. This main or primary component has vanished through either a swing of the jet away from the line-of-sight or a significant drop in the photon production efficiency of the jet close to the black hole. Either change could become visible in high-resolution radio images.

Photometric Data Reduction Pipeline for SEDMv2 – Saarah Hall, Northwestern University

The Spectral Energy Distribution Machine version 2 (SEDMv2), the successor to SEDM, is a new, fully robotic instrument designed for transient classification. SEDMv2 has been mounted on the Kitt Peak 84-in telescope (KP84). SEDM has proven to be a prolific instrument for transient classification, and SEDMv2's larger size and higher quantum efficiency relative to its predecessor promises it be a leading telescope for transient classification. SEDMv2 has a 30"x30" field of view integral field spectrometer mounted in front of an EMCCD camera providing both ultra-low resolution spectroscopy (R ~ 100) as well as the ability to obtain photometric observations.

Here we present a new pipeline to process SEDMv2 photometric observations. This pipeline is nested within "winterdrp," a modular and open-source tool for astronomy image reduction. The pipeline automatically performs astrometric and photometric calibrations before producing calibrated light curves for the target of interest. For transient sources, image subtraction is performed and publication-ready light curves are delivered to the user. We summarize the overall performance of SEDMv2 via astrometric and photometric repeatability measurements.

light-curve: A high-performance toolkit for time-series feature extraction – Konstantin Malanchev, UIUC

Classical pre-processing methods remain popular for machine-learning tasks and characterization of unevenly separated time series, including period extraction and parameter inference. In this poster, we present the "light-curve" package for Python, which offers a high-performance toolkit for time-series feature extraction in transient and variable objects. The package includes a range of features, from magnitude statistics and light-curve shape parameters to fast Lomb-Scargle periodogram and parametric function fits. These fits are particularly useful for transient objects, which exhibit a range of behavior over time. The "light-curve" package is easily installed via pip and the source code is available on Github at https://github.com/light-curve

Search for particular properties of GRBs at high redshift - Graziella Pizzichini, INAF/OAS Bologna

I shall report on an ongoing search for peculiar properties of Gamma Ray Bursts at high redshift

Scary Barbie: An Extremely Energetic, Long-Duration Tidal Disruption Event Candidate Without a Detected Host Galaxy at z = 0.995 - Bhagya Madimugar Subrayan, Purdue University

We report multi-wavelength observations and characterization of the ultraluminous transient AT 2021lwx (ZTF20abrbeie; aka ``Barbie'') identified in the alert stream of the Zwicky Transient Facility (ZTF) using a Recommender Engine For Intelligent Transient Tracking (REFITT) filter on the ANTARES alert broker. From a spectroscopically measured redshift of 0.995, we estimate a peak observed pseudo-bolometric luminosity of log L_(max)=45.7 erg/s from slowly fading ztf-g and ztf-r light curves spanning over 1000 observer-frame days. The host galaxy is not detected in archival Pan-STARRS observations (g>23.3 mag), implying a lower limit to the outburst amplitude of more than 5 mag relative to the quiescent host galaxy. Optical spectra from Lick and Keck Observatories exhibit strong emission lines with narrow cores from the H Balmer series and ultraviolet semi-forbidden lines of Si III] λ1892, C III] λ1909, and C II] λ2325. Typical nebular lines in AGN spectra from ions such as [O II] and [O III] are not detected. These spectral features, along with the smooth light curve that is unlike most AGN flaring activity, and the luminosity that exceeds any observed or theorized supernova, lead us to conclude that AT 2021lwx is most likely an extreme tidal disruption event (TDE). Modeling of ZTF photometry with MOSFiT suggests that the TDE was between a ≈14M⨀ star and a supermassive black hole of mass M_(BH)∼ 10^8M⨀. Continued monitoring of the still-evolving light curve along with deep imaging of the field once AT 2021lwx has faded can test this hypothesis and potentially detect the host galaxy.