List of Abstracts

Session 1

Discovering radio transients with machine learning and citizen science
Alex Andersson, University of Oxford
Current and upcoming interferometers can now sample wide swathes of the radio sky with unprecedented sensitivity and cadence. As a result, we can now discover novel radio transients across an immense range of astrophysical regimes - from flare stars to FRBs. I will discuss recent, serendipitous discoveries being made with the MeerKAT radio telescope and how we can make the most of new facilities coming online. This includes how citizen scientists have scoured through commensal data and uncovered 100s of new variable and transient sources. This is the first crowdsourcing project dedicated to radio transients in this manner and has uncovered variable sources as different as nearby flare stars, pulsars and AGN. I will detail unsupervised machine learning techniques being applied to speed up the search for interesting and anomalous sources. These anomaly detection models can, with the use of active learning strategies, be customised to find not only anomalies, but those that are verified as interesting systems for a particular science case. The tested models show great success in recovering transients in our large dataset and these techniques hold great promise for searching large datasets for rare and unique systems.

An intrinsic luminosity-decay correlation in GRB radio light curves
Samuel Shilling, Lancaster University
With the regular detection of Gamma-ray Burst (GRB) afterglows with Swift over the last 20 years, the number of afterglows has become sufficient to perform statistical analyses across multiple frequencies. Studies of GRB afterglows have discovered a correlation between the luminosity measured in the early stages of the afterglow and the average rate of decay past this time. This correlation has been observed at optical/UV, X-ray and GeV frequencies. These findings suggest that more luminous afterglows decay faster than less luminous ones. At this meeting, we will present a correlation in the radio afterglows of GRBs between the intrinsic luminosity measured at 10 days and the average rate of decay measured from 10 days onwards, complementary to that found in previous studies. We will discuss the radio sample, compare the correlation with that discovered at other frequencies and investigate the possible causes of the correlation.

GRB afterglow emission from structured jet
Sayan Kundu, University of Bath
Gamma-ray burst (GRB) afterglows are produced by collimated outflows of ultra-relativistic plasma. Recent work has shown an increasing role for jet structure in the modelling of these events, where the energy of the jet is not evenly distributed with angle, already from an early stage of jet evolution before lateral spreading. This in turn impacts the observed temporal slope of afterglow emission across the broadband. It also affects the spectra directly, in particular if the synchrotron cooling of shock-accelerated electrons is accounted for

locally within the flow, revealing the hot zones of structured jets. To fully numerically model such jets and their emission characteristics across distance scales requires special relativistic hydrodynamics (RHD) methods. I will present the results from multi-dimensional simulations of structured GRB jets performed with our moving-mesh code, GAMMA. The emission from the jets is computed via a local cooling approach, where each computational cell possesses a distinct synchrotron cooling cutoff, and the collective contribution from these cells determines the overall emission profile. I will show how the interplay between jet structure, cooling, and jet orientation can be used to explore the diversity of afterglow observations, including off-axis observations and jets with delayed or absent jet breaks.

Ultra-deep cover: an exotic and jetted tidal disruption event candidate disguised as a gamma-ray burst

Rob Eyles-Ferris, University of Leicester

GRB 191019A is a unique object - an apparently long gamma-ray burst (GRB) but lacking evidence of a supernova and occuring in the nucleus of a non-starforming galaxy. This points towards it being a member of the growing merger-driven long GRB class, however, its location and the properties of its galaxy point towards a different option - an ultra-deep tidal disruption event (TDE). While most TDEs occur over weeks, months or even years long timescale, in this talk, I will show that the ultra-deep model can reproduce the behaviour seen in GRB 191019A through a minute long hyper-Eddington accretion phase. Future examples of ultra-deep TDEs could be distinguished from more typical GRBs through a soft X-ray flash detectable by wide-field instruments such as those carried by Einstein Probe or SVOM.

"Double-Acct" - the extraordinary double-peaked supernova, SN2020acct

Charlotte Angus, Queens University Belfast

The fates of massive stars are governed by the mass loss they experience during their lifetimes. Theoretically, extremely massive stars (>~60 solar masses) are thought to undergo explosive mass-loss episodes, a result of dynamically unstable contractions of their O-rich cores driving material from the stellar surface. This 'Pulsational Pair Instability' (PPI) can produce luminous, SN-like transients in the months-years prior to final core collapse through collisions of subsequently ejected shells of material. In this talk I will present SN2020acct, an extraordinary double peaked SN. The two peaks of SN2020acct, separated by 58 days in the rest frame, are distinct. The first is luminous, blue and swiftly evolving, with spectroscopic signatures of interacting circumstellar material. The second, fainter peak, marks a terminal explosion, being photometrically and spectroscopically similar to a stripped envelope SN. SN2020acct is one of the strongest PPI candidates discovered to date. I will discuss the properties of this remarkable SN and the implications for its PPI interpretation.

Inferring CSM Properties of Type II SNe Using a Magnitude Limited ZTF Sample

K-Ryan Hinds, Liverpool John Moores University

We present detailed light curve analysis and parameter measurements for over 8000 supernovae (SNe) from the ZTF Bright Transient Survey using forced photometry and multi-band Gaussian process regression. Particular attention is paid to the rise time distribution of Type II SNe, which is thought to reflect the progenitor radius and be impacted by the presence of CSM around their (expected) red supergiant progenitor stars. Using these empirically measured parameters and completeness of the magnitude limited Bright Transient Survey, we provide volume corrected distributions for CSM mass and radial extent in addition to progenitor radii and iron core masses for Type II SNe. Our results suggest that a large majority of Type II SN progenitors have pre-explosion CSM masses above 0.1 Msol and have mass-loss rates >0.001Msol/yr. This has implications for the end-of-life mass-loss rates of RSGs and for late-stage stellar evolution generally. Future applications will include similar photometric demographic studies of other SN types and photometric classification of classified and unclassified ZTF transients.

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Session 2

Detecting millimetre transients (and avoiding satellites) with the Large Aperture Telescope of Simons Observatory

Mike Peel, Imperial College London

Transient science at millimetre (mm) wavelengths is a relatively unexplored area of study with the potential to significantly contribute to our understanding of extragalactic sources such as gamma ray bursts and tidal disruption events (TDE), as well as fast stellar flares from nearby stars and episodic accretion by protostars. Current generations of cosmic microwave background (CMB) experiments scan a large fraction of the sky daily in multiple mm bands with thousands of detectors and ~arcmin resolution, presenting us with the perfect opportunity for serendipitous detection of transients. The South Pole Telescope (SPT) and Atacama Cosmology Telescope (ACT) have already discovered tens of transients, almost all of them consistent with stellar flares. The 6-metre Large Aperture Telescope (LAT) of the Simons Observatory (SO) will start observing in early 2025, with significant UK involvement through SO:UK, observing >40% of the sky every ~3 days. This will enable long-term monitoring of bright variable sources such as blazars, and potentially detecting hundreds of transients during its entire ~8-year science run. SO will make on-the-fly daily maps to catalogue point sources, and to send community alerts of transients within a few hours of them becoming detectable, which we also plan to follow up using other facilities such as ALMA and JCMT. SO will likely also see satellite constellations through thermal emission, which will have to be excluded from alerts. In this talk, we will cover the planned processes for detecting transients and avoiding satellite interference, as well as the potential science and discoveries we could extract from such sources.

Early-Time Supernova Spectroscopy with TiDES - 4MOST

Harry Addison, University of Surrey

The Time Domain Extragalactic Survey (TiDES) will conduct spectroscopic follow-up of LSST transients through the utilisation of the 4-metre Multi-Object Spectroscopic Telescope (4MOST). Current projections indicate that TiDES will observe over 30,000 supernovae (SNe) throughout the planned 5-year survey duration, forming the largest homogeneous SN sample. Presently, TiDES employs a selection function primarily geared towards assembling a cosmological supernova sample from LSST transient alerts. In this presentation, I will discuss the implications of the current TiDES selection function on conducting early-time astrophysical investigations of supernovae with TiDES. I will then present our efforts to develop a new selection function, which focuses on prompt detections of SNe from the LSST transient alerts for follow-up. Next, I will demonstrate the potential of our selection function in facilitating early-time SN spectroscopic observations with TiDES, and thus early-time SN astrophysical studies. Finally, I will outline our proposal for a long-term observing strategy for 4MOST, which optimises TiDES's utilisation of our selection criteria to observe early-time SN spectra.

Photospheric Spectra of Superluminous Supernovae

Aysha Aamer, Queens University Belfast

Superluminous supernovae (SLSNe) are some of the most energetic explosions in the universe reaching luminosities 10-100 times greater than typical supernovae. At peak, the spectra are characterised by a steep blue continuum and a series of O II absorption lines, indicative of high temperatures. As they evolve the spectra look comparable to Ib/c SNe at similar temperatures. Although the powering mechanisms of these events remain a mystery, analysing these spectra could unlock the progenitors and the mechanisms needed to power them. This talk presents work on the largest sample of SLSN photospheric spectra obtained from ePESSTO, the Finding Luminous and Exotic Extragalactic Transients (FLEET) search, as well as all published spectra up to December 2022. I present a catalogue of 204 objects and 661 spectra, and highlight preliminary work on how this will be used to understand these explosions. A main goal for this work is to look for evidence of subpopulations within SLSNe, for example, fast and slow events. I present work on the relationship between phases of SLSNe and Ic SNe providing a framework for comparison between these populations. I also discuss measurements of Fe and O line velocities and how they evolve over time in the context of the structure of these explosions.

A Generalized Model for Parameter Inference of Magnetar-Driven Supernovae

Conor Omand, Liverpool John Moores University
Several types of energetic supernovae, such as superluminous supernovae (SLSNe) and broad-line Ic supernovae (Ic-BL SNe), are thought to be powered by the spin-down of a rapidly rotating magnetar. A common technique for studying these supernovae is Bayesian inference, where the observed supernova light curve is compared to a model with many parameters, allowing a statistically robust way to infer these parameters for large samples of supernovae. In order to perform Bayesian inference, models need to be evaluated tens or hundreds of thousands of times to converge on the best-fitting parameters, so models need to run quickly for this to be feasible. As such, any model used for inference needs to balance being fast enough to perform the technique, but being accurate enough where the inferred parameters are physically meaningful. The most common model currently used for inference of magnetar-driven supernovae makes several assumptions which strongly negatively affect the accuracy of the inferred parameters. In a magnetar-driven supernovae, the pulsar wind nebula (PWN) produced inside the supernova ejecta applies a pressure to the ejecta and accelerates it; this means that the spin-down luminosity of the magnetar is coupled to the dynamics of the supernova. This effect, which is not included in most models, is not as prominent is slower SLSNe, but including it is essential for modeling faster SLSNe or Ic-BL SNe. Most models also assume that the magnetar spins down either through vacuum dipole radiation, but samples of galactic pulsars, as well as magnetar-powered gamma-ray burst afterglows, show that very few pulsars spin down in a way that is consistent with vacuum dipole emission. We present a model where these assumptions are relaxed, which can fully explore the diversity of magnetar-driven supernovae and unite phenomenologically different supernovae, such as SNe Ic-BL and SLSNe, under one theoretical framework. We show that the model can reproduce SLSNe and Ic-BL SN light curves within regions of the parameter space predicted by more computationally expensive numerical models. We also show the results of parameter inference on a few well-known example supernovae to demonstrate that our model can recover parameters for various types of phenomenologically different supernovae, showing that it is now possible to study them as one diverse population.

Magnetic Field Evolution in Tidal Disruption Events

Simona Pacuraru, University of Birmingham
When a star is tidally disrupted by a black hole, its magnetic field gets transferred to the debris, taking part in the subsequent evolution of the tidal disruption event. Making use of magneto-hydrodynamics simulations and a simplified semi-analytical model, I studied the early evolution of the debris stream around the black hole in the presence of magnetic fields. In this talk, I will present the results from this work, focusing on the magnetic field distribution throughout the stream and its impact on the gas through magnetic pressure. For strongly magnetized stars, I find that the magnetic field may become dynamically important, causing a fast increase in the stream width. This effect may impact the subsequent gas evolution, particularly by modifying the strength and the mass involved in the collision when the stream self-intersects. My characterization of the magnetic field in the returning stream will also be crucial to determine its role in providing the source of viscosity when an accretion disc has formed, thus affecting observable signatures such as X-ray radiation and relativistic outflows.

Planning for the eruption of nova T Corona Borealis

Paul Kuin, Mullard Space Science Laboratory, University College London
Nova T CrB erupted at least twice before with an 80-year interval and is expected to erupt again in 2024-2025. It is the closest recurrent nova at 960pc, and expected to be as bright as nova RS Oph, V=2 mag. The binary of WD and red giant orbit in 228 days. Swift has been monitoring the past years; we got HST STIS UV spectra at two phases; there are similarly ground based spectra throughout the orbit. An informal collaboration has been set up to inform all of the different plans for observing T CrB either before, during and after the next eruption.