Swift Cycle 15
Abstracts of selected proposals
(NNH18ZDA001N-Swift Cycle 15)

Below are the abstracts of proposals selected for funding for the Swift Cycle 15 program. Principal Investigator (PI) name, institution, and proposal title are also included. 141 proposals were received in response to this opportunity. On April 4, 2019, 22 proposals were selected for funding.

Roger Blandford/Stanford University
The Missing Piece of the Puzzle: Swift Monitoring of TESS-Fermi Blazars

Although multi-wavelength monitoring of the strongly variable emission of blazars has provided insights into high energy jet phenomena, one major mystery persists: the origin of the X-ray emission. Comparison between wavebands has been hampered in the past due to the sparse sampling and relatively poor photometric precision of ground-based optical timing. We plan to use the newly-launched exoplanet hunter TESS to obtain a cutting-edge sample of optical blazar light curves, leveraging our past success with Kepler. We propose for Swift to provide the critical simultaneous X-ray monitoring of four Fermi blazars to complement radio, optical, and gamma ray light curves and provide unprecedented insight into the physical connections and phenomenologies within relativistic jets.

Slavko Bogdanov/Columbia University
Observing the Next X-ray Binary Radio Millisecond Pulsar Transition

In recent years, three millisecond pulsar binaries have been observed to switch between accreting and rotation-powered pulsar states, thereby unambiguously establishing the long-suspected link between low-mass X-ray binaries and "recycled" pulsars. In the accreting state, they exhibit X-ray and optical variability unlike anything observed in other X-ray binaries. We propose a continuation of our Swift XRT/UVOT target of opportunity program approved in Cycles 10, 11, and 13 to observe the next nearby binary recycled pulsar transformation to an accreting state. This will result in an improved understanding of the peculiar phenomenology of these systems, which may shed light on the little-understood physics of the quiescent regime in neutron star X-ray binaries.
Douglas Cowen/Pennsylvania State University  
**SWIFT FOLLOW-UP SEARCHES OF LOW FALSE ALARM RATE HIGH-ENERGY NEUTRINO + GAMMA-RAY COINCIDENCES**

We request a set of four Swift ToO campaigns to search for X-ray and/or UV/optical counterparts to low false alarm rate multimessenger neutrino + gamma-ray coincidences during Cycle 15. We will be monitoring four distinct channels for such coincidences and will trigger on any with false alarm rates, computed using scrambled datasets, of less than 1/yr.

Our program will flag a priori unlikely coincidences between high-energy neutrino data from the ANTARES and IceCube neutrino observatories and gamma-ray data from the Swift-BAT, Fermi-LAT, and High Altitude Water Cherenkov (HAWC) gamma-ray observatories.

A single pointing or a 7-tile mosaic of pointings will survey each alert localization for new, flaring, or otherwise unusual sources, with further follow-up observations of individual sources scheduled as warranted.

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Ryan Foley/UC Santa Cruz  
**Young Supernova Experiment**

Observations of supernovae (SNe) within hours of explosion provide unique data about the exploding star, its circumstellar environment, and companions. Swift observations can look into a rare window where we see the system before and while the SN overruns its circumstellar material and companion. In particular, X-ray and UV observations probe the interaction between a SN and nearby gas/companion stars. The UV observations of a young SN within hours of explosion provide additional information about the size of the progenitor star, the density of its outer layers, and how the star exploded. With a new transient survey, the Young Supernova Experiment, we will identify dozens of SNe within hours of explosion, dramatically increasing the number of such SNe.

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Jonathan Gelbord/Spectral Sciences Inc.  
**Intensive AGN Disk Reverberation Mapping of Mrk 876 with Swift and TESS**

Led by Swift, Intensive Disk Reverberation Mapping (IDRM) is providing new insights into the physics of active galactic nuclei (AGN) and strongly challenging the standard thin accretion disk/reprocessing model of AGN central engines. Mrk 876, which lies in the TESS continuous viewing zone, presents a unique opportunity to conduct a year-long IDRM campaign with Swift and TESS. Using the unprecedented detail of the TESS light curve (~17,000 measurements) to anchor the cross-correlation analysis will provide by far the strongest test of accretion disk structure to date. We request 366 × 500 s Swift
pointings. These will be combined with TESS and ground-based griz data to perform echo mapping on the disk. Spectral monitoring will be used to disentangle contributions to the lags from the disk and broad-line region (BLR).

Jeroen Homan/Eureka Scientific, Inc.
A rare look at a black hole transient emerging from quiescence

A large fraction of the black hole low-mass X-ray binaries (BH LMXBs) are transient systems. They occasionally go into outburst, during which their luminosities can increase by factors of more than a million. The occurrence of an outburst is difficult to predict. New outbursts are generally first noticed by all-sky monitors or wide-field cameras. However, given the limited sensitivity of such instruments a transient's flux is typically already a factor of $10^3$-$10^4$ above its pre-outburst level when it is first detected, and follow-up observations with more sensitive instruments often do not start until the flux has risen by an additional factor of 5-10. As a result, the early rising phase of BH LMXB outbursts is relatively poorly studied.

In this proposal we ask for an X-ray monitoring campaign with Swift to observe the early outburst rise in the BH transient H1743-322. This source showed a major outburst in 2003, followed by a few smaller ones. In late 2008 H1743-322 entered a very regular outburst pattern, currently consisting of 14 outbursts with similar durations and peak fluxes. H1743-322 is currently the only transient BH LMXB that shows outbursts with this kind of regularity. Its narrow range of recurrence times allows us to predict the start of the next outburst of the source with much higher confidence than for other BH transients. This, in turn, enables us to set up short monitoring programs at various wavelengths that have a high chance of catching H1743-322 as it emerges from quiescence and moves through its early rising phase.

We request Swift X-ray observations and Very Large Array (VLA) radio observations that will complement coverage in the near-infrared (nIR). With our proposed multiwavelength campaign we aim to catch H1743-322 as it emerges from quiescence. Our two main scientific goals are to study:

* Disk-jet coupling during outburst rise: It has been shown for many accreting black holes that they exhibit strong coupling between the matter inflow through a disk and matter outflow through a jet. These inflows and outflows can be studied in X-rays and radio/nIR, respectively. The disk-jet coupling is not the same for all BH LMXBs, however; for the same X-ray luminosity, some systems show strong radio emission and others substantially weaker emission. H1743-322 is one of the 'weak radio' systems, but, like the other 'weak radio' systems it actually joins the 'strong radio' systems at low luminosities, during outburst decay. By studying disk-jet coupling during the rise of H1743-322 we hope to gain a better understanding of when and why some systems become 'radio weak' at high luminosities.
The onset of outbursts in transient BH LMXBs: Although the disk-instability model is widely accepted as the most likely explanation for the onset of outbursts, some aspects, especially relating to the early outburst phase, have not been properly verified in BH LMXBs. With our dataset we will be able to test predictions of the disk-instability model that are difficult to test with existing data, in particular a sudden increase in the rate of brightening during the outburst rise.

We will start monitoring observations mid March 2019 until early July 2019. This allows us to follow (most of) the rise, even if it were to progress at a slow rate initially. We ask for observations once every three days while the source is not yet detected. We ask for another set of observations to cover the period between the first XRT detection and the time that the source reaches an unabsorbed 0.5-10 keV flux of $2 \times 10^{-8}$ erg/cm$^2$/s. For this period we request up to 15 observations, with a maximum cadence of one observation per 1-2 days.

We also ask for six VLA observations as the source traverses the $5 \times 10^{33}$-$1 \times 10^{37}$ erg/s luminosity range, during which we expect the source to switch from the standard radio track to a radio faint one.

Our proposed research addresses item 1 in NASA's Strategic Objective for Astrophysics.

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**Andrew Howell/Las Cumbres Observatory**

**Maximizing Swift's Impact With The Global Supernova Project**

We request Swift UV photometry of 60 supernovae (SNe) over 2 years to be taken in conjunction with optical and IR data from the Global Supernova Project (GSP). The GSP is a 3 year key project led by Las Cumbres Observatory (LCO), involving 150+ members of the global community to obtain lightcurves and spectra of 500 SNe. With this data we will: (1) determine the progenitors of some SNe Ia; (2) probe the radius and structure of SN progenitors via shock cooling; (3) measure the UV flux in SNe where it is poorly known, including SNe Ib/c and fast transients; (4) probe the circumstellar material around some SNe Ia, and (5) create bolometric lightcurves for a large sample of SNe allowing better tests of theoretical models. The combined data set will be of lasting legacy value.

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**Erin Kara/University of Maryland**

**SIMULTANEOUS DISC AND CORONA REVERBERATION MAPPING**

Abstract: Reverberation light echoes from optical up to hard X-rays have successfully mapped out the accretion flows of AGN from the broad line region down (BLR) to the innermost stable circular orbit (ISCO) of the black hole. In recent years, Swift has made a breakthrough in reverberation mapping, by measuring X-ray/UV/optical time lags that map out the accretion disc. Disc reverberation mapping has successfully been completed
in 6 AGN, but the results seem to suggest a departure from the standard picture of a compact X-ray corona irradiating a Shakura & Sunyaev thin disc. These results appear in tension with X-ray reverberation mapping results of sub-Eddington AGN, which prefer a compact corona within 10 gravitational radii irradiating a disc that extends down to or near the ISCO. To resolve this tension, we request a 100-day Swift disc reverberation mapping campaign of the well-known and highly variable AGN Mrk 335, simultaneous with an extensive X-ray reverberation campaign by XMM-Newton. Such a widespread campaign across different wavebands and timescales has never been attempted, and is essential for understanding the connection between the accretion disc and the corona.

Statement of work:
The TBD postdoc will lead the data reduction, analysis and modelling of the Swift XRT/UVOT Reverberation mapping campaign. PI E. Kara will coordinate the observations with XMM-Newton and ground based observatories, will work on developing new analysis techniques and interpretations of results.

Azadeh Keivani/Columbia University
SEARCHING FOR X-RAY AND UV/O COUNTERPARTS OF GRAVITATIONAL WAVE AND HIGH-ENERGY NEUTRINO COINCIDENT SIGNALS WITH SWIFT

We will perform prompt searches for X-ray and UV/optical counterparts to gravitational wave (GW) and high-energy neutrino (HEN) coincident events with Swift. Using GWs detected by LIGO and Virgo detectors and HENs detected by the IceCube Neutrino Observatory, we will perform a realtime coincidence search using our pipeline developed at Columbia University and select well-localized events with high correlation significances and high probabilities of cosmic origin. We set the selection criteria such that we request four triggers during Cycle 15. With the 1deg angular resolution of IceCube HENs, our triggers will prompt a 19-pointing mosaic by Swift, providing a significant coverage of the correlated event localization to 500 s depth in <11 hours. The improved localization of a joint GW+HEN event will create the opportunity for rapid follow-up observations with Swift. The electromagnetic counterparts to GW+HEN events are crucial in understanding of the underlying mechanisms that create them and the physics of the corresponding sources.
Jamie Kennea/Pennsylvania State University

SWIFT LOCALIZATION OF MAXI DISCOVERED GALACTIC X-RAY TRANSIENTS

We propose to continue the highly successful program to use Swift to localize Galactic X-ray transients discovered by MAXI, the operational phase of which has been extended until March 31, 2021. MAXI scans almost the entire X-ray sky every ~92 minutes, with a source detection sensitivity of ~60 mCrab in one orbit and ~15 mCrab in one day, discovering X-ray transients with 0.1-0.5 degree accuracies in the 2-20 keV energy band. Swift provides rapid follow-up of MAXI triggers and localization up to 1.4 error radius, which is vital for identifying any optical/radio counterpart. XRT observations will also provide measurements of the low energy X-ray spectra. UVOT data will provide astrometric corrections and possibly optical counterparts. Swift is proven to be uniquely capable in this task.

Jamie Kennea/Pennsylvania State University

RAPID SWIFT FOLLOW-UP OF FAST RADIO BURSTS

We seek to quickly identify counterparts to Fast Radio Bursts. To date no clear counterpart has been detected at non-radio wavelengths, and the progenitor systems and emission mechanism remain unknown. New radio surveys are now coming on line that will detect a large population of these events in real-time. We propose extremely rapid response follow-up observations with XRT and UVOT. We also propose to save the contemporaneous BAT event-by-event data when the FRB position is within the BAT FOV. This proposal takes advantage of new enhancements to Swift's unique fast-response capability to search for a counterpart in hard and soft X-rays and UV/Optical. This program will provide the earliest and deepest multi-wavelength constraints on non-radio emission from FRBs, as well as the greatest chance of finding a transient counterpart. This program will significantly enhance the science return of the Swift mission, and extend its transient response to help solve the mystery of FRBs.

Abraham Loeb/Harvard University

FIRST X-RAY OBSERVATIONS OF A PECULIAR FLARING AGN OBSERVED BY KEPLER: A SUPERMASSIVE BLACK HOLE BINARY HYPOTHESIS

The Kepler-observed AGN KIC 11606854 exhibits a sawtooth-like oscillation over four years with a 10-day-duration symmetric flare at the center of the steep rising portion of this oscillation. This lightcurve can be exquisitely, and uniquely, modeled by gravitationally self-lensed and Doppler-boosted emission from an accreting supermassive black hole binary (SBHB) at the heart of KIC 11606854. Furthermore, the SBHB hypothesis predicts a unique, periodically repeating signature that can be tested on year timescales. As the Doppler boost scenario requires multi-wavelength data to confirm, and
as lensing is most prominent in the X-ray, we propose for Swift XRT observations to determine the X-ray flux and spectral slope of this bright AGN before the date of the next predicted flare.

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**Thomas Maccarone/Texas Tech University**
**The Swift Galactic Bulge Monitoring Survey: Second Epoch**

We propose to survey a 16 square degree region of the Galactic Bulge, every two weeks during the part of the year when the survey region is observable to Swift. This will allow us to detect new very faint X-ray transients -- objects bright enough that they must be X-ray binaries, but too faint to be detected by all sky instruments. These objects are likely to dominate the total number of X-ray binaries, but they are still known in small numbers due to their faintness. We expect to substantially increase the number of know VFXTs, while also obtaining detections outside the hard-to-follow-up Galactic Center region where most of the currently known VFXTs have been found.

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**Raffaella Margutti/**
**Explosion Mechanisms and Energy Sources Powering Super-Luminous Supernovae**

With peak luminosities $L_{\text{peak}} \sim 10^{45}$ erg/s, the new class of Super-Luminous supernovae (SLSNe) outshine standard SN explosions of a factor $\sim 10-100$ and represent the death of the most massive stars in our Universe. The nature of their exceptional luminosity is still unclear and requires exotic explosion mechanisms and/or peculiar sources of energy. Here we propose rapid Swift follow up of 2 newly-discovered SLSNe to map their UV and X-ray emission during the early stages of their evolution as part of our multi-wavelength effort through programs on the VLA, Chandra and optical/NIR facilities. The final aim is to: (i) Pin down the energy source of SLSNe; (ii) Map the diversity of their progenitor stars and pre-explosion evolution.

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**Dheeraj Pasham/Massachusetts Institute of Technology**
**HIGH-CADENCE XRT MONITORING OF ULTRALUMINOUS X-RAY SOURCES TO SEARCH FOR ORBITAL PERIODS**

Following the successful discovery of a 1.2 d period from high-cadence Swift/XRT monitoring of the ultraluminous X-ray source (ULX) in NGC 55 we propose similar monitoring observations (0.5ks and 1.5ks 5 visits per day for 10 days) of two more variable ULXs with known optical counterparts (Holmberg II X-1 and NGC 247 ULX). Our main goal is to search for orbital periods in the range of a few 10s of hours in these two sources. This particular period range typical of stellar-mass black hole binaries has not been probed before for ULXs. Any detected periods will be an important step towards
dynamical mass measurement of these compact objects. With NGC 55 ULX we have already demonstrated that Swift, with its excellent X-ray sensitivity and fast maneuvering capability, can definitely carry out these observations.

Enrico Ramirez-Ruiz/University of California Santa Cruz
LATE TIME MONITORING OF BRIGHT AND NEARBY OPTICAL TDES

Dormant BHs at the centres of quiescent galaxies reveal themselves through luminous, accretion-powered flares called tidal disruption event (TDEs). These rare events provide us with unique insights into the physics associated with accretion and the BH itself. For most events, observations focus on the initial detection and follow-up of the flare. However, studies of the late time emission have revealed some surprises, indicating that TDEs undergo significant changes in their accretion and emission mechanisms as they evolve. But without detailed monitoring of this late time emission the uncertainties in this evolution is quite large. Here we propose to take advantage of Swift’s multi-wavelength capabilities to monitor the late time emission from some of the brightest/closest TDEs.

Julia Roman-Duval/STScI
Enhancing the UVOT Legacy: Enabling Extended Source Photometry

The Ultraviolet/Optical Telescope (UVOT) on the Neil Gehrels Swift Observatory has been used for an enormous variety of science topics beyond its original purpose of detecting gamma ray bursts. As we have used it to analyze nearby galaxies, we have determined that the calibration is insufficient to accurately measure the brightness of these extended sources. We will therefore use existing UVOT data to improve the calibration and apply it to the SOLV (Swift Observations of the Local Volume) survey, which is imaging 465 local galaxies. The newly-calibrated UVOT data, when combined with archival imaging, will allow us to model the spectral energy distributions of each galaxy, revealing information including their stellar masses, star formation history, and the shape of their dust attenuation curve. This information will contribute to our understanding of the formation and evolution of dwarf galaxies, which in turn will inform theories for the growth of structure at small scales. This addresses the NASA Science Mission Directorate Big Question "How Did We Get Here?", which seeks to understand how the universe transitioned from the Big Bang to the planets, stars, and galaxies we see today.
**David Sand/University of Arizona**  
**HIGH CADENCE UV LIGHT CURVES OF EXTREMELY YOUNG SUPERNOVAE**

The investigation seeks to use Swift to obtain high cadence UV light curves of supernovae (SNe), beginning within hours of their detection. The proposal establishes that early UV light curves should show evidence of shock breakout and interactions with circumstellar material, which will provide information about the progenitor star and its mass-loss history. This is true for both core-collapse and thermonuclear supernovae, and this investigation will observe both types. The DLT40 survey, which is run by the proposal's investigators, finds ~10 young SNe every year, and the investigation aims to obtain high cadence UVOT and XRT light curves of 5 of these, which will be combined with ground-based follow-up.

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**Juan Santander/University of Alabama-Tuscaloosa**  
**Pinpointing the sources of the Fermi isotropic gamma-ray background #1518145**

The origin of the diffuse isotropic gamma-ray background measured by the Fermi gamma-ray satellite at energies between 100 MeV and 820 GeV remains largely uncertain. A detailed knowledge of the sources that contribute to the overall observed isotropic gamma-ray flux is of key importance to understand the density and evolution of these sources with redshift, set constraints on a potential dark matter contribution, and study the link between the Isotropic Gamma-Ray Background (IGRB) and other cosmic backgrounds such as the diffuse neutrino flux discovered by the IceCube observatory.

This proposal outlines a program to perform target-of-opportunity observations of single high-energy gamma rays detected by the Fermi Large Area Telescope using the X-ray and UV telescopes onboard the Neil Gehrels Swift Observatory. These observations will help identify the source of the high-energy gamma rays detected by Fermi-LAT.

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**Allen Shafter/San Diego State University**  
**PROBING THE ERUPTION STATISTICS AND EVOLUTION OF THE UNIQUE RECURRENT NOVA M31N 2008-12A**

M31N 2008-12a is a recurrent nova in M31 with a unique record of 10 observed eruptions in 10 years. Its ultra-short recurrence period presents the only opportunity to study a statistically significant number of eruptions from the same system. We propose a tailored 84-ks Swift X-ray/UV observing campaign of the predicted 2019 eruption as an integral part of a long-term project. The recent 2016 eruption deviated clearly from the previous pattern, underlining the importance of obtaining multi-eruption statistics. This benchmark data set will provide unparalleled insights into binary evolution and the eruption physics that determine the observable parameters. M31N 2008-12a remains the
prime candidate for the progenitor of a type Ia supernova or an accretion induced collapse to a neutron star.

Bradford Wargelin/Smithsonian Astrophysical Observatory
Proxima Centauri’s Stellar Cycle

Fifteen years of V-band monitoring have established the existence of a solar-like 7-year stellar cycle in Proxima Cen, a fully convective dM5.5e star, with further support from Swift X-ray and UV observations spanning a full cycle. This important discovery, along with related theoretical and observational work on fully convective stars in very recent years, is leading to major advances in our understanding of the structure and evolution of late M stars, and of cool-star magnetic fields in general. We request fourteen 3.5-ks observations with 12-day spacing to continue our long term study of the X-ray cycle. Prox Cen is the only late-type M star practical for such studies and Swift is uniquely well suited for the challenges of X-ray monitoring of this flare star.

Alycia Weinberger/Carnegie Institution of Washington
THE ORIGIN AND IMPACT OF FLARES IN THE PROXIMA CENTAURI PLANETARY SYSTEM

At a distance of only 1.3 pc, Proxima Cen is the closest extrasolar planetary system and well-known as a flare star, making it a benchmark case to explore the potential effects of variability on the planet’s properties. Following our detection of a large mm flare, we have been awarded 36 hours of ALMA observations to monitor Proxima Cen in 2019. We propose to obtain simultaneous UV/X-ray coverage with Swift in order to (1) better constrain the properties of detected flares and their potential impact on planetary habitability, and (2) determine how stellar flaring emission correlates across the electromagnetic spectrum. By undertaking this comprehensive, multi-wavelength monitoring campaign of Proxima Cen, we will execute the first truly panchromatic analysis of M dwarf flaring activity.