# Abstract Booklet:
# Poster Contributions

Abstract number: **6**
Author: Slavko Bogdanov
Title: **Determining the Equation of State of Cold, Dense Matter with X-ray Observations of Neutron Stars**

Abstract:
The poorly understood behavior of matter at ultra-high density, high proton/neutron number asymmetry, and low temperature present one of the major outstanding problems in physics. Since matter in this extreme state is known to only exist stably in the cores of neutron stars, astrophysical observations of neutron stars can provide key insight into the properties of matter in a region of the quantum chromodynamics phase space that is otherwise inaccessible. A future X-ray mission with large collecting area, superb spectral and temporal resolution, and rapid slew capabilities will enable multiple complementary approaches based on X-ray pulse profile modeling and spectroscopy of a variety of neutron star source classes, thus producing definitive empirical constraints on the true nature of the densest matter in the Universe.

Abstract number: **10**
Author: Daniel Kocevski
Title: **Findings from the 4th TDAMM Workshop**

Abstract:
Time-Domain and Multi-Messenger Astrophysics (TDAMM) is entering a fundamentally new phase characterized by an unprecedented increase in the rate and diversity of astrophysical transient detections. The field is transitioning from a discovery-limited to a follow-up-limited era, driven by major investments across electromagnetic, gravitational-wave, and neutrino observatories. This discovery-rich landscape creates a major scientific opportunity, but realizing its full potential will depend critically on the ability to rapidly identify, prioritize, and coordinate follow-up observations across a heterogeneous and globally distributed set of facilities. This talk will summarize the findings of the 4th TDAMM Workshop white paper, highlighting the science priorities identified by the community, the infrastructure needed to coordinate multi-facility response, and the policy and programmatic gaps that must be addressed to realize the promise of the coming decade. These findings are directly relevant to the ASTRA initiative, which seeks to identify strategic astrophysics concepts and enabling capabilities for the future. The TDAMM white paper provides a community-driven roadmap for the science cases, operational requirements, and architectural principles that should inform future strategic missions, including distributed and proliferated observatories designed to capitalize on this new era in TDAMM astronomy.

Abstract number: **12**
Author: Ref Bari
Title: **Gravitational Sonar: Imaging Black Holes from Gravitational Waves**

Abstract:
We present an observational technique for predicting the spacetime metric for a binary black hole system to within $<1\%$ error of the innermost-stable circular orbit (ISCO). Our algorithm, coined Gravitational Sonar, is valid in the Extreme-Mass Ratio Inspiral (EMRI) limit wherein $m_1>>m_2$. We validate our algorithm for the Schwarzschild, Kerr, and Johannsen Metrics. We demonstrate that the algorithm can be employed on LISA waveforms with noise $\sigma>0.05$ to test the No-Hair Theorem and probe for beyond-GR corrections.

Abstract number: **29**
Author: Eric Burns
Title: **Connecting Quarks with the Cosmos to Astro2030: NASA's Next Steps on Grand Astro/Physics Questions**

Abstract:
In 2003 the National Academies Connecting Quarks with the Cosmos report posed eleven science questions at the intersection of physics and astronomy to answer this century, from the nature of dark matter and dark energy to the origin of the heavy elements and the states of matter at extreme density. In the twenty-five years since, its eleven questions have organized tens of billions of dollars of coordinated investment across NASA, NSF, and DOE and shaped the strategic-planning documents that direct all three agencies. NASA's fleet has been central to the field's transformation: WMAP pinned the parameters of cosmology, Fermi and Swift opened the high-energy transient sky and caught the gamma-ray counterpart to the first neutron-star merger, NICER weighed and measured neutron stars, JWST delivered the first infrared spectrum of a kilonova, and IXPE performed the first direct test of quantum electrodynamics in the non-linear regime. New missions will take us further: Roman will probe dynamical dark energy, LISA will deliver the most stringent test yet of General Relativity in the strong-field regime, and the Habitable Worlds Observatory will help close the century-long quest to find the origin of the elements. We revisit all eleven questions to ask where each now stands and, given everything learned and built since, what NASA should build next. We trace each through its strategic-planning lineage and committed facilities, then identify the space-based capabilities that would drive the next decisive advance. The result is a forward-looking map from the grand questions to concrete mission architectures, positioning NASA's strategy for the coming decades and informing preparation for the Astro2030 Decadal Survey.

Abstract number: **35**
Author: Frederick Scott Porter
Title: **Interdisciplinary Soft X-ray observations of the Earth's Magnetosphere including from the moon**

Abstract:
The Earth’s plasma environment is governed by the complex interaction of the solar wind with the Earth’s magnetic field and the Earth’s outer atmosphere. This interaction is the source of space weather in the Earth-moon system and a huge field of research. The primary tool for studying the solar wind-magnetosphere interaction are in-situ satellites with suites of instruments that measure plasma and magnetic field parameters as they sweep through the system. What has been missing are global measurements that image the solar wind plasma as it circulates in the magnetospheric system. Luckily, the solar wind plasma emits strongly in the soft x-ray band as the solar wind plasma encounters the Earth’s exoatmosphere, especially in the high-density plasma region near the Earth’s magnetopause. This effect was first observed by ROSAT and subsequently by Chandra, XMM, Suzaku, SWIFT, and XRISM. Unluckily, this emission complicates soft x-ray astrophysical observations especially from low earth orbit. However, what is a complication for astrophysics is high profile science for space weather and heliophysics. Soft X-ray emission is the key to imaging the magnetosphere to improve the models that are needed to predict and account for foreground emission for astrophysical x-ray telescopes. Our astrophysics-heliophysics collaboration has led to a series of missions including four sounding rockets, a cubsat, the LEXI CLPS instrument on the moon, and the just launched European SMILE mission. However, more is needed. Larger, wide field of view X-ray telescopes with substantial throughput are needed to understand the dynamics of the magnetosheath and improve the models needed to predict foreground x-ray emission. Here we will discuss the science from both the heliophysics and astrophysics perspectives, the moon as an excellent vantage point to make these measurements, and what instruments and mission scale (large!) are needed to make progress.

Abstract number: **58**
Author: Saptarshi Bandyopadhyay
Title: **Moon Radio Interferometer for Science and Exploration (MoonRISE)**

Abstract:
The universe below 20 MHz remains largely unexplored, as Earth's ionospheric absorption and distortion, as well as its natural and artificial radio frequency interference (RFI), make these frequencies largely inaccessible from ground or Earth orbit. The Moon Radio Interferometer for Science and Exploration (MoonRISE) is an all-sky imaging radio telescope that will operate in the 100 kHz–30 MHz radio frequency (RF) band, i.e., 3 km–10 m wavelengths. It will be the first radio interferometer (RI) on the Moon and the first connected-element RI in space. Located on the lunar farside — the quietest radio environment in the inner Solar System and shielded from Earth's RFI by the Moon — MoonRISE will observe the entire viewable sky and simultaneously address the NASA Moon to Mars (M2M) Objectives , Heliophysics and Planetary Science Decadal priorities: (1) Characterize solar wind turbulence, (2) Monitor the near-surface lunar electron density and lunar ionosphere, (3) Measure Uranian Kilometric Radiation (UKR), first time since Voyager 2. The Radio Interferometer (RI) consists of 9 dipoles embedded within a 1.5-km optical-fiber tether deployed by the CLPS rover to form a full cross-correlation interferometer observing the entire sky from 100 kHz–30 MHz, at high time (0.1 sec) and frequency resolution (24 kHz). Power-and-RF-over-fiber keeps the 3.5 m dipoles electromagnetically isolated from the tether, for optimized performance. The bistatic Ground Penetrating Radar (GPR), mounted on the CLPS rover, uses 300–2000 MHz pulses to measure regolith dielectric properties and bedrock depth, to characterize the RF performance of the dipoles. All RI and GPR technologies have been matured to TRL 5 and higher with significant JPL and NASA investment. MoonRISE proposal has been submitted to the PRISM-4 proposal call. If funded, MoonRISE will be deployed on the Moon in the 2030-2031 time frame.

Abstract number: **62**
Author: Mariano Javier Dominguez
Title: **GPC-SWARM The COSMOSCOPE: Measuring the geometry of the Universe directly**

Abstract:
GPC-SWARM introduces a transformative approach to cosmic distance measurement: interferometric parallax via wavefront curvature. By deploying a modular, scalable heliocentric swarm (evolving from 4 to 20 satellites), the mission bypasses standard-candle dependencies, enabling direct distance-ladder measurements with minimal astrophysical calibration requirements. Utilizing heritage technologies from LISA (drag-free control), GRACE-FO (laser metrology), and VLTI/GRAVITY (fringe tracking), GPC-SWARM establishes wavefront-curvature interferometry as a new astronomical observable, enabling direct geometric distance measurements from stellar to cosmological scales. Applications include independent measurements of the cosmic expansion history, dark matter and dark-energy constraints, and calibration of the extragalactic distance scale. The mission architecture employs a modular, scalable design to achieve core scientific objectives during the ASTRA-incubated Phase A and B stages, ensuring a high-impact, cost-effective evolution toward the full Flagship configuration. This approach maximizes scientific return early in the mission lifecycle while maintaining robustness by gracefully degrading performance in the event of a node failure. A global coalition of strategic partners—including international space agencies (ESA, ASI, CENS) and research institutions (ESO, NRAO, DOE)—will provide the high-TRL heritage and computational infrastructure required to maximize mission success and cost-efficiency.

Abstract number: **68**
Author: Slava G Turyshev
Title: **Solar Gravitational Lens Observatory (SGLO)**

Abstract:
The Solar Gravitational Lens Observatory (SGLO) is a strategic ASTRA mission concept to use the Sun's gravitational field as the dominant wave-optical element in a calibrated, target-specific observatory for astrophysical observations inaccessible to conventional telescopes or interferometers. By sending a spacecraft or distributed observing system to the SGL's focal region at ~650–900 AU along the line opposite a preselected target, SGLO would measure Einstein-ring signals through annular photometry, spectroscopy, polarimetry, image-plane metrology, and inverse reconstruction. The primary exoplanet objective is to transform one high-priority HWO-era terrestrial planet from an unresolved point source into a spatially resolved remote-sensing target. Published scalar benchmarks for an Earth analog at 30 pc, observed from 650 AU with a 1 m telescope and a 128 × 128 raster (arXiv:2606.14899), demonstrate recoverable ~200–230 km-class broadband spatial contrast under stated calibration and inversion assumptions; higher-raster 10–25 km-class products are credible stretch goals requiring higher raster dimension, more photons, cadence, calibration, and/or multiple spacecraft. SGLO would move exoplanet characterization beyond disk-integrated gas detections to maps and spectral cubes that connect $H_2O$, $O_2/O_3$, $CO_2$, $CH_4$, clouds, aerosols, ocean/ice/land context, rotation, seasons, polarization, and temporal climate behavior. The same target-specific physical-optics observatory can enable ultra-high-resolution astronomy beyond exoplanets (arXiv:2606.18300), including white-dwarf surface and magnetic mapping, nearby stellar surfaces, compact AGN/black-hole structure, velocity-resolved broad-line-region mapping, planet-forming subfields, and SGL transfer-function characterization. The ASTRA study should mature SGLO from compelling physics to a decision-grade mission concept by closing target selection, optical transfer function, calibrated ring extraction, dynamic reconstruction, meter-class image-plane navigation, autonomous operations, communications, power, and solar-sail/NEP/hybrid access trades, leveraging NASA's current high-power NEP maturation where it improves mass, power, communications, or operations. SGLO is timely because HWO-era target discovery can supply the required priors, while recent SGL analyses now define the closure tests needed for ASTRA maturation.

Abstract number: **72**
Author: Spencer Toulouse
Title: **OBERON: A Mission-Scale Multi-Messenger Inference Architecture for Black Hole Discovery and Localization**

Abstract:
The astronomical community has accumulated decades of complementary observations of black holes across the electromagnetic spectrum through gravitational waves, pulsar timing, precision astrometry, neutrino detection, and time-domain surveys. Yet these datasets remain largely analyzed within disciplinary silos. We present OBERON (Observatory for Bayesian Event Reconstruction across Observational Networks), a mission concept that treats the distributed archive of multi-messenger observations as a single inferential system. OBERON is a mission-scale inference architecture that employs modality-specific encoders coupled through a shared probabilistic latent space to perform joint Bayesian inference over black hole source parameters, including sky position, mass, spin, and distance, conditioned on heterogeneous archival observations. Science objectives include improving black hole localization beyond single-messenger and pairwise analyses, constraining black hole population demographics through unified inference, and establishing the data fusion infrastructure required for rapid LISA source localization using pre-existing multi-messenger priors. We present OBERON at CML 1 as a computational mission architecture for ASTRA incubation.

Abstract number: **82**
Author: Priyarshini Ghosh
Title: **CARTIER: Ushering in the Next Era of Precision Ultra-Heavy Galactic Cosmic Ray Measurements**

Abstract:
Ultra-heavy galactic cosmic rays (UHGCRs; Z > 30) are powerful tracers of nucleosynthesis, stellar evolution, and the origin and transport of matter in the Galaxy, yet they remain among the least-measured particles in the cosmos. They can probe r-process and s-process nucleosynthesis channels by providing direct, macroscopic samples of material from core-collapse supernovae, neutron star mergers, and other candidate r-process sites now debated in the multi-messenger astronomy era. By yielding isotopic and elemental abundances inaccessible to astronomical spectroscopy, these ratios constrain the relative contributions of their sources, while their propagation histories encode diffusion, halo geometry, and spallation at the high-charge frontier. Extending measurements to trans-actinide species would open an entirely new nucleosynthetic discovery window. We present the case for CARTIER (Cosmic-ray Actinide, R-process, and Trace Isotopic Element Recorder), a Probe-class instrument designed to deliver a comprehensive isotopic atlas of the trans-iron UHGCRs from Z = 30 through the actinides (Z = 96+). Leveraging a 10–20 m² sr geometric acceptance and picosecond Time-of-Flight system, CARTIER will achieve charge resolution $\Delta Z < 0.2e$ and mass resolution $\Delta A < 0.3$ amu across this wide charge range. Key science targets include Technetium clock isotopes ($^{97,98,99}$Tc) to constrain GCR confinement timescales, the full isotopic pattern of the second r-process peak (Z = 38–50), actinide fluxes (Th, U, Pu, Cm) as ultimate r-process chronometers—including a direct test of whether the live $^{244}$Pu signal detected in deep-sea sediments is consistent with the same nearby r-process event seen in cosmic rays. As a secondary science return, CARTIER will also constrain poorly-known spallation cross-sections for Z > 30 species at GCR energies, directly benefiting propagation models as well as current and future GCR missions. Given the technological advancements of detection systems, CARTIER represents a very timely mission to usher in a higher-precision era of nucleosynthetic discoveries.

Abstract number: **101**
Author: Eduardo Bendek
Title: **PISCES: Photonic Interferometer in Space for Characterization of Exoplanets and Stars**

Abstract:
PISCES (Photonic Interferometer in Space for Characterization of Exoplanets and Stars) is a mission concept that leverages recent advances in integrated photonics to revive space-based optical interferometry as an affordable platform for transformative astrophysics. Two of the most ambitious interferometric missions ever studied—SIM/SIM-Lite, designed to measure true masses and three-dimensional orbits of nearby exoplanets, and the Terrestrial Planet Finder Interferometer (TPF-I), designed to characterize potentially habitable worlds through thermal infrared spectroscopy—were cancelled because of cost and engineering complexity rather than limitations of the underlying measurement techniques. PISCES addresses these historical barriers by replacing large free-space optical benches with a photonic integrated circuit that performs beam combination, phase control, delay, and metrology on a compact, manufacturable chip. The mission is conceived as a scalable architecture beginning with a two-aperture formation-flying interferometer capable of microarcsecond astrometry, stellar multiplicity studies, and dynamical mass measurements of nearby exoplanets. The same integrated photonic correlator naturally scales to additional apertures and longer baselines, enabling aperture synthesis imaging and, ultimately, thermal infrared nulling interferometry for atmospheric characterization and biosignature detection. By placing the primary complexity within photonic hardware rather than precision opto-mechanical structures, the concept offers a practical technology path from a focused pathfinder to future flagship-class interferometers. PISCES is proposed as an ASTRA technology maturation effort to establish the scientific and engineering foundations of photonic space interferometry. The study will evaluate architecture trades, identify critical technology developments, quantify science return as a function of aperture and baseline, and define a credible roadmap toward affordable interferometric observatories capable of addressing key Astro2020 priorities in exoplanet science, stellar astrophysics, and the search for life beyond the Solar System.

Abstract number: **107**
Author: Kevin Fogarty
Title: **ICEpic: An integrated photonic architecture for interferometry in space**

Abstract:
Interferometric Cosmic Exploration with Photonic Integrated Circuitry (ICEpic) is an enabling technology for large-baseline space interferometers. ICEpic will facilitate aperture synthesis imaging and spectroscopy at visible to near-infrared wavelengths (although the architecture is applicable to other wavelengths when implemented with different material platforms) on a device that can be reconfigured based on science needs. ICEpic takes advantage of the rapid tunability and scalability of photonic integrated circuits (PICs) to overcome otherwise stringent challenges for baseline stability and spectroscopic bandwidth that arise when broadband light from astrophysical sources needs to be delay-matched to sub-wavelength precision to directly interfere wavefronts from telescopes separated by hundreds of meters to kilometers. Moreover, PIC reconfigurability will allow ICEpic to function with interferometric arrays with changing numbers and formations of elements. Our proposed architecture consists of two “modules”: the beam combiner and the bulk delay setup. The baseline architecture for the beam combiner consists of a PIC array for spectroscopic sorting, interference, and dynamic aberration compensation, an inverse-propagating baseline calibration source, and a periscope/coupler assembly for transmitting light collected from the interferometric array. For bulk delay, we are considering multiple possible options, including a photonic delay module we are developing for ICEpic. The main advantages of the photonic delay module are its compactness and its ability to rapidly change delays across a large dynamic range. We will describe this concept along with other options for compact tunable delays. Challenges we have identified include broadband performance, field of view, and losses, and we will present the plan for addressing each of these. Finally, we will discuss current and planned technology development for ICEpic. Plans include laboratory study and proposals for technology demonstration flights of incrementally advanced scope and complexity. Our ultimate goal will be to enable a large range of future science cases and interferometric mission concepts.

Abstract number: **109**
Author: Kristin Madsen
Title: **Optics, Coating and Detectors for a Broad Band Observatory**

Abstract:
The requirements for a broad band observatory are different from classical soft X-ray instrumentation and in this talk we discuss the challenges and the opportunities for such instrumentation, identifying the drivers and current limitations. This will be looked at in the context of different sizes of missions.

Abstract number: **125**
Author: Roberto Guenzani
Title: **Precursor Gravity Faraday Cage: A Unified Framework from AGN Spectral Distributions to Deep-Appearance Transient Dynamics**

Abstract:
A self-consistent theoretical framework is developed in which a notion of Faraday cage emerges not as an externally imposed electromagnetic boundary but as the coherent terminal state of a sign-to-symbol syntactic process operating across scales from Active Galactic Nuclei (AGN) Spectral Energy Distributions (SEDs) to granular lattice nanosites. The central observation is that the norm signs of a state variable u(x,t), when interpreted as horizontal integer-value labels and rotated into convexity geometry, generate a triangulation whose connection condition is precisely the condition for Faraday cage activation. Multimodality — the simultaneous observability of electromagnetic, gravitational, and biological signals — is formalised as a homoscedastic condition under a modal operator M, which filters discrete scatter into Gaussian convolution and thereby reveals the coherent field underlying the AGN SED. The No-Hair condition of a central singularity acts as a syntax inhibitor suppressing semantic information until a critical temporal shift Δu triggers the Deep Appearance. By the Pulse Locus propagation of transverse-traceless transmission, the energy-momentum density at this transition satisfies T_uu~|∂_u ψ|^2, bridging gravitational ringdown to biological induction at the same scale-invariant event within a Z_3^3 informational geometry. To develope this model, I propose a notion of saturated cognitive laws dual to Deep Float of a Phonema Cube where a k=3 Chern-Simons topological term, combined with a fixed-angle constraint Q=2/3, phase-locks macro-oscillations to micro-pulses. I show how this mechanism can produce a universal ρ~V_p^(-4) energy density that generates a -5 spectral index encoding gravitational-wave strain and biological placode density in a single reversibly normalised latent space. The Faraday cage is the physical realization of the terminal closure of this manifold offering new Science and Technology Precursors studies.

Abstract number: **126**
Author: chas beichman
Title: **LIFE: A Mid IR Nulling Interferometer for The Search for Extraterrestrial Life**

Abstract:
The challenge of characterizing habitable exoplanets and confirming the presence of atmospheric signatures indicative of the presence of primitive life is a daunting one. The Habitable Worlds Observatory (HWO), presently under study by NASA, will provide the first crucial steps using direct imaging and spectroscopy at visible wavelengths with possible extensions into the UV and near-IR (NIR). Yet HWO will leave critical gaps in our knowledge of these systems that can be remedied only with a mission operating at mid-IR wavelengths. Such a system has been studied for many years, starting with the Terrestrial Planet Finder and Darwin concepts in the 1990s, and currently under investigation as the LIFE mission in Europe. We will discuss the critical role mid-IR observations play in characterizing rocky planets and confirming tentative indications of the presence of life by HWO.

Abstract number: **127**
Author: MAYS AL OBAID
Title: **Extended stellar Counter-Rotation in Disk Galaxies**

Abstract:
Stellar counter-rotating disk galaxies are systems in which two stellar disks rotate in opposite directions. These galaxies provide important clues about galaxy formation, external gas accretion, merger events, and the evolutionary history of disk galaxies. This study investigates the properties of stellar counter-rotating disks through a review of the literature and the construction of a database of known counter-rotating disk galaxies, focusing on systems with available age measurements for both stellar components, mainly S0 galaxies from the SDSS-IV MaNGA survey. A sample of 18 galaxies hosting dual stellar counter-rotating disks was selected from published studies. Stellar ages, metallicities, and luminosity fractions were compiled into a unified database. Three diagnostic plots were produced to examine the relationships between age, metallicity, and luminosity fraction of the counter-rotating components. The results show that the secondary counter-rotating disk is generally younger than the primary disk, with M136248 being the only exception in the sample. The metallicity range of the counter-rotating component is consistently narrower than that of the primary disk and appears largely independent of the primary disk metallicity. In addition, counter-rotating disks with higher metallicities tend to contribute a smaller fraction of the total galaxy luminosity. These findings support formation scenarios involving external gas accretion or merger events followed by subsequent star formation and provide constraints on the origin and evolution of stellar counter-rotating disk systems.

Abstract number: **128**
Author: Omar Ariel Vallejos
Title: **L-RAIL (Lunar Radio-interferometry & Astrophysics Infrastructure Laboratory).**

Abstract:
Scientific Concept L-RAIL is a scientific infrastructure based on the Crystalline Vacuum VCV48 model, which postulates that the quantum vacuum possesses a discrete geometric structure with octahedral symmetry (Oh). This anisotropy induces a periodic 60° azimuthal modulation (m=6) in the radiation polarization in the photon ring of supermassive black holes. The VCV48 model provides a new perspective in Cosmic Microwave Background (CMB) physics. It analyzes large-scale collective oscillations of the vacuum crystal lattice, which introduce a harmonic correction to the expansion rate, affecting the sound horizon at recombination. By calibrating the model's elastic constants using the thermal anisotropy parameter and CMB fluctuations (at the fundamental harmonic), the model becomes verifiable through multiple signals. The Moon provides the favorable environment for a scientific platform. Mission Concept The mission implements a multi-phase operational profile using a lunar VLBI module and Orbital Ionic Tractor. Phase I will execute observation campaigns integrated with the EHT at frequencies from 230 to 690 GHz. Subsequent phases will expand the multifunctional capabilities of the deployed array: Phase II will integrate a deep space antenna in X/Ka bands, while Phase III will incorporate a MIR/IR optical telescope in support of a planetary defense system for NEO detection.

Abstract number: **129**
Author: Himanshi Gulia
Title: **Parameter estimation of generalized Ghosh black holes using shadow observables and Event Horizon Telescope Constraints**

Abstract:
The Event Horizon Telescope images of M87* and Sgr A* give us a unique chance to test gravity in the strong field regime and assess deviations from the Kerr solution. We study the shadows of rotating nonsingular black holes—namely, generalized Ghosh black holes (GGBHs), given by the mass function $m(r) = M e^{-(k/r)^n}$, which reduces to the Kerr black hole ($k \to 0$) and to the original Ghosh model ($n = 1$). We calculate the photon's trajectory via the Hamilton-Jacobi method and construct the shadow seen by a distant observer. For a high spin $a/M = 0.9$, increasing $k/M$ from $0$ to $0.5$ reduces the shadow size by about $13\%$ and the shadow area by about $24\%$, while making the shape more distorted (up to $\sim 20\%$). For larger values $k/M \sim 1.0$, the area can decrease by nearly $30\%$. However, increasing $n$ reduces these effects, and for $n \geq 3$ the shadow becomes very close to the Kerr case (differences below $\sim 5\%$). To compare with observations, we use two simple shadow quantities: the area $A$ and the oblateness $D$. Using EHT observational data, we find that for M87* ($17^\circ$ inclination, $37.8\ \mu\text{as}$ diameter), the parameter is constrained as $k/M \lesssim 0.133$ for $n=1$. For Sgr A* ($50^\circ$ inclination, $48.7\ \mu\text{as}$ diameter), the bound is $\mathbf{k/M \lesssim 0.09162}$. These limits become weaker for larger $n$. Overall, the GGBHs are a \textbf{viable candidate} to the Kerr black hole, and future observations may help to detect or further constrain such deviations.

Abstract number: **130**
Author: Alex Massaro
Title: **SHADOW EYES**

Abstract:
The SHADOW EYES mission introduces a next-generation analysis protocol for recalibrating the HUBBLE telescope's FITS data. The primary goal is to increase the interpretative and instrumental precision of the raw datasets, overcoming the limitations of energy information dispersion (estimated between 30 and 50 percent) resulting from the adoption of standard calibration constants. SHADOW EYES establishes a "galactic pacemaking" process for monitoring the evolutionary stability of stellar systems, enabling predictive capabilities on galactic life cycles, central core dynamics, and large-scale instability phenomena through an analysis based on the laws of fluid physics and thermodynamics. Our operating "constants" are three: Total energetic mass,Active energetic mass and Residual dynamic vectorial (translated as missing mass). In analyzing the core (black hole), we define the radius of the core using vector coordinates such as x, y, and z. By subtracting the total energetic mass and the drainage flow rate, we define the observed state of systemic balance of the body by using 1.13 as a standardized basis for ideal systemic balance. The pipeline also records the compensation radiation activated by the drainage flow during overload. Translated based on 1.13 as homeostatic equilibrium, whenever the system exceeds (e.g., 3.5 or 4.1), when it manages to expel, we see the compensation radiation. This method allows us to monitor the "health" or, more precisely, the evolutionary state of the galaxy or body being observed, as well as improving the study of galactic morphology.

Abstract number: **131**
Author: Thomas Essinger-Hileman
Title: **Astrophysics and Cosmology with an All-Sky CMB Probe+ Survey**

Abstract:
An all-sky mm/sub-mm polarimetric space mission (CMB Probe+) would provide strong constraints on cosmic inflation; properties of light relic particles and neutrinos; reionization and the history of cosmic star formation; the composition of Galactic dust and the role that magnetic fields play in star formation; and high-energy processes that drive time variability at these wavelengths. The resultant maps at 20-800 GHz with the sensitivity of 10,000 Planck missions would have broad legacy value for astrophysics and cosmology. As the 2020 Astrophysics Decadal Survey stated, the “cosmic microwave background (CMB) remains the single most important phenomenon that can be observed” to address outstanding questions in cosmology. A CMB mission was studied in advance of the Astro2020 Decadal Survey (the Probe of Inflation and Cosmic Origins, PICO) that showed compelling science within the current Probe budget. Significant developments since 2020 in the science and programmatic landscape (notably the cancellation of the large-scale CMB-S4 ground-based program), component technologies, and launch capabilities make an ASTRA study in advance of the 2030 Decadal Survey particularly timely. Such a study would also investigate extensions to a Probe mission, including larger telescope apertures and incorporating spectroscopic capabilities for CMB spectral distortions and line intensity mapping.

Abstract number: **133**
Author: Gh. Saleh
Title: **A New Perspective on Planetary Orbital Speeds, Uranus's Axial Tilt, and Venus's Retrograde Rotation**

Abstract:
This paper presents proposed explanations for three questions concerning the Solar System: the differences in planetary orbital speeds, the axial tilt of Uranus, and the retrograde rotation of Venus. The study is based on the view that rotational motion is a fundamental property of matter and that planetary motion originates from the rotational behaviour of particles during the formation of the Solar System. By applying the relation $v = r\omega$, the paper argues that planetary tangential speeds vary according to planetary radius while angular speed remains approximately comparable among planets. It is further proposed that planets located closer to the Sun are more strongly affected by solar gravitational and magnetic influences. Within the same framework, the axial tilt of Uranus is interpreted as resulting from the combined influence of solar magnetism, neighbouring planetary interactions, and planetary internal structure. The reverse rotation of Venus is similarly explained as an outcome of the interaction between gravitational and magnetic effects. These interpretations provide an alternative perspective on understanding planetary motion, orientation, and the dynamical behaviour of planets within the Solar System.

Abstract number: **134**
Author: Erica Sawczynec
Title: **Silicon Immersive Optics for Near-Infrared Spectroscopy**

Abstract:
The University of Texas at Austin has a rich history of silicon grating and grism development. Grisms manufactured by UT Austin have enabled low-resolution NIR spectroscopy in FORCAST on SOFIA (R~200-1500) and with NIRCam on JWST (R~1800). Our immersion gratings in iSHELL (R~75,000), IGRINS & IGRINS-2 (R~45,000), and the future GMTNIRS (R~65,000 in J, H, and K; R~80,000 in L and M) enable high resolution NIR spectroscopy with high efficiency, fixed-formats, and compact instrument designs. Our current prototype mid-resolution (R~7,000-10,000) monolithic cross-dispersed grism, with a higher order grating on the entry face of the prism and a perpendicular low order grating functioning as a cross-disperser on the exit face of the prism, would enable mid-resolution NIR spectroscopy capabilities in imaging-spectrographs. The suite of instruments enabled by silicon diffractive optics has and will continue to contribute to numerous science cases including emission line detections of low- and high-z galaxies, characterization of asteroid composition, magnetic field measurements of young and low-mass stars, emission line kinematic mapping of photodissociation regions, detection and kinematics of exoplanetary atmospheric species, and tracing the Milky Way's galactic chemical evolution using dust obscured stellar populations.

Abstract number: **136**
Author: Lynne Hillenbrand
Title: **CHROMOS: Probing the Dust-Shrouded Inner Galaxy**

Abstract:
The Cosmic Higher Resolution Origins Multi-Object Spectroscopy (CHROMOS) mission concept for ASTRA will fill major science gaps and address fundamental questions identified by Astro2020 that remain critical into the 2030s. CHROMOS features a 2m space telescope with 0.7 sq deg field-of-view (FoV) and will obtain multi-object (MOS) slit spectroscopy at R = 1000 over 1.25–5 microns for up to 16,000 objects simultaneously. It will answer several fundamental questions in cosmology, along with key questions in galaxy evolution, Milky Way science, and exoplanets. Understanding of our home galaxy, the Milky Way, has been hampered by sightlines with visual extinction A_V > 30-100 mag. CHROMOS enables the exploration of the dust-enshrouded regions of the Galactic disk, reaching the far side of the Milky Way to map its 3D structure and quantify its stellar content. CHROMOS will record absorption lines that indicate stellar temperature and surface gravity, as well as emission lines that indicate ionization conditions and probe inflow/outflow in circumstellar environments. The wide FOV and high spectroscopic multiplex will provide large, statistically-significant samples of Galactic sources in young massive star clusters, star forming regions, and dense Galactic plane regions, with high SNR. CHROMOS addresses key questions in Milky Way science: (1) What stellar populations are in the dust-enshrouded regions of the Galactic disk? (2) What are the Star formation rate (SFR) and initial mass function (IMF) in massive Galactic star clusters? (3) What are the ionization conditions in the Galactic HII regions? CHROMOS is a natural follow-on to the Roman Galactic Plane Survey, which will provide a photometric catalog of ~100M plausible CHROMOS targets out to 25 kpc distances.

Abstract number: **137**
Author: Wayne Baumgartner
Title: **The Large Area X-ray Wide Field Monitor (WFM) for Strobe-X**

Abstract:
The Strobe-X Wide Field Monitor is an X-ray coded mask instrument based on large format linear silicon drift detectors (SDD). The WFM is an X-ray transient detector in the 2-50 keV band with four camera module pairs and coverage of one third of the sky (4 sr), with source localization of ~1 arcminute. The WFM is designed for TDAMM science to detect X-ray bursts, including those coincident with GRBs, with the goal of detecting prompt X-ray emission and the transition to the afterglow. Other science targets include sub luminous GRBs, state transitions in accreting objects, coronal events from active flare stars, detection of new sources, and the localization of X-ray counterparts to multi-messenger events from neutrinos and GWs. We report testing of the new custom ASIC developed for this detector system. Initial testing shows electronic noise performance that meets expectations. Coupled with recent low leakage current measurements in reduced channel count prototype detectors, these new results suggest that the ultimate low energy threshold could be significantly below the WFM's designed 2 keV low energy threshold, enabling new detections and observation of transient phenomema such as tidal disruption event, QPEs, and SN shock breakouts.

Abstract number: **137**
Author: Casey T DeRoo
Title: **Optical Designs & Performance Predictions for Next-Generation X-ray Observatories with Commercially-Polished X-ray Mirrors**

Abstract:
Since the production of mirrors for the Chandra X-ray Observatory, computer-controlled grinding and polishing for large-aperture optics has become widely commercially-available. Modern optics shops are able to meet Chandra-like tolerances within normal fabrication processes, making them capable of producing high quality grazing-incidence mirrors routinely and at-scale. An effort to adapt these directly polished grazing-incidence optics for next-generation X-ray observatories is underway at SAO, and culminates in the fabrication, mounting, alignment, and X-ray testing of a prototype telescope module. We examine the optical designs compatible with these optics, with a mind for the variety of missions proposed in the ASTRA concept studies. As a baseline, we adopt designs using fused silica mirrors measuring 200 mm azimuthally, 400 mm axially, and of order a few mm thick; such optics are compatible with this direct polishing process. The axial length allows the production of a primary/secondary profile within a single segment, simplifying the process of alignment. We study Wolter-I, Wolter-Schwartzchild, and polynomial designs in order to understand the types of mission profiles – e.g., wide field of view surveys, hard X-ray probes, spectroscopic imagers – that can be facilitated by use of this technology. “Strawman” configurations of apertures populated with such mirrors are presented, which provide an estimate of the achievable effective areas, angular resolution performance, and mass requirements for missions employing this technology.

Abstract number: **138**
Author: Ethan Rhiannon Partington
Title: **Probing AGN Accretion Physics with X-ray Timing Instruments**

Abstract:
NICER targeted ten nearby Active Galactic Nuclei (AGN) for long-term spectral monitoring with daily observations during campaigns lasting 30–1,600 days. These experiments revealed a diverse set of characteristics in the innermost regions of the AGNs including highly variable, clumpy disk winds in Mrk 817 and NGC 4151 that may shield the accretion disk from X-ray radiation. Contemporaneous UV and optical monitoring enabled reverberation experiments that probe the geometry and nature of individual X-ray emission sources, including the soft excess and reflection features. In eight unobscured AGN, lags between the soft excess and the UV/optical continuum fluxes have been measured for the first time ever using NICER. These lags demonstrate that while some AGN follow the simplest X-ray reprocessing scenario (NGC 7469), others have a complicated relationship between variability in the main X-ray continuum, the soft excess, and the UV/optical emission presumed to come from the accretion disk. In several AGN, NICER monitoring indicates the presence of a “warm corona” region of electrons above the inner disk, emitting in the soft X-rays and EUV. Further study of these sources and new experiments on other AGN will be critical to addressing the puzzling disconnect between the hard X-ray, soft excess, and UV/optical variability in many AGN. The proposed DEUS-X TDAMM machine with its “super-NICER” instrument is the future of these experiments, which require a high-throughput X-ray spectral instrument capable of visiting the same AGN daily to deliver precise lags and absorption strength measurements.

Abstract number: **139**
Author: Jenna Cann
Title: **Accretion Explorer Science: Scientific Discoveries Enabled by High-Resolution X-ray Interferometry**

Abstract:
Despite significant technological advancement across multi-wavelength observatories, our only window into the X-ray universe lies within unresolved images. This technological gap represents a significant barrier to understanding some of the highest energy processes and mysteries within the Universe: from the accretion processes powering AGN to stellar flares that affect habitability conditions on exoplanets. The Accretion Explorer Interferometer (AEI) mission concept is proposed to reach angular resolutions up to six orders of magnitude above current X-ray facilities. During a recent NASA Innovative and Advanced Concepts (NIAC)-funded study, the AEI team explored several science cases that would be uniquely enabled by such high-resolution imaging capabilities. Here we present our four key science pillars, as well as a preliminary science traceability matrix of the technical requirements needed for the successful completion of these science goals.

Abstract number: **140**
Author: Walid Majid
Title: **Resolving the Galactic Center GeV Excess: A High-Frequency Pulsar Census with the Deep Space Network**

Abstract:
The diffuse GeV gamma-ray excess toward the Galactic Center (GCE), detected by the Fermi-LAT, is among the most important unresolved problems in high-energy astrophysics. The two leading interpretations — self-annihilating dark matter, or a large, unresolved population of millisecond pulsars (MSPs) in the Galactic bulge — lead to very different conclusions: one would be evidence for physics beyond the Standard Model, the other a major revision to the census of compact objects in the inner Galaxy. Photon-statistics analyses increasingly point to a point-source-like origin, but the putative MSP population has not been detected, and the question remains open. A direct radio census of the bulge MSPs is the cleanest way to settle it. These searches have historically failed toward the Galactic Center because interstellar scattering broadens pulses roughly as $\nu^{-4}$, smearing the short periods of MSPs beyond detectability at conventional radio frequency bands used for pulsar surveys (< 10 GHz). Moving to high radio frequencies reduces this scattering by orders of magnitude, bringing the inner-Galaxy MSP population within reach. We present the NASA Deep Space Network's 70-m DSS-43 antenna as a well-matched instrument for this measurement: a broadband dual beam and dual polarization K-band receiver providing contiguous 17–27 GHz coverage at 32-μs sampling, with southern-hemisphere siting that places the Galactic Center near zenith. This existing NASA/JPL asset is a low-cost, near-term route to confirming or ruling out the MSP interpretation of the GCE. Settling the GCE is a pressing science question for the 2030s that both motivates and sharpens its science requirements in advance, and ground-based high-frequency radio supplies the astrophysical groundwork the mission's science case depends on.

Abstract number: **143**
Author: James Ross Cheshire IV
Title: **augr: an end-to-end differentiable framework for forecasting and optimizing CMB instrument design**

Abstract:
Observations of the polarization of the cosmic microwave background (CMB), and in particular the search for primordial gravitational waves from inflation, were named a high priority by the Astro2020 decadal survey, but the cancellation of CMB-S4 has made it clear that the time for a probe-scale CMB space mission is now. A NASA-led microwave imaging polarimeter offers a route to these goals and beyond, made more feasible by recent instrument technology developments and advances in launch capability. Designing such a mission demands careful optimization of parameters with respect to the overall science goals. We present augr, a JAX-native, open-source framework that computes the marginalized constraint on the tensor-to-scalar ratio r directly from physical instrument specifications including aperture, focal-plane geometry, feedhorn packing, detector counts, and sensitivities, and is differentiable end-to-end. Because the uncertainty on r is a differentiable function of the design, gradient descent replaces brute-force grid searches, and we optimize instrument parameters jointly given realistic data-processing and foreground-separation efficiencies and a realistic instrument cost model. augr features an internal map-based component separation pipeline (needlet and constrained-moment internal linear combination), self-consistent iterative full- and flat-sky delensing, and both Gaussian and moment-expansion treatments of dust and synchrotron foregrounds, with end-to-end gradients enabling optimization of instrument parameters over the cleaning and analysis pipeline itself, to our knowledge the first public code to do so. A Hamimeche-Lewis likelihood with Hamiltonian Monte Carlo sampling and simulation-based calibration provides honest non-Gaussian uncertainties at large angular scales, and Bayesian experimental design (expected information gain with active subspace dimension reduction) identifies the design directions that most improve r. Validated against published PICO, BICEP/Keck, and component-separated forecasts, augr is a fast, reproducible trade-study engine for maturing a CMB mission concept.

Abstract number: **144**
Author: David Sie Traore
Title: **Exoplanet landing and robotic surface exploration mission**

Abstract:
It is fair to say that if we take into consideration current scientific explanation of how the Universe was created and the principles of inflation, galaxies, stars, planet formation and other celestial entities, each entity is created with a unique set of attributes that differentiate it from the others, as in DNA with life as we know. Planet Earth's DNA is intelligent life; my question is: what are the DNA of other celestial entities? Could one be an Advanced Intelligent (AI) life form that humans and their technologies (including artificial) are not able to detect? To address this hypothesis, I propose an Exoplanet landing and robotic surface exploration mission using the 3 Astrophysics fundamental questions: 1 - How does the universe work? 2 - How did we get here? 3 - Are we alone? To execute the mission, we develop the Cis-Lunar Space Neutrino Laboratory, which is a proposed next-generation spacecraft-based facility designed to study the origins, properties, and applications of Multi-Messenger neutrino, presented at the 235th American Astronomical Society NASA Physics of the Cosmos session. The spacecraft will auto-develop its propulsion system in orbit around the Moon from nucleosynthesis in order to reach a "solar system escape velocity", selected exo-system entry, exo-planetary body of interest selection, descent, landing and surface exploration.

Abstract number: **145**
Author: James Tutt
Title: **Vacuum Vibration Qualification of Large-Aperture Silicon Carbide Grids for X-ray Microcalorimeter Blocking Filters**

Abstract:
High-resolution soft X-ray microcalorimetry is central to open questions identified since Astro2020 about the hot, energetic universe, including tracing AGN-driven feedback, mapping missing baryons in the circumgalactic and warm-hot intergalactic medium, and measuring velocities and light-element abundances in hot plasmas. Realizing this science with next-generation, large-aperture observatories depends on solving a persistent enabling-technology bottleneck: optical blocking filters remain a NASA Tier 1 technology gap, since hydrocarbon contamination steadily degrades soft X-ray throughput over a mission's lifetime, and the warmed-filter strategy flown on XRISM Resolve becomes harder to scale as future apertures grow toward the 160 to 180 mm class needed for concepts like the Lynx X-ray Microcalorimeter. Single-crystal silicon carbide (SiC) grids offer a path forward, providing substantially higher radial thermal conductance than heritage BeCu honeycomb designs, enabling more uniform filter temperatures, denser membrane support, and reduced sidewall X-ray occlusion. However, SiC's brittle failure mode and low inherent damping pose a key qualification risk at large aperture, where modal density rises and grid strength falls with area. We report on a vacuum vibration test campaign at the Penn State Advanced Research Laboratory, using an Unholtz Dickie shaker and laser Doppler vibrometry, which could qualify SiC grid assemblies up to 180 mm against GEVS Qualification Level (+3dB) loads. Smaller-aperture grids (78 to 128 mm) with a two-part frame and backing-plate damping design have shown order-of-magnitude reductions in resonant Q and peak acceleration relative to undamped designs, and informed the strength and geometry carried into the potential 180 mm prototype; this earlier work included SiC-gridded filters sized for the proposed AXIS mission. Performed in partnership with PhotonFoils under NASA SBIR funding, this work supports blocking-filter readiness for Lynx and other large-aperture soft X-ray missions, offering a transferable vibration-qualification approach for brittle-substrate filters across the soft X-ray mission portfolio.

Abstract number: **146**
Author: Lee G Mundy
Title: **Tracing the Assembly of Planetary Systems in the Far-Infrared at High Angular Resolution**

Abstract:
Progress on the fundamental questions of how planetary systems form and evolve requires far infrared observations with sub arcsecond resolution to probe the physical and chemical structure of protoplanetary, their evolution and their diversity. The far infrared regime provides key diagnostics —water ice features and gas lines that trace conditions in the outer parts of the disk, HD emission that reveals the bulk mass distribution, and accretion heating signatures associated with forming planets—that together illuminate how planets assemble and how disk environments regulate their growth and eventual evolution of planetary systems. Evolution of the water reservoir is expected to play a role in the development of habitable planets. ALMA and JWST are transforming our understanding of protoplanetary disks but far-infrared observations at comparable spatial and spectral resolution are needed. Far infrared observations with spatial and spectral resolution probe the cool to warm dust and gas and the transition from protoplanetary to early planetary systems. A space based far infrared interferometer with baselines up to 100 meters can resolve disk substructure, measure planetary activity across evolutionary stages, and dramatically expand the number of systems that can be imaged and spectrally characterized, enabling legacy surveys of over a hundred nearby disks. Such an observatory would reveal how long period planets sculpt their surrounding disk, provide the clearest view of the survivability of planets through the stellar accretion phase, and supply the missing observational foundation needed to address the planet formation priorities identified by Astro2020.

Abstract number: **148**
Author: Meredith Ann MacGregor
Title: **ORACLE – the Observatory for Resolving Atmospheric Chemistry in the Lifecycle of Exoplanetary systems**

Abstract:
Placing “Worlds and Suns in Context” is one of the three major science themes of Astro2020, and observations of planet-forming disks are highlighted as an area of great discovery potential. Yet, despite observational advances, there are still critical gaps in our knowledge of protoplanetary disks and the planets that ultimately form from them. The mid- and far-infrared (MIR and FIR) spectrum provides unique access to critical tracers of planetary systems. Transitions for numerous atomic and molecular species (e.g., O3 at 9.6 μm, CO2 at 15 μm, OI at 63 μm, HD at 56 and 112 μm, and H2O) lie in this bandpass that play a role in the formation of planets through to their atmospheric chemistry and ultimately the habitability of their surfaces. We are entering the era of searching for life elsewhere in the universe. In order to guide our search and maximize our chance of success, we must maintain access to this key part of the electromagnetic spectrum. We present the Observatory for Resolving Atmospheric Chemistry in the Lifecycle of Exoplanet systems (ORACLE) mission concept. ORACLE is a flaglet mission concept operating at MIR through FIR wavelengths and combining high spectral resolution from 4-200 μm with a MIR coronagraph. ORACLE complements the capabilities of existing and planned missions adding new science to NASA’s portfolio and tackling decadal science goals to: (1) Determine the volatile mass and composition of protoplanetary and debris disks, (2) Determine the composition of comets in the Solar System and exoplanet systems, (3) Determine the properties of disk winds and their role in disk dissipation, (4) Determine how photochemistry shapes atmospheric composition and haze production in gas and ice giant planets, (5) Determine the level of atmospheric heating in gas and ice giant planets, and (6) Determine the frequency of inner dust belts and exomoons.

Abstract number: **149**
Author: Ralf Heilmann
Title: **Extending bandpass for high-resolution x-ray grating spectroscopy beyond 3 keV**

Abstract:
High resolving power (R = lambda/(Delta lambda) ~ 10,000) soft x-ray spectroscopy enables sensitive emission and absorption line detection and characterization, key to measuring faint features in the outskirts of galaxies and clusters that trace matter cycling in and out of these systems, as well as tracing matter orbiting and falling into black holes amongst other high-priority science goals from the Astro2020 Decadal Survey. Critical-angle transmission (CAT) gratings are freestanding blazed transmission gratings and an enabling technology for mission concepts such as Arcus or Lynx in support of this science. R ~ 12,000 – achievable with no other technology at these energies – has been demonstrated experimentally for a pair of co-aligned CAT gratings. Fabricated from 200 mm silicon-on-insulator wafers, blazing into higher orders (leading to higher R) is due to grazing-incidence reflection off the Si grating bar sidewalls. This limits efficient blazing to energies below ~ 1.5 keV, depending on graze angle. Coating of the bars with a thin layer of Pt using atomic layer deposition (ALD) has been demonstrated in the past, leading to larger efficient graze angles and extending blazing to higher energies. However, absorption lines for Pt and similar elements (Ir, Ru, etc.) lead to sharp dips in reflectivity near 2 keV. Here we propose new multilayer designs for the ALD coating of Si CAT gratings that smooth over the Pt absorption line dips and could extend the usable bandpass for CAT-grating-based spectrometers into the 4-5 keV range, potentially reaching redshifted iron lines from AGN at z > 1.5. We discuss the tradeoffs between graze angle, effective area, resolving power, grating bar aspect ratio, and interface and surface roughness.

Abstract number: **150**
Author: Stephen James Smith
Title: **Scalable TES Microcalorimeter Detector Technologies for Future X-ray Missions**

Abstract:
TES detector development for Athena/X-IFU has demonstrated the maturity of large arrays of microcalorimeters at the ~1.5k-pixel scale. Future missions will require larger and more varied focal-plane implementations, including 10k-pixel arrays for probe-scale wide-field spectroscopy and 100k-pixel focal planes for a Lynx-like flagship observatory. Meeting this range of needs will require not just larger arrays, but detector designs that can be adapted in pixel pitch, absorber design, energy range, spectral resolution, and readout approach. We are developing TES array technologies that span multiple architectures, including single-pixel sensors optimized for high spectral performance and thermally multiplexed hydras that increase effective imaging-element count without a proportional increase in wiring and readout complexity. This work includes LEM-like main-array detector development, where large-format TES arrays combine high-resolution single pixels and hydra pixels to support wide-field soft X-ray spectroscopy. It also includes Lynx-like detector development aimed at finer pixel pitches, larger effective pixel counts, and enhanced spectral-resolution subarrays for high-angular-resolution imaging spectroscopy. By varying pixel pitch, absorber heat capacity, TES geometry, and thermal coupling, these detector designs can be adapted to a range of future mission concepts. A major focus is the use of multilayer buried superconducting wiring to enable compact, high-density detector layouts. This allows large numbers of TES pixels to be routed through the detector wafer while reducing the need for large electrical interfaces. They also enable bias-circuit components, including compact shunt resistors and high-kinetic-inductance elements, to be incorporated into the detector substrate. This supports more compact focal-plane geometries and direct integration with bump-bonded time-division-multiplexed (TDM) SQUID readout chips, while also providing a path toward microwave SQUID multiplexing for very large future arrays. This presentation will describe current TES development efforts and discuss how these technologies can support future X-ray mission concepts through scalable science-array designs, integrated detector substrates, and adaptable pixel architectures.

Abstract number: **151**
Author: Malgorzata Sobolewska
Title: **The X-ray quest for (sub)parsec-scale separation SMBHs**

Abstract:
Hierarchical galaxy mergers naturally lead to a stage with multiple supermassive black holes (SMBHs) in galactic centers. Determining rates and properties of multiple SMBHs maps merger histories and directly addresses all three themes of the Astro2020 Decadal Survey: Cosmic Ecosystems by revealing how mergers drive SMBH and galaxy assembly and growth; Worlds and Suns in Context by probing how mergers trigger AGN feedback that regulates stellar and planetary formation; New Messengers and New Physics by predicting how low-frequency gravitational-wave (GW) backgrounds and signals will manifest for LISA and pulsar timing arrays like the NANOGrav. The closest-separation binary AGN confirmed to date was resolved with VLBA at ~7 mas (~7 pc). As the angular-size relation peaks near z~1.5 (~8.5 pc/mas), mas angular resolution is required to resolve parsec-scale SMBH pairs across cosmic time. Sub-parsec scales (the "final parsec problem") require <~100 μas angular resolution. While radio-to-UV facilities achieve angular resolutions from 50 mas down to 20 μas, X-ray imaging remains limited by the Chandra's ~0.5 arcsecond resolution creating a multiwavelength imaging capability gap. This gap motivates the development of an ultra-high angular resolution X-ray imaging observatory with a milli- to micro-arcsecond resolving capability. Realizing this concept would unlock powerful synergies between X-rays and GW and radio-to-UV science at matching ultra-high angular resolution, enabling unprecedented studies of SMBH merger rates, final-stage merger physics, gravitational recoil, three-body slingshots, off-nuclear tidal disruption events, and related multi-messenger phenomena.

Abstract number: **152**
Author: Andreas Zoglauer
Title: **Closing the MeV Gap with ARCTIS and Hybrid Germanium Pixel Detectors**

Abstract:
The MeV gamma-ray band (0.2–10 MeV) remains the least-explored window in astrophysics due to a sensitivity gap of two to three orders of magnitude between hard X-ray and GeV instruments. Closing it requires a Compton telescope that simultaneously achieves germanium-grade spectral resolution, close to Doppler-broadening-limited angular resolution, and Compton recoil-electron tracking. No existing or planned detector provides all three. We propose to develop the enabling technology, the Hybrid Germanium Pixel Detector (HGePD), for ARCTIS, a future all-sky MeV Compton telescope that would resolve the diffuse Galactic line emission into individual sources, constrain nucleosynthesis, positron, and r-process physics, detect the prompt MeV counterparts of multi-messenger transients, and characterize magnetar fields through high-energy polarization. A germanium crystal produces two charge signals as electrons and holes drift to opposite faces. The HGePD instruments these faces asymmetrically. A fine-pixel face (~0.2 mm pitch) collects the electron signal for position determination and recoil-electron tracking. A coarse face (~2.0 mm pitch), pixelated or strip-segmented, collects the hole signal optimized for ~3 keV per-interaction energy resolution. Limited waveform sampling adds interaction depth and flags multiple hits within a coarse element. Consequently, this dual-face geometry is expected to deliver, in one detector, the required Ge-class spectral resolution, near-Doppler angular resolution, and recoil-electron tracking. Currently, the technology is at TRL 2 to 3. Different groups have demonstrated fine-pixel germanium imagers, but the required dual-face HGePD has not yet been built. The principal challenges are the asymmetric electrode geometry on a single crystal without charge trapping, a custom 80 K low-noise readout ASIC across the ~100,000 fine-face channels, per-channel power extraction from the cold mass, Ge/Si bond survival through thermal cycling, and minimizing passive material. We are currently working on a first optimized HGePD design, with the goal of being ready for a flight proposal within a decade.

Abstract number: **153**
Author: Eric Miller
Title: **Germanium CCD detectors for future broad-band X-ray missions**

Abstract:
Future X-ray missions will greatly benefit from broad-band sensitivity, with a single instrument covering 0.1--100 keV, to enable simultaneous study of thermal and non-thermal physical processes in extreme environments. MIT Lincoln Laboratory has been developing germanium charge-coupled devices (CCDs) for a decade, with the goal of preserving the characteristics that make silicon CCDs desirable for astronomy -- notably large format, low read noise, excellent spectral resolution, and noiseless on-chip charge summation -- but utilizing a material that exhibits sensitivity spanning both the soft and hard X-ray bands. We have successfully fabricated test devices that detect X-rays, and we steadily improve yield and device performance. We present the current status of this technology, and we detail our expected path toward realizing a large-format CCD with low read noise and broadband X-ray spectral sensitivity that could be deployed on a future strategic mission..

Abstract number: **154**
Author: Eric Miller
Title: **High-speed, low-noise imaging cameras for future X-ray missions**

Abstract:
Future X-ray imaging missions require focal planes capable of fast frame rates while maintaining low noise and excellent broad-band X-ray spectral performance. Our groups at MIT and Stanford University have been developing CCD-based technology that maintains the spectral imaging performance of successful heritage instruments like Chandra ACIS and Suzaku XIS, but operating orders of magnitude faster. Most recently, we developed the High-Speed Camera concept for the AXIS Probe mission, employing 16-channel, fast-readout, MIT Lincoln Laboratory CCDs paired with low-noise ASICs developed by Stanford. We have demonstrated the performance of prototype devices, which meet AXIS requirements with substantial margin, and we designed a robust, high-heritage camera that provides the mechanical and thermal environment required for this demanding mission concept. The design elements of the AXIS camera are extendable to many future strategic X-ray missions, and we continue to develop the detector technology with an eye to increasing the speed. We present the current status of this technology and our plan for future development in the context of ASTRA.

Abstract number: **156**
Author: Caroline Kilbourne
Title: **Essential Supporting Technology for Wide-field, High-Resolution, Sub-2-keV, Imaging X-ray Spectroscopy**

Abstract:
Designing a microcalorimeter-based imaging X-ray spectroscopy mission for ~1-keV science, such as for characterization of the diffuse hot gas around and between galaxies, allows a short focal length, which trades high-energy sensitivity for a wider field of view at a given sensing area, and enables higher spectral resolution through optimizing the microcalorimeter array for a narrower energy band. This approach has been proposed for several mission concepts including HUBS, super DIOS, the Line Emission Mapper (LEM) X-ray Probe, and the Ardua FUV/X-ray mission. The technology impact of this choice extends beyond the design of the optics and the microcalorimeter array to essential supporting technologies. The thin absorbers, relative to broad-band devices, result in less energy deposition by cosmic rays and the secondary particles associated with them, increasing the un-vetoed instrumental background rate per keV. The large physical area of the array requires a large, low-temperature anti-coincidence detector with high rejection efficiency. Microcalorimeter focal planes operate at ~ 50 mK and require a series of thin-film blocking filters, each at a different temperature stage, to attenuate long wavelength radiation from higher temperatures in the dewar and the optic. These filters must also provide usable X-ray transmission down to ~0.1 keV. The large aperture size, which increases rapidly with distance from the focal plane due to the fast beam, requires that these fragile filters have large diameters. The entire aperture subsystem – consisting of barriers, baffles, filter assemblies and mounts that permit reversible filter installation – must be designed to support and thermally anchor the filters, minimize multiple scattering of long-wavelength radiation between filters, and inhibit and remediate potential contamination without imposing thermal loads unacceptable to the functioning of the cooling system. We present the state of the art in background-rejection and aperture technologies and highlight where more investment is needed.

Abstract number: **157**
Author: Fabien Grise
Title: **Advanced Fabrication Methods for Next-Generation UV Gratings: Enabling Habitable Worlds Observatory Spectroscopy Through Precision Nanofabrication**

Abstract:
The Habitable Worlds Observatory (HWO), NASA's next strategic flagship mission, aims to revolutionize our understanding of habitable planets beyond our solar system while enabling transformative astrophysics discoveries. Building on the legacy of the Hubble Space Telescope and previous ultraviolet (UV) missions, HWO requires unprecedented UV spectroscopic performance to achieve its scientific objectives. Leveraging cutting-edge nanofabrication techniques, we present advanced grating fabrication methods critical to meeting these demands. These methods enable the manufacture of echelle gratings, Variable Line-Space (VLS) gratings, ultra-low blaze angle gratings, and aberration-correcting gratings. These innovations are not only pivotal for HWO but also broadly applicable to a wide range of UV missions, including sounding rockets, CubeSats, and Explorer-class missions. By advancing these technologies, we are enabling HWO's ambitious goals while contributing to the future of UV astrophysics.

Abstract number: **159**
Author: Breann Sitarski
Title: **Quantum Processor Enhanced Telescopes**

Abstract:
Quantum Processor Enhanced Telescopes (QPET) replace conventional focal-plane pixels with Quantum Processor Pixels that store photonic amplitudes as qubits and process them before detection. Classical detectors integrate intensity and recover faint structure only afterward, limiting signal-to-noise ratio in photon-starved, non-stationary regimes where speckle, background light, and calibration errors dominate the measurement. QPET reframes imaging as parameter estimation: the instrument suppresses nuisances upstream and measures physical observables, like angular separation, contrast, kinematics, directly rather than forming images and fitting parameters afterward. Each pixel heralds incoming light, maps amplitudes into cryogenic silicon-vacancy centers, and teleports states to a rubidium atom-array processor for multi-photon interference and quantum principal-component sorting of light into the point-spread-function eigenbasis. Recent theory and laboratory demonstrations indicate that this architecture can deliver orders-of-magnitude improvements in effective angular resolution and sensitivity, extracting more information per photon than classical post-detection processing and easing the requirement for ever-larger apertures.

Abstract number: **160**
Author: April Jewell
Title: **Advanced Ultraviolet Silicon Detector Technologies Enabling Astrophysics Missions**

Abstract:
JPL's delta doping technology yields ultrastability and record sensitivity in silicon-based detectors, which has enabled smaller spacecraft— including sounding rockets, suborbital balloons, and CubeSats—to perform sensitive science measurements previously only possible with larger satellite platforms. Here we discuss recent deployments and developments of JPL's UV detector and coatings technologies. We will review performance results of photon-counting, delta-doped EMCCDs on the Faint Intergalactic Red-shifted Emission Balloon (FIREBall-2) mission, the status of delta-doped conventional CCDs on the recently launched astrophysics Star-Planet Activity Research Activity CubeSat (SPARCS) mission, technology advancement with the Heterodyne OH Lunar Miniaturized Spectrometer (HOLMS) sounding rocket mission EMCCD detector prototype, the status of delta-doped CMOS detector development for the astrophysics Ultraviolet Explorer (UVEX) mission, as well as ongoing work on the development of delta-doped UV Skipper detectors. These advancements are critical to demonstrating readiness for future NASA missions. The research described in this paper was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration Copyright 2026.

Abstract number: **161**
Author: Daniel Patnaude
Title: **Probing the Supernova Explosion Mechanism with X-ray Microcalorimeter Observations of Supernova Remnants**

Abstract:
X-ray microcalorimeter observations of Galactic and Magellanic Cloud SNRs are uniquely suited to address questions about the explosion mechanism in core collapse and Ia SNRs. First, detection of trace elements which are sensitive to both the progenitor and neutrino anisotropies can only be made with eV resolution detectors. Second, mapping the velocity field of the ejecta directly probes asymmetries in the explosion of core collapse supernovae, and in the case of Ia SNRs, provides clues as to the nature of the explosion channel. Here we discuss the potential for addressing these questions with an Explorer or Probe-class microcalorimeter. We present simulations of CC and Ia SNRs evolved from state of the art SNe models and show how microcalorimeter observations can be used to infer the explosion and progenitor properties.

Abstract number: **163**
Author: Claudia Puertas González
Title: **Quantum Degenerate Gas Engineering for Space Atom Interferometry**

Abstract:
Bose–Einstein condensates are promising sources for next-generation atom interferometry, combining high spatial coherence, narrow momentum distributions, and compatibility with long interrogation times. These properties are essential for large-scale quantum sensors targeting precision inertial measurements, tests of fundamental physics, dark-matter searches, and future atom-interferometric gravitational-wave detection. This poster presents a theoretical and numerical framework for optimizing quantum-degenerate gas sources for long-baseline and space-based atom interferometers. The motivation is closely connected to mission concepts such as AEDGE, where cold atoms are proposed as sensors for gravitational waves and ultralight dark matter. In such instruments, long interrogation times, large momentum separation, and high contrast require atomic sources with minimal expansion, controlled collective excitations, and robust coherence. The framework combines complementary source-engineering techniques: in-trap lensing, delta-kick collimation, shortcuts to adiabaticity, and optimal-control-inspired protocols. In-trap lensing and delta-kick collimation reduce the expansion energy of the condensate, enabling slowly expanding matter waves suitable for long free evolution. Shortcut-to-adiabaticity methods allow fast transport, trap decompression, and mode shaping while suppressing residual excitation. Optimal-control strategies provide a systematic route to designing realistic time-dependent potentials under experimental constraints. Numerical simulations are used to evaluate source quality in terms of cloud size, expansion velocity, residual excitations, coherence preservation, and interferometric mode matching. The results emphasize that transport, collimation, and trap shaping must be optimized together rather than treated as separate tuning steps. By turning source preparation into a predictive optimization problem, this work supports the development of robust Bose–Einstein-condensate sources for large-baseline sensors, microgravity experiments, and future space missions. It contributes to the technological foundation required for atom-interferometric gravitational-wave detection, dark-matter searches, and quantum sensing in space.

Abstract number: **164**
Author: Simon Richard Bandler
Title: **Architectural Capabilities and Implementation Strategies for a Future Flagship X-ray Microcalorimeter**

Abstract:
The next generation of X-ray flagship missions will require transformative imaging spectroscopy to study the X-ray universe spatially, spectrally, and temporally. This capability will support a broad science portfolio, including black hole growth and feedback, galaxy formation, the physics of clusters and the cosmic web, supernova remnants and chemical enrichment, compact objects, stellar astrophysics, and time domain phenomena. We detail the Lynx 2030 SAG Microcalorimeter Working Group's recommended instrument capabilities and implementation strategies, optimized to achieve transformative science goals within modern technological constraints. We present a targeted evolution of the microcalorimeter baseline centered on a graded-pixel focal plane. We detail an architecture utilizing sub-arcsecond pixels (0.5–1″) in the central field to capture point-source and small-scale phenomena, transitioning to 2–5″ pixels in an extended outer field spanning 10–15 arcminutes in diameter for faint-diffuse surveys. We outline how energy-resolution enhancements should be strategically targeted to maximize readiness and performance. We detail recommendations for achieving 2 eV in the main array by reducing hydra multiplicity, alongside preserving a 0.3 eV ultra-high-resolution inner sub-array for energies below 1 keV. We also discuss implementing the usable energy bandpass, emphasizing the technical approach to explicitly protect soft-X-ray sensitivity down to the 0.3 keV carbon edge, while extending capabilities up to 12 keV via signal reconstruction on Transition-Edge Sensor (TES) or Magnetic Microcalorimeter (MMC) devices. Finally, we address crucial design trade-offs, demonstrating why attempting a uniform <2 eV resolution across the full expanded field of view adds significant technical complexity without proportional science return. By outlining this strategically graded architecture, supported by maturing cryogenic readout technologies, this presentation provides a robust, ready-to-implement framework for the next major X-ray observatory in NASA's astrophysics portfolio.

Abstract number: **166**
Author: Gina Kleinsteinberg
Title: **Simulation of Space-borne Atom Interferometers for Fundamental Science and Applications**

Abstract:
Space-borne cold atom interferometers promise unprecedented sensitivity for measuring accelerations and rotations. Advancing their technology readiness and maturing space deployment requires dedicated technological demonstrators. Following the community roadmap for cold atoms in space, several embarked testbeds are planned over the next decade to raise the TRL of space-borne atom interferometry and provide pathfinding measurements for Fundamental Physics and Earth Observation. The Cold Atom Laboratory [1], aboard the ISS, has already demonstrated successful source preparation. Its successor, BECCAL, will feature two interferometry axes, serving as a testbed for measuring accelerations, rotations, and gravity gradients, and for dual-species experiments such as tests of the universality of free fall. Looking further ahead, dedicated satellite missions aim to exploit calmer environments than the ISS to achieve higher-precision space-borne atom interferometry. CARIOQA [2] is a pathfinder mission for quantum accelerometry for Earth observation, while the STE-QUEST proposal [3,4] aims to test the universality of free fall at the 1e-17 level. Deriving experimental requirements and sensor performance for these missions calls for dedicated simulation tools capable of capturing the realistic impact of the experimental environment on the interferometer. We present a Python-based simulation framework that generates realistic phase signals for space-borne atom interferometers across all the missions above. The tool models the atom interferometer itself alongside systematic effects from environmental influences, enabling generation of realistic phase-shift signals from which sensor performance can be assessed and requirements on platform stability or atom source preparation can be derived. To identify optimal operational modes for a given setup, we apply multi-objective optimization to explore trade-offs among mission parameters while simultaneously optimizing sensor performance. [1] J. R. Williams et al., Nat. Commun. 15, 6414 (2024). [2] T. Lévèque et al., arXiv:2211.01215 (2022). [3] N. Gaaloul et al., arXiv:2211.15412 (2025). [4] C. Struckmann et al., Phys. Rev. D 109, 064010 (2024)

Abstract number: **167**
Author: John Hennessy
Title: **Detector-integrated and stand-alone filter coatings for UV/Vis/NIR instrumentation**

Abstract:
Next-generation NASA astrophysics missions, including the MIDEX UltraViolet EXplorer (UVEX) and the Habitable Worlds Observatory (HWO), require advanced optical systems with unprecedented performance. A critical challenge is achieving high in-band quantum efficiency while simultaneously suppressing out-of-band light using highly uniform, flight-ready optical elements. This poster presents recent progress in developing custom metal-dielectric filter stacks utilizing highly controlled vacuum coating techniques. By combining atomic layer deposition (ALD) of ultra-thin dielectrics with physical vapor deposition of aluminum, we engineer precise thin-film structures. We highlight the integration of these bandpass filters directly onto back-illuminated, delta-doped silicon image sensors. These detector-integrated coatings enable highly efficient, solar-blind operation while preserving the high internal quantum efficiency achieved by JPL's 2D-doping process. Furthermore, we detail spatially graded-thickness coatings designed to map a detector's spatial response directly to a spectrometer's dispersion, maximizing focal plane throughput. Building on successful far-ultraviolet demonstrations, we are extending this graded-thickness approach into the visible and near-infrared bands to support broader spectrograph designs. Beyond detector-integrated applications, we demonstrate utilizing ALD to construct robust, stand-alone transmissive optics and filter elements. Leveraging ALD's sub-nanometer thickness control, we are developing standalone UV bandpass filters operating in transmission and reflection to address critical technology gaps for HWO. We will present initial characterization results for these architectures and outline the roadmap for advancing these technologies through ongoing programs, paving the way for infusion into future sub-orbital payloads, Explorers, and flagship astrophysics instrumentation.

Abstract number: **168**
Author: Sven Herrmann
Title: **X-ray Camera Electronics for Future Missions**

Abstract:
State-of-the-art X-ray CCDs are close to delivering the key performance metrics for most next generation of X-ray observatories, except the required frame rates. Our group at Stanford is addressing this technology gap, in collaboration with colleagues at the Massachusetts Institute of Technology (MIT) and MIT Lincoln Laboratory (MIT-LL). To meet this need, we are developing advanced multi-channel readout electronics that utilizes integrated micro-electronics, waveform sampling and FPGA based digital signal processing. To support high data throughput, we have developed a number of high performance components that can be combined to support a range of mission profiles. The first is a high-speed, low-power, low-noise application-specific integrated circuit (ASIC), denoted the Multi-Channel Readout Chip (MCRC) that reads and amplifies CCD signals. Following amplification, the analog signals are digitized and processed to construct a pixel array, prior to event detection. For this purpose, we have developed ADC- and FPGA-based camera electronics that enables high-speed, parallelized readout of the CCD channels. The on-board FPGA then performs preprocessing of pixel data into a raw image, which then can be further processed for X-ray event extraction and background rejection. The architecture supports AI methods to enhance detector performance, including enhanced particle background screening and improved event characterization. The final data products are streamed over a 1 Gb Ethernet link to the back-end electronics hub or a satellite bus. We will provide an overview of these components and their potential application in future X-ray missions.

Abstract number: **169**
Author: Enrico Biancalani
Title: **Pathways to exo-world discovery with fluidic space-assembled telescopes**

Abstract:
In-space assembly of mirrors via the scale-invariant technology of fluidic shaping can enable the paradigm shift from space-borne to space-assembled telescopes. Such fluidic telescopes can be strategically scaled up to larger apertures at a lower cost and in an iterative fashion. Starting from a minimal pathfinder fluidic telescope, we explore some of the potential exo-world science cases that can be made observationally accessible by various architectures. In particular, we propose to study the feasibility of a dedicated intermediate-aperture fluidic telescope to conduct a long-term relative-astrometry monitoring campaign on the directly-imaged habitable-zone giant exoplanet candidate α Centauri Ab---with respect to its coronagraphed host star---in search of Earth-like exomoons. This could serve as a stepping stone coronagraphic mission in between the Nancy Grace Roman Space Telescope---of which we assess the exomoon discovery potential and limits for coronagraphic astrometry---and the Habitable Worlds Observatory (HWO). Then, we review the benefits of follow-up direct-imaging missions to HWO. E.g., the Large UV/Optical/IR Surveyor (LUVOIR) concept could be revived into a fluidic telescope with a ~12-m-aperture off-axis optical configuration that yields about 3 times the ~25 exo-Earth candidates recommended by the Decadal Survey on Astronomy and Astrophysics 2020 (alias Astro2020), over a 2-year blind-search survey. With a photonic coronagraph, the yield multiplier could theoretically reach about 5x; and the number of confirmed candidates would scale up proportionally, given an underlying binomial distribution. We also show that, at the limit where the cumulative time spent on overheads dominates the survey time, an even larger fluidic telescope could be assembled that yields ~300 exo-Earth candidates, in search of biosignatures or technosignatures.

Abstract number: **170**
Author: Vallia Antoniou
Title: **Forward Modeling the X-ray Binary Population of the Large Magellanic Cloud for Lynx2030 Science**

Abstract:
The Large Magellanic Cloud (LMC) provides a unique laboratory for studying the formation and evolution of X-ray binaries (XRBs) in a low-metallicity environment. The completed 1 Ms Chandra Very Large Program (VLP), consisting of ten contiguous 100 ks ACIS-I pointings, has produced the deepest X-ray survey of the LMC to date, detecting more than 1,500 sources. This dataset establishes an empirical benchmark for future flagship X-ray observatories. We propose to develop a forward-modeling framework that begins with an assumed intrinsic source population and simulates how it appears after observational selection effects, source confusion, and instrument response. Using the Chandra VLP catalog as an empirical anchor, the framework will predict the science return of the Lynx2030 mission. Rather than relying solely on idealized population synthesis, the approach combines observed source properties with probabilistic classification, AGN logN-logS distributions, spatial priors tied to the LMC stellar population, and X-ray luminosity functions to construct statistically consistent realizations of the intrinsic source population. Initial source classes include high-mass XRBs, supernova remnants, foreground stars, and background AGN, with each source assigned probabilistic class membership. The resulting catalogs will be extended below the Chandra completeness limit to include faint XRBs and AGN not detected in the VLP. These catalogs will be used for end-to-end simulations of both the Chandra configuration and the evolving Lynx2030 concept under identical survey geometry and exposure time. This enables direct comparison of source completeness, confusion, positional accuracy, luminosity-function recovery, and counterpart identification. Because the LMC contains both crowded star-forming regions and sparse fields within a single galaxy, it provides an ideal testbed for assessing how improved angular resolution and collecting area translate into scientific gain. The proposed methodology is designed to be readily adaptable to other nearby galaxies, providing a general framework for forecasting the scientific return of next-generation flagship X-ray missions.

Abstract number: **171**
Author: Douglas Buisson
Title: **Recurrent, reversible jumps in spectra and variability, 'flip-flops', as markers of the hard-to-soft state transition in X-ray binaries**

Abstract:
An early division known in the types of emission observed in the X-ray sky is between the hard and soft states of what we now know as X-ray binaries. As observational capabilities improved and counterparts in other wavebands have been identified, additional states, including various intermediate and edge cases, have been added to the observational picture of accreting sources. Both because of and despite this rich phenomenology, the details of the processes at work are still a topic of active research, in part because different observable states are apparent to different instruments. We will focus on 'flip-flops', recurrent changes in spectral and timing properties that occur during the broad-sense state transition of X-ray binaries. With the example of a detailed case study of the prototypical source GX 339-4, we show that a method of fitting individual periodograms can be used to minimise the loss of features to time averaging, thereby allowing finer constraints on parameters of interest and resolving fast qualitative changes in the emission state. More generally, we will describe how relating differences between observed states with continuous or discontinuous or reversible or irreversible changes may help to distinguish between similar states related with a quantitative change and qualitatively different states. Furthermore, we will argue that identifying the regions of the observational state space that may contain qualitative changes is an instructive method to develop future-proof phenomenological descriptions and to guide efficient future observing strategies. As flip flops are a phenomenon of bright sources covering a brief time interval and with clearer signal in variability than energy spectra, observations to gather a representative population sample are most efficiently made with an X-ray instrument capable of fast timing over a wide area, or at least frequent monitoring of many sources.

Abstract number: **173**
Author: Eduardo Bendek
Title: **Astrometric Detection of Exomoons with a Self-Calibrating Kernel-Nulling Interferometer**

Abstract:
The detection of exomoons remains one of the most compelling open problems in exoplanet science, yet no unambiguous detection has been achieved. We present a concept for detecting exomoons through high-precision differential astrometry with a kernel-nulling interferometer. A moon forces its host planet to orbit the planet–moon barycenter, producing a periodic reflex displacement of the planet relative to the star. By suppressing starlight through destructive interference while retaining the planet signal, and by using the metrology-defined fringe pattern as an angular ruler, the instrument measures the planet's position relative to the nulled star with the plate scale set by wavelength and baseline rather than detector calibration. Kernel-null observables, robust to piston errors to second order, provide a self-calibrating position measurement referenced to the stellar null. We show that, for a fiducial moon-to-planet mass ratio, the angular wobble is comparable (~100–300 μas) across target classes because the growth of the planet's Hill sphere with orbital distance nearly cancels the distance penalty; consequently moon orbital period and photon-limited signal-to-noise—not signal amplitude—discriminate feasible targets. Nearby mature systems are strongly favored: α Centauri A b (if confirmed) emerges as a flagship, with a large wobble, a months-long moon period, and a trivially resolved separation that nonetheless demands the starlight suppression a nulling architecture uniquely provides. Young self-luminous giants (e.g., HD 206893 B) constitute the near-term demonstration set, building on GRAVITY's tens-of-microarcsecond dual-field astrometry. A photon-limited error budget shows that probe-class apertures and tens-of-meter baselines reach few-microarcsecond precision, making systematic stability—not photons—the binding constraint the kernel-null directly addresses. A mid-infrared, photonic-integrated implementation, naturally suited to space, offers strong synergies between astronomical instrumentation and the emerging space-photonics industry.

Abstract number: **174**
Author: Peter Maksym
Title: **Poster to accompany: An X-ray Extremely wide-field Spectroscopic Surveyor (XESS, or “chess”)**

Abstract:

Abstract number: **175**
Author: John Krizmanic
Title: **Poster to accompany The Probe Of Extreme Multi-Messenger Astrophysics (POEMMA) Observatory**

Abstract:

Abstract number: **176**
Author: Naceur Gaaloul
Title: **Poster to accompany AEDGE: Atomic Experiment for Dark Matter and Gravity Exploration in Space**

Abstract:

Abstract number: **180**
Author: Leo Singer
Title: **Poster to accompany Ad Astra Per Lunam: A Flagship TDAMM Observatory on the Lunar Surface**

Abstract:

Abstract number: **181**
Author: Richard Scott Miller
Title: **Poster to accompany** Time-domain All-Sky Nuclear Gamma-ray Observatory (TANGO)

Abstract:

Abstract number: **158**
Author: Casey McGrath
Title: **The Cosmic Positioning System (CPS)**

Abstract:
Measuring the Universe's expansion history is central to cosmology as highlighted in the Astro2020 Decadal Survey. However, current studies put the measurement of the Hubble constant in a statistically large tension that is yet unresolved. As the main science case for the Cosmic Positioning System (CPS) mission concept, CPS envisions placing radio antennae in the distant Solar System to directly measure the curvature of the electromagnetic wavefront from Fast Radio Bursts (FRBs). This would allow a new and direct distance measurement to these sources, independent of current techniques, that could help resolve this outstanding cosmological problem. CPS is fundamentally a different kind of mission. Nearly every strategic astrophysics mission of the past forty years is at its heart a single large telescope that collects and focuses light. CPS is instead a distributed metrology instrument: its science comes from measuring the relative space-time positions of five spacecraft, and the arrival times of radio wavefronts across them, to centimeter and sub-nanosecond precision over tens-of-AU baselines. This concept could enable other types of valuable scientific observations, such as detecting sources in the microhertz gravitational wave spectrum or measurements of the mass distribution of the Solar System.