Infrared Science and Technology Integration Group Splinter Session at the 243rd Meeting of the American Astronomical Society

Tuesday Jan. 9, 2024 9:00-10:30AM CT
Ernest N. Morial Convention Center -- Rm 242

"Guest Observer Science with a FIR Probe"

Meeting Agenda

9:00-9:05AM	**Roberta Paladini** IRSTIG Co-Chair	IPAC & IRSTIG	*IRSTIG Introduction: Community Engagement Efforts & Leadership Council Recruitment*
9:05-9:17AM	**Jon Arenberg** on behalf of the SALTUS team	Northrop Grumman	*SALTUS: The Single Aperture Large Telescope for Universe Studies*
9:17-9:29AM	**Matt Bradford** on behalf of the PRIMA team	NASA JPL	*PRIMA: The PRobe far-infrared Mission for Astrophysics*
9:29-9:41AM	**Asantha Cooray** on behalf of the FIRSST team	UC Irvine	*FIRSST: The Far-Infrared Spectroscopy Space Telescope*
9:41-9:48AM	**Justin Spilker**	Texas A&M University	*Charting the Rise of Small Dust Grains from Reionization to the Present with the SALTUS Probe Concept*
9:48-9:55AM	**Jay Chittidi**	University of Colorado – Boulder	*Tracing Planet Formation in the Hidden Far-Infrared*
9:55-10:02AM	**Erini Lambrides**	NASA Goddard Space Flight Center	*Hunting for the Highest Redshift Obscured AGN*
10:02-10:09AM	**Jed McKinney**	University of Texas Austin	*Far-IR Line Follow-up to Measure Gas and Dust Conditions in Distant Galaxies*
10:09-10:16AM	**Kamber Schwarz**	Max Planck Institute for Astronomy	*Protoplanetary Disk Science with SALTUS*
10:16-10:23AM	**Will Fischer**	Space Telescope Science Institute	*Far-Infrared Luminosity Bursts Trace Mass Accretion onto Protostars*
10:23-10:30AM	**Nima Chartab**	Carnegie Observatories	*Unraveling Cosmic Metallicity: The FIRSST View on Protoclusters at Cosmic Noon*

Abstract Booklet

In response to the Astro2020 decadal survey, NASA solicited proposals for $1B class probe missions to explore either Far-Infrared or X-Ray astrophysics. Should an IR probe mission be selected, the community may have access to "Guest Observer" time to make observations of their choosing. To help facilitate the sharing of infrared science cases developed around the probe mission call, and motivations for current and future infrared science, we invite submissions for feature talks at the [Infrared Science and Technology Interest Group's Splinter Session](#) at [the 243rd American Astronomical Society Meeting](#). This session will begin with talks from the teams of each submitted FIR probe mission describing their mission architecture and proposed capabilities. Following this, we invite members from the community-at-large to speak to Guest Observer (GO) science ideas of their own. We also hope to highlight science pushing the capabilities of current Infrared facilities, and how work that motivates GO program science with probes.

Roberta Paladini: IRSTIG Co-Chair – IPAC
IRSTIG Introduction: Community Engagement Efforts & Leadership Council Recruitment
9:00-9:05AM

Jon Arenberg on behalf of the SALTUS team – Northrop Grumman
SALTUS: The Single Aperture Large Telescope for Universe Studies
9:05-9:17AM

Single Aperture Large Telescope for Universe Studies (SALTUS) is a proposed NASA Probe class mission that will provide a powerful far-infrared (far-IR) pointed space observatory to explore our cosmic origins and the possibility of life elsewhere. During its 5-year baseline mission, SALTUS will perform groundbreaking studies towards 1000's of astrophysical targets, including the first galaxies, protoplanetary disks, and numerous solar system objects. More than 3.5 years of the SALTUS mission will be dedicated to its Guest Observer (GO) program. SALTUS employs a deployable 14-m aperture, with a sunshield that will radiatively cool the off-axis primary to <45K. It will host cryogenic coherent and incoherent detectors that span the wavelength range between 34 to 660 μm at both high and moderate spectral resolutions. This spectral range is unavailable to any existing ground or space observatory. SALTUS will have 16x the collecting area and 4x the angular resolution of Herschel and is designed for a lifetime ≥5 years. With its large aperture and powerful suite of instruments, SALTUS's observations will provide a giant leap forward in our capabilities to study the local and distant universe.

Matt Bradford on behalf of the PRIMA team – NASA JPL
PRIMA: The PRobe far-infrared Mission for Astrophysics
9:17-9:29AM

The PRobe far-Infrared Mission for Astrophysics (PRIMA) concept was proposed to NASA's Astrophysics Probe Explorer (APEX) call in late 2023. PRIMA is designed for a broad range of astrophysical topics. Our 3 PI themes are a) the roles of elemental abundances and water in planetary system formation, b) the co-evolution of star formation in supermassive black hole growth in galaxies, and c) the evolving properties of dust and metallicity over cosmic time. These PI programs will serve to calibrate the observatory and all their data will be in a public archive for general investigations (GI). The bulk of PRIMA's discoveries will come from general observers (GO), and 75% of the mission science time is reserved for GO programs. Many prototype cases have been developed and are described in the PRIMA GO book. The observatory features a 1.8 m telescope cooled to 4.5 K with two science instruments: the Far-InfraRed Enhanced Survey Spectrometer (FIRESS) and the PRIMA Imager (PRIMAger). FIRESS provides continuous spectral coverage from 24 to 235 µm in two spectral resolution modes ($R \geq 85$ and R up to 4,400 × (112 µm/ λ)) with more than 10x sensitivity improvement over previous far-IR observatories for pointed measurements, and much greater gains in mapping speed. PRIMAger delivers similar sensitivity advances with first-of- its-kind far-IR hyperspectral narrow-band imaging (R= 10) from 25 to 84µm, and polarimetry in four broadband filters from 80 to 261 µm. Detectors are the most challenging and important technical element in a far-IR observatory, and we can report that our development program has recently demonstrated PRIMA's required sensitivities in flight-like prototype arrays, both in our NASA labs (JPL, GSFC) and in Holland (SRON).

Asantha Cooray on behalf of the FIRSST team – UC Irvine
FIRSST: The Far-Infrared Spectroscopy Space Telescope
9:29-9:41AM

FIRSST is a far-infrared pointed observatory led at APL, in partnership with Ball Aerospace. FIRSST payload consists of a 1.8m telescope that is cryo-cooled to a temperature of 4.7K and two instruments that allow sensitive far-infrared spectroscopy between 35 and 600 microns, spectro-imaging surveys, spectral line polarization mapping, and rapid-response time domain observations with an instantaneous field of regard greater than 50% of the sky. The PI-led science program of FIRSST aims to fingerprint the planetary reservoirs to understand why super-Earths and mini-Neptunes are the most frequent planets, trace water to rocky planets to explain how water accumulates into oceans and unveil the drivers of galaxy growth to determine how the intergalactic medium influences star formation. 75% of the minimum five-year mission lifetime is available to the astronomical community through general observing time allocations. This talk will summarize science objectives, observatory capabilities, and technical design and development plans of FIRSST.

Justin Spilker – Texas A&M University
Charting the Rise of Small Dust Grains from Reionization to the Present with the SALTUS Probe Concept
9:41-9:48AM

As ALMA and early JWST results continue to show, dust played an important role in the growth of galaxies even back to the earliest times. Although dust grains constitute only a small fraction of the mass of galaxies, they have a large effect on the detectable properties of galaxies. Polycyclic aromatic hydrocarbons (PAHs) blur the line between small dust grains and large molecules, and are the only spectroscopic signatures of dust. While JWST has provided an intriguing first look at early-universe PAHs, its limited wavelength coverage means that the most constraining features will remain out of reach until a future far-IR space mission. I will outline the case for PAH studies in the early universe with a far-IR probe, focusing mostly on the SALTUS mission concept. SALTUS, with a 14m aperture and unmatched sensitivity, will resolve PAHs even in 'normal' IR-bright galaxies into the reionization epoch, z~10, with no spatial or spectral confusion. These observations will place novel constraints on the formation, growth, and destruction physics at work in the universe's first dust factories and chart the rise of the dusty universe from early times to the present.

Jay Chittidi – University of Colorado – Boulder
Tracing Planet Formation in the Hidden Far-Infrared
9:48-9:55AM

The past decade of Atacama Large Millimeter/submillimeter Array (ALMA) observations have revolutionized our understanding of the formation and evolution of planetary systems, but they are unable to answer pressing questions on the net material available to form planets, the speed at which these processes occur, and establish a clear water trail. The far infrared is home to a wealth of tracers of planet formation and evolution, including HD, water lines, and other spectral lines that can inform us about disk chemistry (ex. [OI] and [CII]) and photoevaporation (ex. [OI] and [NII]). Detecting and resolving both the 56µm and 112µm HD lines will enable the strongest constraints on the mass distribution of protoplanetary disks and establish the inventory of material available for planet formation. Water lines from prestellar cores and disks will allow us to track the inheritance of water during early planet formation, while spectral features from icy dust grains and sensitive measurements of cometary D/H ratios can survey the latter part of the water trail. I'll mention the above ideas briefly, which are some of the science goals for the FIR probes, and then ponder a few more niche GO program ideas. Removing the far infrared observational gap will allow for continuous coverage towards ALMA wavelengths for the first time since the end of the Herschel mission in 2013.

Erini Lambrides – NASA GSFC
Hunting for the Highest Redshift Obscured AGN
9:55-10:02AM

The growing number of $z > 6$ extremely powerful active galactic nuclei (AGN) newly identified by JWST has launched intense debate surrounding their triggering, growth, and host-galaxy evolution. Whether these sources can be used to understand the role most AGN play during Cosmic Dawn is contested, largely due to the fact that almost all of these newly identified sources are unobscured or only partially attenuated. According to theory, over 80% of $z > 6$ AGN are predicted to be heavily obscured by the dense, clumpy ISM of their host-galaxies. Thus, studies on powerful, dust-enshrouded AGN are paramount in order to understand both AGN and massive galaxy evolution at these epochs. Rest frame mid-infrared (5 -30 microns) spectroscopy is the gold standard in pinpointing the existence and constraining the power of these buried AGN while simultaneously constraining the star-formation properties of their host galaxy. Unfortunately, there is currently no one instrument in operation nor in history with the resolution, sensitivity, or wavelength range that is able to unambiguously uncover these sources at Cosmic Dawn. Thus new far-infrared telescopes are critical. In this talk, I present the urgent case for new FIR telescopes with sufficient resolution and sensitivities to uncover the observationally scarce but demographically plentiful population of heavily obscured AGN at the highest redshifts.

Jed McKinney – University of Texas Austin
Far-IR Line Follow-up to Measure Gas and Dust Conditions in Distant Galaxies
10:02-10:09AM

Far-infrared fine-structure lines like [C II] 157.7 um provide a window into cold gas conditions. But the most robust methods for measuring interstellar radiation field strengths, gas densities, and dust properties require a combination of emission line diagnostics from across the IR spectrum. Therefore, a far-IR probe will have natural synergies with observatories operating at shorter and longer wavelengths. I will discuss the merits of GO programs targeting far-IR lines in sources already detected in e.g., radio CO emission or mid-IR atomic and molecular lines. Such data sets will unveil the conditions from which stars form across cosmic time.

Kamber Schwarz – MPIA
Protoplanetary Disk Science with SALTUS
10:09-10:16AM

With its large collecting area and high spectral resolution, SALTUS is an ideal observatory for studying faint molecular lines. I will present an overview of the ways SALTUS's capabilities can be leveraged for disk science, including surveys of complex organic molecules in Class 0/I systems, nitrogen and sulfur bearing hydrides in Class II disks, searching for exo-Kuiper Belts, and measuring the C/O ratio in gaseous debris disks.

Will Fischer – Space Telescope Science Institute
Far-Infrared Luminosity Bursts Trace Mass Accretion onto Protostars
10:16-10:23AM

Evidence abounds that young stellar objects undergo luminous bursts of intense accretion that are short compared to the time it takes to form a star. It remains unclear how much these events contribute to the main-sequence masses of the stars. By modeling protostellar spectral energy distributions, we demonstrate the power of time-series far-infrared photometry to answer this question compared to similar observations at shorter and longer wavelengths.

Nima Chartab – Carnegie Observatories
Unraveling Cosmic Metallicity: The FIRSST View on Protoclusters at Cosmic Noon
10:23-10:30AM

Optical spectroscopic measurements show that ultraluminous infrared galaxies (ULIRGs), which are dusty and starbursting galaxies in the local Universe, have a lower metal content in their gas compared to star-forming galaxies with similar masses. This finding led to the hypothesis that ULIRGs are primarily fueled by metal-poor gas that falls into these galaxy merger systems. However, recent gas-phase metal abundance measurements using emission lines at far-infrared wavelengths that trace oxygen and nitrogen in local ULIRGs show that they are already chemically matured. This suggests that the underabundance of metals, previously derived from optical emission lines, is likely due to heavy dust obscuration. As infrared-bright galaxies that are obscured by dust dominate the star formation rate density of the Universe during the peak epoch of star formation, it is crucial to study the metal enrichment of cosmic noon galaxies with far-infrared emission lines, which provide unbiased measurements. Recent advances in intergalactic medium (IGM) tomography have uncovered a population of protoclusters at z~2.5, previously undetected by optical surveys. The unique capabilities of the Far-Infrared Spectroscopy Space Telescope (FIRSST) will enable unbiased studies of high-redshift protoclusters, shedding light on the mechanisms driving galaxy evolution, such as gas accretion, feedback, and mergers.