DECam at 10 years - Looking Back, Looking Future

Tucson, September 12-14, 2022

ABSTRACTS

MONDAY SEPTEMBER 12 - MORNING

DECam - Status and Future [09:00 - 09:15]

Alistair Walker, NOIRLab/Cerro Tololo Inter-American Observatory

We are celebrating 10 years of DECam science operations at this time, and expect to continue to operate the instrument well into the era of the Vera C. Rubin's Large Scale Survey of Space and Time. Here I introduce DECam, briefly discuss its status and evolution, and provide a few statistics - all in the hope of motivating discussions of how NOIRLab can best evolve DECam operations so it can continue as a leading science-machine for the community.

INVITED TALK: From High Energy to Dark Energy and the Creation of DECam [09:15 - 09:50]

Brenna Flaugher, Fermilab

The Dark Energy Camera was conceived and constructed as a joint NSF DOE-HEP project to study the nature of Dark Energy by measuring photometric redshifts of approximately 300 million galaxies over a 5000 square degree area in a total of 525 nights. Excellent image quality, high sensitivity in the near infrared and low readout noise were critical to the scientific goals. To meet the requirements, within tight budget constraints and with a limited amount of time for construction, we designed a camera with a three square degree field of view, a five lens optical corrector and a large focal plane with 74 fully-depleted, 250-micron thick charged-coupled devices (CCDs). This talk will describe how the Dark Energy Camera came into being and some thoughts for the future.

INVITED TALK: Cosmology from the Dark Energy Survey -- pushing boundaries, setting standards, and shaping the community [09:50 - 10:25]

Chihway Chang, University of Chicago / KICP

The Dark Energy Survey (DES) has been extremely productive in its various approaches in stress-testing our cosmological models. In that process, we learned a lot of new things about both the Universe and our ability to understand it. Complex, innovative and rigorous analyses in DES are setting the new landscape for modern cosmology from photometric galaxy surveys. I will first give a summary of the cosmology results from DES up to now, and then outline the plans for analyzing the final Year 6 DES data. I will also highlight how lessons we have learned in DES are now benefiting many of the future surveys such as the Rubin Observatory's Legacy Survey of Space and Time.

INVITED TALK: The Milky Way Science Revolution: Yesterday, Today, and Tomorrow [10:45 - 11:20]

Burçin Mutlu-Pakdil , Dartmouth College

Over the last decade, the Dark Energy Survey has played a critical role in resolved stellar population studies, revealing dwarf galaxies, globular clusters, and stellar streams with extremely low luminosity and revolutionizing our understanding of galaxy formation and dark matter. I will quickly review these exciting DES results, discuss complementary ongoing efforts, and conclude with a preview of what is possible in the next decade.

INVITED TALK: Solar System science with the Dark Energy Survey [11:20 - 11:55]

Pedro Bernardinelli, University of Washington

The sparse cadence and primarily off-ecliptic coverage of the Dark Energy Survey (DES) is unusual compared to most other surveys targeting small Solar System bodies. On the other hand, the 5000 deg^2 coverage of the survey along 6 years in the grizY bands means that the DES serendipitously potentially observed a wide variety of these Solar System objects in multiple bands and, for slow moving objects, in multiple observing seasons. I will present a challenging search for trans-Neptunian objects (TNOs) in the DES data. I will briefly overview the technical aspects of how, among 10^{10} single epoch detections, over 800 objects with observations in multiple years were recovered (over 700 of these being new discoveries), representing a significant portion of the currently known population of TNOs. I will describe the implications of these objects to models of the outer Solar System, including to the hypothesis that an unseen, distant planet clusters the orbits of some of the most distant TNOs. This search led to the discovery of C/2014 UN271 (Bernardinelli-Bernstein), the largest and most distant Oort Cloud comet to date. I will describe this fascinating object, and present a detailed characterization using data from DES. I will conclude by presenting ongoing work to obtain the colors and light curve amplitudes for all of the DES TNOs, and some initial inferences from this data.

Mapping the Growth of Supermassive Black Holes with DECam [11:55 - 12:15]

Zhefu Yu, The Ohio State University

Accurate mass measurements for supermassive black holes (SMBHs) are critical for understanding their growth over cosmic time. Outside of the local Universe, reverberation mapping (RM) of active galactic nuclei (AGN) is the most accurate method for measuring SMBH masses. RM measures the time lag between the continuum and broad emission line region (BLR) variability of AGN, which gives the virial mass when combined with the broad line width. DECam enables one of the leading RM campaigns, the Dark Energy Survey (DES) - Australian DES (OzDES) RM project which monitored 735 AGN for the whole duration of DES. I will present the high-quality Mg II lags and a new relationship between the Mg II BLR radius and the continuum luminosity (R-L relation) from the OzDES RM project. The Mg II R-L relation is extremely important because it is widely used to estimate the masses for large numbers of SMBHs from single-epoch spectra and study the SMBH demographics at cosmic noon – the peak of AGN activity. I will also present AGN accretion disk size measurements based on the DECam photometry, and simulations of the LSST survey strategy for improving the scientific yields of accretion disk studies in the Deep Drilling Fields.

The Merian Survey: Characterizing dark matter and feedback in 100,000 star-forming dwarf galaxies [12:15 - 12:35]

Yifei Luo, UC Santa Cruz

The Merian survey is an ongoing medium-band imaging survey that will use 62 nights on DECam to cover 800 deg^2 of the sky within the HSC SSP wide field, aiming to characterize dark matter halo and stellar feedback in bright dwarf galaxies. With two custom-made medium-band filters targeting at Hα and OIII emission lines at z~0.1, we expect to detect 100,000 star-forming dwarf galaxies. The Merian survey will allow us to measure the full dark matter profile of dwarf galaxies via weak gravitational lensing for the first time. I will discuss how to measure the dark matter halo properties of dwarf galaxies from observations and the predicted

lensing measurement. I will then present the filter design, survey description and the current status of the Merian survey. Finally, I will discuss several other science cases of the Merian survey such as searching for Lyman-alpha emitters at higher redshifts

MONDAY SEPTEMBER 12 - AFTERNOON

SMASHing the Magellanic Clouds with DECam [13:35 - 13:55]

Yumi Choi, UC Berkeley

The Large and Small Magellanic Clouds (LMC and SMC, respectively) are the closest interacting pair on their first infall to the Milky Way potential along with a satellite population. These aspects make them a valuable tool to understand the evolution of dwarf galaxy pairs, the mass assembly of our Milky Way, and their impact on the Milky Way halo. The first step to acquire that knowledge is to better characterize various properties of the LMC and SMC themselves. The wide field-of-view and high fidelity of DECam allowed us to closely study both the main bodies and peripheries of the LMC and SMC using resolved stellar populations imaged in ugriz. In this talk, I will share what we particularly learned about the LMC from the Survey of MAgellanic Stellar History (SMASH). SMASH mapped the Magellanic Clouds to depths of ~24th mag in ugriz and reported measurements for ~360M objects across 197 fields.

The synchronised star formation history of the Magellanic Clouds [13:55 - 14:15]

Pol Massana, Montana State University

According to the current cosmological paradigm, galaxy interactions influence the subsequent evolution of galaxies. Galaxy interactions impact the mass assembly, star formation history, and structural evolution of galaxies. The Magellanic Clouds (MCs) are the closest interacting pair of galaxies to us (~50-60 kpc), evidenced by morphological features such as the Magellanic Bridge and the Magellanic Stream, and thus represent the best laboratory at hand to study galaxy interactions. We present results of the SMASH DECam survey where we quantitatively derive the star formation history (SFH) of the Small Magellanic Cloud (SMC) using CMD fitting techniques. We identify five distinctive peaks of star formation in the last 3.5 Gyr, at ~3, ~2, ~1.1, ~0.45 Gyr ago, and one presently. We compare these to the SFH of the Large Magellanic Cloud (LMC) finding unequivocal synchronicity, with both galaxies displaying similar periods of enhanced star formation over the past ~3.5 Gyr. Thanks to the unprecedented deep DECam photometry, reaching well below the main sequence turn-off for both galaxies, we are able to show for the first time a clear relation between their SFHs. This parallelism indicates that tidal interactions between the MCs have recurrently played an important role in their evolution for at least the last ~3.5 Gyr, tidally truncating the SMC and shaping the LMC's spiral arm. The SMC-LMC correlated SFH at recent times show enhancements of star formation are localized in the northern spiral arm of the LMC, and globally across the SMC. These novel findings should be used to constrain not only the orbital history of the MCs but also how star formation should be treated in simulations. Additionally, we will also update on ongoing and future MCs science using both SMASH as well as oher DECam surveys.

The DECam Local Volume Exploration Survey (DELVE) [14:15 - 14:35]

Alex Drlica-Wagner, Fermilab/University of Chicago

The DECam Local Volume Exploration survey (DELVE) is a 126-night survey program on the 4-m Blanco Telescope at the Cerro Tololo Inter-American Observatory in Chile. DELVE seeks to understand the characteristics of faint satellite galaxies and other resolved stellar substructures over a range of environments in the Local Volume. DELVE combines new DECam observations with archival DECam data to cover >17,000 deg^2 of the high-Galactic-latitude (|b| > 10 deg) southern sky to a 5σ depth of g,r,i,z ~ 23.5 mag. In addition, DELVE covers a region of ~2,200 deg^2 around the Magellanic Clouds to a depth of g,r,i ~ 24.5 mag and an area of ~135 deg^2 around four Magellanic analogs to a depth of g,i ~ 25.5 mag. I will present an overview of the DELVE science program, an update on the survey progress, and a summary of the DELVE public data releases, which are available via the NOIRLab Astro Data Lab science platform.

Gas-rich ultra-diffuse galaxies in the field [14:35 - 14:55]

Michael Jones, Steward Observatory

HI-bearing ultra-diffuse galaxies (UDGs) are a peculiar class of low surface brightness (LSB) dwarf galaxies that unlike most other UDGs, which are typically found in clusters and groups, are bona fide field objects, not satellites of another, larger galaxy. These objects were originally identified via their HI line emission in the ALFALFA survey and their near invisible stellar counterparts in SDSS. Now with updated photometry from DECaLS, we find that these objects span the range of UDG definitions, with some meeting the strictest criteria, while others are more akin to classical LSB galaxies. This re-enforces the suggestion that UDGs (at least this sub-population) are the extreme of a continuum of LSB galaxies, rather than an entirely distinct population. Recent HST observations of these objects have also revealed that they host few globular clusters (GCs), in marked contrast to the GC-rich UDGs in clusters. This provides strong evidence that there must be at least two pathways to form UDGs, as field UDGs cannot be the progenitors of those in clusters.

Exploiting large astronomical data archives for space debris research [14:55 - 15:15]

Stephan Hellmich, École polytechnique fédérale de Lausanne (EPFL)

Currently, there are about 8400 satellites in orbit around the Earth. They are accompanied by hundreds of used rocket stages, launch adapters and other mission-related objects. Collisions between these objects and breakup events have resulted in an estimated total of more than 1 million debris particles larger than 1 cm, and the trend is increasing. The growing amount of space debris not only endangers active missions, but is also a growing concern for astronomers as the traces of space debris on astronomical data become more and more apparent.

Large astronomical archives like the data taken with ESO-VST or the CITO-DECam data contain valuable information about space debris. We are currently developing novel methods to efficiently extract observations of satellites, orbital debris and solar system objects from large astronomical archives to obtain a better picture of the evolution and current state of the debris population. Photometric reduction of the observed objects will allow us to determine the rotational and physical properties of the observed objects. This information is of great value for planning active space debris removal missions, establishing guidelines for satellite manufacturers to reduce impacts on astronomical observations, and achieving more sustainable use of space in general.

We will present preliminary results from our processing pipeline, give an estimate of the amount of data we expect to find in the ESO VST archive, and explain how our work can be extended to the DECam data archive.

The Power of High Precision Photometry on Near Field Cosmology with DECam [15:35 - 15:55]

Ting Li, University of Toronto

DECam has been a powerful tool surveying the sky in the past decade. It has delivered tons of discoveries in our Milky Way; furthermore, DECam has largely improved the target selection efficiency for spectroscopic follow-up observations thanks to the high precision photometry DECam brings. In this talk, I will show some examples on how the photometric data from DECam can be used to select rare tracers, including metal-poor stars as well as blue horizontal stars. These stars are very important for substructure search (e.g. dwarf galaxies and stellar streams) as well as target selection for follow-up observations. The high precision photometric data from DECam, especially from DES, shows the strong promise of next generation photometric survey LSST from the Rubin Observatory on resolved stellar population studies and discoveries.

RR Lyrae stars in ultra-faint dwarf galaxies in the era of the large surveys [15:55 - 16:15]

Clara Martinez-Vazquez, NOIRLab / Gemini Observatory

Since the discovery of the first RR Lyrae (RRL) star by Wilhelmina Fleming at the beginning of the last century and thanks to their well-know period-luminosity relation (Henrietta Leavitt Law), the popularity of this kind of stellar pulsators has increased exponentially, specially over the past decades. The enormous detection of RRLs in surveys like ASAS, Catalina, DES, Gaia, OGLE, PanSTARRS, ZTF (and the future LSST), and the fact that RRLs are stellar tracers of old stellar populations makes them powerful archaeological tools. They have been used to detect/confirm new ultra-faint dwarf galaxies (UFDs). In particular, from our catalog of ~7000 RRLs detected in DES (Stringer et al. 2021), we found that an RRL-based search is more sensitive than those using resolved stellar populations in the regime of large (r > 500 pc), low-surface-brightness dwarf galaxies. Our team has concentrated in the past years on increasing the census of RRLs in UFDs. We detected RRL members for the first time in several UFDs from time-domain studies made with Blanco/DECam + SOAR/Goodman (Martínez-Vázquez et al. 2019, 2021b,c) and using the Gaia DR2 RRL catalog (Vivas, Martínez-Vázquez & Walker, 2021). We also identified possible candidate extra-tidal RRLs in some of the UFDs.

Furthermore, we made a comprehensive and updated analysis of the number of RRLs in dwarf galaxies. This allows us to predict that the method of finding new UFDs by using two or more clumped RRLs will work only for systems brighter than M_V ~ -5 mag. Finally, our works not only offer independent and accurate distances to the host but also provide clues about the contribution of UFDs in the formation of the halo of the Milky Way to ascertain how much of the long-period tail of field halo RRL stars can be attributed to disrupted UFDs.

Variable Stars as tracers of the stellar population of diffuse satellite galaxies of the Milky Way [16:15 - 16:35]

Kathy Vivas, NOIRLab / Cerro Tololo Inter-American Observatory

Variable stars have a long tradition of being tracers of different stellar populations. In particular, RR Lyrae stars, which unequivocally trace an old population (>10 Gyr), have been found in almost all of the satellites of the Milky Way, even in ultra-faint dwarf galaxies. RR Lyrae stars are useful not only to obtain a distance to the stellar systems, but also to trace the structure of the galaxies. They have proven particularly useful for studying Crater II and Antlia II, two of the largest satellites around the Milky Way, which were just recently discovered because they have a very low surface brightness. In these galaxies the contamination by foreground stars and faint background galaxies is a major challenge. To overcome this problem, we have used the Dark Energy Camera (DECam) at the 4m Victor Blanco Telescope at CTIO to obtain multi-epoch, multi-band data of these large galaxies. We identified a large population of RR Lyrae stars in both systems which have allowed us to study the structure, shape, distance, metallicity dispersion and population gradients, among others.

Discovering Distant RR Lyrae Stars in the Milky Way Halo with Sparsely Sampled Photometry Data [16:35 - 16:55]

Yuting Feng, University of California, Santa Cruz

RR Lyrae stars are powerful tracers of Galactic structure, substructure, accretion history, and dark matter content. The characteristic photometric variability of RR Lyrae stars makes it relatively easy to distinguish them from other objects, and they are excellent standard candles. Here we report the discovery of 208 distant RR Lyrae stars, including some of the most distant stars known in the Milky Way halo, with Galactocentric distances larger than 300 kpc. The data used in this study is taken in the u∗, g′, i′, z′ bands with the Canada-France-Hawaii Telescope as part of the Next Generation Virgo Cluster Survey (NGVS). Compared to two recent RR Lyrae surveys using DECam, the High cadence Transient Survey (HiTS), and the Dark Energy Survey (DES), our NGVS study has smaller sky coverage, comparable cadence, similar lightcurve template fitting algorithm, and better single-epoch photometric precision, and our RR Lyrae sample is the most complete and robust at large distances, with the best measured pulsation parameters. We also compare the halo stellar distribution estimated by these three RR Lyrae samples, in which our result shows an $r^{-3.9}$ power-law radial density profile over most of this 20-320 kpc distance range with no signs of a break. These newly discovered distant stars show the feasibility of identifying RR Lyrae using sparsely and limitedly sampled photometry data, and are an important addition to the few secure tracers beyond 200 kpc in the Milky Way halo.

A wide view of different stellar sub-populations in NGC2808 [16:55 - 17:15]

Annalisa Calamida, Space Telescope Science Institute

Wide-field and deep DECam multi-band photometry, combined with HST data for the core of the Galactic globular cluster NGC2808, allowed us to study the distribution of different stellar sub-populations throughout the extension of the cluster. We used the Cugi index to identify three chemically distinct sub-populations along the red-giant branch and compared their spatial distribution: the most enriched population, P3, shows a more extended distribution compared to the primordial population, P1. Furthermore, the P3 sub-population center is shifted compared to P1 and shows a lower eccentricity. We also analyzed the spatial distribution of red and blue horizontal branch stars and found that their relative fraction does not vary from the center until the tidal radius. Also, a deficiency of red-giant branch stars is present towards the outskirt of the cluster. A similar distribution of stellar sub-populations was also found for Omega Centauri, based on combined DECam and HST data. Here we provide a comparison of the properties of the two most massive Galactic globular clusters in the context of their origin.

TUESDAY SEPTEMBER 13 - MORNING

INVITED TALK: DECaLS DR10: Updating the Dark Energy Camera Legacy Survey [09:00 - 09:35]

Aaron Meisner, NOIRLab

The Dark Energy Camera Legacy Survey (DECaLS) is a public survey covering ~16,000 square degrees of the extragalactic sky, incorporating both archival griz DECam imaging and 203 nights of its own DECam grz observations. DECaLS employed an innovative observing strategy with dynamic exposure times and automated field selection to maximize survey uniformity. Raw images are reduced with the NOIRLab Community Pipeline and inference-based catalogs simultaneously measuring optical griz and infrared WISE fluxes are generated using The Tractor. By combining DECam imaging with space-based datasets — WISE and Gaia — DECaLS has enabled a broad array of science, ranging from the solar neighborhood to record-setting quasars. Via DECaLS, DECam has played a fundamental role in the successful target selection for DESI, now in operation at Kitt Peak National Observatory's Mayall 4-meter telescope. DECaLS is currently preparing its tenth data release (DR10), which fills in much of the remaining southern extragalactic sky with DeROSITAS images.

INVITED TALK: The Siena Galaxy Atlas: Large Angular Size Galaxies from the DESI Imaging Legacy Surveys [09:35 - 10:10]

Stephanie Juneau, NOIRLab

The Siena Galaxy Atlas 2020 (SGA-2020) is a multiwavelength atlas of 383,620 nearby galaxies constructed from new deep, wide-area imaging from the DESI Legacy Imaging Surveys (20,000 square degrees in grz to r<23.4 AB) and all-sky infrared imaging at 3.4-22 microns from WISE. The atlas delivers precise coordinates, multiwavelength mosaics, azimuthally averaged surface brightness profiles, integrated and aperture photometry, and additional information for the full sample. The SGA-2020 will yield new insights into the history of galaxy formation through detailed studies of the internal structure, global physical properties, environments, and faint, low surface-brightness features of galaxies, and will support current and future cosmological surveys like DESI by enabling precise masking of large angular diameter foreground galaxies. We describe the input imaging data (from Blanco/DECam, Mayall/Mosaic-3, and Bok/90PRIME), the selection of the sample primarily by apparent diameter, the construction of the atlas, and the release of the SGA-2020 as a supplement to the ninth public data release (DR9) of the DESI Legacy Imaging Surveys through legacysurvey.org

Edge-on galaxies in the DESI Legacy Imaging Surveys [10:10 - 10:30]

Aleksandr Mosenkov, Brigham Young University

Edge-on galaxies are suitable targets for not only studying their 3D structure but also for detecting and exploring low surface brightness features around them. Using the DESI Legacy Imaging Surveys, we present a classification of various structures which start to appear in deep optical images, such as tidal low surface brightness features (tails, streams, loops, shells, etc.), faint polar and tilted structures (polar rings, polar bulges, polar halos, disk warps, possible AGN jets, etc.), and off-plane faint spiral arms. For a sample of more than 12,000 edge-on galaxies, we present the statistics of the identified structures and describe their general properties.

INVITED TALK: Synergies between DECam/DES and DESI [10:50 - 11:25]

Paul Martini, The Ohio State University

The Dark Energy Camera produced a revolution in wide field imaging that has impacted science topics that range from the solar system to the high-redshift universe. In this talk I will describe how DECam also enabled an enormous leap forward in astronomical instrumentation, and specifically how DECam influenced the development of the Dark Energy Spectroscopic Instrument. These influences include the prime focus corrector and support system, active optics system, instrument control software, and commissioning planning. I will describe the instrumentation heritage of DECam within DESI, give a report on the current status of the DESI instrumentation and survey, and share some thoughts on the synergies between these projects as a model for future instrument development.

Dynamic Observing for Uniform Surveys [11:25 - 11:45]

David Schlegel, Lawrence Berkeley Lab

Both the DECaLS imaging survey and the DESI spectroscopic survey have employed dynamic observing to create uniform surveys. The exposure times are adjusted in response to observing conditions. For DESI spectroscopy, where this is done in real time, the resulting spectra are demonstrated to be near-uniform S/N for the faintest targets. For DECaLS imaging using DECam, dynamic observing using "Copilot" with a lag of 2 exposures led to adequately uniform depths. In the future, Copilot could be further integrated with the DECam control system to achieve a higher level of survey uniformity.

The DECam Ecliptic Exploration Project (DEEP) [11:45 - 12:05]

David Trilling, Northern Arizona University

We are now in year 4 of the DECam Ecliptic Exploration Project (DEEP), an NOAO/NOIRLab survey program to carry out a deep search of the faint outer Solar System with the Dark Energy Camera (DECam). Through the digital tracking technique we reach a depth of VR~26.7 over some 100 square degrees, resulting in the detection of thousands of trans-Neptunian objects down to sizes of tens of kilometers. In this talk I will present (i) an overview of the science goals of DEEP; (ii) a brief summary of our technical approaches to searching for faint trans-Neptunian objects; and (iii) a summary of some of our results to date. This work is supported by grants from NASA and NSF.

Constraints on the Shape Distribution of TNOs with DEEP [12:05 - 12:25]

Ryder Strauss, Northern Arizona University

The region of the Solar System beyond Neptune hosts the most primordial populations of Solar System objects. Understanding the physical and dynamical properties of these populations can provide insight into the properties of the early Solar System and its evolution. The DECam Ecliptic Exploration Project (DEEP) is a large-scale survey of the outer solar system, covering >120 square degrees to a single-exposure depth of R~24, and a digitally stacked depth of R~26.5. Here, we present the methods and results from the object identification and partial lightcurve extraction within our single-exposure images, and discuss the constraints that these lightcurves provide on the overall shape distribution of the TNO population.

A wide-scale search for solar system objects with DECam in the NOIRLab Source Catalog [12:25 - 12:45]

Katie Fasbender, Montana State University

New solar system object (SSO) discoveries, both distant and nearby, are becoming more common with advancements in technology and detection methods. Individual surveys and projects made possible by DECam have vastly expanded our knowledge of SSOs, and there remains potential to identify missed objects or recover previously unassociated measurements of known SSOs within used survey data. The NOIRLab Source Catalog (NSC) combines all publicly available exposures from NOIRLab's Astro Data Archive into one uniform dataset with over 68 billion measurements, DECam providing over 80 percent of the images in each data release. NSC DR3, currently undergoing construction, will contain nearly half a million exposures taken by DECam. From nearly a decade of observation, NSC DR2 sources have a median depth of 22 mag and cover 300,000 square degrees of the sky, making this catalog well-suited for solar system object detection. We report 600,000 moving objects from the second NSC data release, with a median apparent magnitude of 21.9 mag and a mean proper motion of 32''/hr. Objects are identified from measurements in all seven of the NSC's photometric bands (ugrizY and VR). Ephemerides are being iteratively formed from initial measurement linkages, and will be updated as new measurements are added to the NSC. As the scientific community continues to use DECam, the NSC will continue to improve and remain a useful catalog of ground-based public data in the optical and infrared wavelengths.

TUESDAY SEPTEMBER 13 - AFTERNOON

The Dark Energy Camera Plane Survey 2 (DECaPS2): More Sky, Less Bias, and Better Uncertainties [13:35 - 13:55]

Andrew Saydjari, Harvard

Deep optical and near-infrared imaging of the entire Galactic plane is essential for understanding our Galaxy's stars, gas, and dust. The second data release of the DECam Plane Survey (DECaPS2) extends the five-band optical and near-infrared survey of the southern Galactic plane to cover 6.5% of the sky, |b| < 10° and 6° > l > -124°, complementary to coverage by Pan-STARRS1. Typical single-exposure effective depths, including crowding effects and other complications, are 23.5, 22.6, 22.1, 21.6, and 20.8 mag in *g*, *r*, *i*, *z*, and *Y* bands, respectively, with around 1 arcsecond seeing. The survey comprises 3.32 billion objects built from 34 billion detections in 21.4 thousand exposures, totaling 260 hours open shutter time on the Dark Energy Camera (DECam) at Cerro Tololo. The data reduction pipeline features several improvements, including the addition of synthetic source injection tests to validate photometric solutions across the entire survey footprint. A convenient functional form for the detection bias in the faint limit was derived and leveraged to characterize the photometric pipeline performance. A new post-processing technique was applied to every detection to de-bias and improve uncertainty estimates of the flux in the presence of structured backgrounds, specifically targeting nebulosity. The images and source catalogs are publicly available at http://decaps.skymaps.info/.

The Blanco DECam Bulge Survey [13:55 - 14:15]

Michael Rich, University of California Los Angeles

The Blanco DECam Bulge Survey has imaged 200 square degrees of the Southern Galactic bulge from -10 < l -+10 to -10 <b <-3. The 50 TB of data have been reduced and flux calibrated to produce a contiguous photometric dataset of roughly 500 million distinct measurements, using DAOPHOT. We have observed ugrizY data, all of the DECam bands. We have dereddened our data using a fine grid reddening map from the VVV survey.

Using DECam and Gaia to Identify Globular Clusters in the Local Universe: Substructure and Mass of Centaurus A [14:15 - 14:35]

David Sand, University of Arizona

Globular clusters are important tracers of the chemical, dynamical and star formation history of galaxy halos. Due to their high luminosities and compact sizes, they can be identified and spectroscopically studied throughout the Local Universe. Here we describe a new technique that combines multi-band DECam imaging with Gaia astrometric and photometric parameters to confidently identify globular cluster candidates around nearby galaxy halos. As a showcase, we highlight our results around Centaurus A, the nearest accessible elliptical galaxy. Using DECam+Gaia, and wide-field spectrographs, we have identified 122 new globular clusters around Centaurus A out to ~150 kpc, and have correlated these new star clusters with known stellar substructures (dwarf galaxies, stellar streams). We have also measured a new mass of the Centaurus A halo. We close by looking ahead at the role that DECam can play in understanding the globular cluster population and stellar halos of galaxies in the nearby universe.

Measuring Hot Jupiter Occurrence Rates in High-Alpha Stellar Populations with DECam [14:35 - 14:55]

Alison Crisp, Louisiana State University

Though the giant planet formation rate is known to be strongly correlated with metallicity, the specific elements that cause the correlation are yet unknown. Some low-metallicity stellar populations such as the Galactic thick disk appear to have higher occurrence rates of giant planets than are expected from their metallicities alone. One possible reason for this relative enhancement in occurrence rate is that the abundance of alpha elements, [α/H] = [α/Fe] + [Fe/H], is higher for low-metallicity thick disk stars than for thin disk stars at the same metallicity. We are performing the Multi-band Imaging Survey for High-Alpha PlanetS (MISHAPS) to probe this potential solution. MISHAPS uses DECam to survey both the high-metallicity, high-alpha Galactic bulge, and the low-metallicity, high-alpha globular clusters 47 Tuc and Omega Cen to detect hot Jupiters and characterize their host stars. The end goal of the survey is to estimate the hot Jupiter occurrence rates for these regions and compare them to planet occurrence rates measured in the local thin disk. Here, we present an overview of MISHAPS surveys and preliminary analysis of some early hot Jupiter candidates.

Searching for Chemically Pristine Stars with Narrowband Photometry [14:55 - 15:15]

Vinicius Placco, NOIRLab

The lowest metallicity stars in the Milky Way Halo are the fossil records of the earliest star- forming environments in the Universe. Chemo-dynamical studies of such rare objects can address a myriad of open questions, ranging from primordial nucleosynthesis and the mass function of the first stars to the nature of the astrophysical r-process and the early merger history of the Milky Way. The detailed abundance patterns of these stellar relics, which can only be obtained from high-resolution spectroscopy, help us build a clear understanding of the pathways that led to the chemical complexity we observe today. In this talk, I will present the discovery of an ultra metal-poor (UMP) star in the halo of the Galaxy with one of the most pristine chemical compositions ever found in a star. SPLUS J2104-0049 is only the 35th UMP star identified in the Milky Way, with the lowest carbon abundance within this group. It was first identified from the S-PLUS narrow-band photometric information, then followed up as part of an observational campaign with

Gemini South and Blanco. After having its unique chemistry confirmed, a high-resolution spectroscopic follow-up of SPLUS J2104-0049 with Magellan/MIKE allowed for the determination of the chemical abundances for 18 elements. Comparison with the yields of zero-metallicity supernovae models suggests that this is a bona fide second-generation star, formed from a gas cloud polluted by a single metal-free ~30Mo supernova at early times in the history of the Universe.

The DECam Magellanic Cloud Emission-Line Surveys [15:15 - 15:35]

Sean Points, NOIRLab

Supernovae and their remnants are one of the main forces driving the evolution of the interstellar medium in galaxies. Optical identification of supernova remnants (SNRs) has been primarily through the [SII]/H-alpha ratio, to distinguish shock-heated material like SNRs from photo-ionized regions. The Large Magellanic Cloud (LMC) provides an ideal location to investigate the physical properties of a global SNR sample and its impact on the host galaxy, because of its nearby distance and low foreground extinction. An H-alpha (N662) survey of a 54 sq deg region of the LMC was performed using the Dark Energy Camera (DECam) on the Blanco 4m telescope in 2019B, providing exquisite deep and high spatial resolution data. We have performed a deep DECam [SII] survey of the LMC using the N673 filter that covers the same area as the 2019 H-alpha (N662) survey.

These combined surveys are approximately 10 times deeper and have several times higher spatial resolution than the much-used Magellanic Cloud Emission Line Survey (MCELS) of the LMC, providing detailed morphological information not only on known SNRs, but also on superbubbles and the many extended emission structures throughout the LMC. We are using these data to search for large faint shells that may be the oldest SNRs in the process of melding back into the ISM. To maximize the legacy value of these surveys, we are creating flux-calibrated, continuum-subtracted mosaics and will make them available to the community as a high-level data product

WEDNESDAY SEPTEMBER 14 - MORNING

INVITED TALK: Lyman Alpha Galaxies in the Epoch of Reionization (LAGER) [09:00 - 09:35]

Sangeeta Malhotra, Goddard Space Flight Center, NASA

The LAGER survey (Lyman Alpha Galaxies in the Epoch of Reionization) uses the wide field of view and red sensitivity of DECam to perform the most sensitive and extensive survey for Lyman-alpha emitters at z=7 yet. For this survey we designed a custom narrow-band filter to exploit the low noise window in the night sky spectrum at 9640 angstrom.

Some highlights of the survey:

(1) We have found ~300 z~7 galaxies with strong Lyman-alpha emission.

(2) The spectroscopic success rate is ~80%.

(3) There is an excess of LyA galaxies with L > 3L*, compared to the Schechter function.

(4) We find rich protoclusters traced by LyA galaxies.

(5) There is no evidence for significant attenuation of LyA from neutral IGM.

We will summarize these results and ongoing work in LAGER, and also preview plans for the follow-on z=7.3 survey CIDER (Charting Ionization During the Epoch of Reionization).

INVITED TALK: Blobs, Galaxies, and Protoclusters Found with Lyman Alpha: Early Science from ODIN [09:35 - 10:10]

Eric Gawiser, Rutgers University

We present a new NOIRLab Survey called ODIN (One-hundred-deg^2 DECam Imaging in Narrowbands). ODIN built narrow-band filters centered at 419, 501, and 673 nm and uses them to select Lyman Alpha emission at z=2.4, 3.1, and 4.5 in seven wide-area fields on the sky, including the HSC Deep Fields and all 5 LSST Deep Drilling Fields. The completed survey will open a unique window by discovering over 100,000 Lyman Alpha Emitting (LAE) galaxies at these epochs, offering a factor of 20 increase in statistics versus existing surveys. LAE overdensities identify protoclusters, which represent the most massive cosmic structures at these epochs, and we will study their evolution across cosmic time. Initial results will be presented in the COSMOS and Deep2-3 fields, including a first measurement of the cross-correlation function between LAEs and Lyman Alpha Blobs and the association between protoclusters and blobs.

INVITED TALK: TBA [10:10 - 10:45]

Jim Annis, Fermilab

TBA

Searching for Kilonovae: Using DECam and the DESGW Data Pipeline in Pursuit of Optical Counterparts to Gravitational Wave Events [11:00 - 11:20]

Nora Sherman, University of Michigan

The direct detection of gravitational waves (GW) from the mergers of dead star remnants – including neutron stars and black holes – has helped revolutionize the field of multi-messenger astronomy. It has opened new doors for resolving the Hubble Tension and permitted the observation and detailed study of such events as the binary neutron star merger GW170817, for which the follow-up in the gamma ray, radio, x-ray, and optical regimes led to the first, and currently only, discovery of a kilonova (AT 2017gfo) associated with a GW event. The Dark Energy Survey Gravitational Wave group (DESGW) contributed significantly to the optical detection of this event, using the Dark Energy Camera to capture detailed images of the transient within a matter of hours following the GW trigger. To plan our observations and make such discoveries, DESGW relies on a robust search and analysis pipeline that processes the DECam images to render them science-ready, performs difference imaging to reveal novel optical variations, and produces, then reduces and refines, a list of candidate electromagnetic counterparts to the event. In this talk, I will detail the function of this search and discovery pipeline, discuss previous and ongoing DESGW searches utilizing it, and delve into recent improvements and work on that pipeline in preparation for the next GW observing run by the LIGO/Virgo/KAGRA collaboration.

Low Redshift Clusters from SV to 2022B and Beyond [11:20 - 11:40]

Ian Dell'Antonio, Brown University

I'll summarize the results of targeted observations of low (z<0.15) galaxy clusters (primarily for weak lensing) over the past decade, highlighting advances in both image reduction techniques and lensing analyses. I'll then talk about the prospects for studies of these clusters with DECam in the Rubin Observatory/LSST era

Weighing the fgas giants with DECam Data [11:40 - 12:00]

Lucie Baumont, CEA Paris-Saclay

Huge volumes collapsed to form galaxy clusters, such that their matter content represents that of the Universe on cosmological scales. Consequently, the ratio of baryonic matter to total matter in a massive cluster, fgas, can be considered representative of the matter content of the Universe as a whole. X-ray measurements of the cluster baryonic mass fraction from the most massive, dynamically relaxed galaxy clusters place powerful constraints on both the dark energy equation of state parameter and cosmological matter density. However, the dominant systematic uncertainty in the matter density stems from uncertainties in X-ray cluster mass estimates that can be calibrated using weak lensing mass estimates.

We have expanded the well-tested THELI data analysis pipeline to process DECam data from pixels to cluster lensing masses. Besides including DECam specific corrections for crosstalk, non-linearity, and the brighter-fatter effect, we update weak-lensing analysis methodology, notably including state-of-the-art shear calibration and Bayesian mass inference methods. Besides improvements from updated lensing methodology, this additional six-filter DECam cluster data doubles the statistical power of current fgas measurements.

Strong Gravitational Lenses from DECam [12:00 - 12:20]

Suchitoto Rose Tabares-Tarquinio, Lawrence Berkeley National Lab

We have discovered 3000 strong lens candidates in the DESI Legacy Imaging Surveys (Huang et al. 2020, 2021; Storfer et al. 2022). The majority of these candidates have been discovered in the 14,000 deg^2 of the DECam data within the Legacy Imaging Survey Data Release 9. Follow-up Hubble Space Telescope snapshot program has confirmed 51 of 51 candidates. In addition, a DESI secondary target program has obtained spectra for hundreds of candidate lensing systems. Preliminary redshift results have confirmed well over 100 candidates found in the DECam data. For these systems, we will measure velocity dispersion for the lensing galaxies and infer their dynamical mass. This will be combined with our lens modeling effort to determine the dark and luminous matter mass profiles of the lenses, using both HST and DECam observations.

DECam + Roman in the age of Rubin: Enhancing Roman's Microlensing Planet Haul [12:20 - 12:40]

Matthew Penny, Louisiana State University

The Nancy Grace Roman Space Telescope will spend over a year in total staring at ~3 deg^2 of the Galactic bulge in order to discover over ~1000 cold exoplanets and hundreds of free-floating planets with microlensing and complete the census of exoplanets begun by Kepler. Roman itself will only be able to make an order of magnitude estimate of the masses of its free-floating planets, but

simultaneous high-cadence observations from Earth can be used to measure the microlens parallax and with that precise free-floating planet masses. Only 4m+ telescopes with wide-field imagers can accomplish the task, and would need to provide dedicated access for several hours a night for 2+ months at a time. While Rubin's mirror and instruments meet the requirements for such observations, they would be extremely disruptive to its regular survey operations. I will discuss how DECam's current operations modes and capabilities are perfectly suited to support Roman's exoplanet survey, both for measuring free-floating planet masses and for addressing other limitations of Roman exoplanet survey.

WEDNESDAY SEPTEMBER 14 - AFTERNOON

The power of DECam, its archive, and novel algorithms: discovering tens of thousands of "undiscoverable" asteroids in the DECam data [13:40 - 14:00]

Mario Juric, University of Washington

We present the first results, enabled by DECam and its archive, from a new algorithm enabling the discovery of solar system objects in nearly any astrophysics-oriented wide-field datasets.

Present-day asteroid discovery strategies rely on the telescope taking multiple images of the same area of the sky each night. These images allow the object to be detected as moving, estimate its rate of motion, and link it to similar repeated observations in subsequent nights. Unfortunately, this requirement for intra-night re-observations made it impossible to use datasets not observed with such cadence for asteroid discovery – including the majority of nearly a decade of DECam imaging.

Our THOR algorithm (Moeyens et al. 2021) deployed on the B612 ADAM/Google Cloud (https://adam.b612.ai; Kiker et al. 2022) removes this constraint. It enables us find asteroids in any dataset as long as there are enough observations to uniquely determine an asteroid's orbit (about 5 in a 30-day window). It does this by efficient sampling and searching of the orbital parameter space, leveraging the computational power and scalability of modern computing platforms.

DECam, and especially the NOIRLab Source Catalog (NSC; Nidever et al. 2020) presented an ideal dataset to search with these new systems due to uniform reductions, a well-organized archive, image access APIs, and public availability. The initial processing of <0.5% of NSC returned thousands of new candidates, 104 of which have so far been submitted and accepted by the MPC. We extrapolate that by the end of the processing we will have discovered between 20 and 60 thousands of new asteroids in the NSC. This illustrates the value of wide-field cameras, but also of well-maintained archives and catalogs in enabling unforeseen applications years after the observations were taken.

INVITED TALK: DECam's Contributions to Rubin/LSST Now and in the Future [14:00 - 14:35]

Jeff Carlin, Rubin Observatory

The Vera C. Rubin Observatory is scheduled to begin its Legacy Survey of Space and Time (LSST) in mid-2024, embarking on a 10-year survey during which ~18,000 square degrees of sky will be imaged over 800 times total in the ugrizy filters. The resulting dataset will open a vast discovery space for studies of transient and variable phenomena, cataloging the Solar System, dark energy and dark matter, and the structure of the Milky Way. LSST builds on the legacy of DECam's various surveys, which include pilot studies to develop tools for processing and distributing LSST-like data products, development of advanced "self-calibration" methods that can be adapted for LSST use, observational datasets that are used regularly for testing and developing LSST pipelines, and discoveries that glimpse the phenomena that drove Rubin Observatory and LSST's design. During LSST operations, DECam will remain one of the largest field-of-view cameras available for follow-up of transient phenomena such as gravitational wave sources, and carry narrow-band filters that compliment the broad-band capabilities of Rubin, making it a vital part of the full suite of expected follow-up facilities for Rubin discoveries.

AEON on SOAR and Blanco: status and future perspectives [14:35 - 15:10]

César Briceño, NOIRLab / CTIO-SOAR

The Astronomical Event Observatory Network (AEON) is a facility ecosystem for accessible and efficient follow up of astronomical transients and Time Domain science. AEON was created as a tool to expand and maximize science from the LSST. The SOAR 4.1m telescope has been the pathfinder AEON facility among the MSO 4m telescopes. We are now starting work to add the Blanco 4m telescope to AEON. With DECam, and soon NEWFIRM, Blanco will bring important synergy with the LSST, providing wide field optical imaging in other filters, higher cadence on selected fields, and deep near-IR mapping of large areas.

In this talk I will provide an overview of AEON, its current status, and perspectives for MSO 4m-class telescopes.

Processing DECam data using the Rubin LSST pipeline: LoVoCCS and MMA [15:10 - 15:30]

Shenming Fu, NOIRLab

The Rubin LSST Science Pipelines software (LSP) is being developed to use the state-of-the-art algorithms to process and measure future Rubin LSST images, but is also applicable to other telescope systems (e.g. DECam, CFHT, SDSS). The performance of LSP

has been well tested and verified on HSC imaging data. In this talk, I will present two DECam projects: one studies static sky and the other is on time domain. Both projects use LSP to process the raw DECam data and analyze the results with our own pipelines, and therefore the data products and tools will be compatible with Rubin LSST.

(1) The Local Volume Complete Cluster Survey (LoVoCCS). LoVoCCS is an ongoing NSF's NOIRLab survey that studies the mass distribution and galaxy population in nearby X-ray luminous galaxy clusters. I will talk about our pipeline and early science results based on our first paper.

(2) DECam Multi-Messenger Astrophysics (MMA). The growth of gravitational wave/high-energy neutrino/gamma-ray burst events requires rapid and wide-field follow-up observations and image processing pipelines to study the optical counterparts. We are building a pipeline for DECam MMA: LSP runs difference image analysis, and we filter the catalogs and run real/bogus classification; the results will be sent to alert brokers (e.g. ANTARES). I will report the results of testing the pipeline on different types of targets in different environments using archival DECam data to obtain high-quality light curves.

The NOIRLab 4m telescopes and their future [15:50 - 16:20]

Arjun Dey, NOIRLab

The NOIRLab 4m telescopes have been instruments of astronomical exploration and discovery over the last 50 years and will continue to play this critical role into the near future, even in the era of large ground-based and new space-based observatories. I will discuss possible evolutionary paths that these telescopes and their instrumentation suites may take in order to maximize their scientific impact over the next two decades.

POSTERS

S-PLUS: 12-filter photometric survey observing ~9000 sq.deg. in the South Hemisphere

Felipe Almeida-Fernandes, University of Sao Paulo / NOIRLab

S-PLUS is an ongoing photometric survey observing an area of ~9000 sq degrees in the southern hemisphere using a dedicated 80-cm robotic telescope located in Cerro Tololo, Chile. The main particular characteristic of the survey is the use of 12 filters from the Javalambre photometric system, which covers the whole optical range and includes 4 SDSS~like filters (g, r, i, z), the Javalambre u filter, and 7 narrow bands (J0378, J0395, J0410, J0430, J0515, J0660 and J0861), all centered around key spectral features. While the instruments and filter system are the same as the J-PLUS survey in the northern hemisphere, S-PLUS is the only large area photometric survey in the southern hemisphere that observes the whole footprint using this many filters (at the expense of photometric depth). These narrow-bands enable several different scientific applications, from the study of single stars to the identification and characterization of galaxy clusters. Providing accurate calibrated magnitudes that are suitable for so many different applications is challenging, as the optimal photometric technique, aperture definitions and calibration approach may differ depending on the nature of the source and their location in the sky. We have developed a new photometry and zero-point calibration pipeline that can be specifically configured to the characteristics of each observation in order to extract the best results in each case. In particular, the calibration relies on previous observations of other surveys in the same region and uses a synthetic magnitudes library to predict the S-PLUS magnitudes for a selection of stars in each observation. Using the STRIPE82 region as a reference for the calibration, we estimate the final zero-point errors in S-PLUS to be $\lesssim$ 10 mmags for filters J0410, J0430, g, J0515, r, J0660, i, J0861 and z; $\lesssim$ 15 mmags for filter J0378; and $\lesssim$ 25 mmags for filters u and J0395.

Characterization of Photometric Redshifts for Cosmic Shear in DELVE

Raul Basilides Gomez del Estal Teixeira, University of Chicago

We use the Bayesian Photometric Redshift (BPZ) algorithm to produce photometric redshifts for galaxies in the DECam Local Volume Exploration Survey (DELVE). This analysis uses photometry based on an early set of coadded images produced by running the Dark Energy Survey Data Management (DESDM) pipeline. To efficiently obtain the redshift distribution, we implement a sampling algorithm in the BPZ code. This algorithm samples a random point for each galaxy's posterior distribution weighted according to the probability of each spectral energy distribution (SED) template. We present our derived redshift distribution for a galaxy sample that will be used for a forthcoming cosmic shear analysis. Since the DELVE coadded tile production is ongoing, these results are preliminary. However, when completed, this work will be a key component for a cosmic shear analysis to constrain cosmological parameters and stress-test the ΛCDM model.

The HETDEX/SHELA Photometric Catalog: Galaxy Evolution from the Cosmic Dawn to Noon

Gene Leung, The University of Texas at Austin

The Hobby-Eberly Telescope Dark Energy Experiment (HETDEX) is an unbiased, wide area integral-field spectroscopic survey that aims to detect ~800,000 Lyman-alpha emitters (LAEs) at z=1.9-3.5. The Spitzer/HETDEX Exploratory Large-Area (SHELA) survey supplements HETDEX by providing multiwavelength imaging data covering 24 square degrees within the footprint of HETDEX spectroscopic observations. The SHELA dataset includes photometry for ~4,000,000 sources in the ugrizy bands from DECam and HSC, as well as J, K, 3.6 and 4.5 micron bands from NEWFIRM, VIRCAM, WIRCam and Spitzer/IRAC. We present a new multiwavelength photometric catalog that enables a wide range of science spanning the cosmic dawn and noon in the SHELA field. We showcase two of these science projects. In the first project, we use the photometry and photometric redshifts in the SHELA catalog to identify 9 candidate bright galaxies at z>10. This highlights the critical role of large-area ground-based imaging surveys in identifying these most luminous and rarest objects, supplementing deep imaging surveys by JWST. In the second project, we use the photometry in the SHELA catalog to robustly measure galaxy properties of the largest sample of spectroscopically detected LAEs at z=1.9-3.5 in HETDEX, and determine properties that promote Lyman-alpha production and escape in galaxies, with potential implications to the reionization of the universe.

Searching for Dwarf Galaxies Around Isolated, Low Mass Hosts

Jonah Medoff, University of Chicago

Dwarf galaxies are the oldest, least evolved, and most dark-matter-dominated galaxies in the universe, therefore studying them can shed light on the formation of some of the first galaxies to exist, the evolution of larger host galaxies like our Milky Way, as well as the abundance and distribution of dark matter across the Local Universe. Most research to date involving dwarf galaxies has focused specifically on those orbiting the Milky Way and Andromeda. However, despite being more difficult to observe, it is important to also study dwarf galaxies beyond the Local Group in order to learn about the properties of dwarf galaxies located in different environments – i.e., those orbiting galaxies with different masses and morphologies than that of the Milky Way. To do this, our DECam Local Volume Exploration (DELVE) - DEEP Survey performs 135 deg^2 of deep imaging in the g and i bands around four Magellanic analogs in the Local Volume: NGC55, NGC300, Sextans B, and IC 5152. I will present an overview of our survey around one of these galaxies, NGC55, and our efforts to search for dwarf galaxy satellites around this low-mass host. With the full DECam coverage of its dark matter halo, our efforts will be able to produce the first complete satellite luminosity function for a distant LMC-mass galaxy down to an unprecedented limit of $M_V \sim -7$.

A search for hostless short GRBs with large aperture telescopes

Brendan O'Connor, The George Washington University

Short gamma-ray bursts (sGRBs) were unambiguously connected to binary neutron star (BNS) mergers through the simultaneous detection of GW170817 and GRB 170817A. As such, sGRBs play a significant role in astrophysics with far-reaching implications, from the rate of detectable gravitational wave events to the production of heavy elements in the Universe. Their environments and distance scales yield important information as to their progenitors and their formation channels, complementing the constraints derived from gravitational wave astronomy. We performed a systematic follow-up campaign targeting all sGRBs without a host galaxy association. Here, we present the results of our observing campaign, including deep Gemini, Keck and HST imaging of 31 short GRBs. Our study doubles the sample of well-studied sGRB galaxies. We have uncovered evidence for a redshift evolution in their locations within their hosts, and for a missing population of high redshift events.

DECam Deep Drilling Survey: Characterizing Variable Stars in the DECaPS-East field

Avi Patel, Haverford College

The ongoing DECam Deep Drilling survey is a pathfinder to Vera Rubin Observatory's Legacy Survey of Space and Time. We have characterized variable sources detected in the Galactic fields by this survey. One purpose of our work is to offer preliminary science results for demonstrating the effective survey design and potential. We use an unsupervised real-bogus (RB) classifier to remove bogus detections and obtain a list of around 200,000 "good" candidate variables from the Galactic fields. We examine the light curve properties of these variables in each passband along with cross-matching them with well-established variable star catalogs from Gaia Data Release 3 (DR3) and the Optical Gravitational Lensing Experiment (OGLE). In the future, we can use these cross-matched data sets as the training samples to perform ML classification of the remaining variables. Making use of the multi-band time series data from DECam, we use an algorithm developed by Soraism et al. 2020 to detect anomalous sources in our sample of candidate variables. After visual inspection of the lightcurves for a few hundred of the most anomalous sources based on their scores, we select 3 interesting candidates, which include a cataclysmic variable (CV) and low-mass X-ray binary. We find one candidate whose lightcurve has symmetric outburst-like profiles, characteristic of microlensing events lasting about tens of days. This is likely a new microlensing event.

Photometric Calibration of the DECam Local Volume Exploration (DELVE) Survey

Chin Yi Tan, University of Chicago

We compute and validate photometric zeropoints for the DELVE processing of all publicly available DECam data. Individual DECam CCDs are calibrated by matching SourceExtractor catalogues to the ATLAS Refcat2 catalogue. The ATLAS Refcat2 catalogue contains sources from various surveys, including Pan-STARRS1 (PS1) and SkyMapper DR1, transformed into the PS1 bandpass

system. We derive transformation interpolations from the ATLAS Refcat2 system to the DECam system by comparing the magnitudes of stars in ATLAS Refcat2 to calibrated stars from Dark Energy Survey (DES). We correct for a photometric offset between the PS1 and SkyMapper regions by deriving independent transformations. We assess the quality of our zeropoints by transforming our calibrated DECam g,r,i,z measurements to the Gaia G-band and comparing to matched stars from Gaia EDR3. We find that our procedure yields a photometric uniformity of 5.3 mmag over the DECam sky area. Further improvements can be made replacing the shallower SkyMapper catalogues with synthetic photometry derived from Gaia DR3 low-resolution spectra.

The DECam Serendipitous Asteroid Program

Francisco Valdes, NOIRLab / CSDC

The DECam Community Pipeline Moving Object Detection System (CP-MODS) serendipitously detects and measures asteroids from programs with suitable observing patterns: three or more exposures of the same pointing in the same (broadband) filter in a night or consecutive nights. The measurements are reviewed and submitted to the Minor Planet Center (MPC). This poster presents statistics showing that the program has been wildly successful. It rivals full-time dedicated asteroid programs and, as would be expected for the world class combination of the Blanco and DECam, it dominates for faint detections. All this while not not impacting the wide variety of observing programs. To summarize the 10 years of measurements (as of Aug 2022): 5.5M measurements, 1.2M tracklets, 550K designated asteroids (202K distinct), and 301K tracklets yet to be designated. While there are many "discoveries" a large number of reports were in MPC limbo for years so that this statistic is complicated.

* One program, the DECam NEO Survey (30 assigned nights), had an optimally designed observing strategy and stands out relative to all other programs combined.