2024 STScI Spring Symposium Workshops

Google Sheet sign-up to express interest in each session (according to the interest we may have some of the sessions in parallel):
https://forms.gle/udifYtXv477yrDf29

Session 1A:

Dr. David Thilker, JHU

Exploring the PHANGS-HST+JWST+ALMA+MUSE Treasury of Nearby Galaxies
workshop at the 2024 STScI Spring Symposium `Recipes to Regulate Star Formation at All Scales'

The `Physics at High Angular resolution in Nearby GalaxieS' (PHANGS) collaboration invites you to a workshop devoted to learning all about publicly available data products for studying star formation activity and the ISM in nearby galaxies, delivered in support of community-led science. Recent PHANGS Treasury programs with HST and JWST, plus a Large program using ALMA, have systematically observed a sample of 74 main sequence galaxies within ~20 Mpc. Efforts are ongoing to secure VLT/MUSE IFU spectroscopy for all the targets. Collectively, these data chart the observed population of star clusters, multi-scale stellar associations, dust filaments, molecular clouds, and nebulae. Ancillary data from other observatories has also been obtained (e.g. FUV/Astrosat, HI/MEERKAT+VLA) and will be summarized. Finally, environmental masks and tables of locally evaluated physical properties constructed based on lower resolution panchromatic imaging will be discussed.

A plenary component of the workshop will aid interested users in understanding the following aspects of PHANGS: (1) available observations and current status of ongoing programs; (2) methods adopted to generate derived catalog products with emphasis on determination of physical properties and applications of machine learning, including each of the populations mentioned above; (3) ensemble characteristics of the cataloged objects; (4) generally how to access and interact with the datasets, including available on-line tools for exploration; and (5) insight on the linkage between global galaxy characteristics and the resolved quanta of the star formation cycle captured by PHANGS.

A fully-interactive portion of the workshop will follow, possibly conducted in sub-groups. Workshop leaders will guide participants through a small set of analysis-oriented python notebooks and specialized software for utilizing components of each `pillar' PHANGS dataset

(ALMA, MUSE, HST, JWST) though HST+JWST will be emphasized. Plans for specific notebooks are still being developed, but we anticipate one notebook focused on exploration of the cluster catalog (including embedded candidates from JWST) requiring subset selection and image cutout server use, another on multi-scale stellar association analysis that involves region-based catalog linkage and auxiliary image photometry, and another using environmental masks / tables to examine dependencies of molecular cloud or nebulae properties on location. There will also be a software demonstration of SAMP-enabled connected usage of tools such as TOPCAT and ds9.

A devoted discussion session is planned to end the workshop. The purpose of this session is to allow time for additional Q&A and permit direct feedback to the PHANGS team in terms of suggested additions or improvements to forthcoming data products.

Session 1B: Derivation of ISM properties

Dr. Ryan Sanders, University of Kentucky

This workshop will focus on methods of deriving gas-phase metallicities and other ionised gas properties such as temperature, density, and ionisation parameter, and provide a tutorial for applying some of these methods. We will go through some of the advantages and pitfalls of different methods (e.g., strong-line calibrations, the direct T_e method, etc.), and ways to evaluate what may or may not be an appropriate tool to apply to a particular observational sample. We will discuss the underlying assumptions that go into different methods of metallicity estimation and how they can potentially bias the results. I will provide some Python notebooks with example code segments deriving gas-phase metallicity from a set of strong-line calibrations, from a photoionization model grid, and using the direct method to derive the electron temperature, density, and gas-phase abundances with the Pyneb package. I will demo these notebooks, and there will be time to take these notebooks and apply them to your favourite spectroscopic data sets and discuss or troubleshoot any questions that come up.

Session 2: Hubble Advanced Science Products

Dr. Travis Fischer, STScI

The Hubble Advanced Spectral Products (HASP) program, a cornerstone in astronomical research, provides unparalleled, coadded spectral data from the Hubble Space Telescope's Cosmic Origins Spectrograph (COS) and Space Telescope Imaging Spectrograph (STIS). By automating the coaddition of data within the Mikulski Archive for Space Telescopes (MAST), HASP seamlessly integrates both new and archival data

with the latest calibrations. This innovation is particularly crucial for astronomers focused on galaxy evolution, offering enhanced insights into star formation processes, stellar feedback, and the intricate dynamics governing galaxies across various epochs.
HASP's meticulous multi-stage filtering and coaddition of spectra across different central wavelengths and instruments play a crucial role in enhancing the quality and scope of observational data. This is especially relevant for studying star formation conditions, stellar feedback mechanisms, and the chemical evolution of galaxies. HASP's improved signal-to-noise ratios and expanded wavelength coverage enable more precise measurements and interpretations of star formation rate indicators, the role of stellar and AGN feedback, and the chemical enrichment processes within galaxies across various epochs.
For researchers exploring the intricate relationship between star formation and galaxy evolution, HASP serves as an indispensable tool. It not only offers enhanced data quality but also ensures the continual updating of spectral products, reflecting the best possible reduction techniques. HASP's contributions are instrumental in advancing our understanding of galaxy evolution, from local analogs to high-redshift observations, thereby complementing the objectives of the 2024 STScI Spring Symposium and the broader astrophysical community.

Session 3: Exploring ILLUSTRIS-TNG simulations to derive observationally-comparable Star formation rates and metallicities

Bryanne McDonough, Boston University

This workshop will introduce attendees to the IllustrisTNG suite of cosmological, hydrodynamic simulations and how these simulations can be leveraged for research into galaxy evolution, particularly as it pertains to star formation. By the conclusion of the workshop, attendees will leave equipped with the tools to harness IllustrisTNG data for their research and will have experience accessing data through the TNG API. The learning goals for this workshop are as follows:

Understand the scope and purpose of the Illustris TNG simulation suite, including available simulations, observational tensions, and limitations to the simulation.

- Navigate and interpret essential TNG data products, such as Halo/Subhalo catalogs, supplementary catalogs, merger trees, and particle data.
- Learn to access and manipulate TNG data using the TNG API, through both browser-based exploration tools and Python API requests.
- Derive observationally comparable parameters relating to star formation from TNG galaxies, including calculating global and local (resolved) star formation rates and determining luminosity-weighted ages.
- Gain practical skills in translating simulation data into meaningful astrophysical insights.

- Apply acquired knowledge and skills to conduct research using Illustris TNG data.
- The workshop will begin with a brief overview of the TNG simulation suite, including the simulations available, validation, known observational tensions, and numerical limitations. We will also cover how star formation and feedback processes are modeled in the simulations.

We will then explore the various data types available and attendees will use the API to request data in Python. These data types include group catalogs that provide integrated group (halo) and galaxy (subhalo) parameters, particle-level data for more detailed investigations, merger trees that track the evolution of galaxy parameters, and the types of supplementary catalogs available. Attendees will also be introduced to the browser-based tools available for data exploration and visualization.

Deriving observationally comparable star formation rates and stellar ages for simulated galaxies is key to making meaningful predictions and facilitates testing of physical models employed by the simulation. This workshop will include practical exercises in deriving luminosity-weighted ages and global star formation rates from the simulation. We will also discuss obtaining maps of resolved SFRs, a more computationally intensive process.

Finally, the workshop presenter will welcome questions and discussion regarding specific cases in which attendees would like to leverage the TNG simulations.

The workshop presenter is in her sixth (and last) year of the astronomy PhD program at Boston University. The material in this workshop is based on her experience using the TNG simulation for her dissertation work on resolved star formation in central and satellite galaxies.

Workshop attendees are encouraged to complete the New User Registration form on the TNG website ahead of the workshop in order to fully participate. This registration will provide you with an API key to access publicly available IllustrisTNG data.