Category: Astrophysics

Title: Hunting for gold with the R-Process Alliance

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Abstract:
Heavy elements like gold and uranium are produced via the rapid neutron-capture (r-)process. This process only occurs in rare explosive events in the Universe like supernovae (SNe) and neutron star mergers (NSMs), making it highly challenging for astronomers to gather direct observations of the element creation. Likewise, it is difficult for nuclear physicists to recreate and study the nuclear process in the laboratory. These obstacles are why we today, seven decades after the theoretical prediction of the r-process, still don't fully understand how and where gold and uranium are made in the Universe. However, in 2017, the R-Process Alliance (RPA) initiated a successful new search to uncover bright metal-poor stars enriched with r-process elements. These stars are invaluable laboratories for studying the r-process as the gas from which these stars formed was polluted by at most a few enrichment events --- perhaps even a single explosion. The RPA has collected spectra of ~2000 stars and discovered over 70 new highly r-process-enhanced stars. I will report recent results from the RPA efforts, including evidence for the formation of super-heavy elements during the r-process and abundances from new Hubble Space Telescope observations.

Title: Neutron Star properties through Collider experiments

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Abstract: With the advent of multimessenger astronomy, neutron stars are studied through multiple observational methods. These observations, combined with data from collider experiments such as those at the LHC at CERN, help constrain the Equation of State (EoS) of neutron matter. The symmetry energy parameter (L_{sym}) in the EoS is of great interest due to its connection with the neutron skin thickness of heavy nuclei. The rising field of nuclear structure, -including neutron skin properties- in collider physics has emerged to improve the understanding of the initial conditions in heavy-ion collisions. Neutron-rich and spherically symmetric nuclei such as ^{48}Ca and ^{208}Pb serve as ideal testbeds for investigating nuclear structure effects and their implications for astrophysical systems. Recent neutron skin measurements from the CREX and PREX-II experiments have revealed a significant discrepancy in the extracted L_{sym} values for ^{48}Ca and ^{208}Pb, respectively, leading to ongoing discussions about nuclear structure and the EoS. We aim to motivate the study of the neutron skin of ^{48}Ca in collider experiments by assessing its sensitivity to various observables. Such investigations could inform the

design of future CERN runs, where precision measurements of neutron-rich systems may serve as a bridge between low-energy nuclear structure and high-energy heavy-ion physics.

Title: Phase resolved optical spectroscopy of the rapidly varying white dwarf ZTF 1851+1714

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Abstract:
We report on phase resolved optical spectroscopy and photometry in the B- and R-bands of the white dwarf candidate ZTF 1851+1714. The source has been reported to be variable with a large amplitude of close to 1 magnitude and a short period of 12.37 min. We confirm this period and interpret it as the spin period of the white dwarf. The optical spectrum shows emission lines from hydrogen and helium superposed on a featureless continuum. The continuum changes shape during the phase such that it is redder when the source is bright. There is tentative evidence for Doppler shifts of the emission lines during the spin phase with an amplitude of a few tens of km s^−1. Notably, the Hα and Hβ lines exhibit different radial velocity amplitudes, suggesting that they come from different emission regions. We also identify a candidate orbital period of 1.03 hours, based on potential orbital sidebands. These features—Doppler shifts modulated at the spin frequency, brightness variations and continuum shape changes—are consistent with the accretion curtain model, in which material is funneled from a truncated inner disk along magnetic field lines onto the magnetic poles of the white dwarf.

Title: A power spectral study of PHANGS galaxies with JWST MIRI: On the spatial scales of dust and PAHs

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Abstract: The interstellar medium (ISM) consists of a diversity of structures on a variety of spatial scales, intimately tied to galactic evolution. In this work, Fourier analysis is used to characterize the spatial structures of dust and Polycyclic Aromatic Hydrocarbons (PAHs) in the ISM of PHANGS-JWST galaxies observed in the four photometric mid-infrared (MIR) filters from F770W-F2100W (ie. 7.7 to 21 μm). We quantify the abundance of structures on different spatial scales by the power-law slope, α, of the power spectra. The distribution of α's across all length scales are dramatically different between filters with steep slopes for PAH filters ($\alpha_{F770W} = 2.19^{+0.16}_{-0.15}$, $\alpha_{F1130W} = 1.88^{+0.25}_{-0.37}$) and shallower for the dust-continuum ($\alpha_{F1000W} = 1.48^{+0.33}_{-0.47}$, $\alpha_{F2100W} = 0.94^{+0.23}_{-0.28}$). The distribution of α across galaxies is narrower for PAH than continuum dust dominated bands, showing that PAH structures are more homogeneous. This could be due to PAH tracing photo-dissociate regions dominated by similar physical processes across local galaxies, while dust structures are an integrated property over the evolutionary history of its host galaxy. The PAH bands display a break in the power spectrum, showing that PAH structure, unlike dust structure, has a characteristic scale, $l_0=(162^{+5}_{-9})$pc, beneath which structures are suppressed.