

Seminar/Talk

A Race Against the Clock: The Rapid Enrichment of Early Galaxies

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Host: Astronomers

Oxygen, nitrogen, and carbon are powerful tracers of chemical enrichment, linking stellar nucleosynthesis, star-formation histories, and interstellar medium (ISM) conditions across cosmic time. While oxygen is produced rapidly by massive stars, nitrogen and carbon production depends sensitively on a range of stellar properties and occurs over a range of timescales that make N/O and C/O ratios critical but complex probes of galaxy evolution. However, recent JWST observations have revealed unexpectedly extreme nebular conditions and anomalous abundance ratios in galaxies only a few hundred million years after the Big Bang, challenging canonical chemical evolution models.I will discuss some important tools for understanding the physical origins of early enrichment by combining JWST/NIRSpec observations at high redshift with insights from nearby galaxy analogs observed with HST/COS. I will show that extreme ISM conditions, such as high gas densities, play a central role in shaping inferred emission line ratios, biasing both abundance measurements and their interpretation. I will discuss the search for extremely metal-poor galaxies and what we know about the evolving abundance patterns that characterize star-forming galaxies. Finally, I will present a N/O-enhanced lensed galaxy at z ≈ 6 that exhibits nitrogen-phase Wolf-Rayet (WN) star signatures, making it the most distant confirmed WR galaxy to date. Its highly non-uniform abundance pattern, with elevated N/O and suppressed C/O relative to its O/H, is consistent with rapid, localized enrichment from WN stars during a brief post-burst phase. Further, the inferred frequency of such N-emission systems implies bursty star-formation cycles on short timescales at cosmic dawn.Together, these results suggest that galaxies experience short-lived phases of nitrogen enhancement driven by bursty episodes of massive star feedback in compact, dense ISM environments. Nitrogen thus emerges as a key clock for tracing the earliest star formation episodes and for linking stellar physics at cosmic dawn to the chemical foundations of later galaxy and planet formation.

Thursday, November 26, 2026 11:00am - 12:00pm
Mondi 2a+b, Central Building

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