

Evidence for Cold Gas in the Circumgalactic Medium of Galaxies

While the circumgalactic medium (CGM) hosts the majority of a galaxy's baryons, its precise role in galaxy formation and evolution remains uncertain. In this talk, I will present evidence for the presence of cold gas in the CGM using two distinct techniques at different cosmic epochs, demonstrating that the CGM contains not only hot, ionised gas but also cold gas — a more direct precursor to star formation.

I will use high-resolution spectroscopy from VLT/UVES and Keck/HIRES to reveal cold gas in the CGM at $z > 2$, by stacking blends of weaker absorption-line systems in the Lyman-alpha forest (SBLAs). This analysis uncovers a persistent population of cold gas absorbers at this epoch, even within absorbers with HI column densities $N_{\text{HI}} < 10^{17}$ atoms/cm².

I will also present evidence for the first detection of cold, extended molecular gas in the CGM at $z \sim 0.5$, traced by CO(2–1) emission using deep (48-hour) observations with the Atacama Millimetre Array. While extended cold gas reservoirs have been observed around extreme systems such as quasars and clusters, typically at $z > 2$, this marks the first such detection at low redshift around typical star-forming galaxies.

Together, these results provide new insights into how galaxies retain cold gas across cosmic time, a picture that will be further refined by forthcoming instruments such as the Extremely Large Telescope and the Atacama Large Aperture Submillimetre Telescope.