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Presentation Requested: oral
Category: Environment, Large Scale Structure and Galaxy Evolution
Question: How has (or how will) ALMA (with other telescopes) help us better understand the impact of the environment on galaxy evolution? Can ALMA or one of the other new facilities detect the gas in the large scale structure, outside of galaxies? What can we learn from dwarf galaxies or galaxies in clusters and groups in the nearby Universe using ALMA + other facilities & how has this helped us understand galaxy evolution at higher redshifts?

Discovery of a Very Large Structure at Z=3.78

We report the discovery of a very overdense large-scale structure at $z = 3.78$ in the Boötes field of the NOAO Deep Wide-Field Survey. Within a transverse comoving size of 72 Mpc$\times$72 Mpc, we have identified 65 Lyman alpha emitters (LAEs) at $z = 3.790 \pm 0.015$, and four additional galaxies at $z_{\rm spec} = 3.730, 3.753, 3.780, 3.835$. The galaxy distribution within the field is highly non-uniform, exhibiting three large ($\approx 5-7\times$) overdensities, each containing 9$-$12 galaxies within a 8 Mpc (comoving) radius circle. These overdensities, which are candidate protoclusters, are separated by $40-50$ Mpc and are connected by filamentary structures traced by LAEs. We estimate that by $z = 0$ the largest overdensity will grow into a Coma-like cluster of mass $\approx 10^{15} M_{\odot}$, and the two smaller overdensities into clusters of mass $(2-5) \times 10^{14} M_{\odot}$. The highest concentration of galaxies is located at the very southern end of the image, suggesting a possibility that the true extent of this forming cluster may be even larger. The size and level of overdensity of this structure is similar to that typically found in local superclusters. The largest structures at high redshift such as this one will provide best laboratories for ALMA to study early evolution of (cluster) galaxies in the densest environments.