

# Neighbourhood Issues: The Impact of Environment on Galaxy Properties at Cosmic Noon

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Recent observations of galaxies at high redshift have challenged our understanding of galaxy formation: some have extremely high star formation rates unmatched by anything seen at present day, others show signs of rapid inflows or outflows, and indications of very massive black holes. In particular observations of massive quenched galaxies present when the Universe was only 1Gyr old have proven difficult to reproduce. I will show that this is because simulations require both large volumes as well as very high resolutions to capture these observed properties. This is especially true as many of such galaxies live in environments that will eventually collapse into massive groups or clusters at present day, but at high redshift are typically spread over a large area of sky as the protocluster and protogroup structures are only beginning to assemble.

Using one of the largest sets of fully hydrodynamical cosmological simulations, the Magneticum simulation suite, I show how quenched galaxies are formed at such high redshifts, how they are connected to the environment they form in, and how the feedback from these galaxies enriches the surrounding gas with metals. Furthermore, I discuss the properties of the galaxies in the first emerging protocluster cores, demonstrating that the hot gas atmospheres of the protoclusters start to build up at redshifts around  $z=4$ , and how this impacts the galaxy populations in these environments. Finally, I will show that the extent of the future collapsing regions can be traced by probing the large scale environment, thus allowing for protocluster regions to be distinguished from proto groups and massive galaxies that will starve in isolation.

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