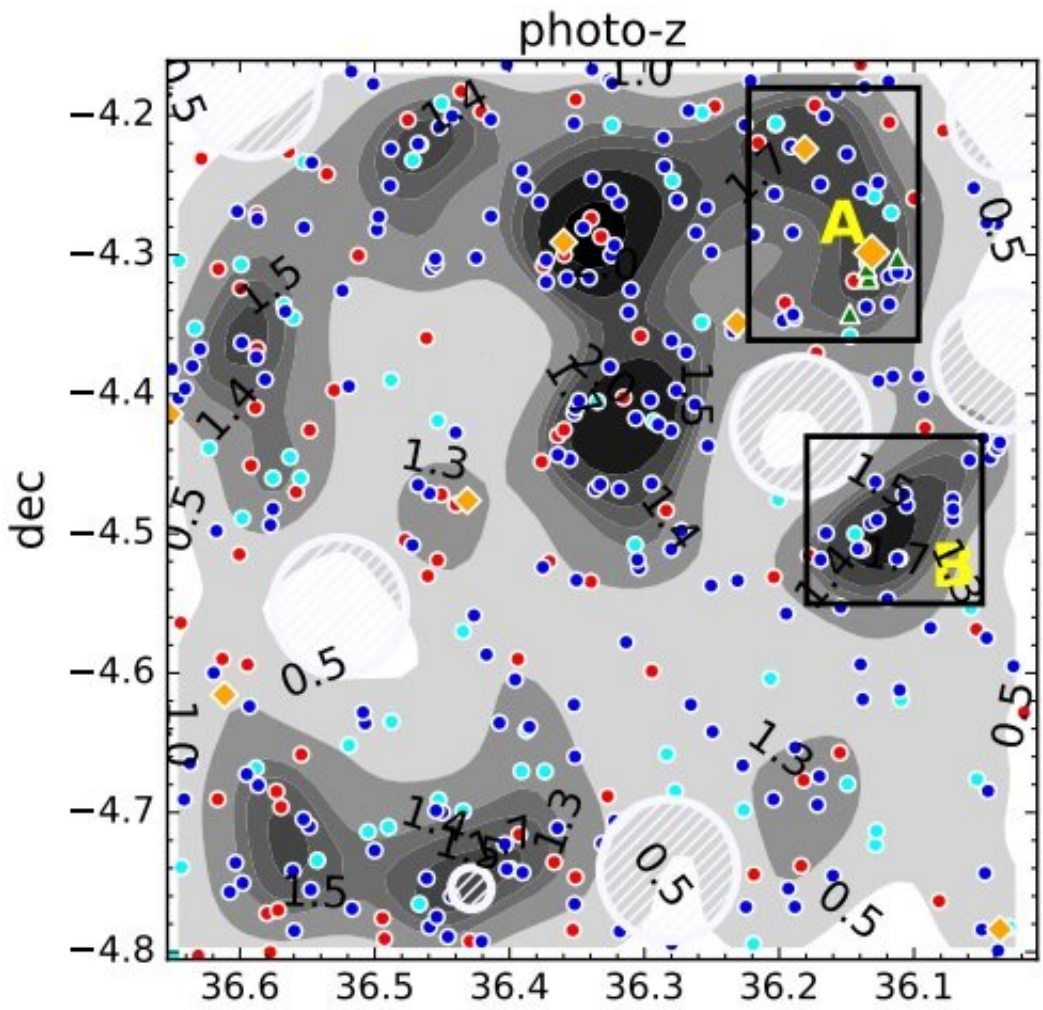
Hundreds of candidate galaxies identified in the protocluster D1UD01

July 21 2020, by Tomasz Nowakowski



Sky distributions of galaxies in D1UD01 with photometric redshifts between 2.9 and 3.3. Credit: Shi et al., 2020.

Astronomers have conducted a detailed multiwavelength study of a distant protocluster of galaxies known as D1UD01. As a result, over 350 candidate galaxies have been detected in this protocluster. The research is detailed in a paper published July 14 on the arXiv pre-print server.

Galaxy clusters contain from hundreds to thousands of galaxies bound together by gravity. They are the largest known gravitationally bound structures in the universe, which could serve as excellent laboratories for studying galaxy evolution and cosmology. Astronomers are especially interested in studies of protoclusters of galaxies, the progenitors of clusters. Such objects, found at high redshifts, could provide essential information about the universe at its early stages.

At a redshift of approximately 3.13, D1UD01 is a protocluster of galaxies discovered in 2016. Initial observations of this protocluster have identified five member galaxies. However, D1UD01 has not been comprehensively studied in different wavelengths yet and it is assumed that many more galaxies, mostly massive ones, are still waiting to be uncovered.

That is why a team of astronomers led by Ke Shi of the Xiamen University, China, decided to perform a multiwavelength investigation of D1UD01, hoping to find new galaxies and to shed more light on the properties of this protocluster. For this purpose, they analyzed the available data from the Canada-France-Hawaii-Telescope Legacy Survey (CFHTLS) and the WIRCam Deep Survey (WIRDS). The study was complemented by data from NASA's Spitzer spacecraft.

"In this paper, we present a multiwavelength study of galaxies in and around a protocluster in the D1 field of the Canada-France-Hawaii-Telescope Legacy Survey (CFHTLS)," the researchers wrote in the paper.

Initially, 532 sources were selected with photometric redshifts between 2.9 and 3.3 as potential candidate galaxies. After further inspection of this sample, 356 objects were identified as photometric-redshift protocluster galaxy candidates.

In general, the research uncovered diverse galaxy populations in D1UD01, including normal star-forming galaxies, massive quiescent galaxies and dusty star-forming galaxies. The astronomers added that their sample includes a high abundance of massive galaxies, with masses of at least 10 billion solar masses.

Furthermore, the study identified two significant photometric-redshift overdensities around the protocluster region. The northern overdensity, designated "A," is observed to be largely co-spatial with the largest overdensity of the so-called Lyman break galaxies (LBGs) in D1UD01. The "A" overdensity was found to have a relatively high fraction (about 42 percent) of quiescent and dusty galaxies. When it comes to the southern "B" overdensity, it contains only around 22 percent of quiescent and dusty galaxies. This structure overlaps with an overdensity of emission line galaxies, such as Lyman-alpha emitters (LAEs), in D1UD01.

The astronomers suppose that the "A" and "B" structures could be two distinct protoclusters in different formation stages. It is likely that they will grow independently into two massive clusters and eventually form a supercluster.

The researchers also found that the D1UD01 galaxy members have in general higher star-formation rates (SFRs) than the field galaxies by about 76 percent. They assume that the protocluster galaxies are in a phase of accelerated mass assembly, rapidly consuming their gas content, and will likely become quiescent in a short period of time.

More information: A detailed study of massive galaxies in a protocluster at z=3.13, arXiv:2007.07055 [astro-ph.CO] arxiv.org/abs/2007.07055

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