We study how the cosmic environment affects galaxy evolution in the Universe by comparing the metallicities of galaxies in voids with similar-sized galaxies in more dense regions. Ratios of the fluxes of emission lines, particularly those of the [Oii] and [Sii] transitions, provide estimates of a region’s electron temperature and number density. From these two quantities and the emission line intensities, we estimate the abundance of oxygen with the Direct T_e method. We estimate the metallicity of 2865 void low-luminosity galaxies and 6448 wall low-luminosity galaxies using data from SDSS via the MPA-JHU Garching catalogue. We find very little difference between the two sets of galaxies, indicating little influence from the large-scale environment on the history of star formation. Of particular interest are a number of extremely metal-poor low-luminosity galaxies.

Metallicity

Metallicity is often described in terms of the ratio of oxygen to hydrogen (O/H) present in the gas-phase. Metallicity is inversely proportional to the amount of gas-phase metallicity in low-luminosity galaxies.

Galaxy selection criteria

- M_r > -20 – low-luminosity galaxies
- M_r < -20 – high-luminosity galaxies

Large-scale environmental dependence

It is suspected that the metallicity of low-luminosity void galaxies is less than that of low-luminosity galaxies in higher-density regions, for a variety of reasons:
- More pristine gas surrounding void galaxies [reduces metallicity]
- Fewer galactic interactions [induces star formation, which eventually increases metallicity]

Since the metallicity is an indicator of star formation history, this would indicate a very different star formation rate between the two types of galaxies. Indeed, previous studies of select void desert galaxies have found them to have low metallicities (Pustilnik et al. 2009, 2011) for example. However, as the histograms below indicate, there is no significant difference between the metallicity of galaxies in different regions. There is a collection of extremely low metallicity galaxies, but these exist in both the voids and walls. These results are a strong test for galaxy formation models of the ΛCDM theory, as void galaxies are currently found to have lower mass and be retarded in their star formation when compared to wall galaxies.

Future work

- Investigate the N/O ratio in these galaxies – this will help us discern the extreme low-metallicity values
- Use the metallicity and other physical characteristics to trace the evolution of dark matter

References