GAMA Survey: SFR, metallicity and mass relationships in clusters

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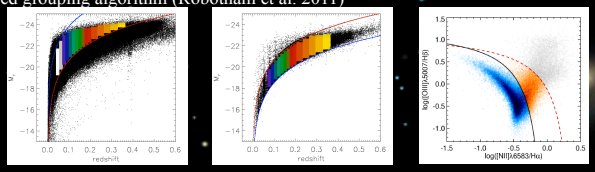
Abstract

The star formation rate (SFR), stellar mass and metallicity are among the fundamental parameters of galaxies. An understanding of the interplay between those properties as well as their environmental dependence will give us a general picture of the physics and feedback processes ongoing in clusters of galaxies. We studied the relationships and environmental dependencies between the SFR, stellar mass, and gas metallicity for more than 1900 galaxies in clusters up to redshift 0.35 using GAMA (Galaxy And Mass Assembly), a spectroscopic survey with data taken with the 3.9m Anglo-Australian Telescope (AAT). Using a control sample of more than 28,000 star-forming field galaxies, we found evidence of an increment in the SSFR and a decrement of the gas metallicity for galaxies in clusters.

Sample Selection

From the whole GAMA and SDSS samples, we constructed 16 volume limited samples by selecting narrow redshift bins of equal absolute Petrosian r-band magnitudes, as shown in Figs. a & b. The red line in both plots show the apparent Petrosian r-band lower/upper limit for SDSS/GAMA, respectively. Finally, we selected Star-Forming (SF) galaxies, shown in blue in Fig. c, following the Kauffmann et al. (2003) curve. Metallicities for GAMA were estimated using the method of Pettini & Pagel (2004), and SFRs were estimated using Hopkins et al. (2003). GAMA galaxies in clusters are identified using a friends-of-friends (FoF) based grouping algorithm (Robotham et al. 2011)

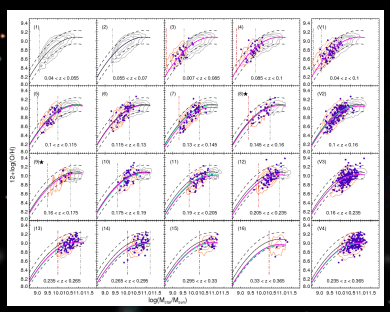


Mass, metallicity, and SFR relationships

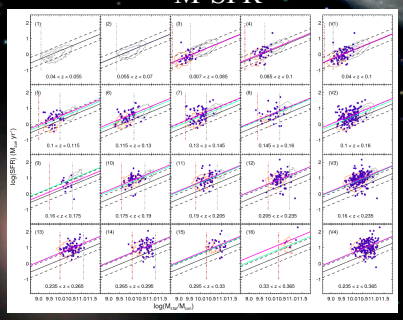
The M-Z relation connects the mass to the metallicity of galaxies, with massive galaxies being found to have higher metallicities than less massive ones (e.g. Tremonti et al. 2004). The stellar mass is also related to the SFR and SSFR (SFR/stellar mass), in the sense that more massive galaxies have higher SFRs and lower SSFRs (e.g. Brinchmann et al. 2004).

In the panels below, we see for the 16 volume limited samples the derived mass-metallicity (M-Z), mass-SFR (M-SFR), mass-SSFR relationships for the GAMA (red contours) and SDSS (black contours) SF galaxies. In each panel, GAMA galaxies in clusters are shown in purple circles, the black solid line indicates the local ($0.04 < z < 0.1$) SDSS and GAMA fit to each relationship, the green line shows the fit of the zero point for each volume limited samples for redshifts > 0.1. The pink line shows the fit of the zero point for the galaxies in clusters. Panels labeled from V1 to V4 (left columns of each relationship) show concatenated volume limited samples of the redshifts indicated.

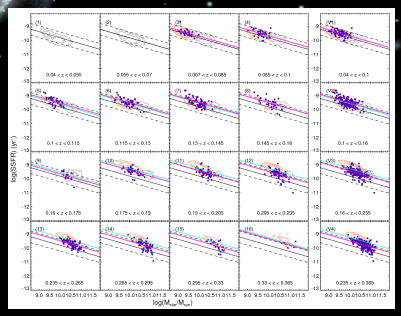
M-Z



M-SFR



M-SSFR



Environmental effects

For samples V1 to V4, we generated histograms for the stellar mass, SFR, metallicity, and SSFR. In every histogram, the GAMA field galaxies are plotted in red solid lines, while GAMA galaxies in clusters are plotted in purple dashed lines. Galaxies in clusters show a slightly lower metallicity and a considerably lower SSFR compared to the rest of the sample. A detailed discussion will be presented in Lara-López et al. (2012, in preparation)