Outliers from the Mass–Metallicity Relation
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Introduction
The mass–metallicity relation (right) has an intrinsic scatter of ~0.15 dex. Since most star-forming galaxies fall on this locus, we can attempt to learn about galaxy evolution from those galaxies that lie in unusual parts of this parameter space.

We find that, as a population, the outliers from the mass–metallicity relation represent relatively short-lived phases in the lives of galaxies. We postulate that the high-metallicity outliers are nearing the end of their star formation, whereas the low-metallicity outliers are the result of relatively pristine outer gas being driven into the galaxy centers during a merger event.

Right: Oxygen abundance (a proxy for “metallicity”) v. stellar mass for star-forming galaxies from SDSS DR4 (grey points). The green histogram denotes the median oxygen abundance in bins of stellar mass. The metal-rich dwarf galaxies are denoted in pink and the massive low-metallicity outliers are denoted in blue. Abundances and stellar masses are from Tremonti et al. (2004).

Morphologies of high-metallicity low-mass outliers
- Smooth, undisturbed, compact
- Occasional blue and/or bright core (see top two rightmost images below); other studies indicate star formation is limited to nuclear regions in these cases

Sample spectrum used to verify O/H is relatively high:

Morphologies of low-metallicity high-mass outliers
- Strongly interacting, merging, or post-merging systems
- Some double-nuclei seen; more compact galaxies show evidence of tails

Sample spectrum used to verify O/H is relatively low:

Eliminating contamination
SDSS DR4 is a large sample; not all of the outliers from the mass–metallicity locus are galaxies with truly extreme metallicities for their mass and luminosity. A large percentage of the contaminating objects are sources which have been misidentified as star-forming galaxies. We also require our outliers to also be outliers in the more directly observable 12+log(O/H) v. M_∗, M_B, and M_R planes.

Right: At low masses, HII regions misidentified as individual galaxies are a large source of contamination.

Below: At low metallicities, low-level AGN (as indicated by strong [OII]λ6300 emission) are a significant contamination source:

Star Formation Rates and Integrated Colors

Left: Color–magnitude diagram for the spectroscopic galaxy sample from SDSS DR6. The high-metallicity low-mass galaxies are denoted in pink and the low-metallicity high-mass outliers are denoted in blue. Many of the high-metallicity outliers are approaching or already on the red sequence, suggesting that these are indeed transitional galaxies. Conversely, the low-metallicity outliers are extremely blue, which is indicative of very little dust and is probably a result of their large star formation rates. The k-corrections are calculated using the low-resolution templates of Assef et al. (2008).