Exploring Systematic Effects in the Mass-Metallicity-SFR Relation

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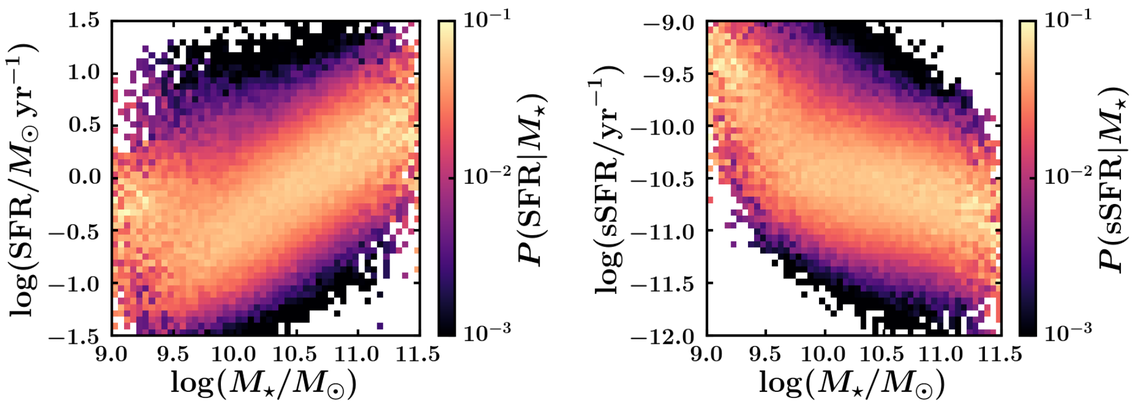
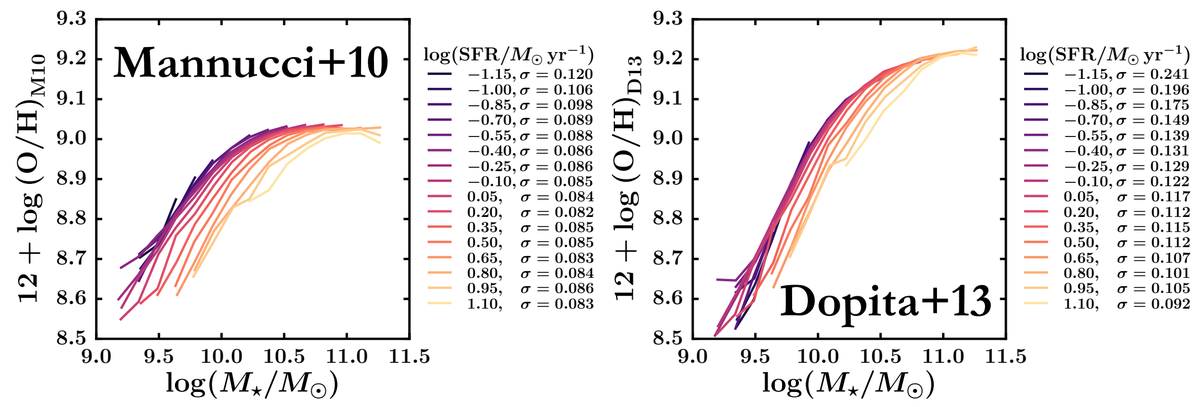
Using SDSS to Study the Secondary Dependence of the MZR on SFR



Use data for ~150,000 galaxies from the MPA/JHU catalog.

The conditional probability distributions for (s)SFR given stellar mass demonstrate that the sample is biased at low mass.

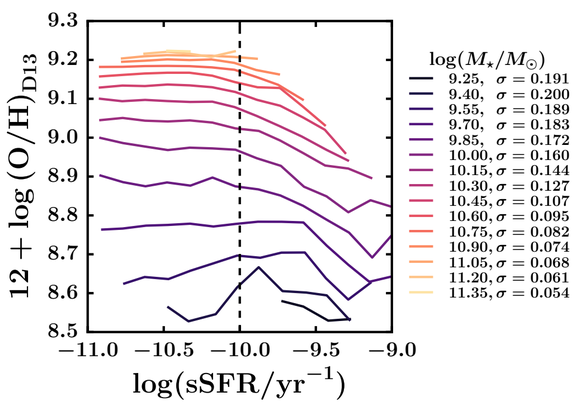
How strongly the mass-metallicity relation depends on SFR is an important constraint for chemical evolution theories.



Use different metallicity indicators: Mannucci+10 (N2 & R23) and Dopita+13 (recombination lines, solves for ionization parameter).

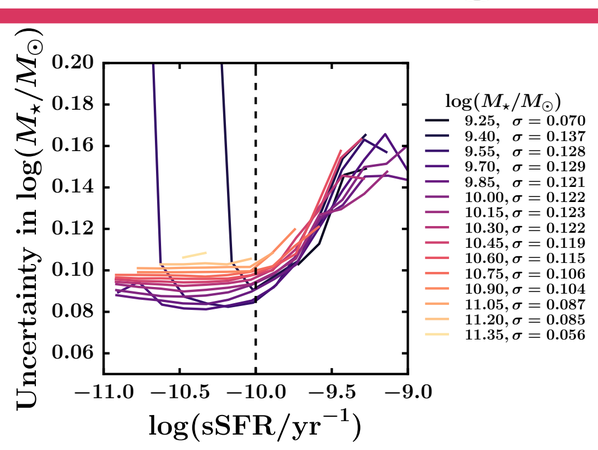
Dopita+13 calibrations give ~55% weaker anti-correlation with SFR.

Systematics May Affect the Strength of SFR Dependence



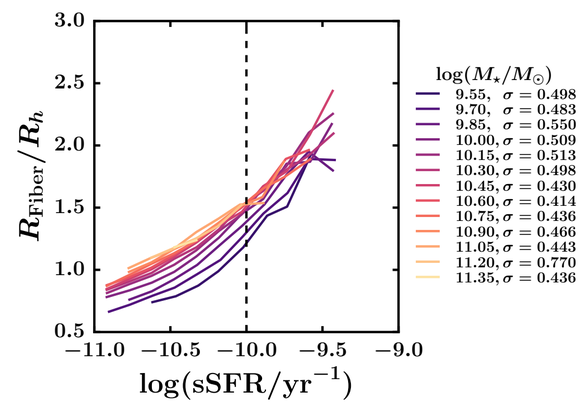
Recasting the Dopita+13 M-Z-SFR relation in terms of sSFR. There is no anti-correlation with SFR at low sSFR; only in high sSFR galaxies.

Different physics in different regimes of star formation?



Uncertainty in mass increases for high sSFR galaxies, where young stars dominate the light.

If stellar masses are biased high (low), may increase (weaken) the strength of anti-correlation with SFR.

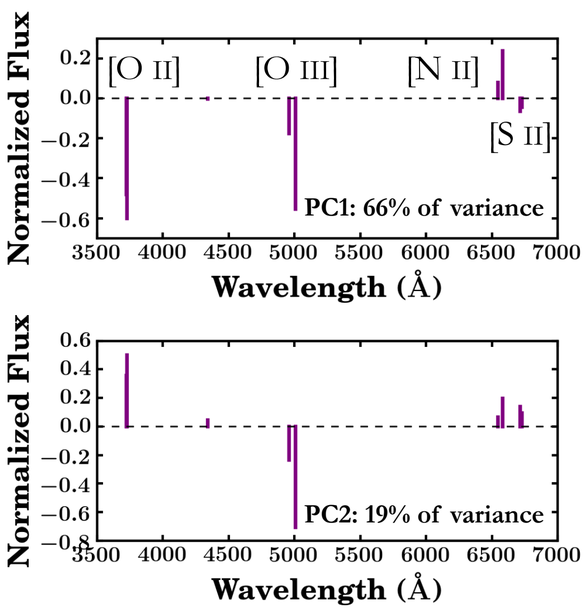


SDSS fiber covers a larger fraction of galaxy area at higher redshift. Higher sSFR galaxies are also preferentially selected at higher redshift.

Fiber may preferentially sample low metallicity outskirts at high sSFR.

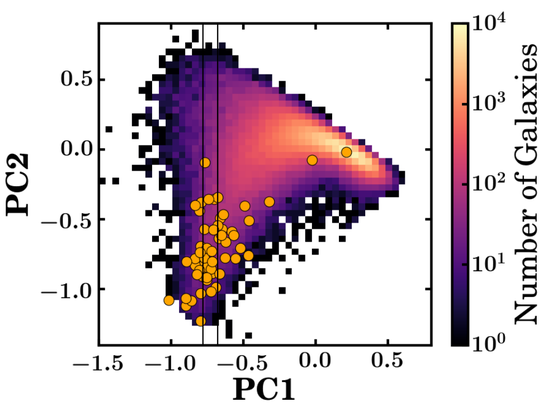
Measuring Direct Method Metallicities from Stacked Spectra

When direct method metallicities from spectra stacked in bins of mass and SFR are used to study the M-Z-SFR relation, the anti-correlation with SFR appears very strong. How similar are galaxies in a given M/SFR bin?

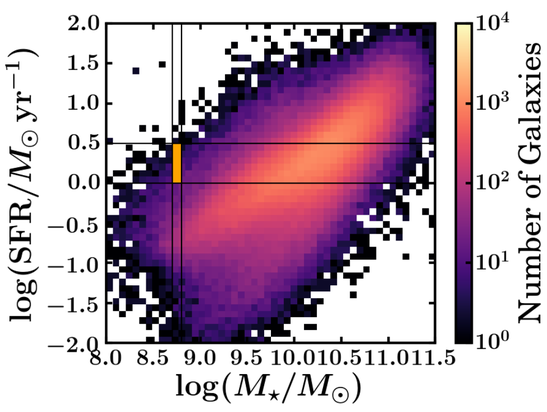


Run PCA on normalized strong emission line fluxes to identify similar spectra.

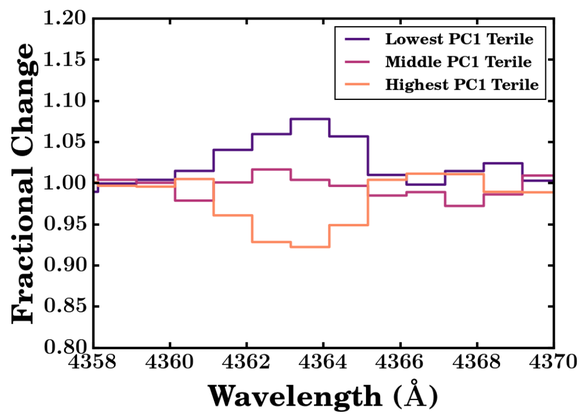
PC1: increasing [N II]/[O II]
PC2: decreasing [O III]/[O II]



In the PC1-PC2 plane, nearby galaxies have similar spectra, and therefore similar physical conditions.



The 57 galaxies in a narrow bin of mass and SFR are spread across the PC1-PC2 plane (orange box and points).



Stacking spectra in a single bin of mass and SFR divided into teriles of PC1 yields ~10% changes in [O III]λ4363 line relative to stacking the whole bin.

T_e and metallicity change within a single M/SFR bin.

Not all galaxies in a narrow bin of mass and SFR have similar spectra; this may bias metallicities measured from stacked spectra.

References

http://www.mpa.mpa-garching.mpg.de/SDSS/DR7/
Mannucci et al. 2010, MNRAS, 408, 2115
Dopita et al. 2013, ApJS, 208, 10
Andrews & Martini 2013, ApJ, 765, 140

Acknowledgements

OGT is supported by NSF IGERT grant DGE-1258485 and by an ARCS foundation fellowship. This work made use of the Python language, including the matplotlib, numpy, and scipy packages. All Dopita+13 metallicities were calculated using the pyqz module.