The Keck Type Ia Supernova Galaxy Survey

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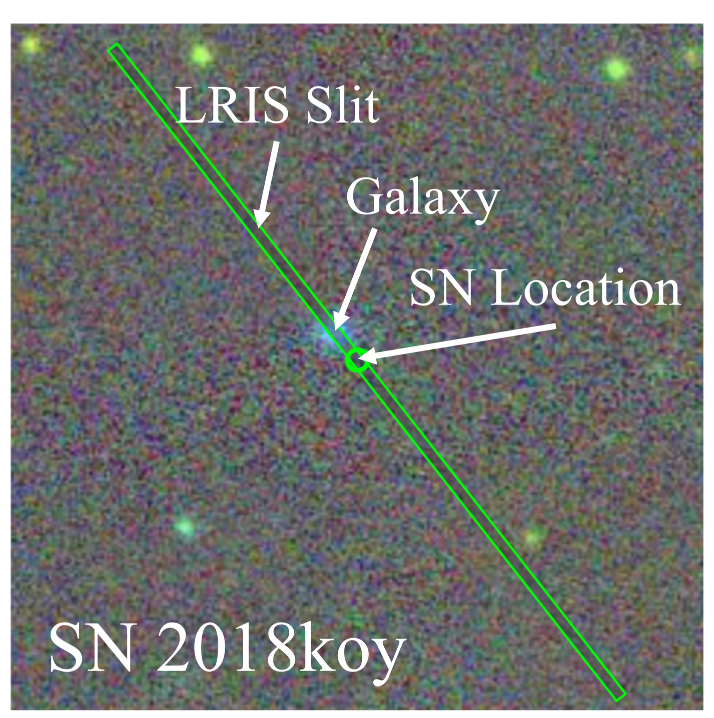
Introduction

In order to use Type Ia supernovae for cosmological investigations, we correct their luminosity for a variety of effects, including an empirical correction based on the mass of a supernova's host galaxy. The large-scale properties of a galaxy must be a proxy for something more local such as the progenitor star composition. Theory suggests that the metallicity of a white dwarf will affect the resulting nucleosynthesis of the explosion, affecting the peak luminosity in a way that could cause the host-mass/luminosity correlation. To test this theory and to make more local measurements, we have obtained host-galaxy spectroscopy for the Foundation and Swope combined cosmological SN sample. The Foundation/Swope survey is the largest low-z SN sample, and we have observed 363/523 SN host galaxies. Keck observations contribute to 34% of our host-galaxy sample, and LRIS was critical for obtaining redshifts and properties of 88% of all targets with r > 18.5 mag. Our spectroscopic measurements of local star-formation rate and metallicity may unravel the underlying physical cause of the empirical host-galaxy correction.

Methodology

- We align the slit with the SN position and galaxy core (right) so we are able to obtain measurements at both positions.
- We use FIREFLY (Wilkinson et al. 2017) to fit the stellar continua of our host galaxies (orange curve below).
- We fit Gaussian profiles to the nebular emission lines in order to estimate metallicity and SFR. (inset panels below)



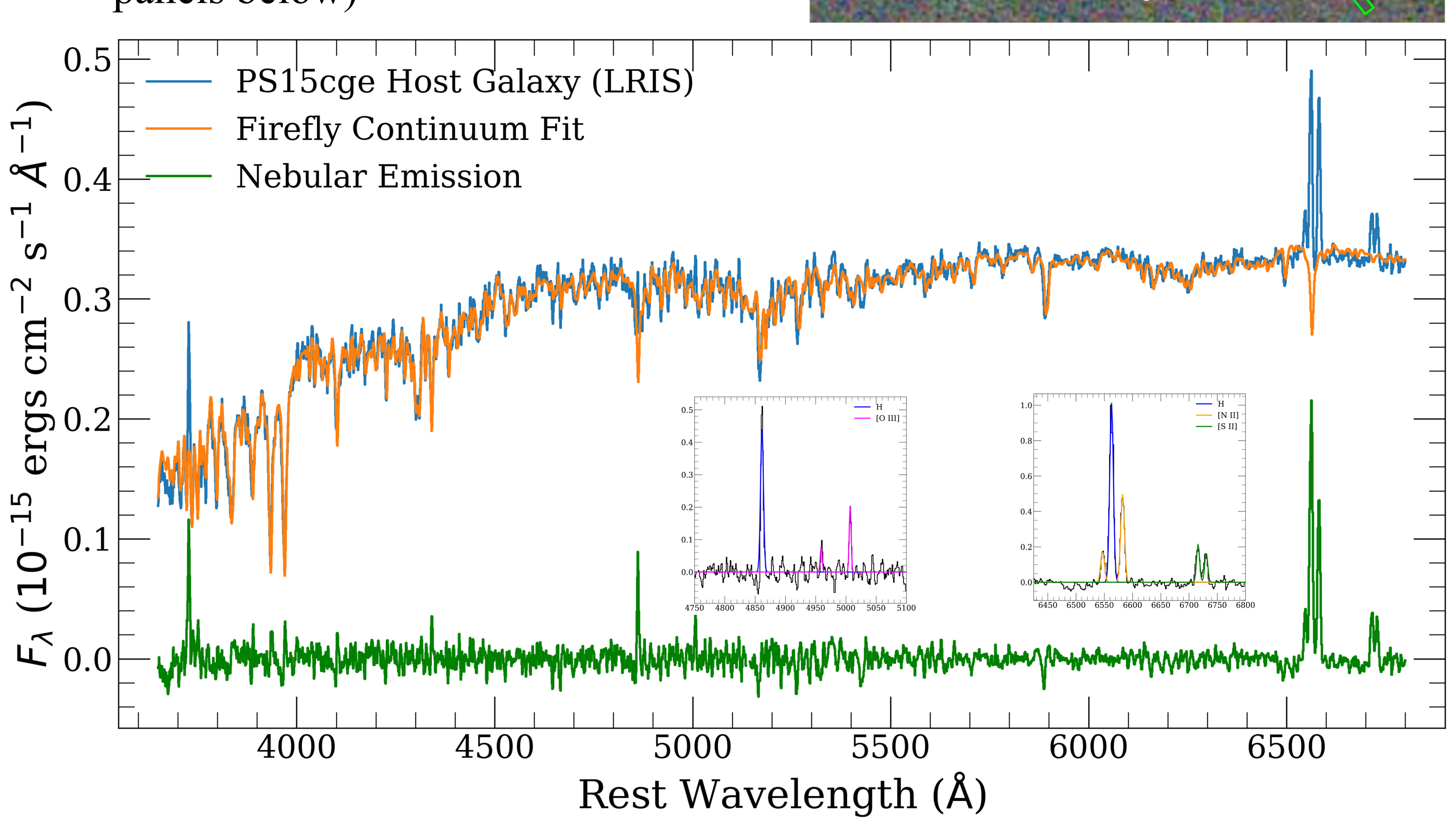


Fig. 1: Example stellar continuum fit using FIREFLY (Wilkinson et al. 2017). Accounting for stellar absorption allows for a more accurate determination of the gas-phase metallicity.

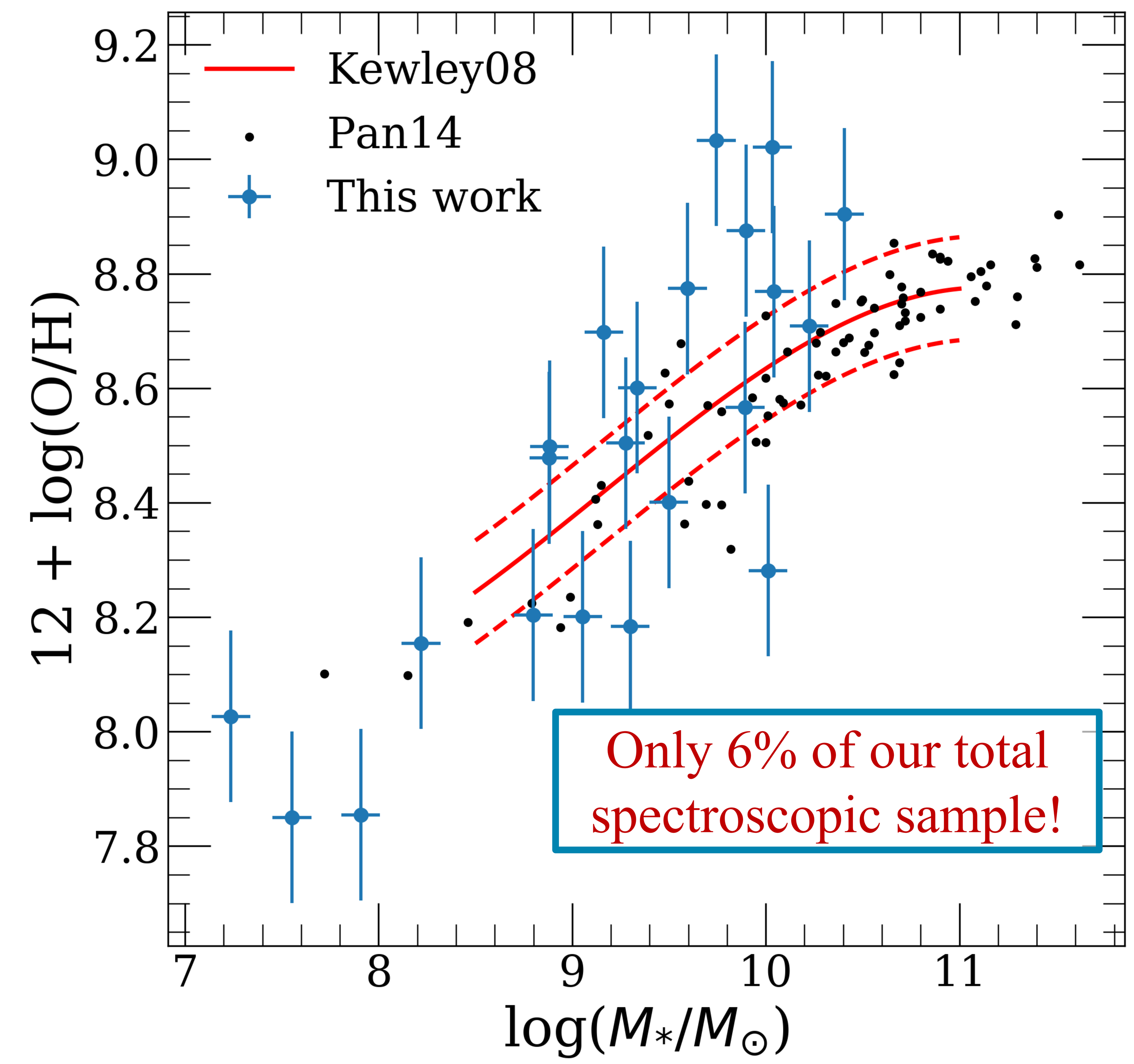


Fig. 2: The mass-metallicity relation derived from our sample. We find good consistency with the relation for field galaxies (Kewley et al. 2008), and results from similar work (Pan et al. 2014)

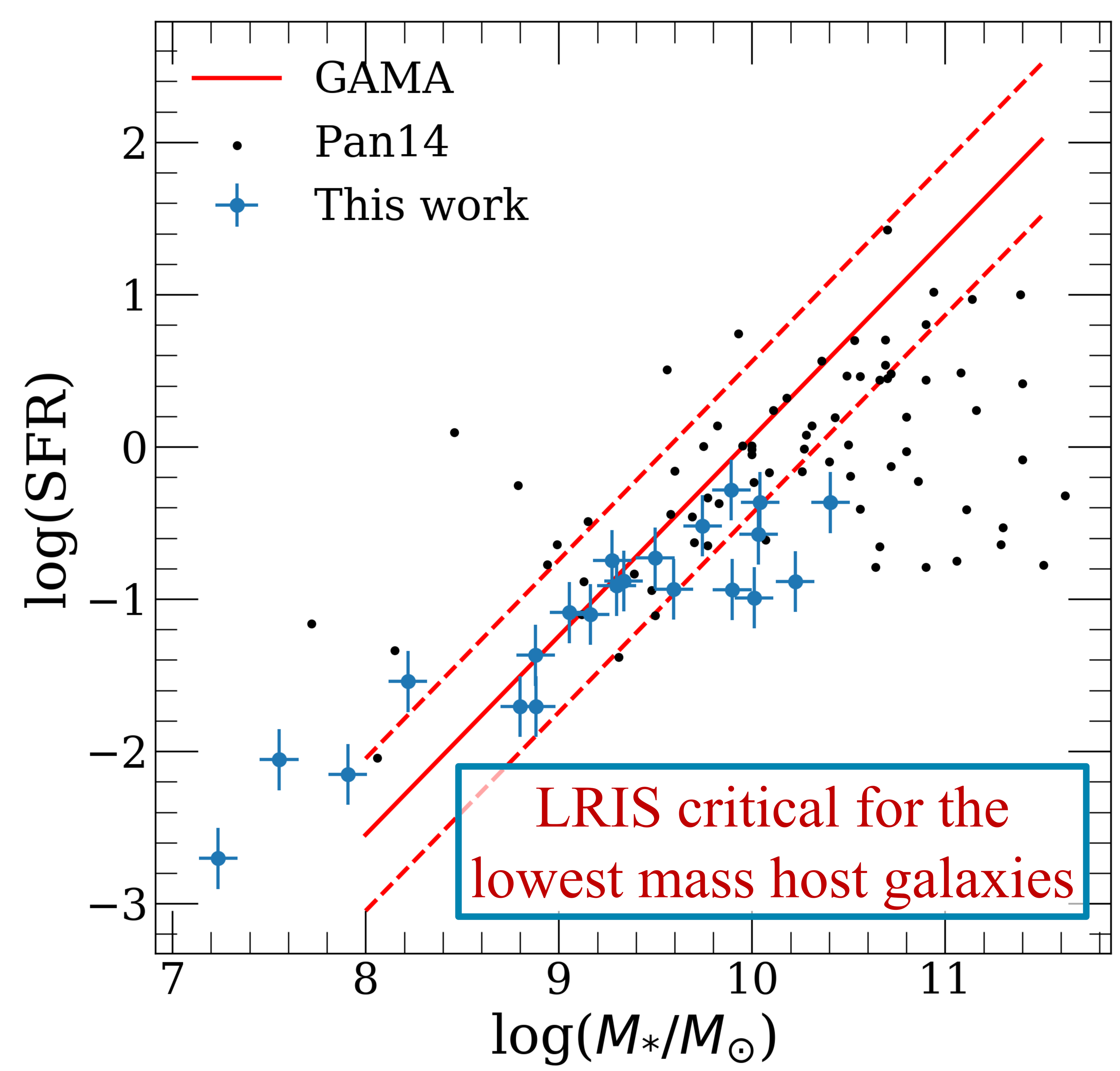


Fig. 3: The mass-SFR relation derived from our sample. Our limited sample includes 4 galaxies with log(M_*/M_{sun}) < 8.25. This is already comparable to Pan et al. 2014 and Childress et al 2013b with 3 and 5 galaxies with log(M_*/M_{sun}) < 8.25, respectively

Results

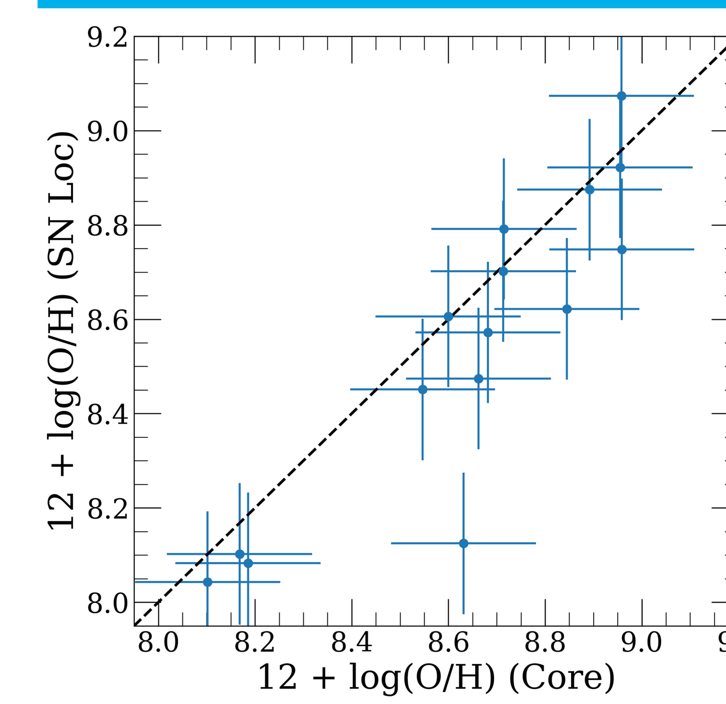


Fig. 4: Local SN vs. galaxy core metallicity. Local metallicities may be biased toward lower values.

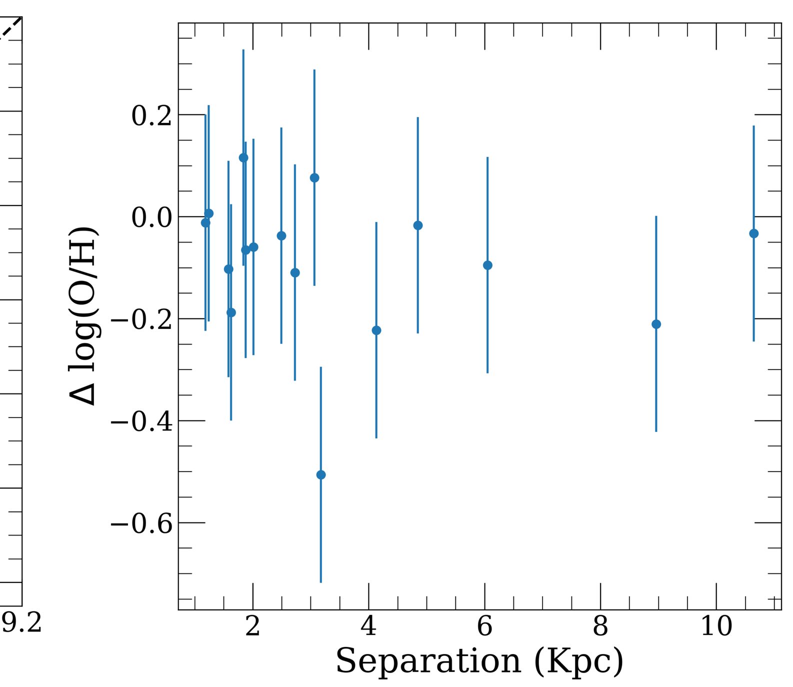


Fig. 5: The Local – Core metallicity vs. physical offset. So far we do not find strong evidence for a metallicity gradient in our sample.

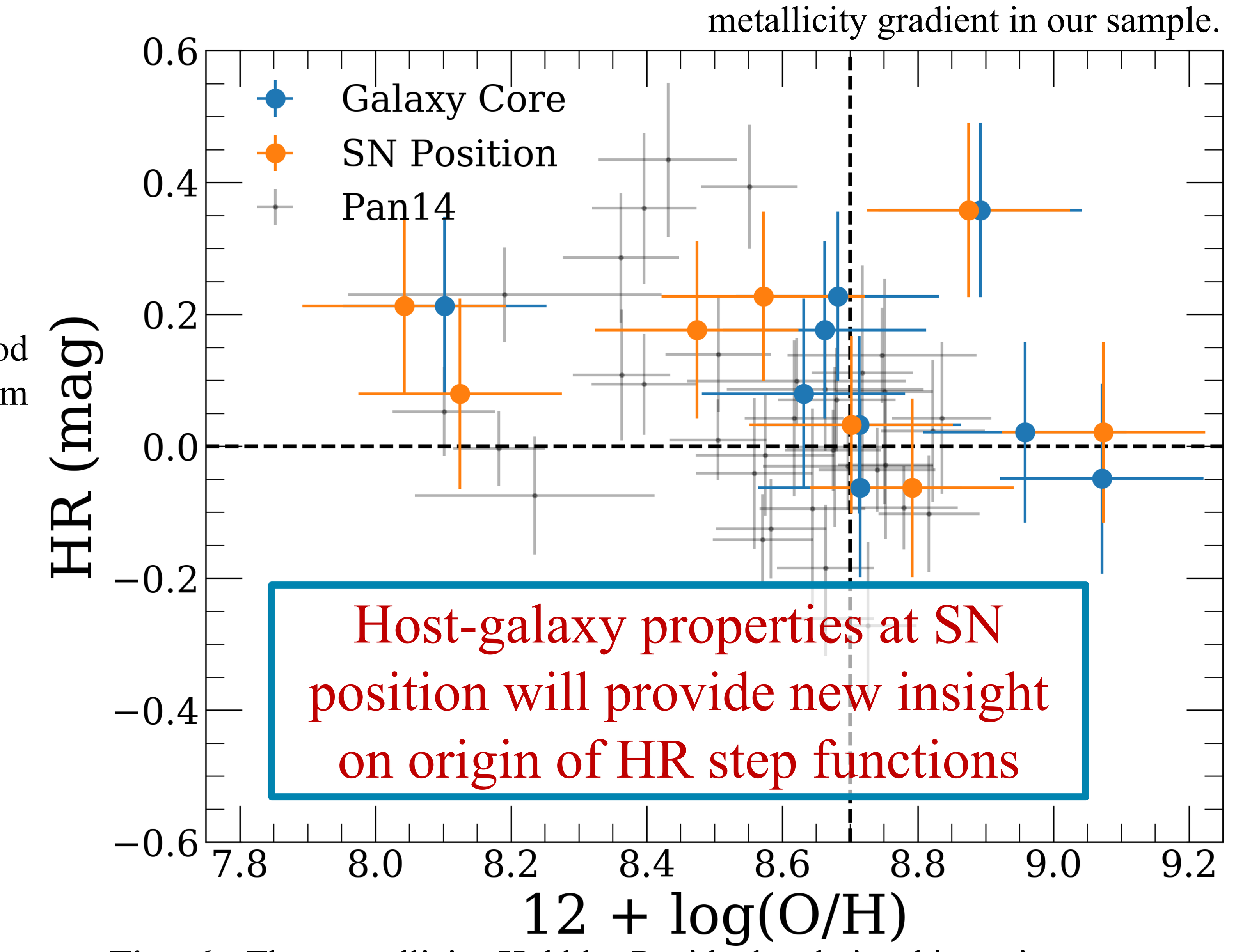


Fig. 6: The metallicity-Hubble Residual relationship using spectroscopic measurements from the galaxy core and SN location. Even with the limited sample, we see an indication of a metallicity step

Future Work

After the full sample has been reduced, we will investigate the functional form of the Hubble Residual step functions of mass, gas-phase metallicity, and sSFR. This will be the definitive sample for determining if metallicity drives the "mass-step", and whether we can infer that value from just photometry, or if spectra are required. Our initial results from the Keck SN Ia Galaxy Survey indicate that these data will be important for understanding the most extreme environments in a cosmological sample. An empirical host-galaxy mass correction is currently applied to SN distances without any knowledge of of its cause, potentially introducing a bias. The faintest galaxies in the Keck sample will serve as important local analogs and are essential for understanding how these biases could evolve with redshift.