Shooting for Star Cluster Chemical Abundances with *The Cannon*

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Motivation

Many open cluster chemical abundance studies have substantial uncertainties from study to study. A few reasons are due to varying data quality, the type of data, which catalog was used for distances, and different data analysis methods between studies. These differences translate into widely varying results when attempting to determine a chemical abundance gradient across the disk of the Milky Way. In this study, we determined chemical abundances for a set of 31 open clusters based on a uniform system.

Open Cluster Sample

Data for clusters used in this research were taken from a study by Frinchaboy & Majewski (2008). Observations were taken using the Blanco 4-m Hydra spectrograph in Chile. Frinchaboy & Majewski (2008) also did membership analysis for each cluster and Figure 1 is an example of the results for M67.

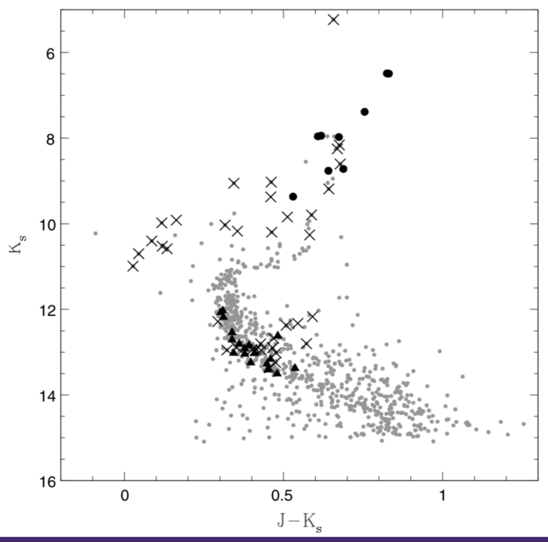


Figure 1: Color-magnitude diagram for NGC 2682 (M67). Members used in this study are shown as large black circles.

The Cannon

The Cannon (named after Annie Jump Cannon who is shown in Figure 2), developed by Ness et al. (2015), offers a unique way to find stellar parameters without having to use any models. Instead, it takes a subset of stars, called a reference set, with known parameters or "labels" and creates a model. This model can be applied to the rest of the set of stars to infer labels for them. The labels used for this study were taken from the Sloan Digital Sky Survey (SDSS) IV/ APOGEE DR14, which observed the same stars as our CTIO/Hydra-based study. The results from applying the reference set are shown in Figure 3.

Figure 2: Annie Jump Cannon examining a photographic plate. Credit: Harvard-Smithsonian Center for Astrophysics

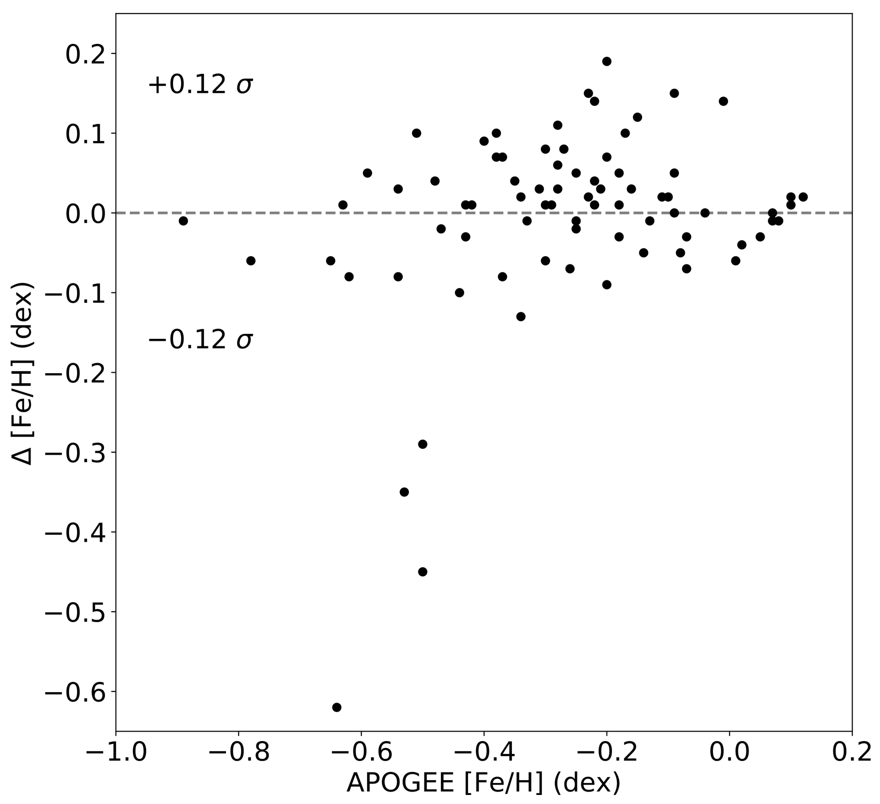


Figure 3: *The Cannon* output for the reference set compared to APOGEE DR14 parameters.

New Open Cluster Values

Cluster Name	No. of Stars *This Study*	[Fe/H] (dex)
Collinder 205	1	+0.05 ± 0.12
Collinder 258	1	+0.06 ± 0.12
NGC 2437	3	+0.09 ± 0.07
NGC 2546	1	+0.06 ± 0.12
NGC 2579	2	+0.06 ± 0.08
NGC 2669	1	+0.06 ± 0.12
NGC 5281	1	+0.09 ± 0.12
NGC 6124	3	+0.07 ± 0.07
NGC 6167	2	+0.07 ± 0.08
NGC 6250	1	+0.06 ± 0.12
NGC 6885	2	−0.34 ± 0.08
Ruprecht 119	1	+0.06 ± 0.12

We found average [Fe/H] values for 12 open clusters that do not have prior measurements from spectroscopic data. The preliminary results are shown in the table to the right.

Comparison to Other Studies

In order to confirm our results, we compared [Fe/H] cluster values to two high resolution spectroscopic surveys, one by Santos et al. (2009) and another by Reddy et al. (2013;2015). We also compared to 14 additional studies with varying resolutions. Three one-to-one plots of comparisons are shown in Figure 4.

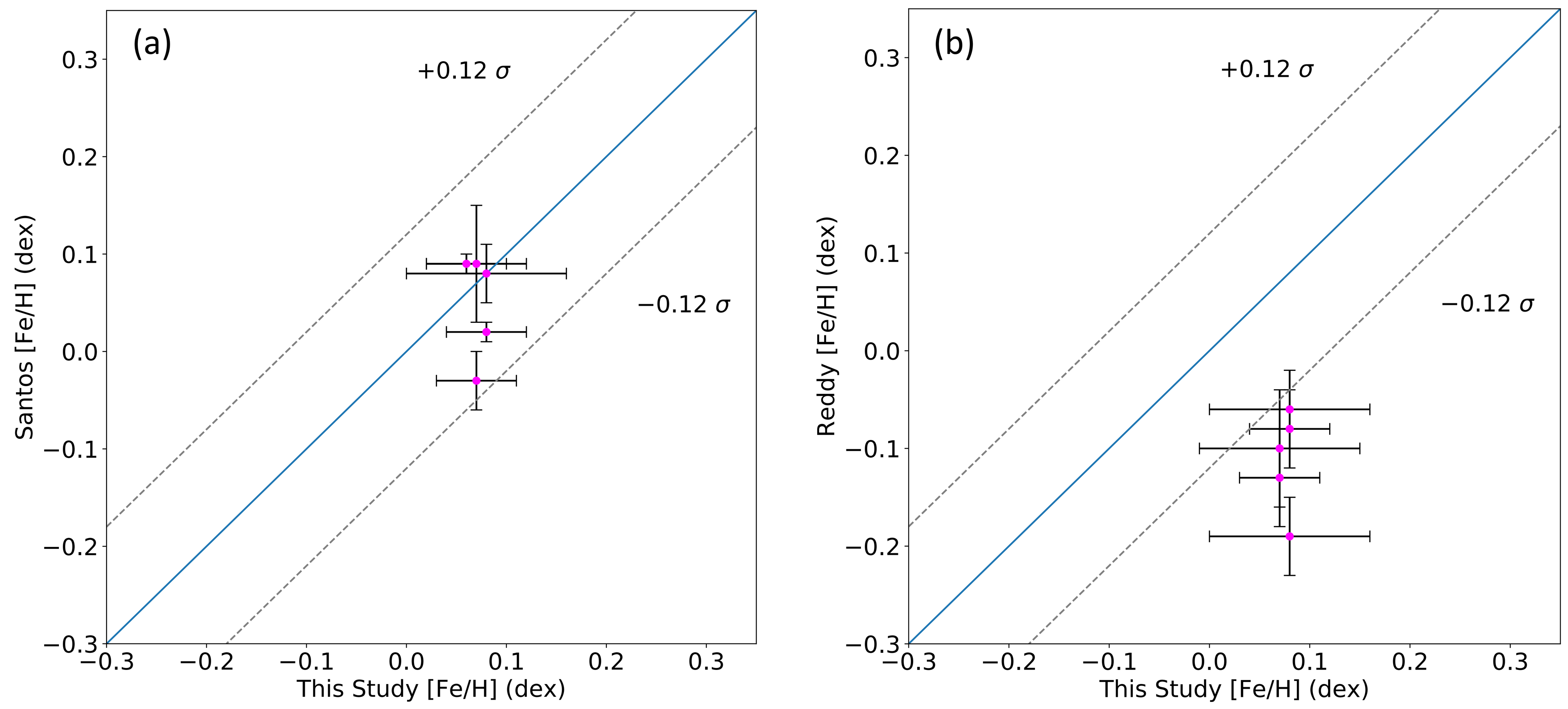
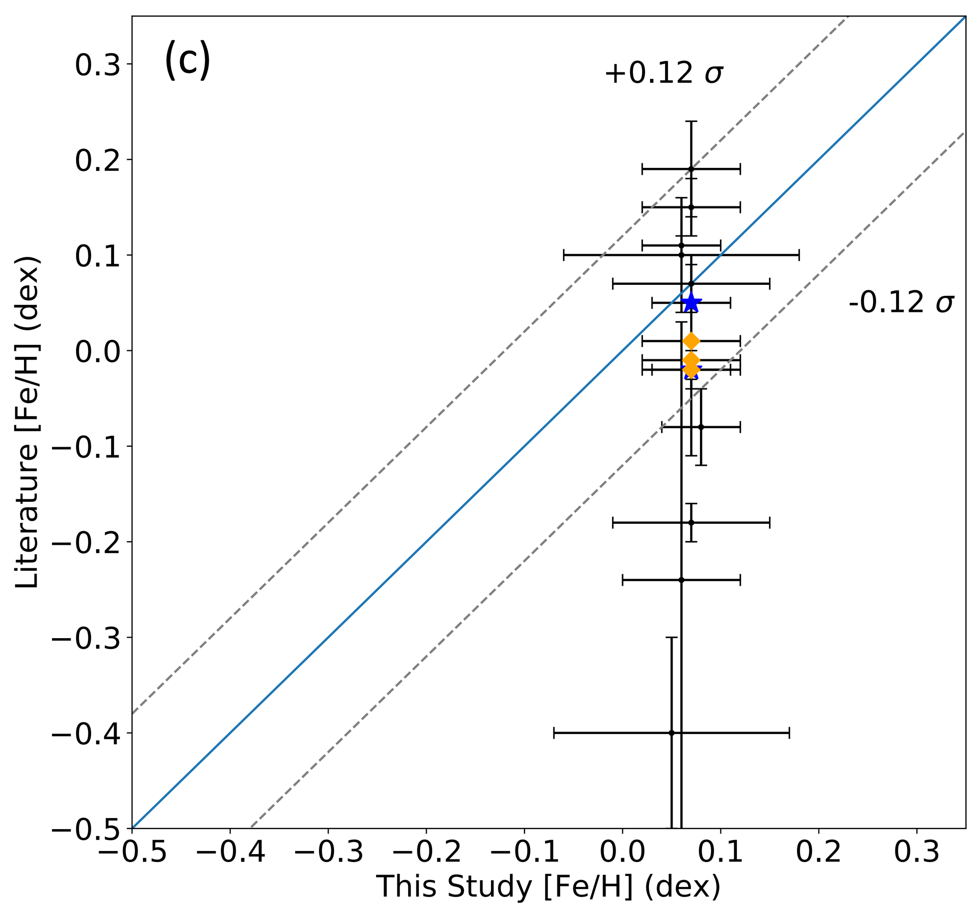


Figure 4: (a) Comparison to 5 open clusters in common with Santos et al. (2009). (b) Comparison to 5 open clusters in common with Reddy et al. (2013;2015). (c) Comparison to other studies for 11 open clusters.



Future Work

We will combine the clusters from this study with 19 from a study by Donor et al. (2018) that are also based on APOGEE data. This will allow us to examine abundance trends in the galactic disk over a larger radius. There are 22 additional open clusters that can be analyzed with *The Cannon* after completing membership analysis.

References

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