The Most Metal-Poor Candidates in SDSS-I DR-5 (and SEGUE)

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Abstract

There are some 194,000 R = 2000 stellar spectra reported in the final public release of the Sloan Digital Sky Survey (SDSS-I), known as DR-5. Even after setting aside the stars observed during the course of early tests for the Sloan Extension for Galactic Understanding and Exploration (SEGUE), which will be considered in more detail in the future, this leaves a total of about 168,000 stellar spectra. The stars in this sample were targeted for a wide variety of reasons, and hence do not represent a sample from which an unbiased metallicity distribution function (MDF) of stars in the thick-disk or halo populations may be drawn. However, there exist some 4000 stars with estimated metallicities [Fe/H] < −2.0 and effective temperatures in the range 5000 K < T_{eff} < 7000 K among this sample, based on application of the SDSS/SEGUE Spectroscopic Parameter Pipeline (SSPP) described in other contributions at this meeting.

This sample represents, by a factor of more than two, the largest database of very metal-poor stars yet assembled. We report on the catalog of these stars, and show preliminary results derived from results of the SEGUE observations conducted to date.

Introduction

Detailed understanding of the nature of the first generations of stars has long been limited by the relatively small existing samples of stars in the Galaxy with the lowest measured abundances, [Fe/H] < −2.0. Even after some 50 years of effort, a total of no more than 2000 such stars have been discovered from the summed effort of armies of astronomers.

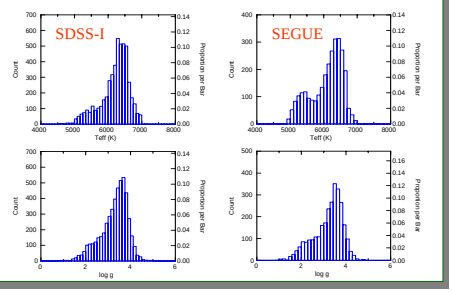
The huge database of stellar spectra obtained during the course of SDSS-I, many of which were originally targeted as spectrophotometric or reddening calibration objects, and ongoing work from SEGUE, is rapidly improving this situation.

Here we describe a sample of over 5000 stars from SDSS-I and SEGUE with reasonably accurate determinations of [Fe/H] based on the SSPP (see poster 168.15 for details) that are consistent with [Fe/H] < −2.0. The kinematics of a subset of these stars are considered in poster 168.09.

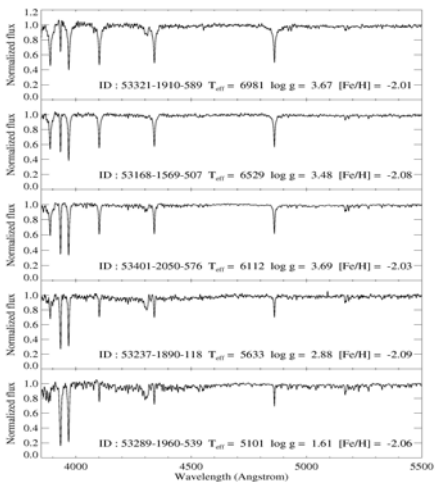
For the purpose of this exposition, we have selected stars from these surveys over the temperature range 5000 K < T_{eff} < 7000 K, where the SSPP is expected to perform the best. The expected errors in metallicity for the stars with S/N > 10/1 are on the order of 0.20-0.25 dex.

Distribution of T_{eff} and log g

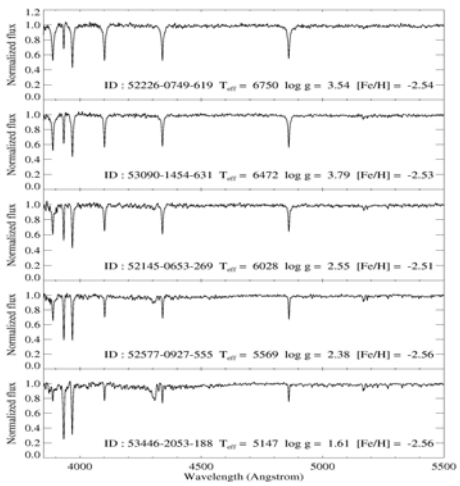
The figures below show the distribution of derived effective temperatures and surface gravities for the stars from SDSS-I and SEGUE with [Fe/H] < −2.0. Note that the SDSS-I sample has a larger fraction of warmer stars than the SEGUE sample; it is dominated by calibration objects. SEGUE targets stars with a wider range of atmospheric parameters, so as to better sample more distant stars, hence includes a larger fraction of cooler stars.



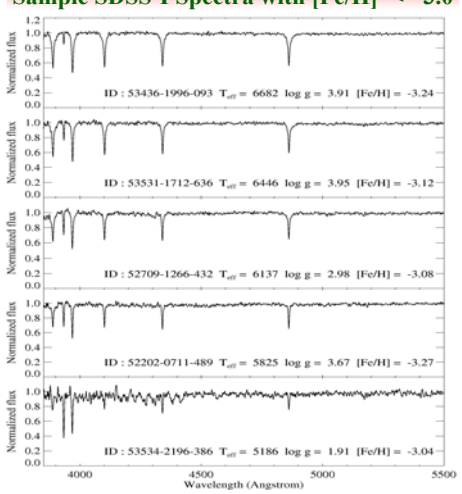
Sample SDSS-I Spectra with [Fe/H] ~ −2.0



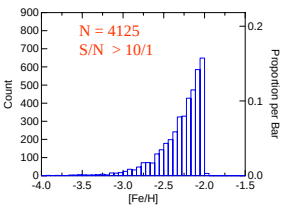
Sample SDSS-I Spectra with [Fe/H] ~ −2.5



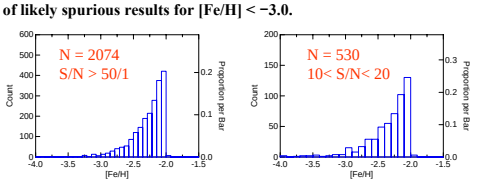
Sample SDSS-I Spectra with [Fe/H] < −3.0



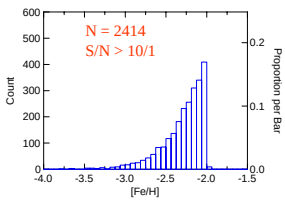
The Low-Metallicity Tail of the Metallicity Distribution Function of SDSS-I Stars



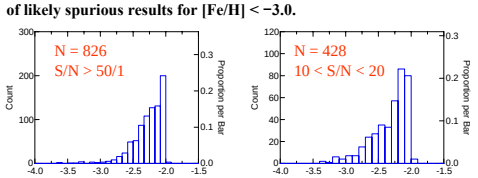
The low-metallicity tail of the observed MDF for SDSS-I stars. In the top panel is the complete sample including all stars with spectra having S/N > 10/1. In the lower two panels, we contrast the highest quality (S/N > 50/1) and lowest acceptable quality (10 < S/N < 20/1) samples. Note that the lower S/N sample includes a number of likely spurious results for [Fe/H] < −3.0.



The Low-Metallicity Tail of the Metallicity Distribution Function of SEGUE Stars



The low-metallicity tail of the observed MDF for SEGUE stars. In the top panel is the complete sample including all stars with spectra having S/N > 10/1. In the lower two panels, we contrast the highest quality (S/N > 50/1) and lowest acceptable quality (10 < S/N < 20/1) samples. Note that the lower S/N sample includes a number of likely spurious results for [Fe/H] < −3.0.



Results and Discussion

We have assembled our present best information on the MDF of low-metallicity stars based on application of the SSPP to data from SDSS-I and SEGUE. A few points are to be noted:

• Although SDSS-I is now complete, the SSPP is not quite in its final stage of development and refinement. This milestone will likely occur within the next few months, but until then, results should still be considered preliminary.

• The data presently in hand from SEGUE represents only about 1/3rd of the total amount of spectroscopy that will be obtained in the next two years. The majority of the SEGUE data obtained is in directions at lower galactic latitude, where the fraction of halo stars is likely to be substantially lower than that which will be found at higher latitudes.

• To obtain measurements of the full suite of elemental abundance patterns for numerous stars, high-resolution spectroscopic follow-up observations of as many SDSS-I/SEGUE targets as possible should be carried out in the near future. A first-pass effort to accomplish this goal has already started using the Hobby-Eberly Telescope for some 1000 of the brightest (g < 16.0) stars with [Fe/H] < −2.0. Since many of the most interesting stars revealed in these surveys have fainter magnitudes, dedicated surveys with new and future high-throughput spectrographs on 8m and eventually 20-30m telescopes will be required in order to make full use of the bounty of information that is now coming available.