Project Summary

This is a proposal to identify and make detailed analyses to determine the chemical composition of the most chemically deficient stars in the Galaxy. These are among the first stars formed in the Galaxy and the abundance patterns carry the imprint of the first events and processes that began the chemical enrichment of the Galaxy. Current thinking is that the first post-Big Bang synthesis of elements was in very massive "Pop III" objects that may have pre-dated the formation of the Galaxy and in "classical" core-collapse supernovae (SNII) formed from the first generation of 8 - 80$M_{\odot}$ stars.

This proposal has several components. The principal ones are to:

- Efficiently and with high-fidelity identify bona-fida extremely metal-poor stars ([Fe/H]<-2.8; EMP) from the published lists of candidates and by selection from the publicly-released spectroscopic data from the Sloan Digital Sky Survey. This will be a continuation of a very successful program using the ESI spectrometer at the Keck II 10m telescope.

- Determine the abundances of elements throughout the periodic table, sampling elements from the full range of nucleosynthetic origin, for EMP stars. These abundances will be determined using spectra obtained with the newly-upgraded, high-resolution spectrometer HIRES at the Keck I 10m telescope. Particular emphasis will be on the light elements C, N, and O and the heavy neutron-rich elements thought to be made near the imploding core of SN II. The abundances will be used to (1) make a careful census of the different classes of EMP star abundance patterns, (2) directly test the models for metal-poor SNII nucleosynthesis in this regime where chemical evolution models are at their simplest, and (3) identify the nature of Pop III objects through their nucleosynthetic fingerprints.

- Identify the source(s) of C in EMP stars. The procedure will be to use spectrum synthesis of CH in the ESI spectra to measure [C/H] in a large sample of EMP stars covering a range of evolutionary status from the main sequence to almost the tip of the Red Giant branch. The trends with evolutionary state, and between C and other classes of elements from distinct nucleosynthetic origins will be analyzed. A program monitoring the radial velocity of a large sample of EMP stars with unprecedented precision ($<$ 50 m/sec) using the Lick planet finding procedures will also be used to determine the fraction of binary stars in the C-rich and C-poor subsamples.

Much of the proposed work will be carried out by post-doctoral researchers, graduate students and undergraduates providing training in a forefront scientific investigation. We will also make the Keck spectra freely available via a public WWW site. Other workers in the field will have full access and these legacy-quality data will be available for educational purposes.