Chemical abundance analysis of the Galactic outer halo stars with Subaru/HDS

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We present chemical abundances of 57 metal-poor ([Fe/H]<-1) halo stars whose orbit reach distances of more than 5 kpc above and below the Galactic plane (Z_{max}>5 kpc). Based on the high-resolution spectra obtained with Subaru/HDS, chemical abundances of odd-Z, alpha, Fe-peak, neutron capture elements were derived. Our results suggest that the outer halo sample have lower [Mg/Fe] ratios than the inner halo stars.

Motivations

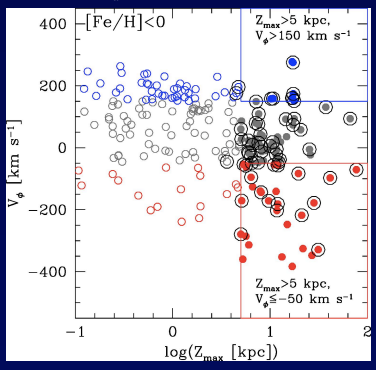
Making constraints on the hierarchical assembly history of the MW halo using kinematics and chemical abundances of solar-neighborhood metal-poor stars as tracers.

✧ **Examining chemical abundance inhomogeneity among nearby halo stars as a function of their kinematics, especially targeted at the *outer halo***

✧ **Comparing the abundance ratios of the outer halo stars with metal-poor stars belonging to the MW satellite galaxies.**

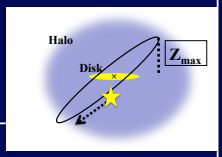
Sample kinematics

A plot of samples with known kinematics and abundance analyses on a Z_{max}-V_Φ plane



☐ The sample in this study (*symbols marked with large open circles*): 57 bright (V>13 mag) metal-poor ([Fe/H]<-1) stars with Z_{max}>5 kpc and various V_Φ

☐ Samples from literature: Samples from Stephens & Boesgaard 2002; Gratton 2003, that include a large number of Z_{max}≤5 kpc stars



Subaru/HDS Observation

✧ Dates: July 26, 27 2008.

✧ Spectral coverage: ~4050-6700

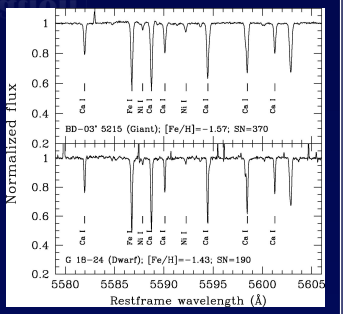
✧ Wavelength resolution: R≈50000

✧ Signal-to-noise ratio: >100

✧ Number of targets: ~30

(Other half of the sample were already observed and analyzed in Zhang et al. 2009, in prep.)

✧ Data reduction: standard IRAF routines



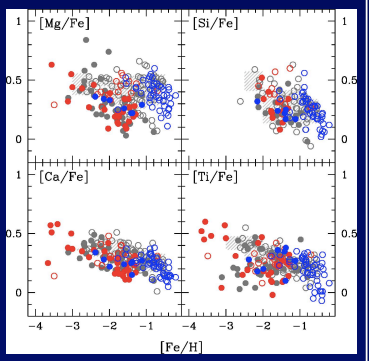
✧ Abundance analysis: Na, Mg, Si, Ca, Ti, Cr, Mn, Ni, Zn, Y, Ba + stellar atmospheric parameters (T_{eff}, log*g*, v_{turb}) were derived in a homogeneous manner using an LTE-abundance analysis code (Aoki et al. 2009).

Results

Derived abundance ratios ([X/Fe]) as a function of metallicity ([Fe/H])

☐ Z_{max} domains (***Inner/outer halo***)
- *Open* symbols: Z_{max}≤5 kpc (***Inner***)
- *Filled* symbols: Z_{max}>5 kpc (***Outer***)

☐ Vphi domains
- *Blue*: V_Φ>150 km s^{-1}
- *Gray*: -50<V_Φ≤150 km s^{-1}
- *Red*: V_Φ≤-50 km s^{-1}.



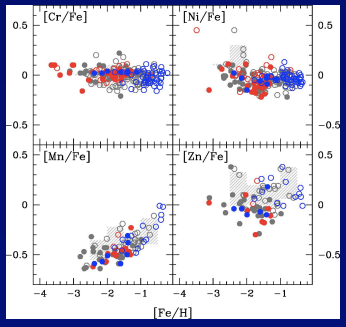
I. *α*-elements:

✧ In the metallicity range of -2<[Fe/H]<-1, the [Mg/Fe] ratios are lower by ~0.2 dex for the outer halo sample compared to the inner counterparts.

✧ Similar tendency is seen in the [Ca/Fe] plot, although the difference is relatively modest.

✧ For [Fe/H]<-2 samples, the inner and the outer halo samples are indistinguishable for these 2 elements, except for a few stars showing extremely high [Mg.Fe].

II. Fe-peak elements:



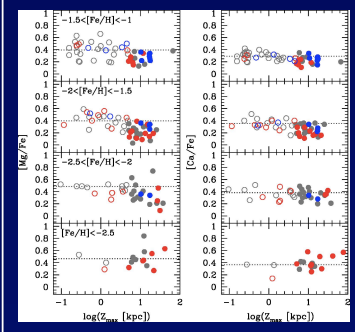
✧ The [Cr/Fe] and [Ni/Fe] ratios among the outer halo sample are approximately solar values with a very small scatter (<0.1 dex) in the surveyed [Fe/H] range.

✧ The [Mn/Fe] ratios show a increasing trend with [Fe/H].

✧ The [Zn/Fe] tend to be lower for the outer halo sample in the metalllicity range of -2<[Fe/H]<-1.

Discussions

I. Abundance-kinematic relation - [*α*/Fe] vs log (Z_{max}) -

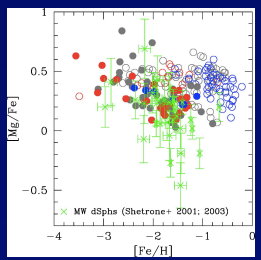


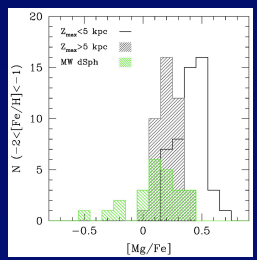
✧ For the [Mg/Fe] ratio, the outer halo sample have lower values on average, especially for the metallicity range of -1.5<[Fe/H]<-1.

✧ Because of our sample slection biased toward the high Z_{max} stars, presence of gradient with log(Z_{max}) is unclear.

II. Comparison of [a/Fe] with the MW satellites

- A [a/Fe] comparison between the MW satellite samples and the MW *outer halo* sample -





✧ Both population partly overlap in the metallicity range of -2<[Fe/H]<-1

✧ The lower [Mg/Fe] tail (<-0.1) seen among the MW satellite samples is not reproduced with the outer halo sample.

∗ For other elements (Na, Y, Ba, etc) and more detailed discussions on each elements, please see Zhang et al. (2009 in prep.) and Ishigaki et al. (2009 in prep.)

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