Abundance trends for α-elements in the Milky Way and Dwarf spheroidal galaxies

INASAN

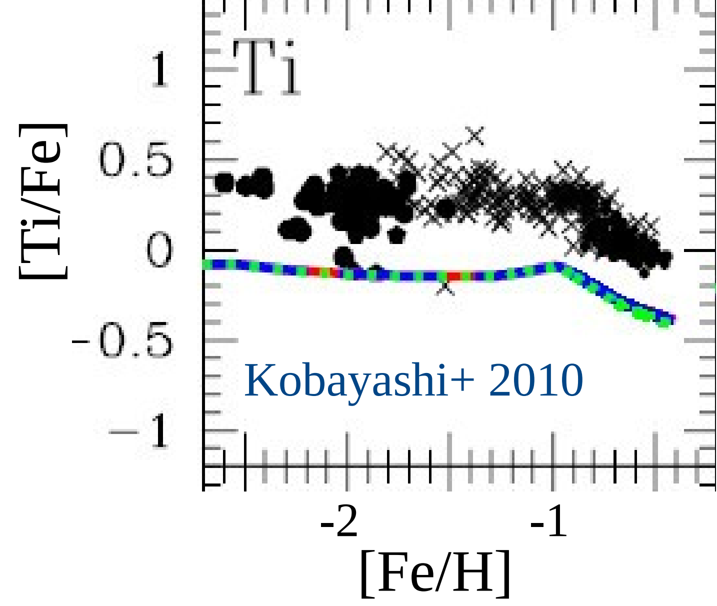
Tatyana Sitnova

Lyudmila Mashonkina

O

Mg, Si, Ca

Ti ?



α-process
BBFH 1957:

$$_{20}Ca^{40} + {}_{2}He^{4} \rightarrow {}_{22}Ti^{44} + \gamma$$

$$_{22}Ti^{44} + e^{-} \rightarrow {}_{21}Sc^{44} + \nu_{+} \qquad \tau_{\frac{1}{2}} \sim 1000 \text{ years}$$ 58 ± 10 years (Meβner 1995)

$$_{21}Sc^{44} \rightarrow {}_{20}Ca^{44} + \beta^{+} + \nu_{+} \qquad \tau_{\frac{1}{2}} = 3.9 \text{ hours.}$$

If the alpha-capture lifetimes are greater than 1000 years, then the foregoing decays occur before Ti^{44} captures another alpha particle. Then one has

$$_{20}Ca^{44} + {}_{2}He^{4} \rightarrow {}_{22}Ti^{48} + \gamma,$$

^{48}Ti: decay product of ^{48}Cr during Si burning, He fusion (SN II, Ia, Hughes+2008)

Maeda & Nomoto 2003:
bipolar SN, 40 M_{o}
[Ti/Fe] = 0.11 ([Fe/H] = -4, [O/Fe] = 0.62)

Nearby FGK dwarfs with -2.6 < [Fe/H] < 0.2

Accurate atmospheric parameters determined by common methods (Sitnova+2015)
T_{eff}: Infra red flux method
log g: Hipparcos parallaxes
[Fe/H] from NLTE analyses of Fe I and Fe II lines

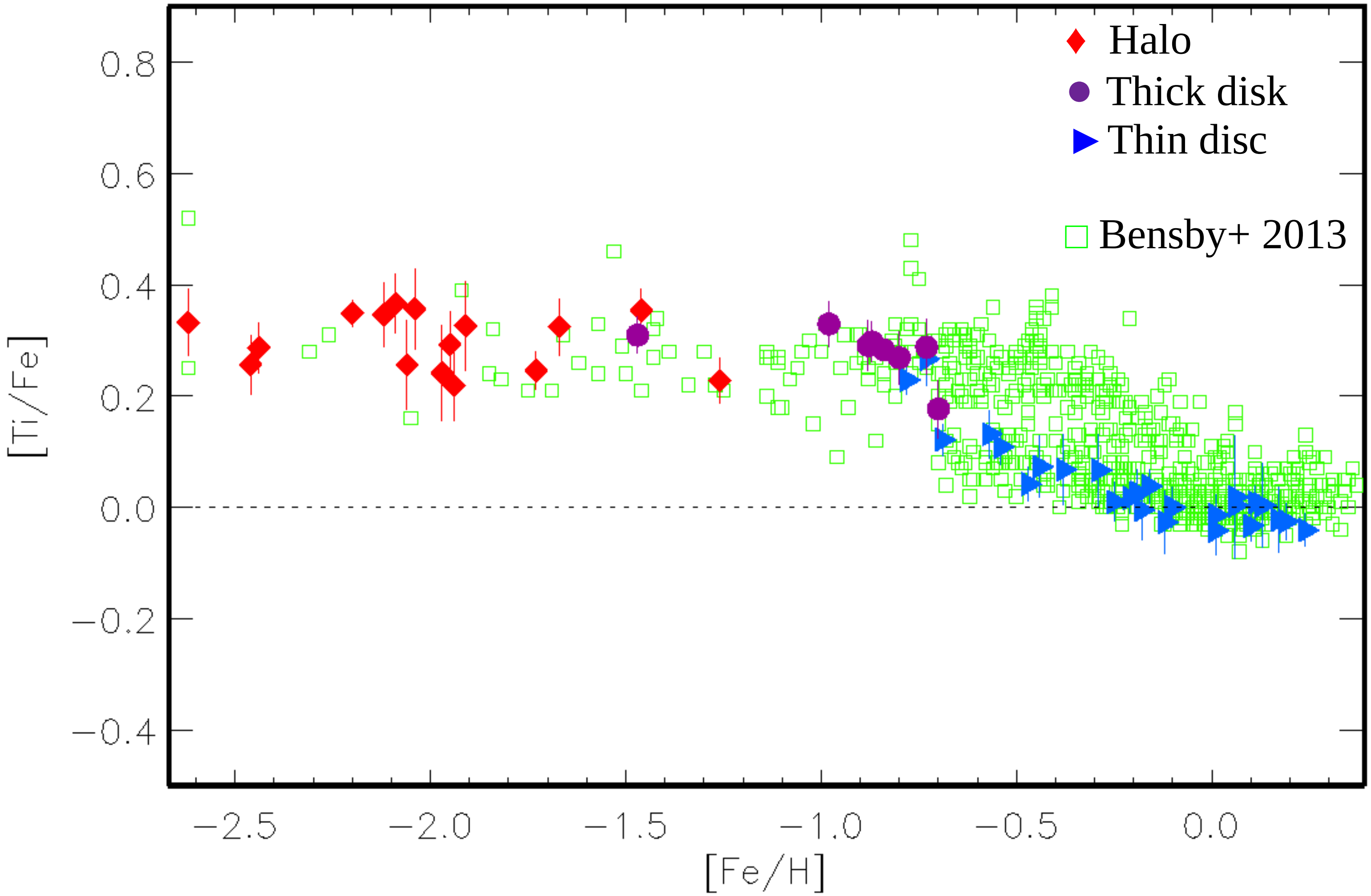
Ionisation equilibrium is fulfilled, and | Fe I – Fe II | < 0.06 dex in NLTE
T_{eff}, log g, [Fe/H] checked with evolutionary tracks from (Yi+ 2004)

MARCS model atmospheres (Gustafsson+2008)

NLTE level populations from DETAIL code (Butler and Giddings 1985, updated)
with model atoms:
O I (Sitnova+2013)
Mg I (Mashonkina+2013)
Ca I-II (Mashonkina+2007)
Ti I-II (Sitnova+2016)
Fe I-II (Mashonkina+2011)

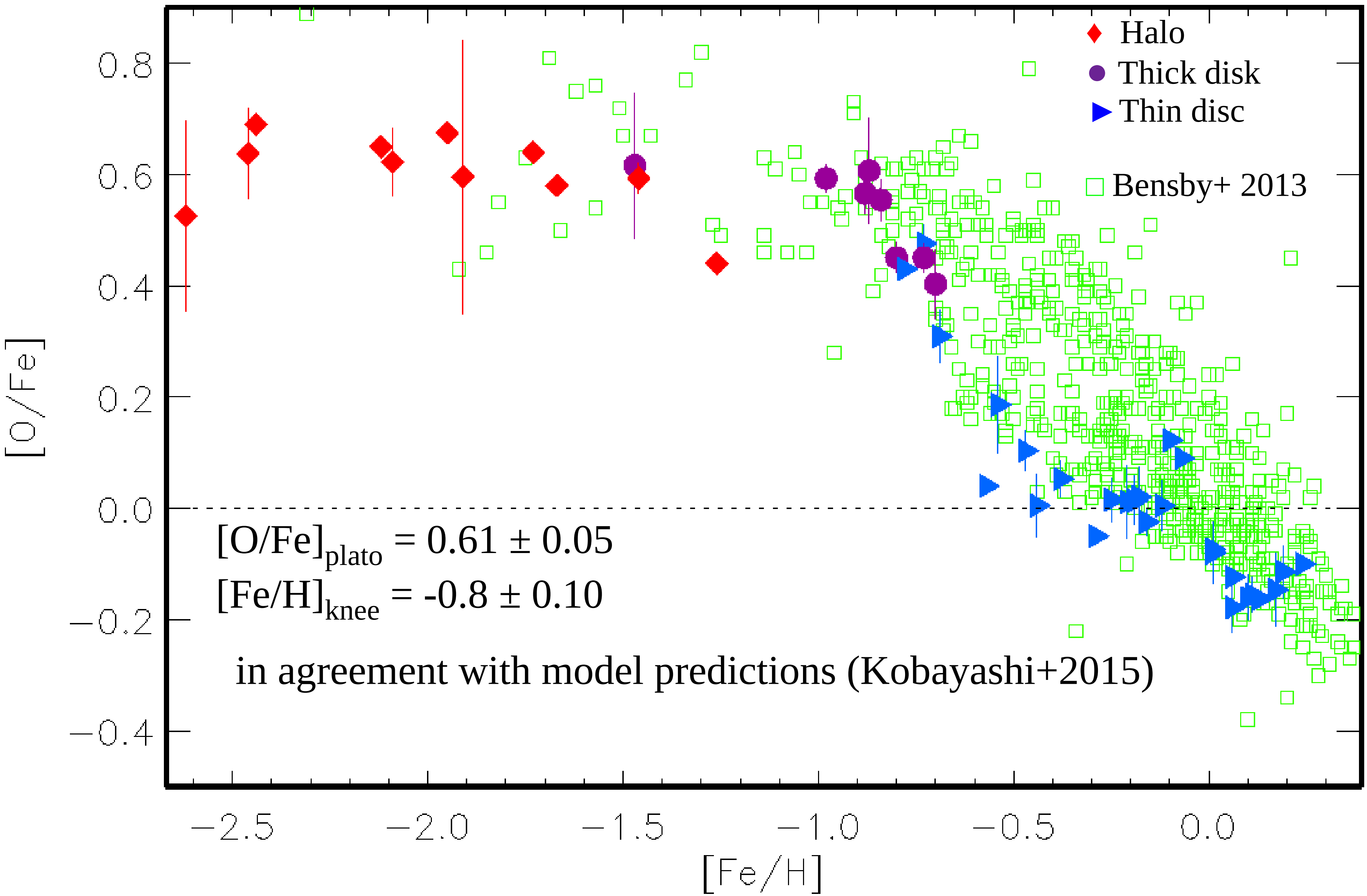
NLTE abundances from Ti II lines

$[Ti/Fe]_{plato} = 0.30 \pm 0.05$ $[Fe/H]_{knee} = -0.7 \pm 0.10$

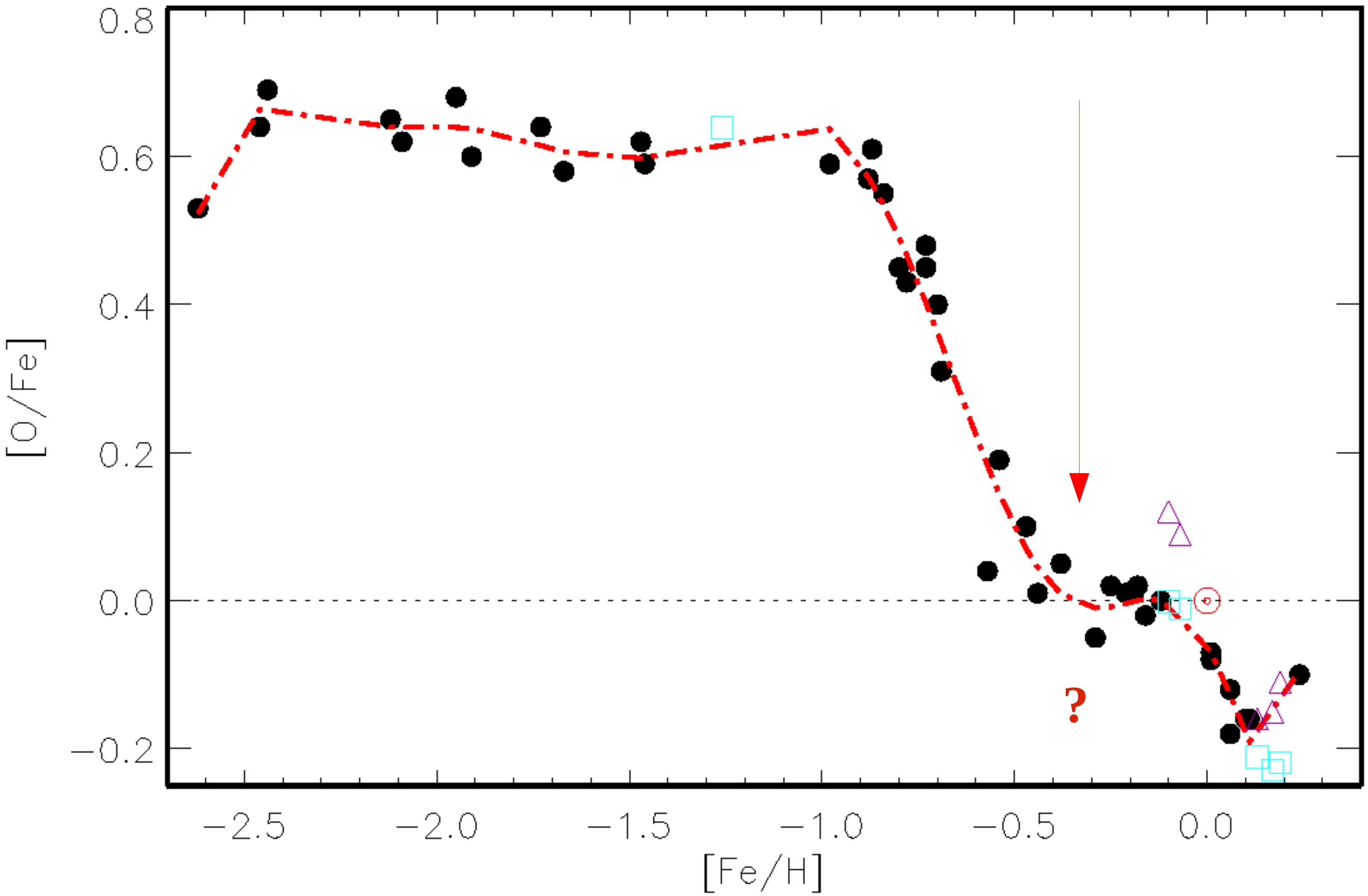


[Ti/Fe] behaviour is in line with [Ca/Fe], [Mg/Fe], [Si/Fe] (Zhao+2016)

NLTE abundances from O I lines



Thin disc stars: non-linear behaviour of [O/Fe] ([Fe/H] > -0.8)



Outliers:
HD142091,
HD30562,
HD82943,
HD89744,
HD115617 –
planet host stars

Solar [O/Fe] is
0.06 dex higher
compared to stars
with close [Fe/H]

? a signature of star formation quenching 8-10 Gy ago (Fuhrmann 2004, Haywood+2016)

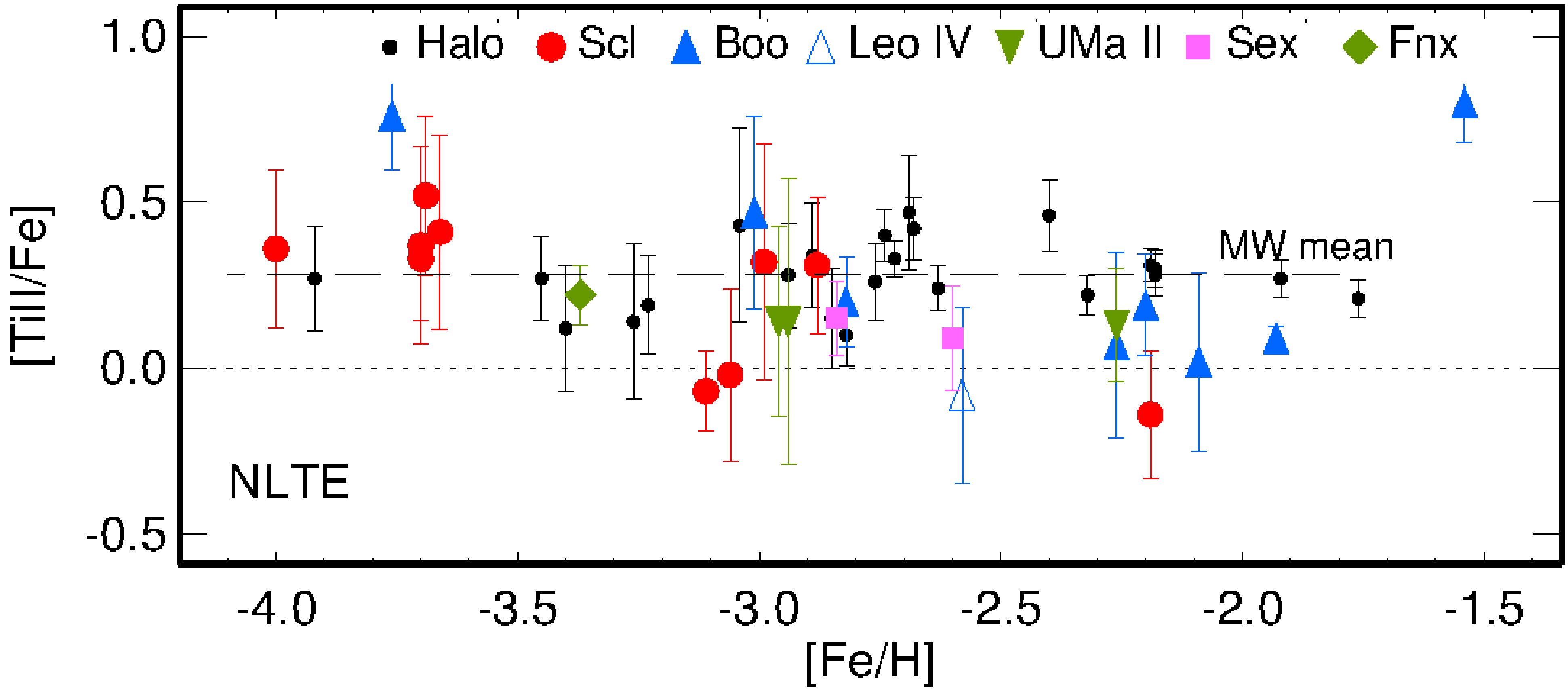
Analysis of VMP ([Fe/H] < -1.5) giants from MW and MW satellites

Classical: Scl, Sex, For
Ultra faint: Boo I, UMa II, Leo IV

+ 12 MW halo giants (comparison sample)

Method:
- non-spectroscopic T_{eff} and log g
- MARCS model structures
- EWs from the literature
- codes: WIDTH, DETAIL (for NLTE)

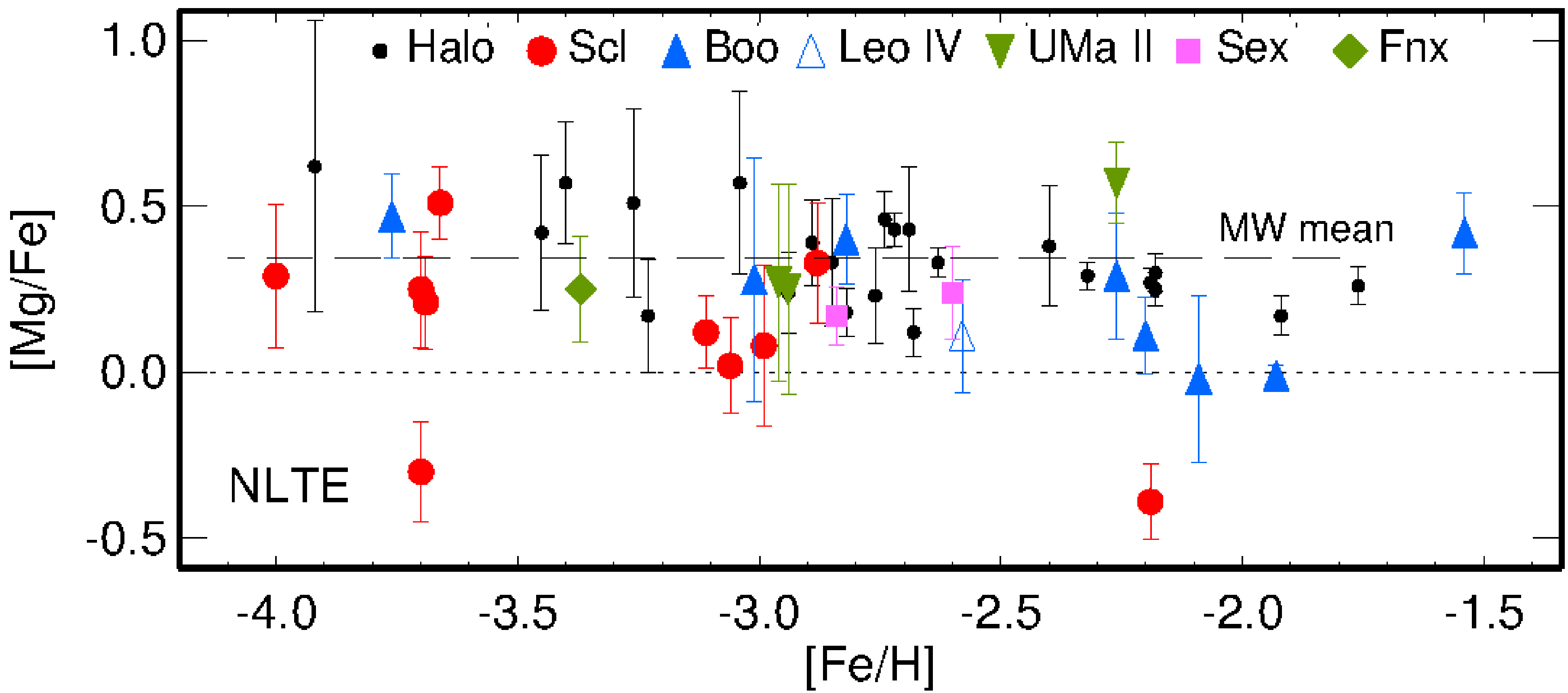
L.M. talk
(Mashonkina+2016, in preparation)



MW dwarfs and giants show the same $[Ti/Fe]_{plato}$

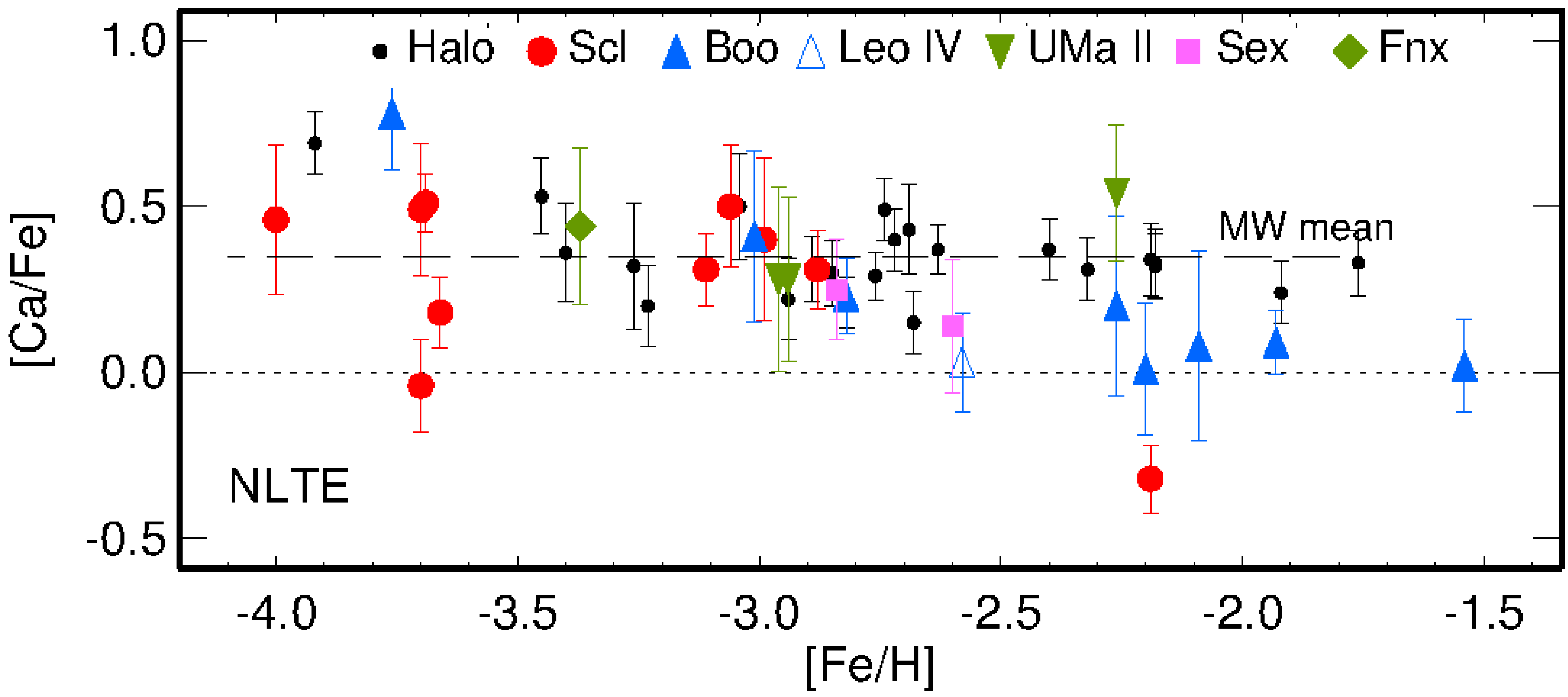
MW and MWS stars show the same $[Ti/Fe]_{plato}$

The same is true for [Mg/Fe] and [Ca/H]

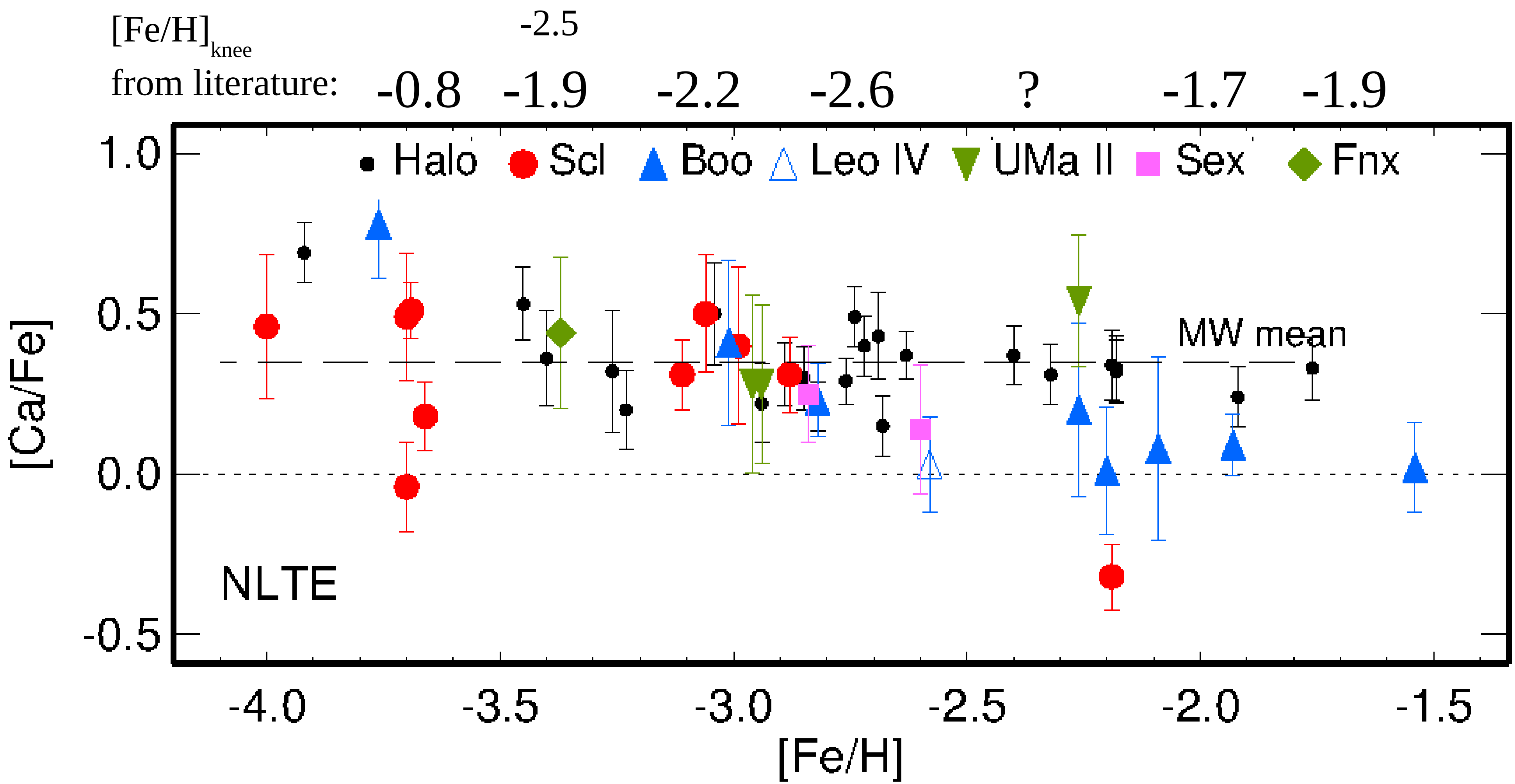


Halo
Scl
Boo
Leo IV
UMa II
Sex
Fnx
1.0
0.5
0.0
-0.5
[Mg/Fe]
MW mean
NLTE
-4.0
-3.5
-3.0
-2.5
-2.0
-1.5
[Fe/H]

3 outliers



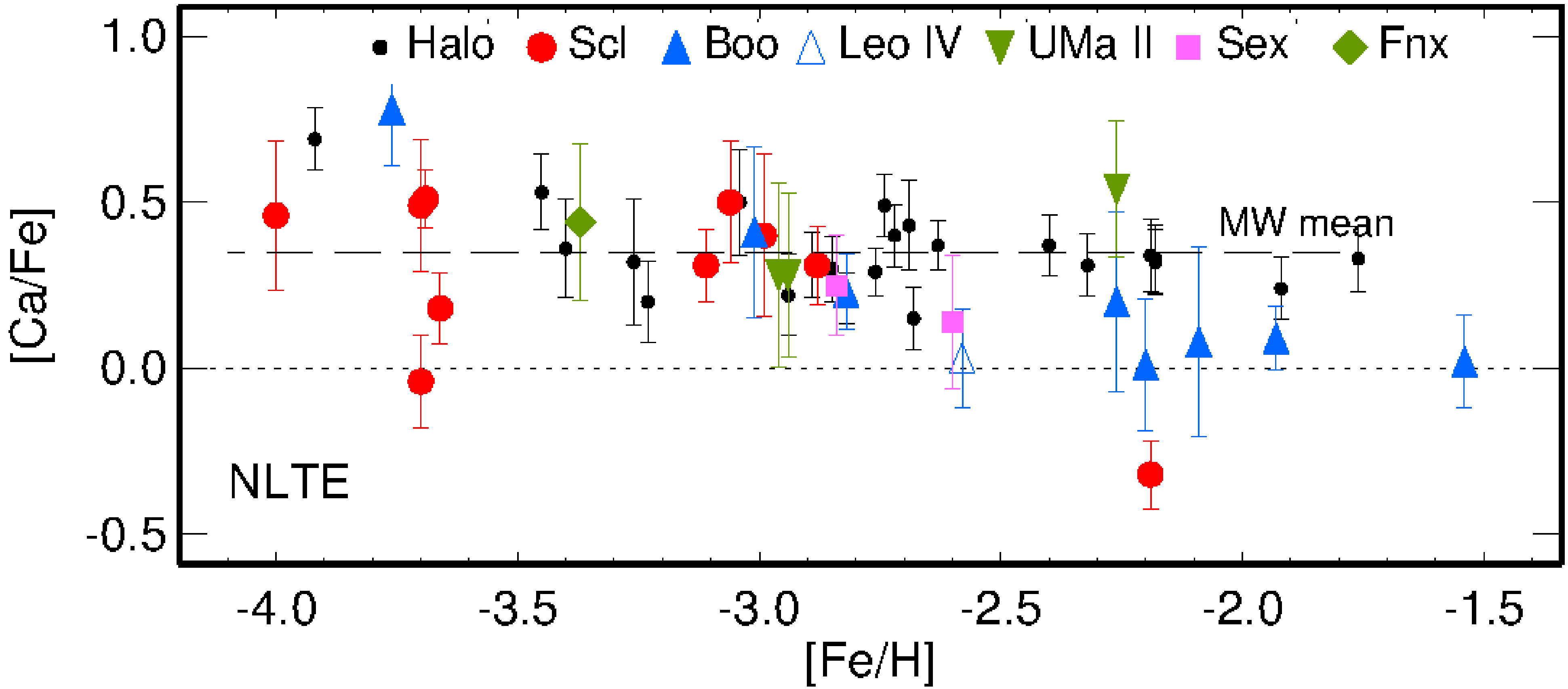
UFd Boo I, Leo IV : star formation time > 1 Gyr



UFd Boo I, Leo IV : star formation time > 1 Gyr

[Fe/H]$_{knee}$ -2.5

from literature: -0.8 -1.9 -2.2 -2.6 ? -1.7 -1.9



UFd Boo I, Leo IV : star formation time > 1 Gyr

To study formation history of MW and MWS comprehensive high resolution spectral observations are necessary.