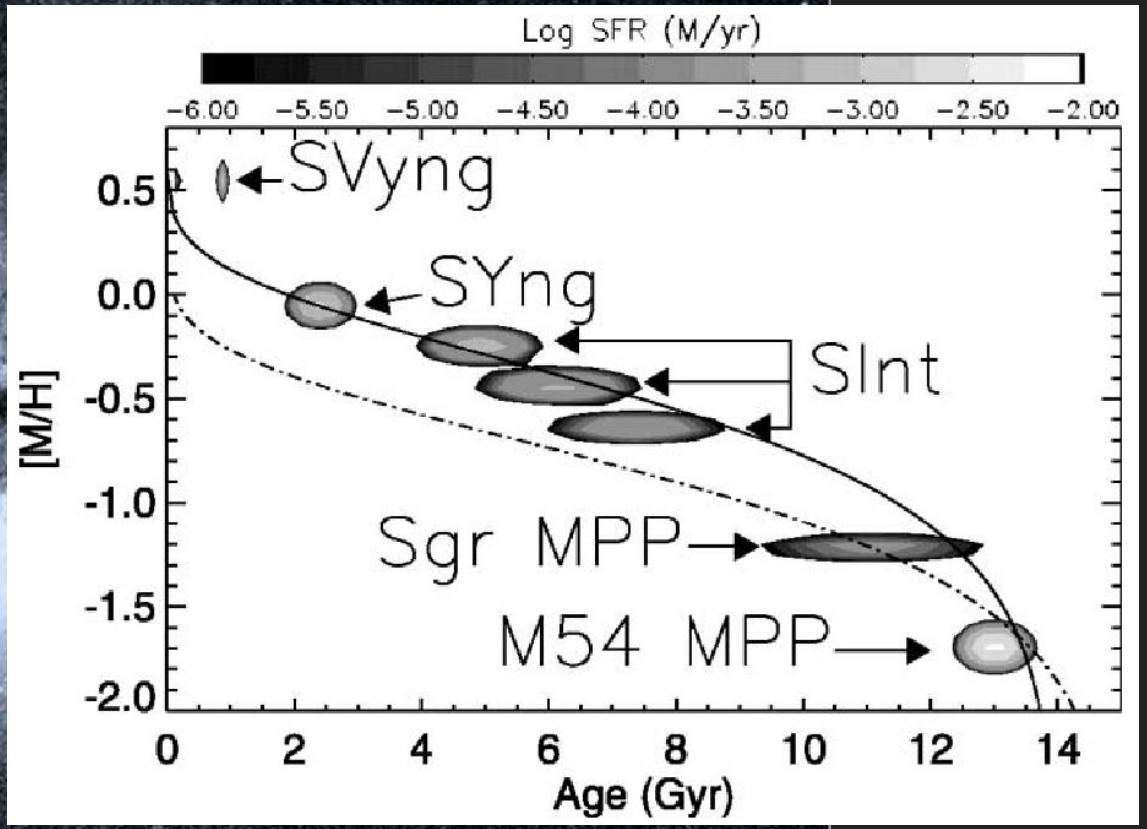
# APOGEE Chemical Abundances of the Sagittarius Dwarf Galaxy

Sten Hasselquist (NMSU)

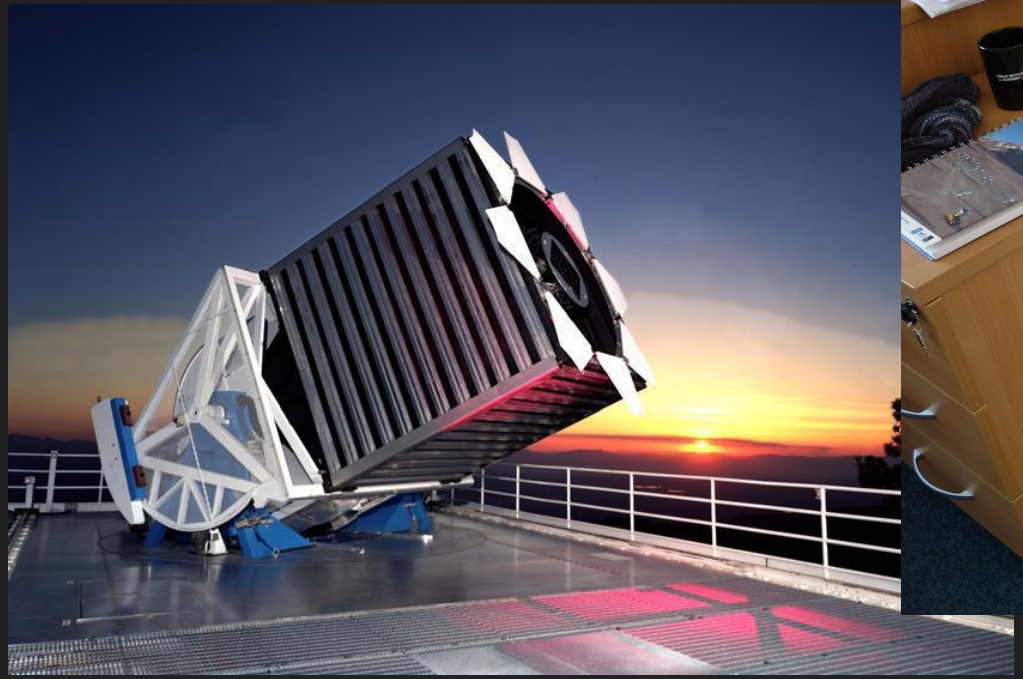
32nd New Mexico Symposium, NRAO

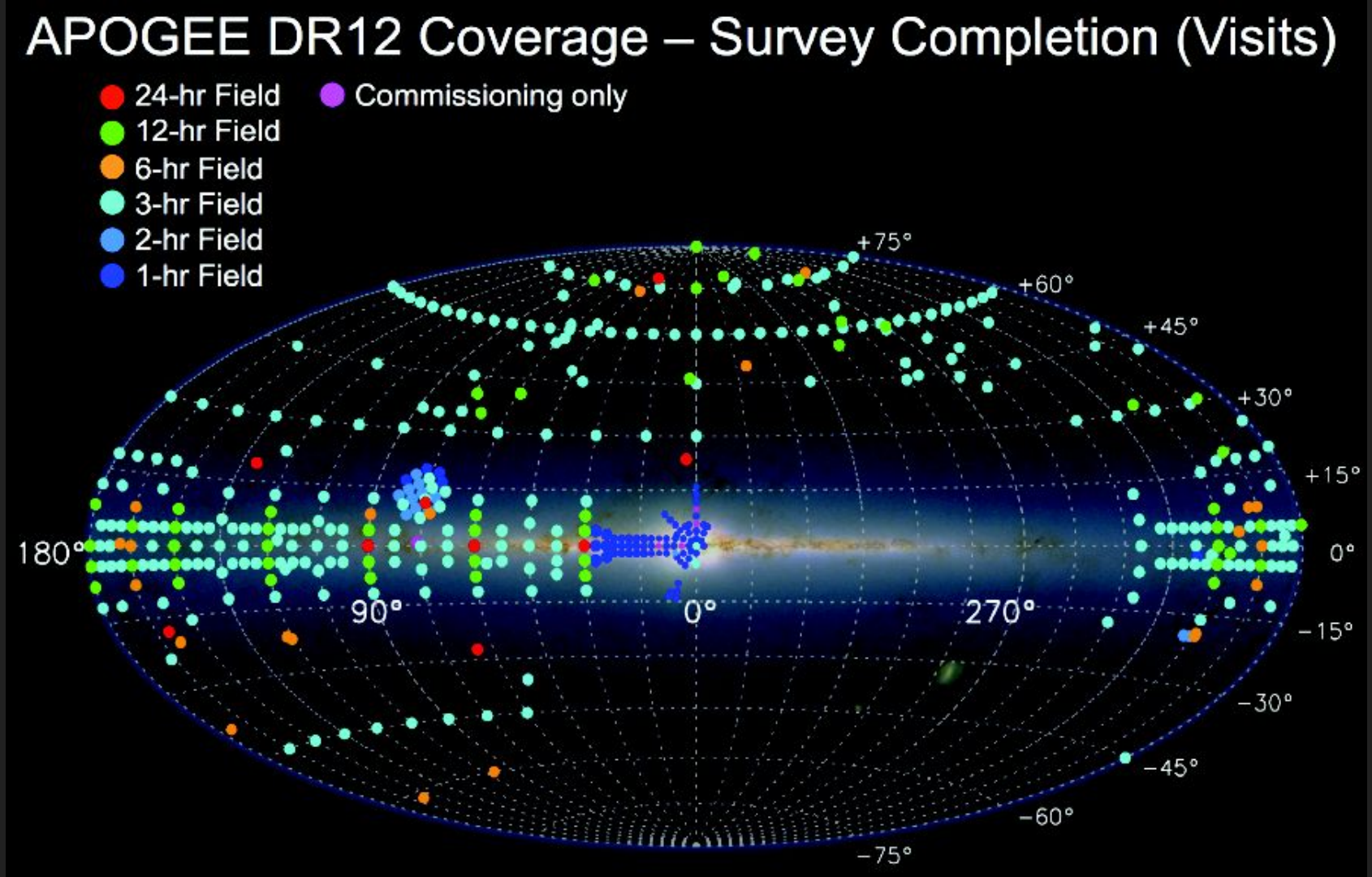
# What is Sgr?

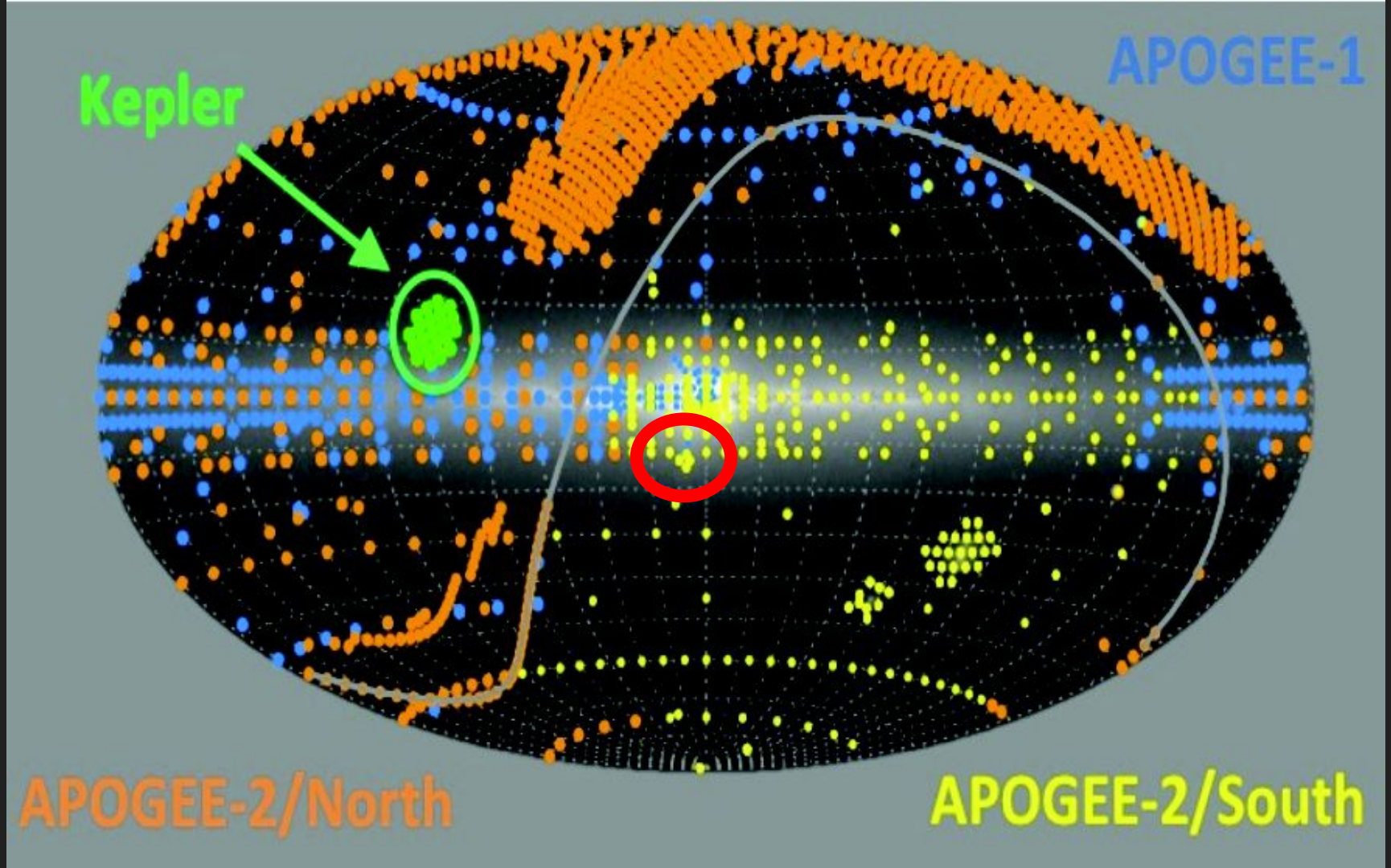
# What is Sgr?


Log SFR (M/yr)
−6.00 −5.50 −5.00 −4.50 −4.00 −3.50 −3.00 −2.50 −2.00
SVyng
SYng
SInt
Sgr MPP
M54 MPP
[M/H]
0.5
0.0
-0.5
-1.0
-1.5
-2.0
0 2 4 6 8 10 12 14
Age (Gyr)

# Apache Point Observatory Galactic Evolution Experiment (APOGEE)




APOGEE DR12 Coverage – Survey Completion (Visits)
24-hr Field
12-hr Field
6-hr Field
3-hr Field
2-hr Field
1-hr Field
Commissioning only
+75°
+60°
+45°
+30°
+15°
0°
−15°
−30°
−45°
−60°
−75°
180°
90°
0°
270°


Kepler
APOGEE-1
APOGEE-2/North
APOGEE-2/South

C, N, O, Na, Mg, Al, Si, P, S, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Nd, Ce, OH, MY

| CNO | Alpha | Odd -Z | Fe-peak | n-capture |
|---|---|---|---|---|
| **C** | **O** | **Na** | **V** | **Ce** |
| **N** | **Mg** | **Al** | **Cr** | **Nd** |
| **O** | **Si** | **P** | **Mn** | |
| | **S** | **K** | **Co** | |
| | **Ca** | | **Ni** | |
| | **Ti** | | | |

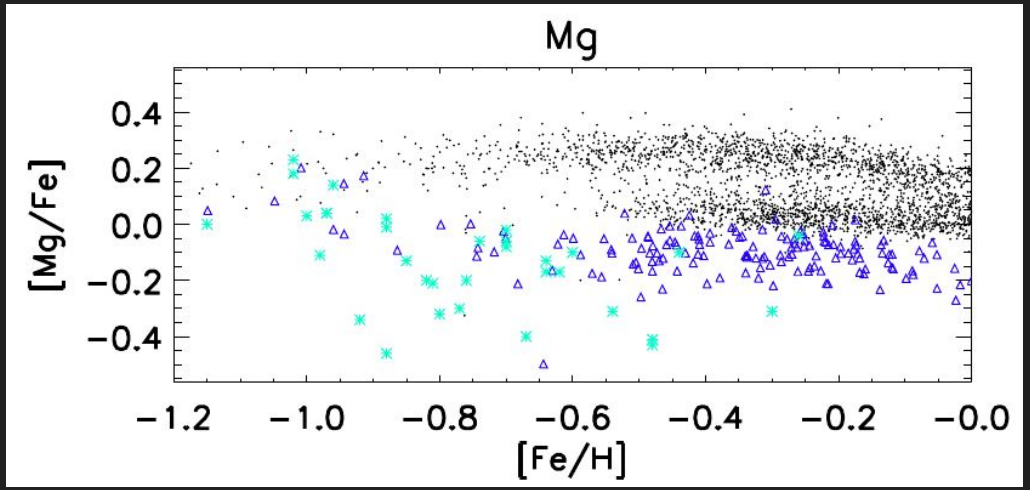
# Chemical Characterization of Sagittarius Dwarf Galaxy (Sgr)

-- APOGEE observed 350 Sgr members which is an order of magnitude more stars than the previous largest detailed chemical abundance study

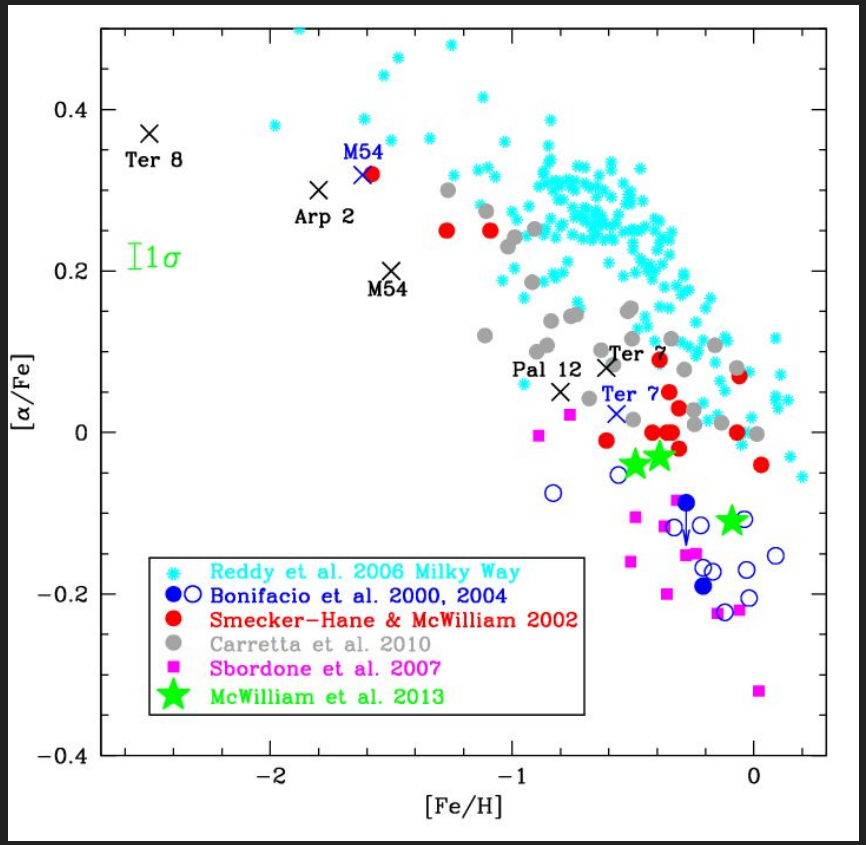
-- First time C, N, and some of the Fe-peak have been studied

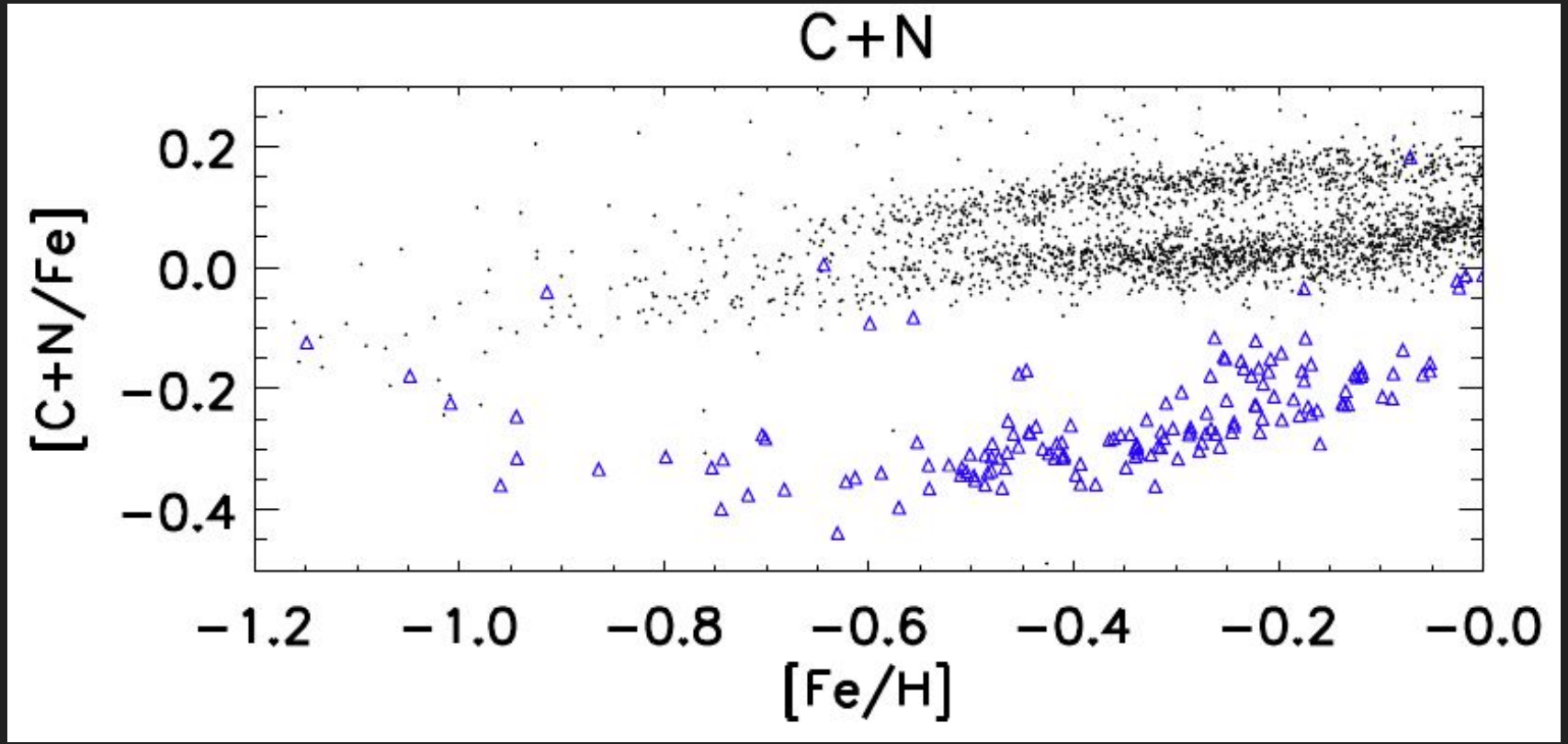
-- Previous largest chemical abundance study of Sgr to date done by McWilliam et al. 2013. Suggested that Sgr's lack of hydrostatic burning products indicates that at least the more metal rich Sgr stars formed from a top-light IMF

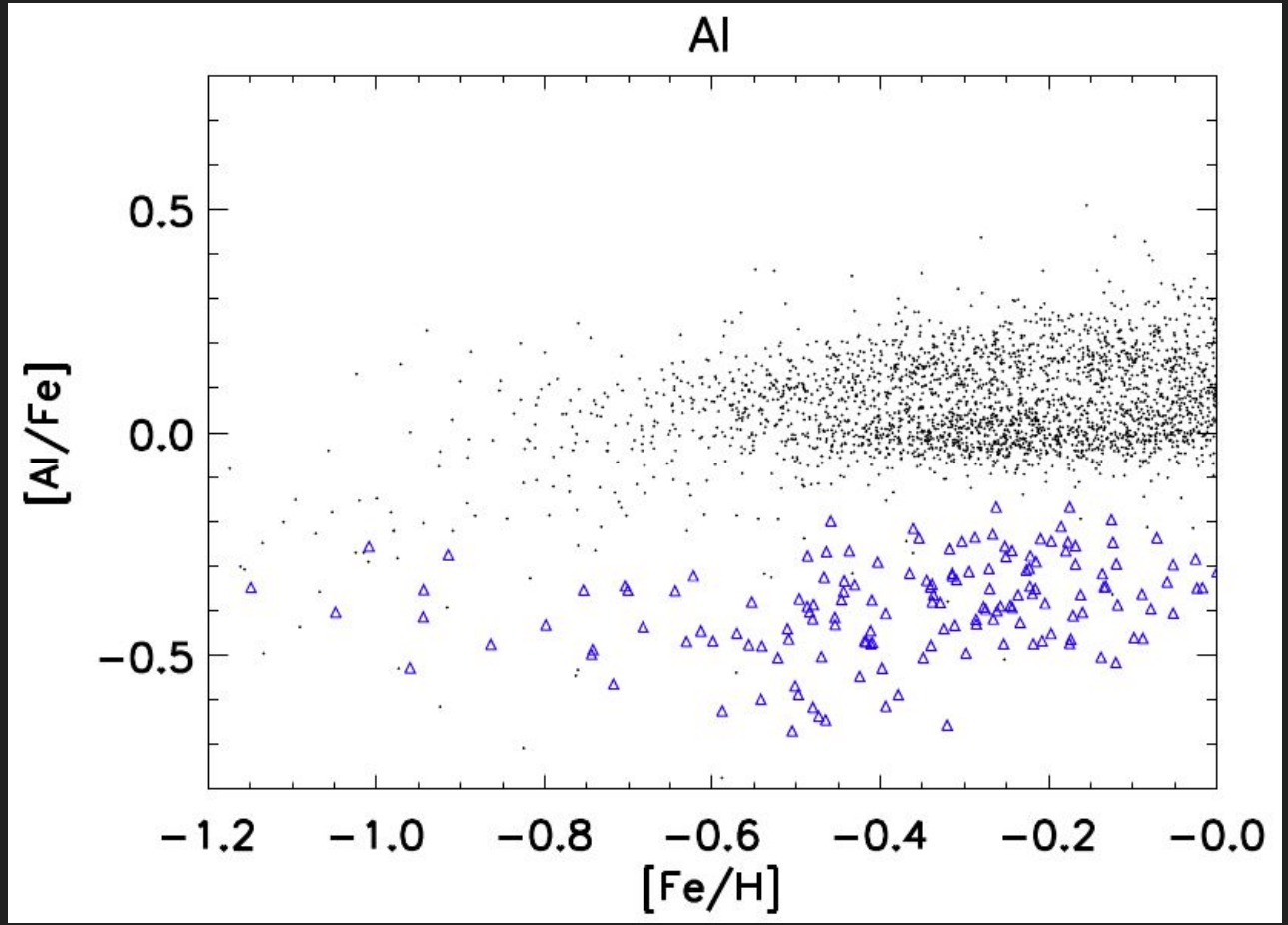
**-- What can we learn about dwarf galaxy star formation and chemical evolution from the APOGEE chemical abundances?**

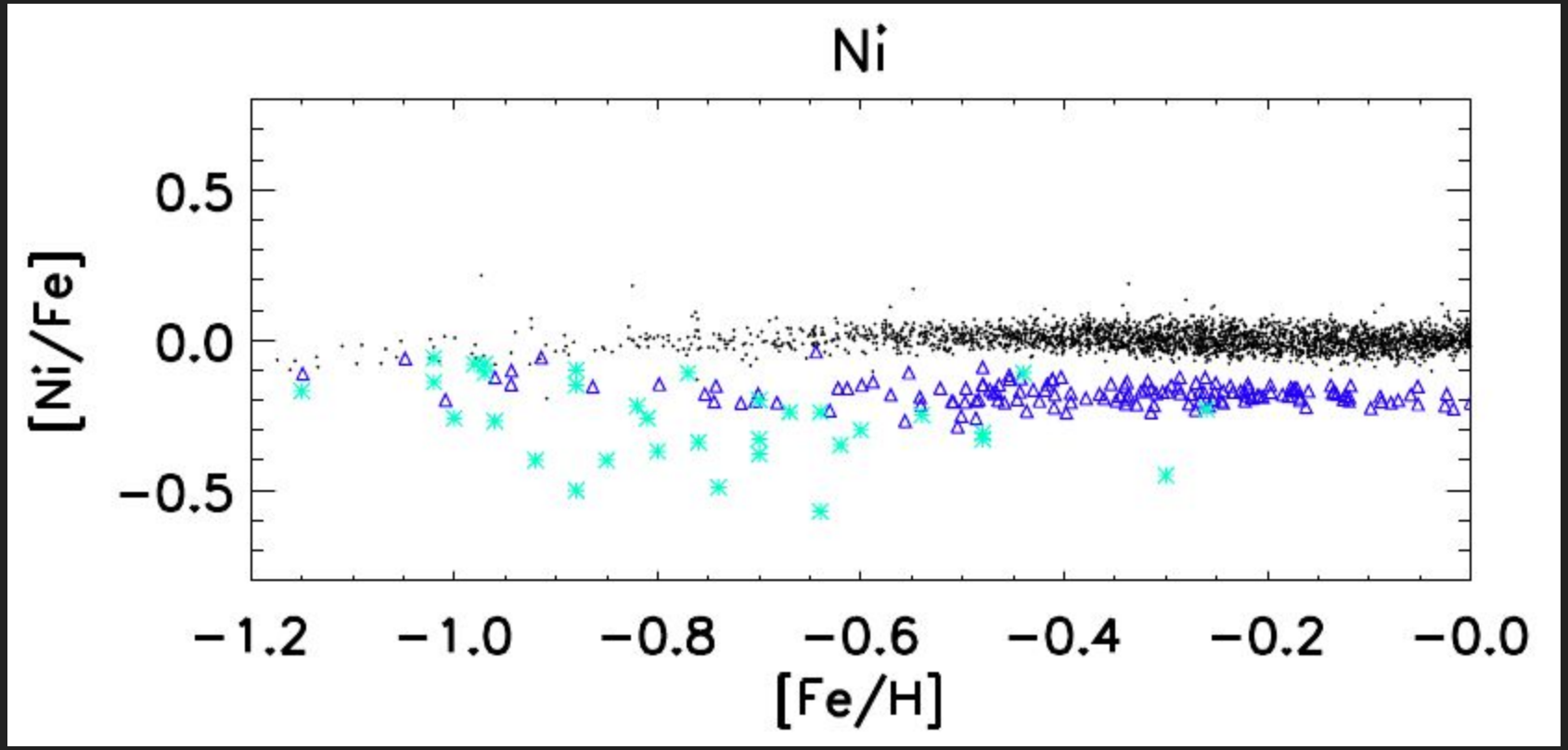

Mg
[Mg/Fe]
0.4
0.2
0.0
−0.2
−0.4
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
−0.0
[Fe/H]

MW
Sgr
Fnx


Ter 8
M54
Arp 2
M54
1σ
Pal 12
Ter 7
Ter 7
0.4
0.2
0
−0.2
−0.4
[α/Fe]
−2
−1
0
[Fe/H]
Reddy et al. 2006 Milky Way
Bonifacio et al. 2000, 2004
Smecker−Hane & McWilliam 2002
Carretta et al. 2010
Sbordone et al. 2007
McWilliam et al. 2013

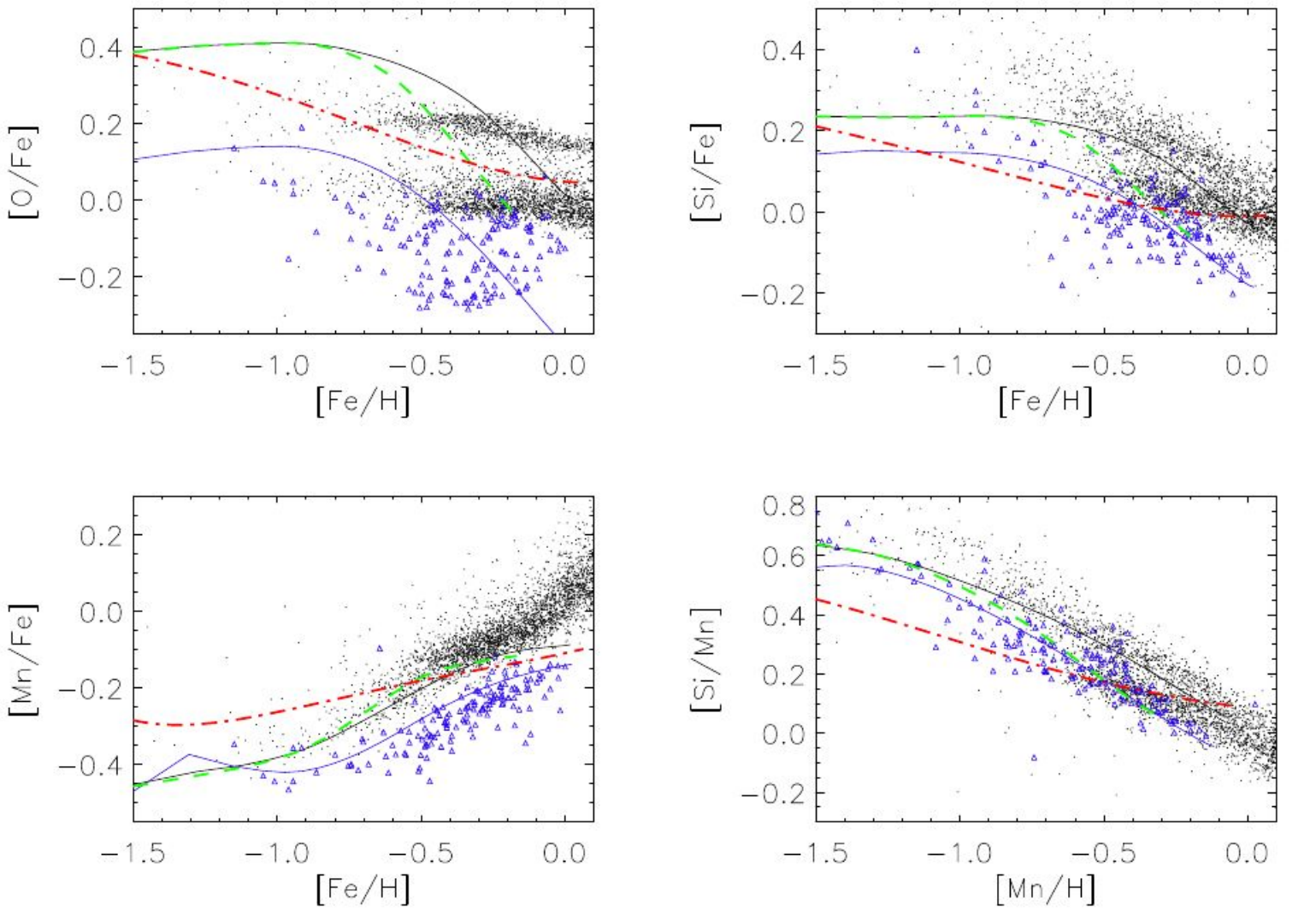

C+N
0.2
0.0
−0.2
−0.4
[C+N/Fe]
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
−0.0
[Fe/H]

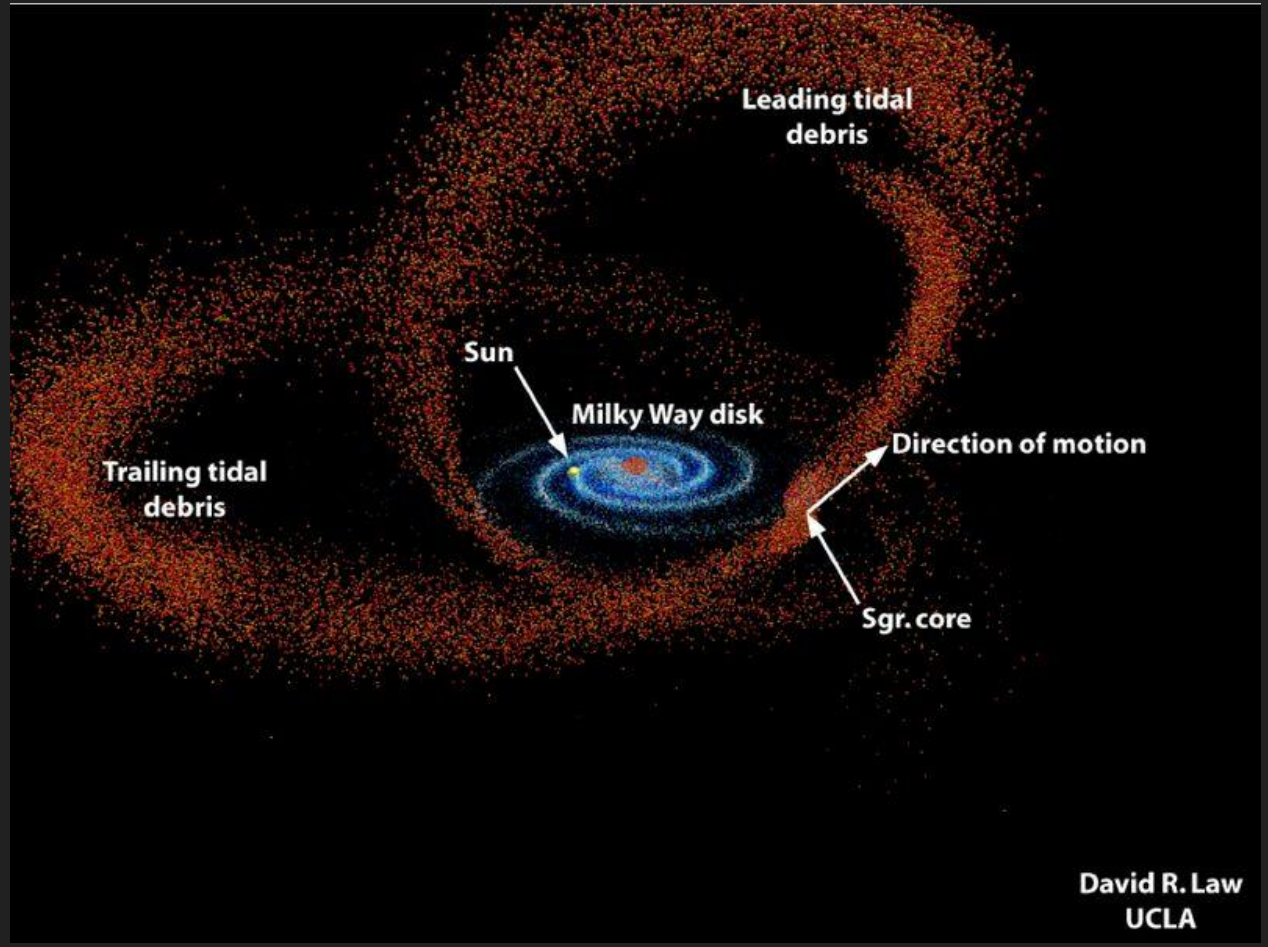

Al
0.5
0.0
−0.5
[Al/Fe]
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
−0.0
[Fe/H]


Ni
0.5
0.0
−0.5
[Ni/Fe]
−1.2
−1.0
−0.8
−0.6
−0.4
−0.2
−0.0
[Fe/H]

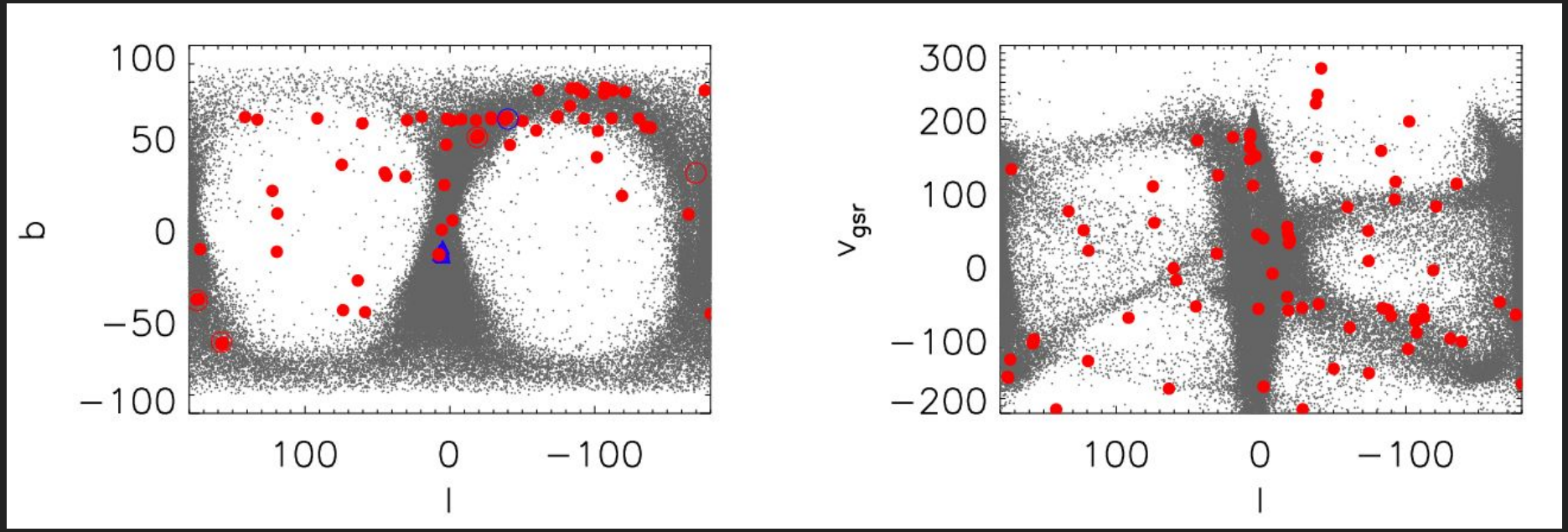
# NEAT

But what does it mean?


[O/Fe]
[Fe/H]
[Si/Fe]
[Fe/H]
[Mn/Fe]
[Fe/H]
[Si/Mn]
[Mn/H]


Leading tidal debris
Sun
Milky Way disk
Direction of motion
Trailing tidal debris
Sgr. core
David R. Law
UCLA

# Tracing Sgr Stream Stars in the Halo



# Summary

-- We have increased the sample of Sgr members with detailed chemical abundances by an order of magnitude with APOGEE

-- Chemical abundance patterns reveal that Sgr is unique and suggest that the current generations of Sgr stars were formed from gas lacking in massive Type II SNe

-- It is possible to find Sgr stars that lie in the MW halo through chemistry alone