MOS STELLAR SURVEY

2020. 2. 12.

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Motivation

- MOS bright galaxy survey (cosmology)
  - *Originally from KIAS*
  - *Ho Seong' talk*
- Proposal for 2021 KASI medium size project
  - *LSB galaxies+*
- Targets for bright nights
  - *Stars!*
  - *Metal poor stars*

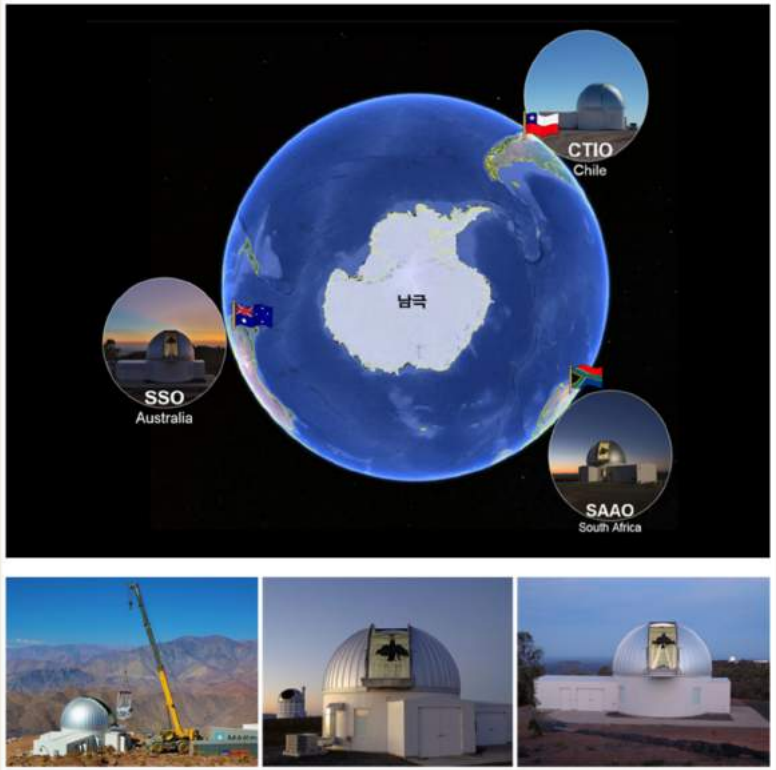
Telescope/instrument requirements

- From proposal for MOS galaxy survey

FOV	>6deg^2
# of fiber	>140 (~114 for target, ~26 for sky), Maximum : 228
Resolving power (R)	1000-2000 (or >30~50 km/s)
Coverage (angstrom)	3700A - 7500A
Individual exposure	<15min (10min target + 5min overhead)
Nights to complete survey	215 nights = (4*pi/dtor^2) / 6 deg^2 * 15min/60 / 8hours
Fiber size	~3” (diameter)

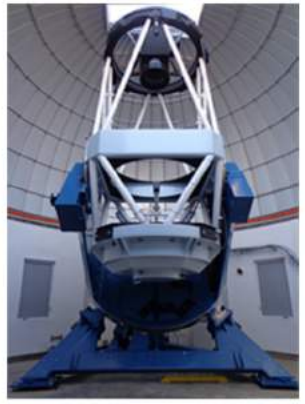
A candidate telescope : KMTNet

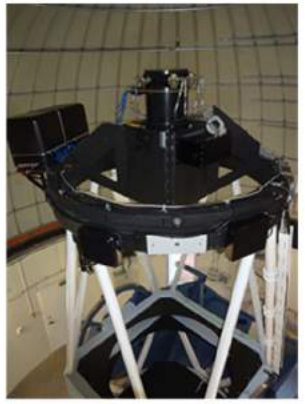
- First candidate because it is owned by KASI

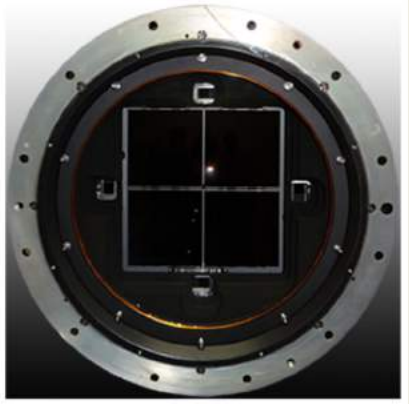


Wide-field Photometric Systems

Telescope	Camera	FOV	Site	Target
PanSTARRS 1.8m × 4	1400M pixel CCD	7.0 deg^2	Haleakala, USA	All sky survey
MOA 1.8m	80M pixel CCD	2.4 deg^2	Mt. John, New Zealand	Galactic Bulge
KMTNet 1.6m × 3	340M pixel CCD	4.0 deg^2	CTIO - SAAO - SSO	Galactic Bulge
SkyMapper 1.35m	268M pixel CCD	5.7 deg^2	SSO, Australia	All sky survey
OGLE-IV 1.3m	268M pixel CCD	1.4 deg^2	LCO, Chile	Galactic Bulge







(kmtnet.kasi.re.kr/kmtnet)

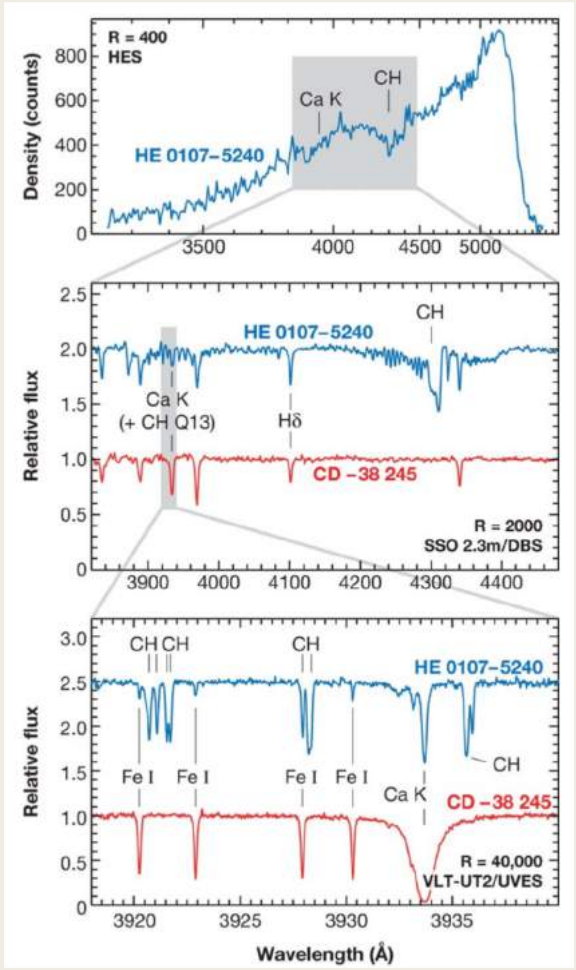
Another concern

- Feasibility for high-resolution spectroscopy
- Gemini
  - *GRACES*
  - *GHOST*

- Target magnitude to obtain high-resolution spectrum
  - *Brighter than 17-18 mag.*

Steps to obtain abundance for metal poor star

- From Beers & Christlieb 2005
  - *Object prism*
  - *Moderate-resolution*
  - *High-resolution*



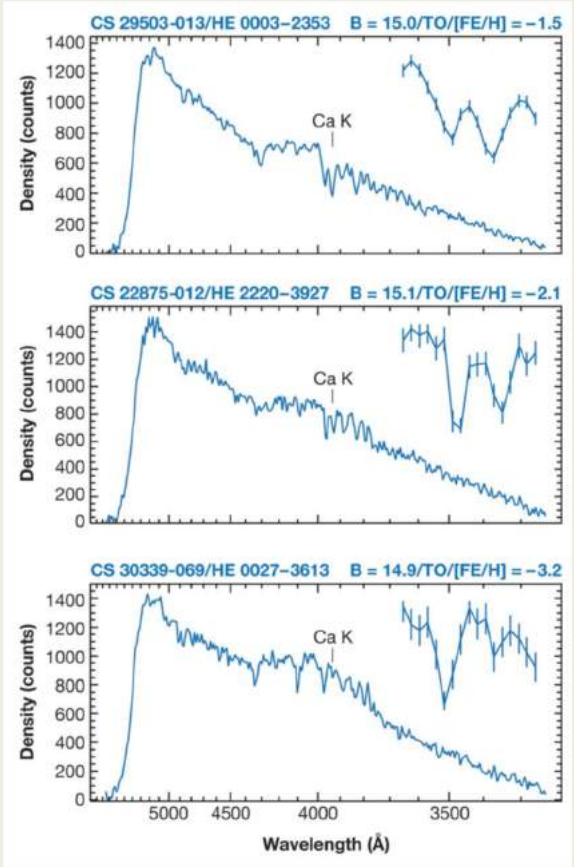
(Beers & Christlieb 2005)

Prism survey

- HK survey (Beers et al. 1985)
  - *0.6m Schmidt*
  - *2800 deg^2 (~4100 deg^2)*
  - *N & S hemisphere*
  - *1000 [Fe/H] < -2.0*
- HES survey (Wisotzki et al. 2000)
  - *1m Schmidt*
  - *Southern off-plane (|b|>30d) sky*
  - *~10000 metal poor candidates*

Spectra of metal poor stars

- Similar temperatures, different abundance



(Beers & Christlieb 2005)

Narrow band filter

- Ca H & K lines

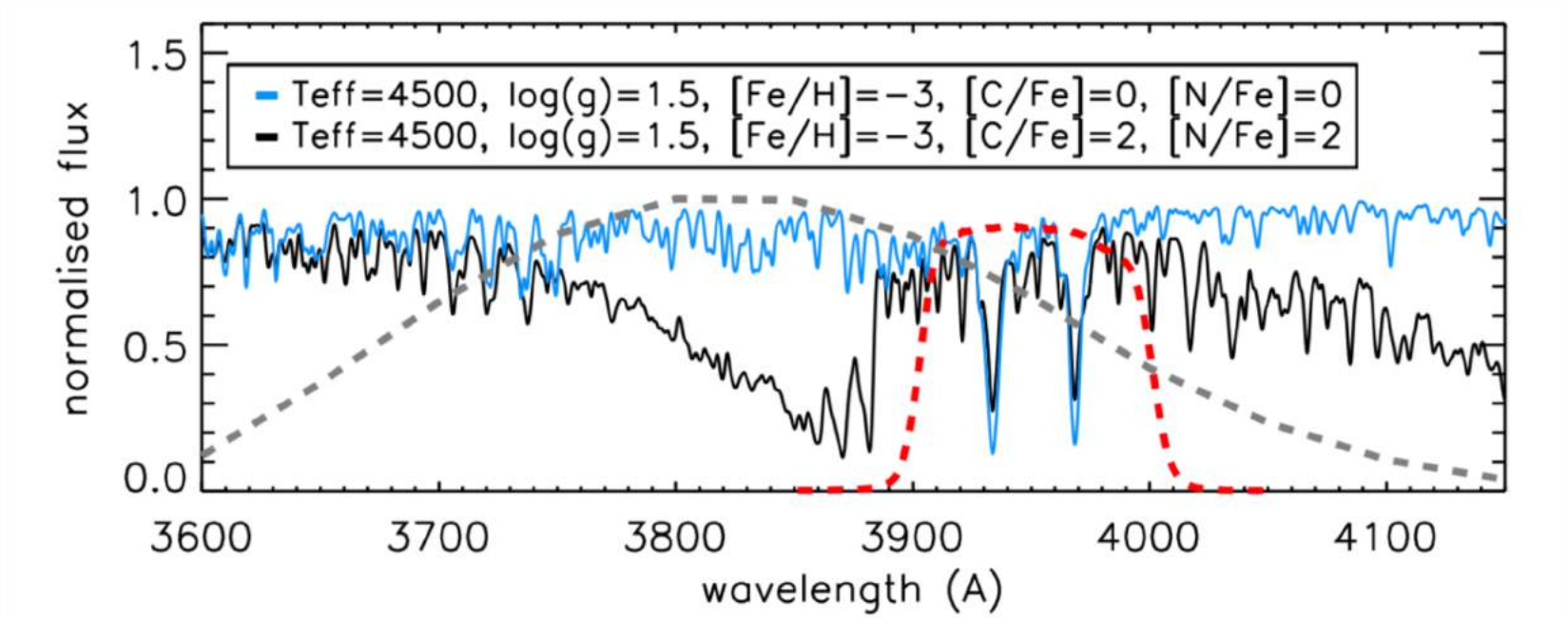


Figure 2. Scaled throughput curves of the Pristine Ca H&K filter (red) and the SkyMapper *v* filter (grey) plotted over synthetic model spectra of an extremely metal-poor giant. The black spectrum is additionally enhanced in C and N by 2 dex.

Existing survey : Skymapper

- EMP photometric candidates & 2618 stars followed by 2.3m spectroscopy

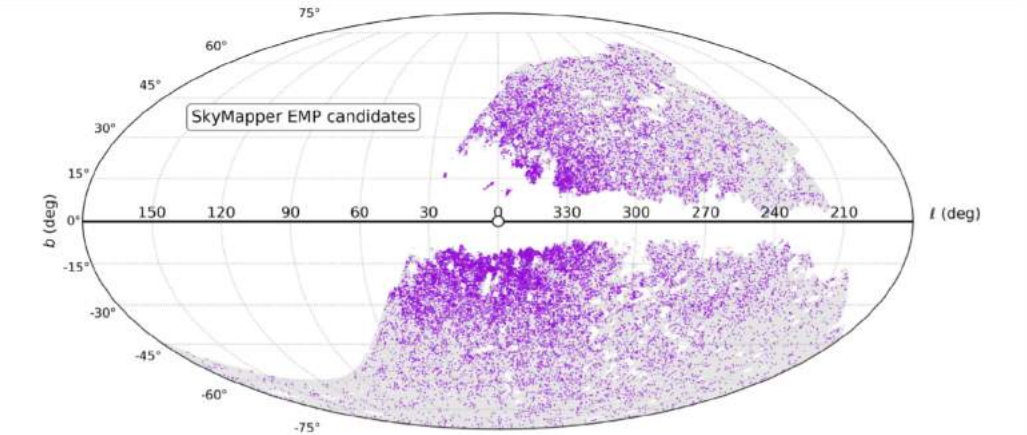


Figure 4. A Mollweide projection of the southern sky in Galactic coordinates on which the SkyMapper DR1.1 EMP photometric candidates are plotted as small purple dots on top of the complete photometric selection (grey background). The white areas indicate regions where SkyMapper DR1.1 data are lacking or incomplete. The EMP candidates are clearly concentrated towards the Galactic Centre as would be expected for a population dominated by halo stars.

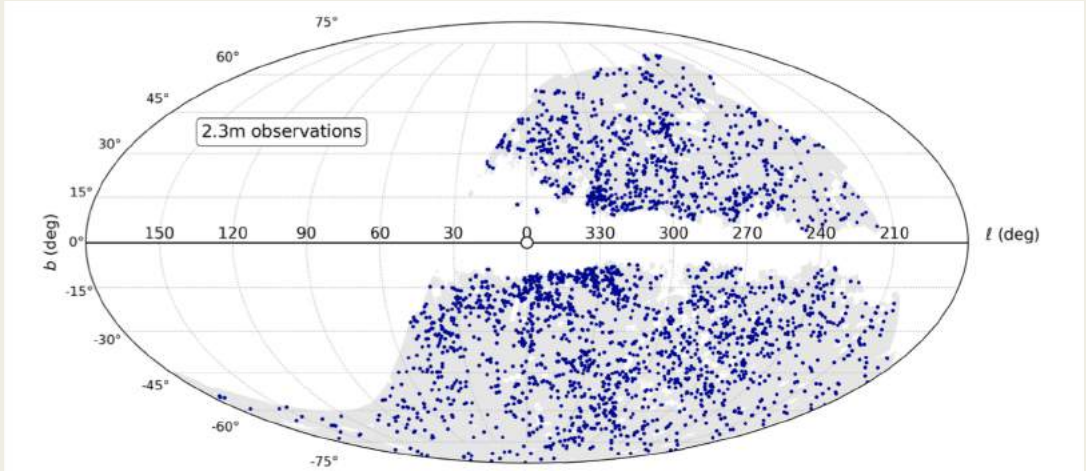
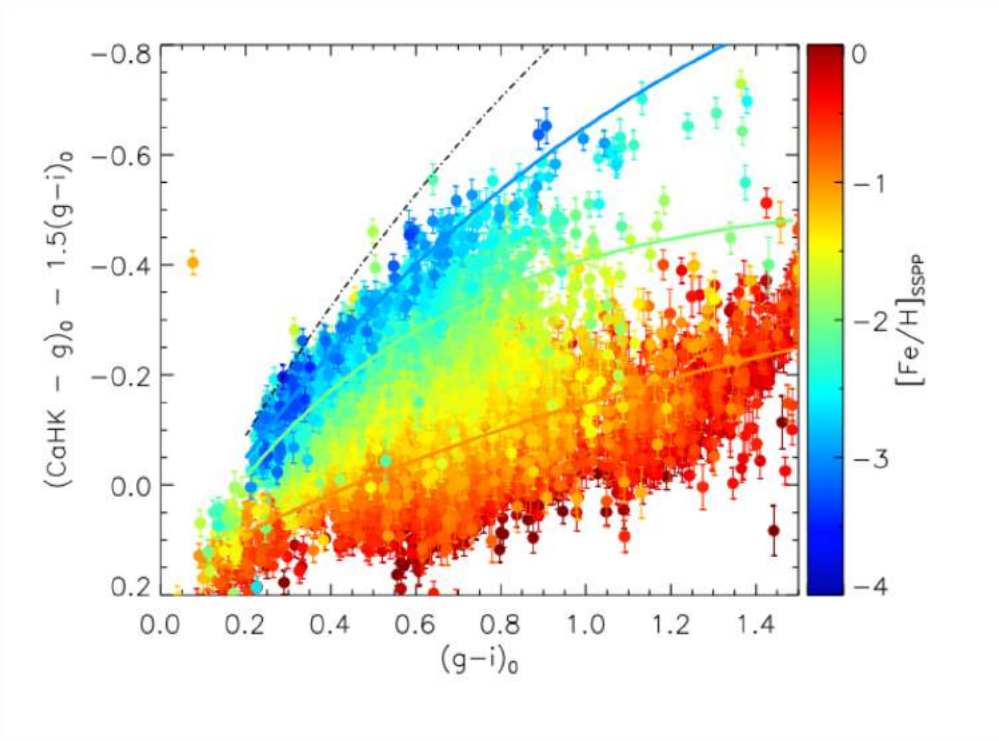


Figure 14. As for Fig. 4 except that only the locations of the 2618 stars within the photometric selection window and which have been observed at the 2.3m are shown.

(Da Costa et al. 2019)

Existing survey : Pristine



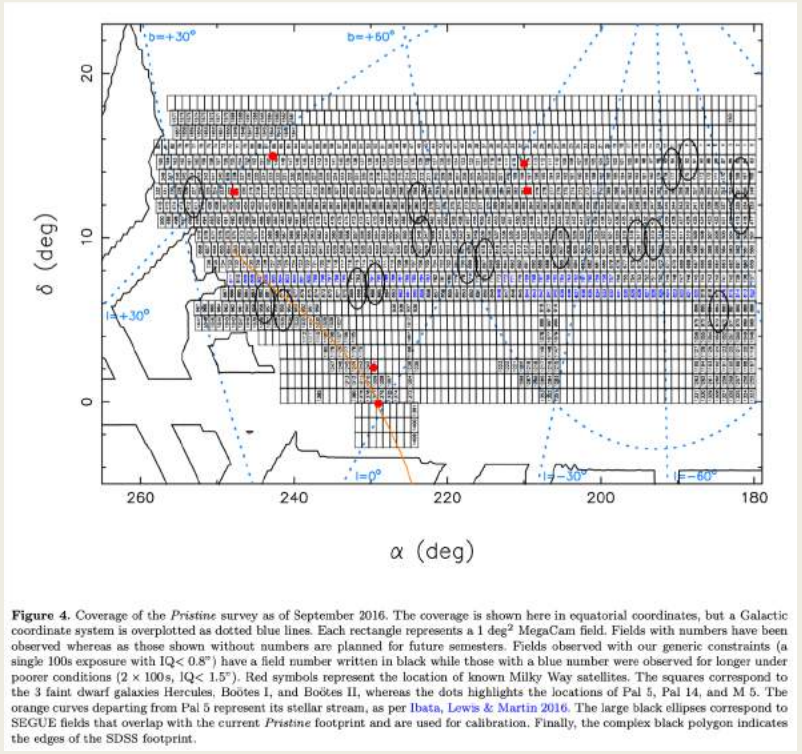
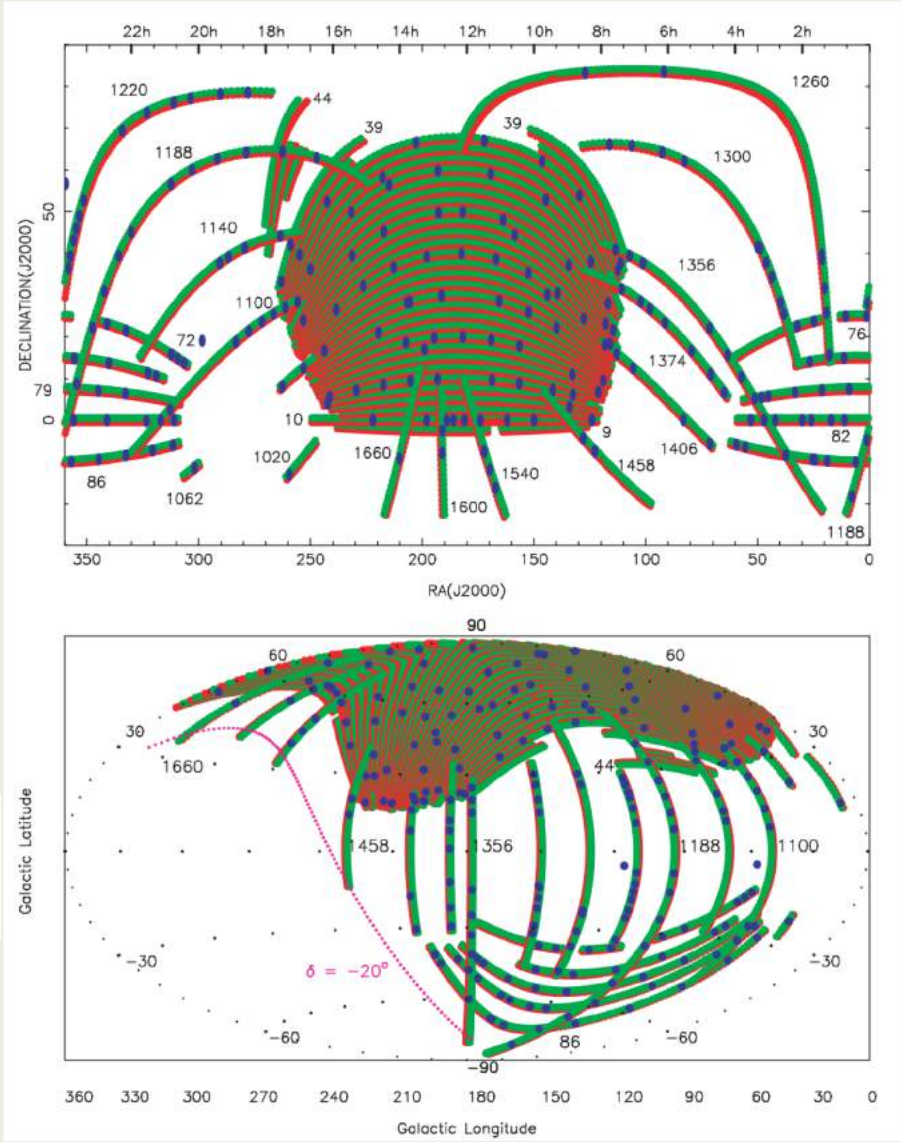


Figure 4. Coverage of the *Pristine* survey as of September 2016. The coverage is shown here in equatorial coordinates, but a Galactic coordinate system is overplotted as dotted blue lines. Each rectangle represents a 1 deg^2 MegaCam field. Fields with numbers have been observed whereas as those shown without numbers are planned for future semesters. Fields observed with our generic constraints (a single 100s exposure with IQ< 0.8") have a field number written in black while those with a blue number were observed for longer under poorer conditions (2 × 100 s, IQ< 1.5"). Red symbols represent the location of known Milky Way satellites. The squares correspond to the 3 faint dwarf galaxies Hercules, Boötes I, and Boötes II, whereas the dots highlights the locations of Pal 5, Pal 14, and M 5. The orange curves departing from Pal 5 represent its stellar stream, as per Ibata, Lewis & Martin 2016. The large black ellipses correspond to SEGUE fields that overlap with the current *Pristine* footprint and are used for calibration. Finally, the complex black polygon indicates the edges of the SDSS footprint.

(Starkenburg et al. 2017)

Existing survey : SEGUE

Low Metal	v4.6	0×80010000	$r < 19, -0.5 < g - r < 0.75, 0.6 < u - g < 3.0, l^e > 0.135$	150,29788,0.12
	v3.4		Changed l-color cut to $l > 0.135$	
	v3.3		Changed l-color cut to $l > 0.15$	
	v3.1		Weighted by l-color and magnitude (bright targets favored)	
	v3.0		$r < 19.5, -0.5 < g - r < 0.75, l > 0.12$	
	v2.0		$r < 20.2, -0.5 < g - r < 0.9, 0.3 < u - g < 3, l > 0.15$	



(Yanny et al. 2009)

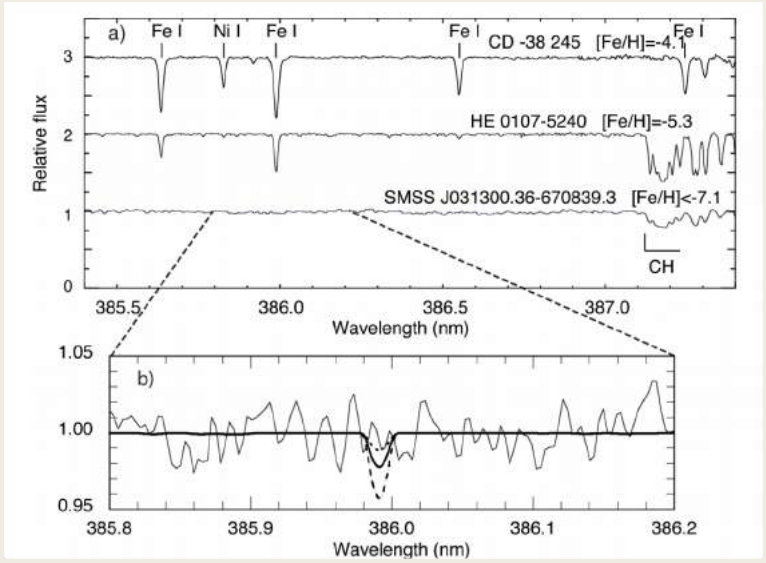
Our approach

- More stars
  - *Stars brighter than 18 mag. (>~1 mag. brigther than SEGUE)*

- Identification of weak (interesting) line, if possible
  - *Resolving power of >5000*

Most metal poor stars

- [Fe/H] < -4.0
  - ~ *30*
- [Fe/H] < -5.0
  - ~ *5*
  - *SMSS J0313-6708*



(Keller et al. 2014)

Metallicity distribution

- SAGA database (data compiled from published papers)

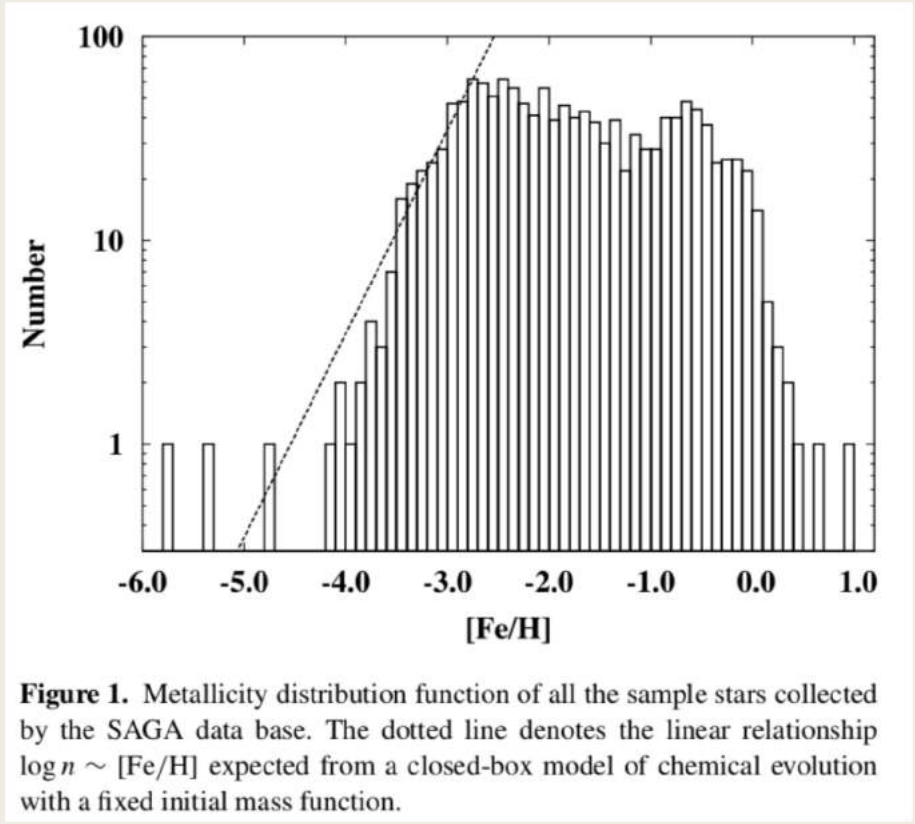


Figure 1. Metallicity distribution function of all the sample stars collected by the SAGA data base. The dotted line denotes the linear relationship $\log n \sim$ [Fe/H] expected from a closed-box model of chemical evolution with a fixed initial mass function.

(Suda et al. 2011)

Chemically peculiar stars

- Dynamically Tagged Group (DTG) and associated chemically peculiar stars

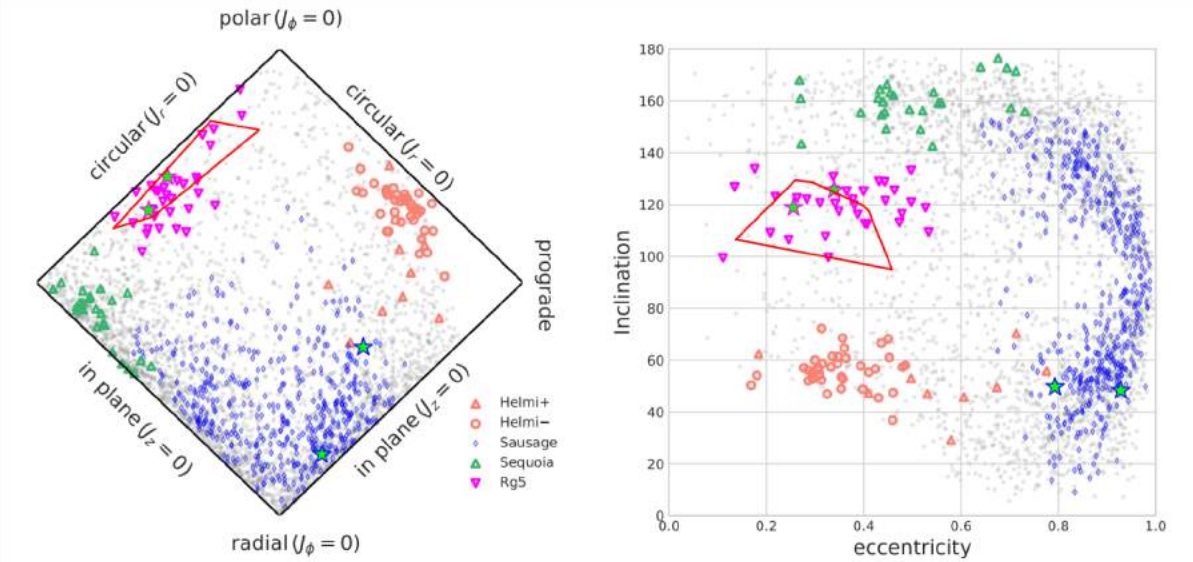


FIG. 4.— The panels show the known VMP substructures in projected action space, and in the space of orbit-averaged eccentricity and inclination angle, as inferred from numerical integration. In the left panel, the x-axis is $(J_\phi/J_{\rm tot})$, and the y-axis is $(J_z - J_R)/J_{\rm tot})$, where $J_{\rm tot} = J_z + J_R + |J_\phi|$. The gray dots represent all of the VMP halo stars in the catalog. Note that the stars with disk dynamics are excluded, thus the corner of very prograde orbits in the action space panel is empty. Similarly, the representative region of low e and small i in the space of eccentricity and inclination angle is not occupied. Notice that the DTGs associated with the *Gaia* Sausage are highly eccentric, while the Sequoia DTGs all have high inclination, consistent with its very retrograde origin. The red polygon boxes show the Rg5 group from Myeong et al. (2018c). The two r-II stars associated with Rg5 are shown as magenta star symbols with green shading, and are well within the red boxes. The two r-II stars associated with the *Gaia* Sausage are shown as blue star symbols with green shading. The stream discovered by Helmi et al. (1999) is shown as salmon circles and triangles, depending on the sign of the vertical velocity.

ASSOCIATED CHEMICALLY PECULIAR STARS

Substructure	Group	Star ID	Type	Confidence	[Fe/H]	[C/Fe]	[Ba/Fe]	[Eu/Fe]	Reference
Helmi	DTG-3	HE 1135-0344	CEMP-no	87 %	−2.63	+1.03	...	...	Barklem et al. (2005)
Sausage	DTG-13	CS 22898-027	CEMP-*i*	44 %	−2.49	+2.11	+2.56	+1.92	Masseron et al. (2012)
		SDSS J0924+4059	CEMP-*s*	41 %	−2.51	+2.73	+1.86	...	Aoki et al. (2008)
	DTG-18	HE 1249-3121	CEMP-no	26 %	−3.23	+1.86	...	...	Barklem et al. (2005)
	DTG-38	J00405260-5122491	*r*-II	100 %	−2.11	−0.04	−0.04	+0.86	Hansen et al. (2018)
		2MASS J2256-0719	*r*-II	28 %	−2.26	+0.18	+0.26	+1.10	Sakari et al. (2018)
		CS 22945-024	CEMP-*s*	87 %	−2.58	+2.30	+1.43	+0.44	Roederer et al. (2014)
		HE 0007-1832	CEMP-no	32 %	−2.79	+2.66	0.09	< +1.75	Cohen et al. (2013)
	DTG-41	CS 22958-042	CEMP-*s*	46 %	−3.40	+2.56	−0.61	< +1.54	Roederer et al. (2014)
Sequoia	DTG-5	CS 29514-007	CEMP-no	37 %	−2.83	+0.89	−0.14	< +1.74	Roederer et al. (2014)
Rg5	DTG-10	SDSS J2357-0052	*r*-II	26 %	−3.36	+0.43	+1.08	+1.92	Aoki et al. (2010)
		CS 31082-001	*r*-II	25 %	−2.90	+0.29	+1.12	+1.62	Hill et al. (2002)
	DTG-53	HD 005223	CEMP-*s*	28 %	−2.11	+1.58	+1.88	...	Goswami et al. (2006)
New Rg	DTG-29	CD-62:1346	CEMP-*s*	42 %	-1.59	+0.86	+1.58	...	Pereira et al. (2012)
New Rg	DTG-28	CS 29526-110	CEMP-*s*	79 %	−2.38	+2.20	+2.11	+1.73	Aoki et al. (2002)
New Rg	DTG-33	BD+04:2466	CEMP-*s*	62 %	−1.92	+1.17	+1.70	...	Pereira & Drake (2009)
New Pg	DTG-19	SDSS J0212+0137	CEMP	65 %	−3.57	+2.28	+0.16	...	Bonifacio et al. (2015)
New Polar	DTG-45	BD-01:2582	CEMP-*s*	96 %	−2.62	+0.86	+1.05	+0.36	Roederer et al. (2014)
		CS 22880-074	CEMP-*s*	53 %	−1.93	+1.30	+1.31	+0.50	Aoki et al. (2002)

Yuan et al. 2019

Summary

- Complementary to Complete 3D Mapping (Ho Seong)
  - *R ?*
- Large number of stellar spectra
- Finding metal poor stars
  - *Most metal poor*
  - *Distribution*
  - *Peculiar*