The Best and Brightest Metal-poor Stars

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Kavli Fellow, MIT

The Milky Way and its Stars:
Stellar Astrophysics, Galactic Archaeology, and Stellar Populations
3 February 2015

Schlaufman & Casey (2014), ApJ, 797, 13
Casey & Schlaufman (2015), ApJ, submitted

Nick Risinger (Photopic Sky Survey)

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Kevin Schlaufman and Andy Casey
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Metal-poor Star Candidates

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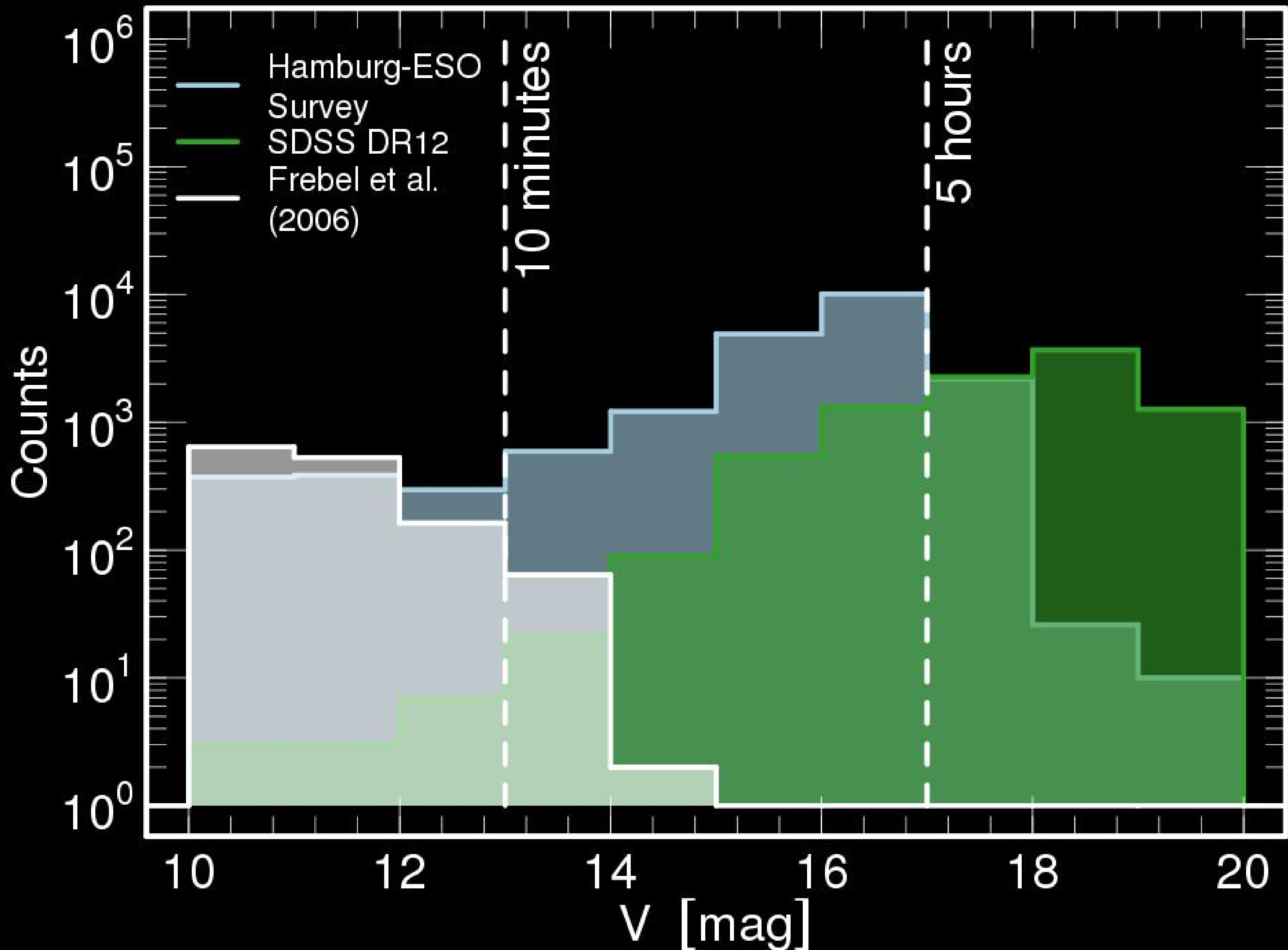

Theory of Infrared EMP Selection

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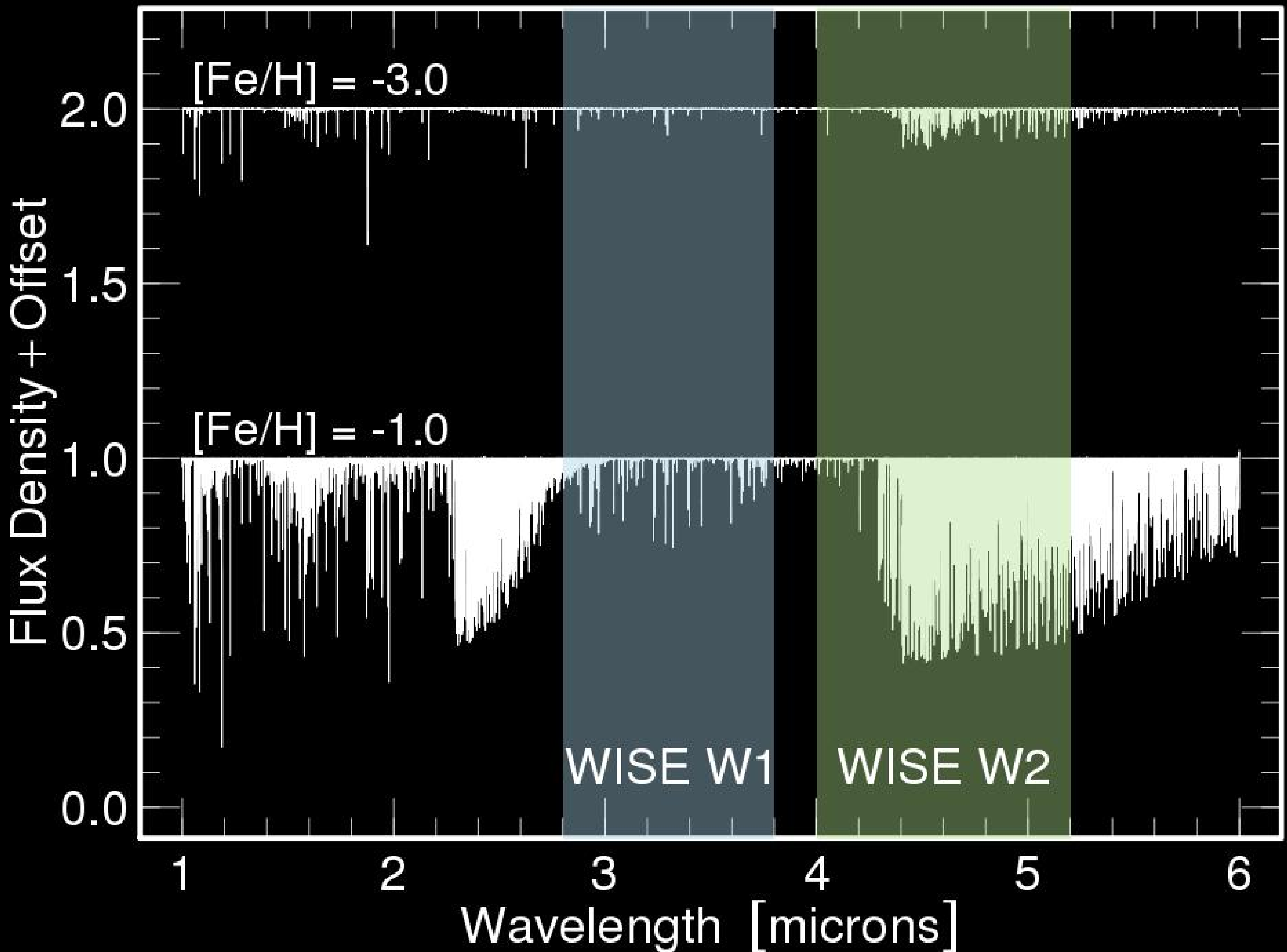
Schlaufman & Casey (2014)



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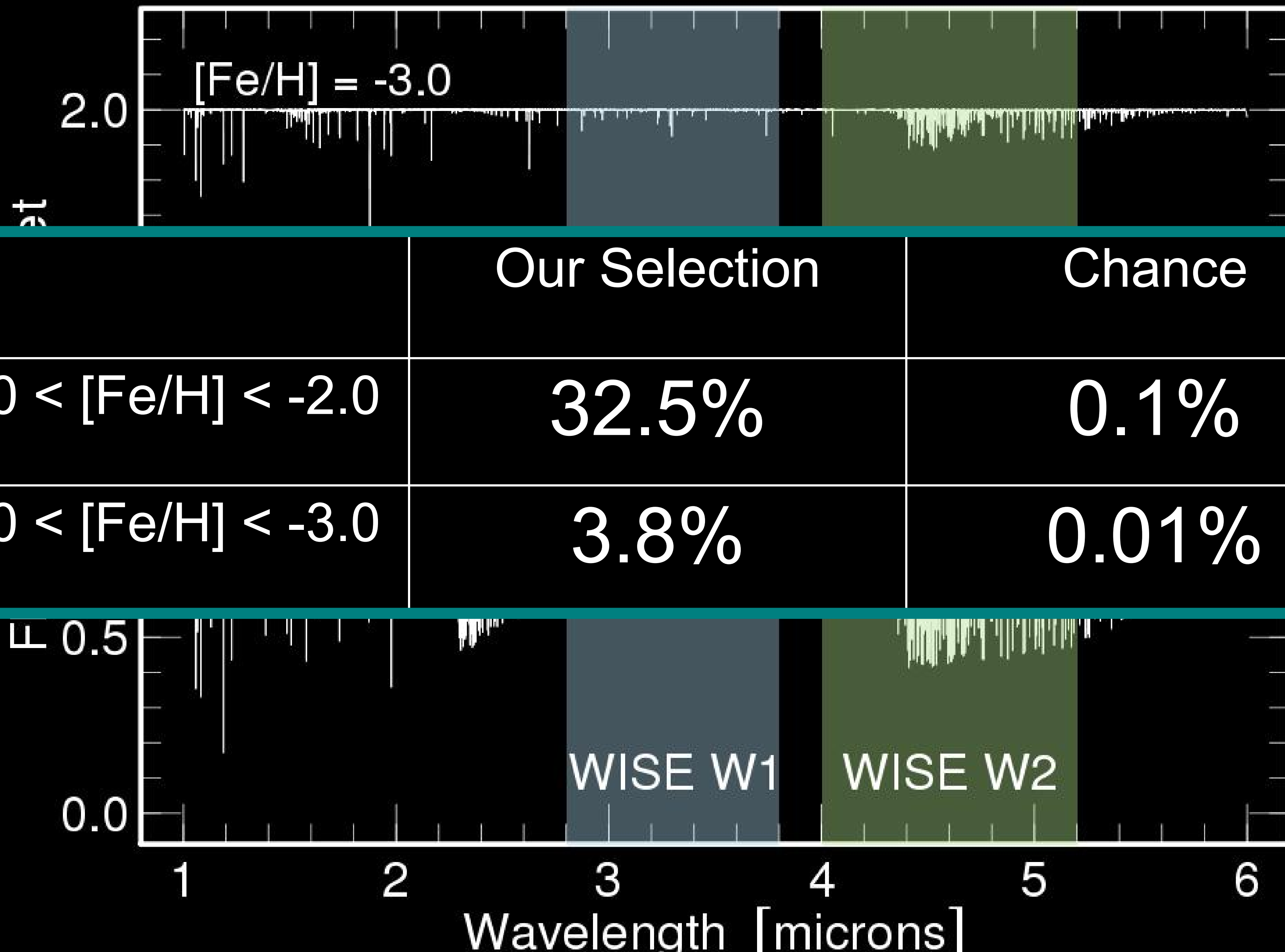

	Our Selection	Chance
-3.0 < [Fe/H] < -2.0	32.5%	0.1%
-4.0 < [Fe/H] < -3.0	3.8%	0.01%

Apparent Magnitude Distribution

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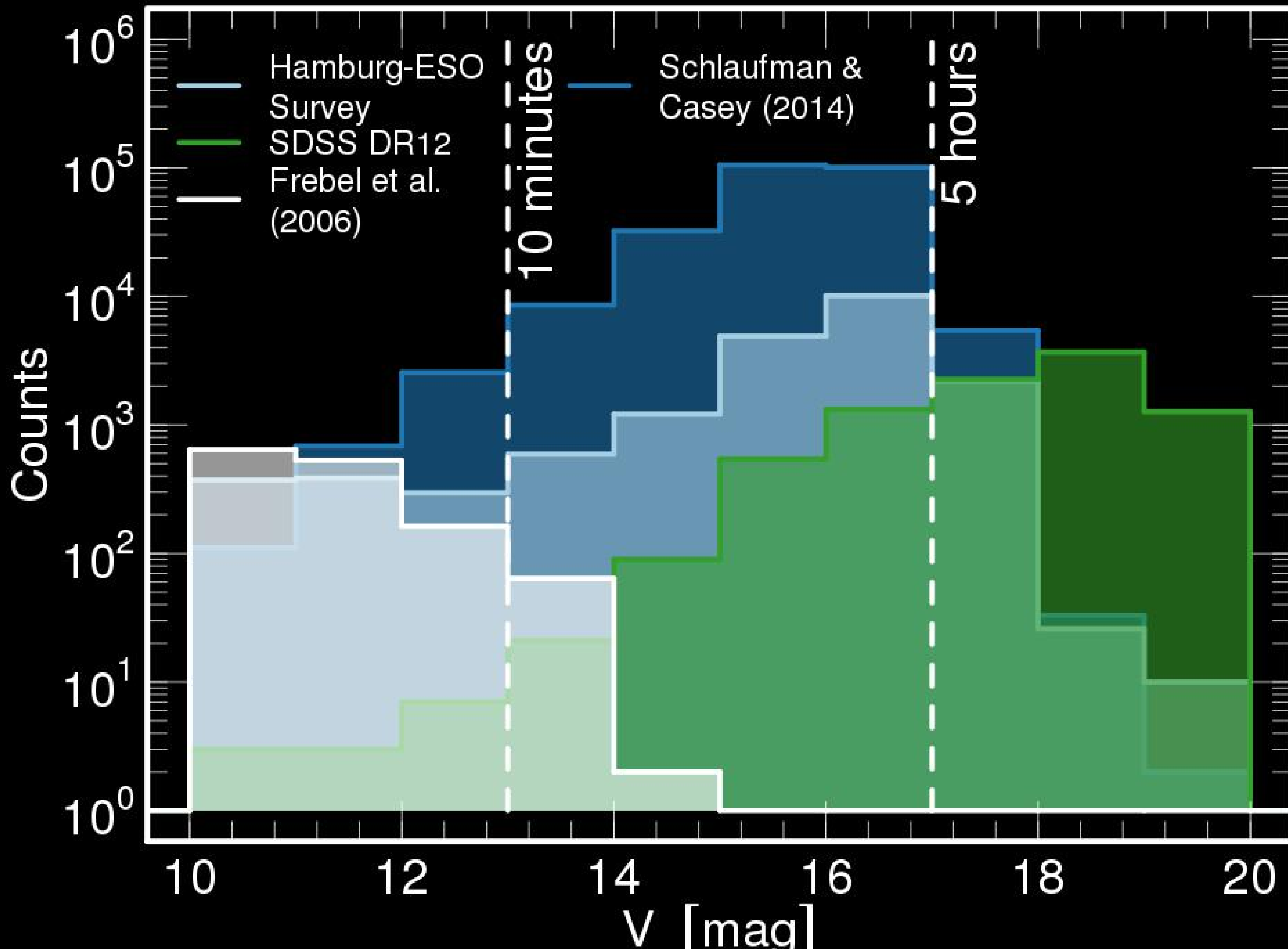

Distance Distribution

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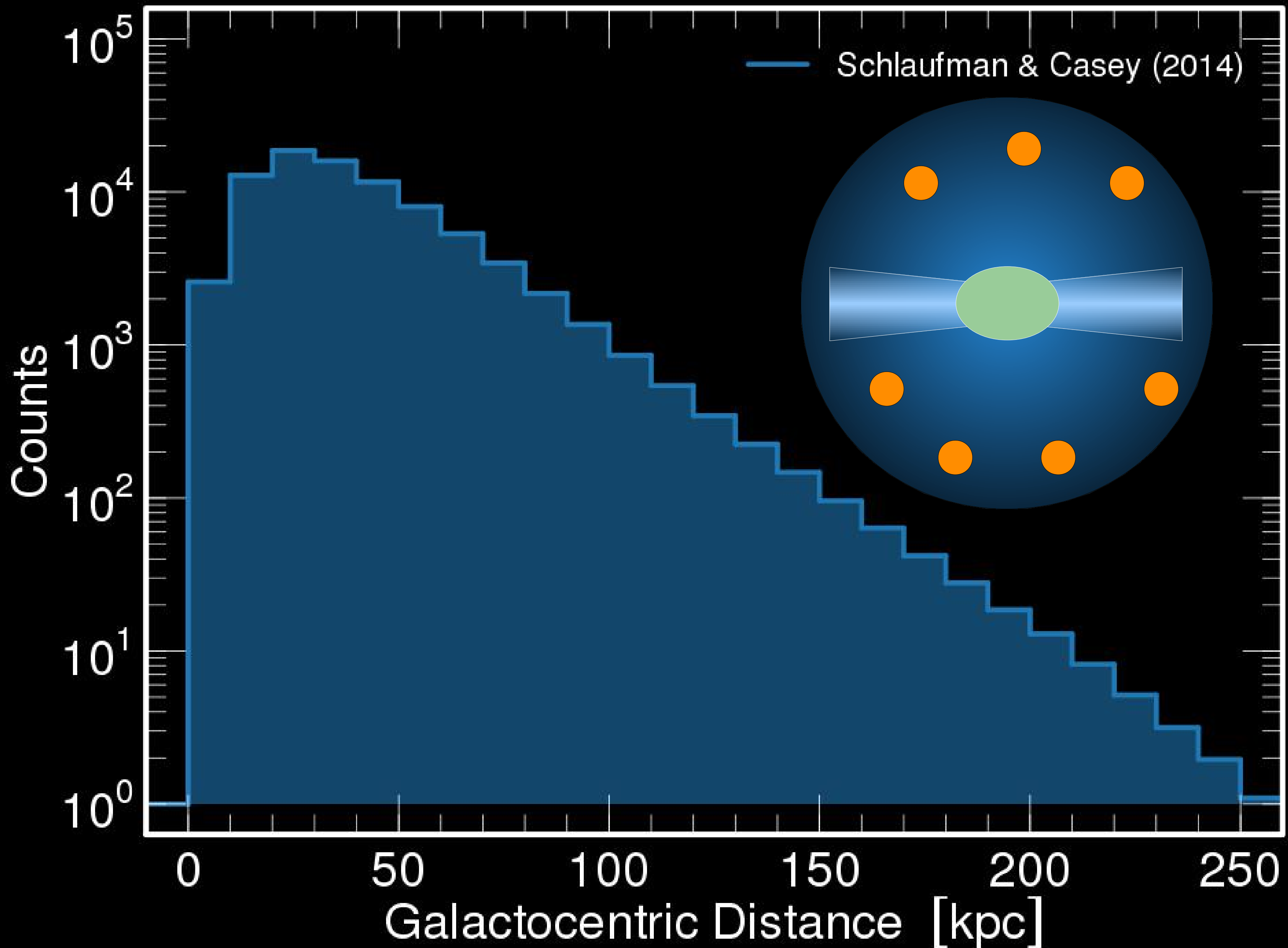

Follow-up Program

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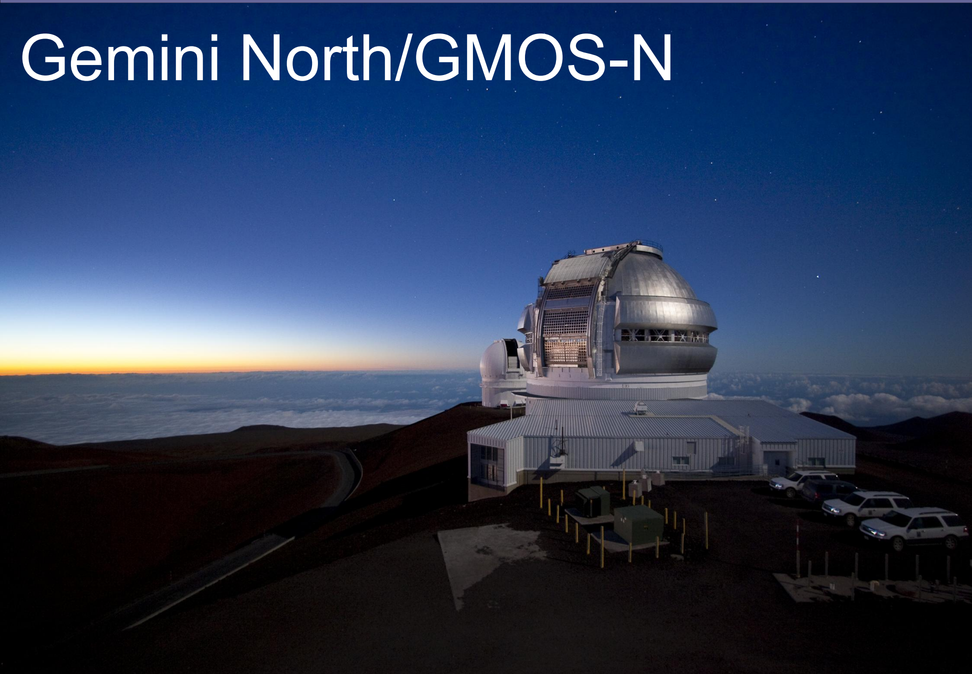

Most Metal-poor Stars in the Bulge

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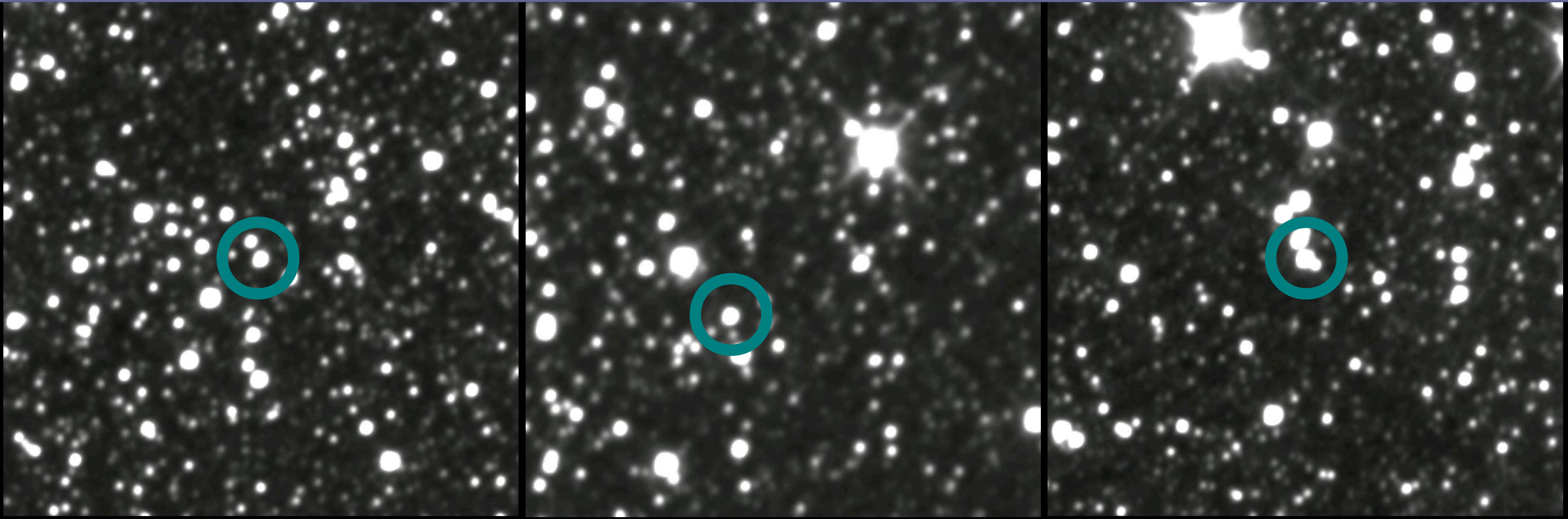
Schlaufman & Casey (2014)



Star (2MASS)	T_{eff}	log *g*	[Fe/H]
J183713-314109	4797	0.99	-2.70
J181503-375120	4728	1.09	-2.84
J155730-293922	4720	1.12	-3.02

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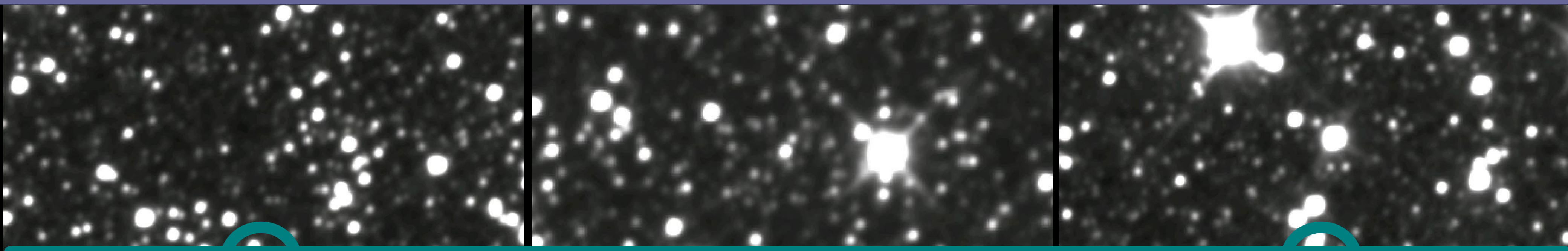

There's a 70% chance that at least one of these stars formed at $z \geq 10$!

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Detailed Abundances

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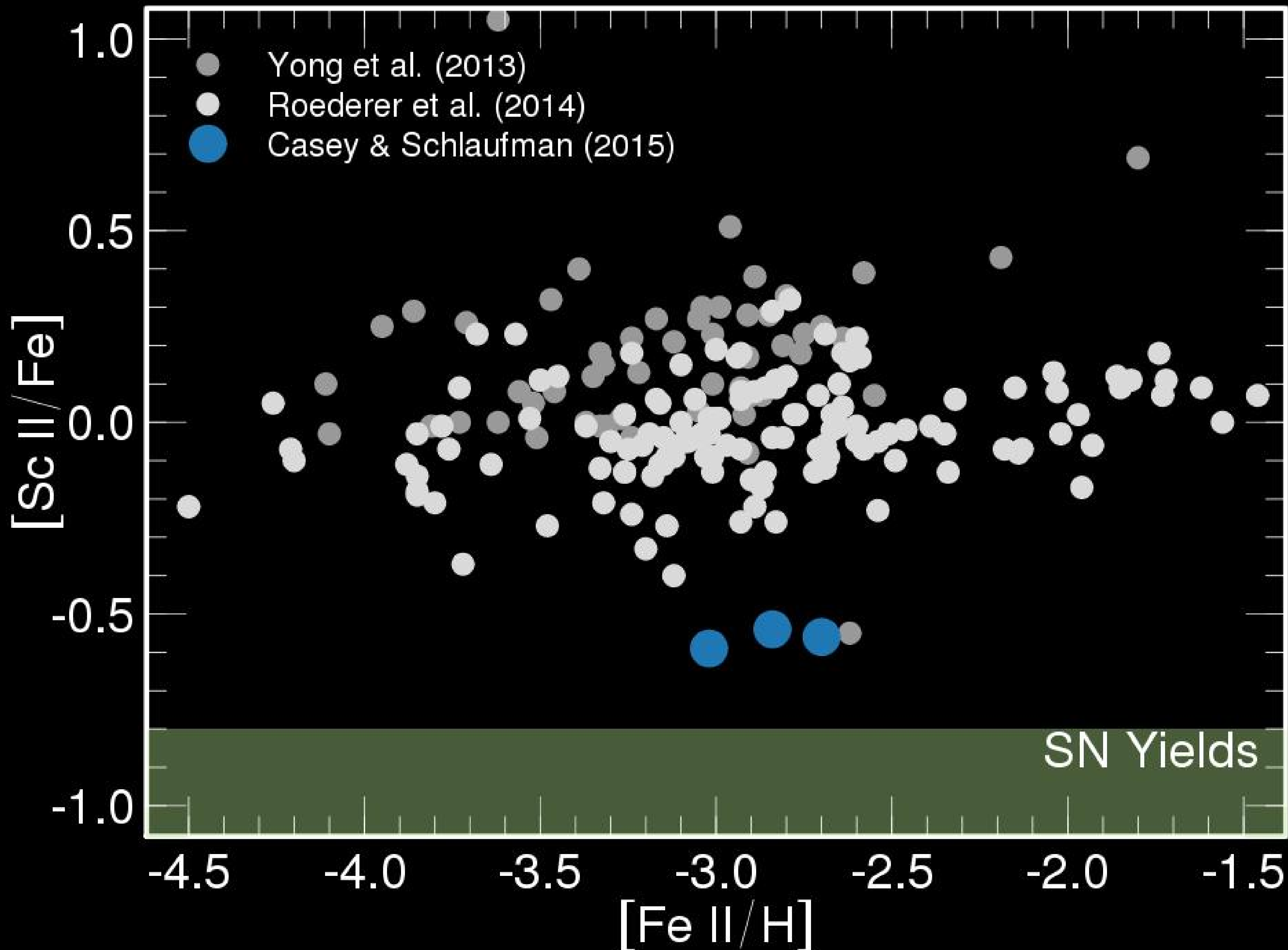

Exploiting This Technique

A few possibilities...

(1) Metal-poor K giants as tracers of the distance halo
- Dark Energy Spectroscopic Instrument (DESI), Subaru Prime Focus Spectrograph, William Herschel Telescope WEAVE, 4MOST,...

(2) Asteroseismology of extremely metal-poor stars
- *K*2, Transiting Exoplanet Survey Satellite (TESS), CHaracterising ExOPlanets Satellite (CHEOPS), PLAnetary Transits and Oscillations of stars (PLATO),...

(3) Extremely metal-poor stars in dwarf galaxies, including the Magellenic Clouds

(4) Extremely metal-poor stars in highly-reddened regions (e.g., the bulge)

(5) Extremely metal-poor stars in the halos of nearby galaxies with *JWST*/NIRCam grism spectroscopy

(6) *HST*/STIS and/or *HST*/COS UV spectroscopy of brightest confirmed extremely metal-poor stars

(7) Gaia parallaxes and proper motions for orbital analyses

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Spectroscopy First

While classical searches for metal-poor stars have achieved many successes, they are not perfect:

(1) They are resource intensive.
(2) They fail in regions of high extinction and/or reddening.
(3) They fail in crowded regions.
(4) They only identify candidates with faint apparent magnitudes.

The Old and the New

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WISE Photometry

The infrared selection of Schlaufman & Casey (2014) addresses many of those issues:

(1) It uses only public APASS optical, 2MASS infrared, and WISE mid-infrared photometry.
(2) A infrared-only variant is well suited to the identification of metal-poor stars in highly extincted and reddened fields.
(3) It works well in crowded fields.
(4) It identifies many bright candidates