



AIP

The RAVE logo features the word 'RAVE' in large, bold, dark blue letters. A colorful ring, composed of green, blue, and red segments, encircles the letters. Below the letters is a red horizontal bar containing the text 'RADIAL VELOCITY EXPERIMENT' in white, uppercase letters.

RAVE

RADIAL VELOCITY EXPERIMENT

Matthias Steinmetz (AIP)



AIP



Survey Description

The **RAVE** survey

RADIAL VELOCITY EXPERIMENT

- Spectroscopic high latitude survey of the MW
 - ◆ $9 < l < 13$
- GAIA spectral range and resolution
 - ◆ Ca triplet region (8400-8800Å)
 - ◆ $R_{\text{eff}}=7500$
- Scheduled operation: 2003 – 2011
 - ◆ 6dF MOS on UKST at Siding Spring
 - ◆ 7 nights per lunation up to 8/2005
 - ◆ >20 nights per lunation since 8/2005
- Goal: 1 Million spectra
- Public data releases





AIP

RAVE and SEGUE are complimentary

SEGUE

- selected pointings
- deep exposures
- low resolution
($R=2000$)
- large wavelength coverage
- northern hemisphere

RAVE

- wide angular coverage
- intermediate depth
- intermediate resolution
($R=7500$)
- limited wavelength coverage
- southern hemisphere



AIP



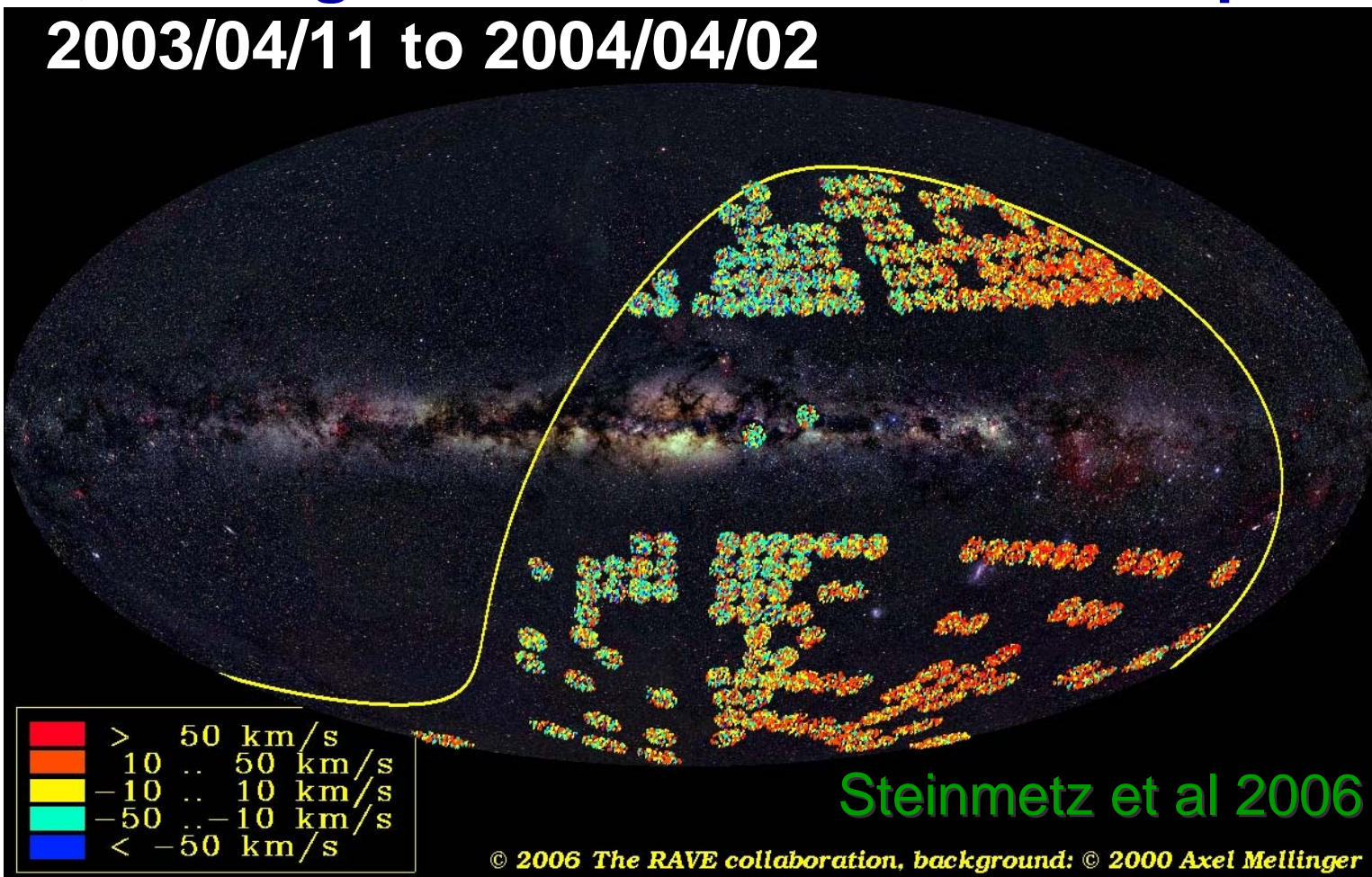
Data Product

1st Data Release

Coverage : ~4,670 sq.deg
25,274 radial velocities
24,748 targets

240 fields
5.7° diameter
1 hour exposures

2003/04/11 to 2004/04/02



Steinmetz et al 2006

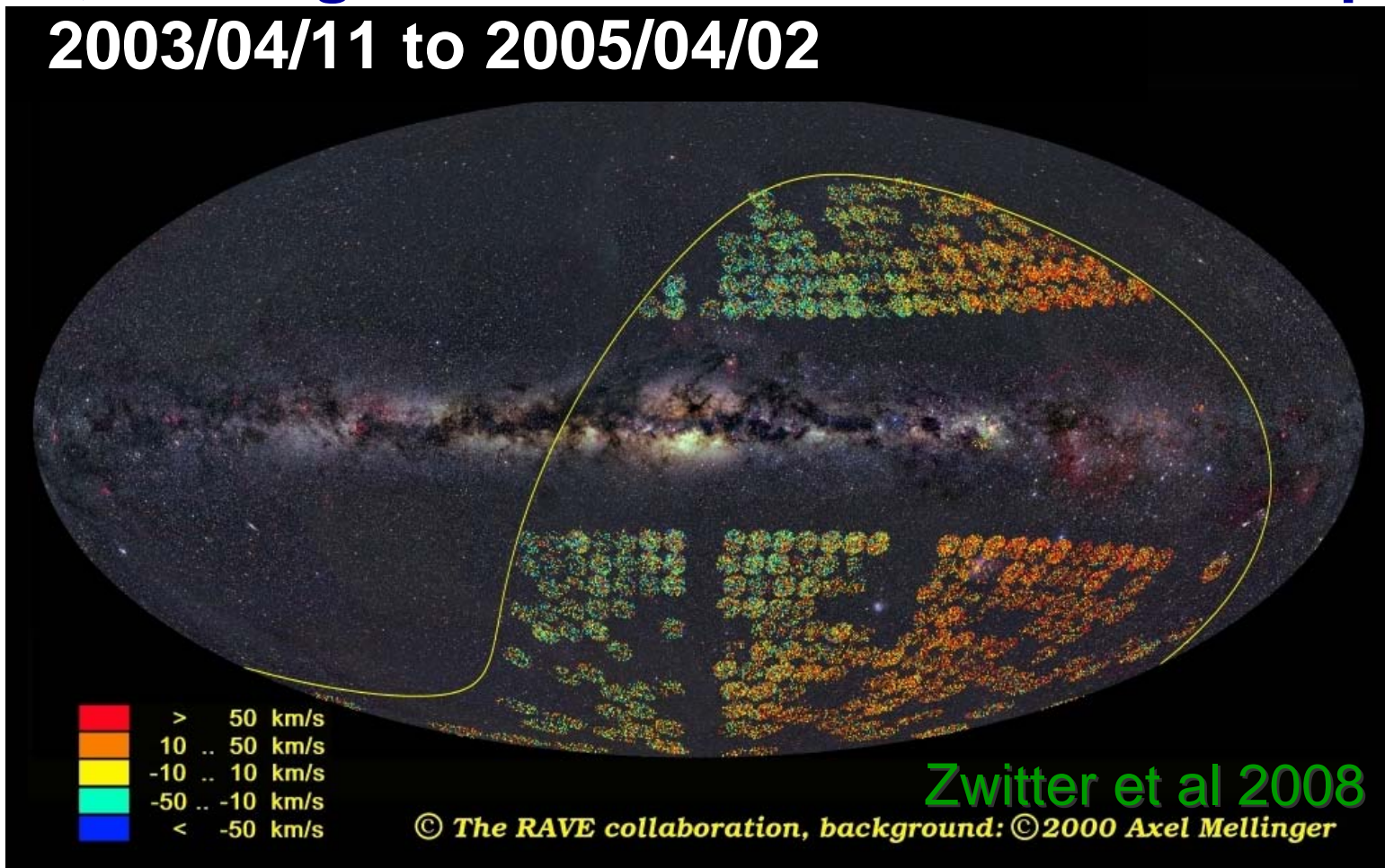
2nd Data Release



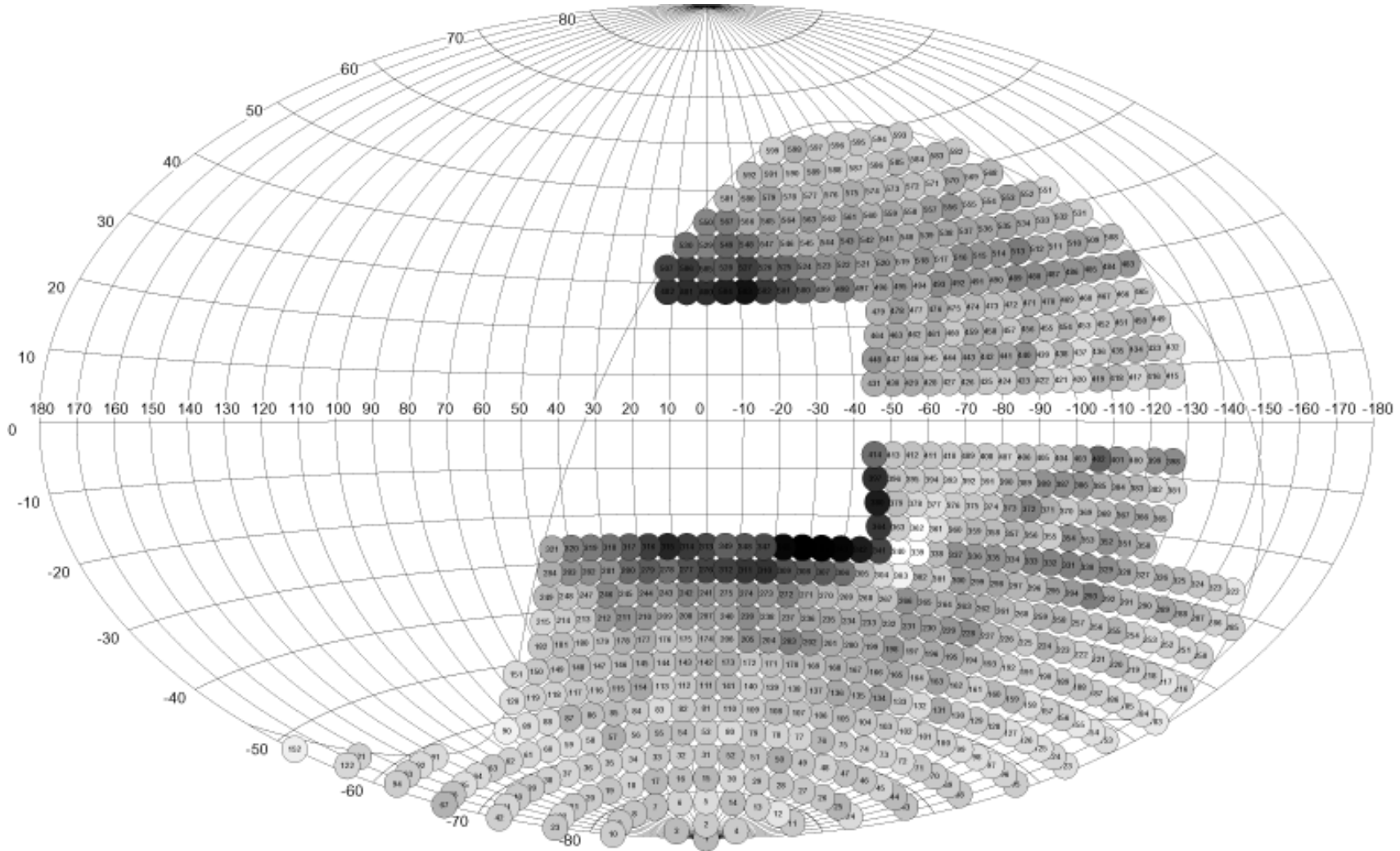
Coverage : ~6800 sq.deg
51,829 radial velocities
49,327 targets

500 fields
5.7° diameter
22407 stellar par.

2003/04/11 to 2005/04/02



RAVE's progress



02/27/2008 : 350,000 spectra for 300,000 stars

DR2 Internal errors:

DR1

Mean : 2.3km/s

Median : 1.9km/s

Peak : 1.7km/s

DR2-DR1

Mean : 2.2km/s

Median : 1.5km/s

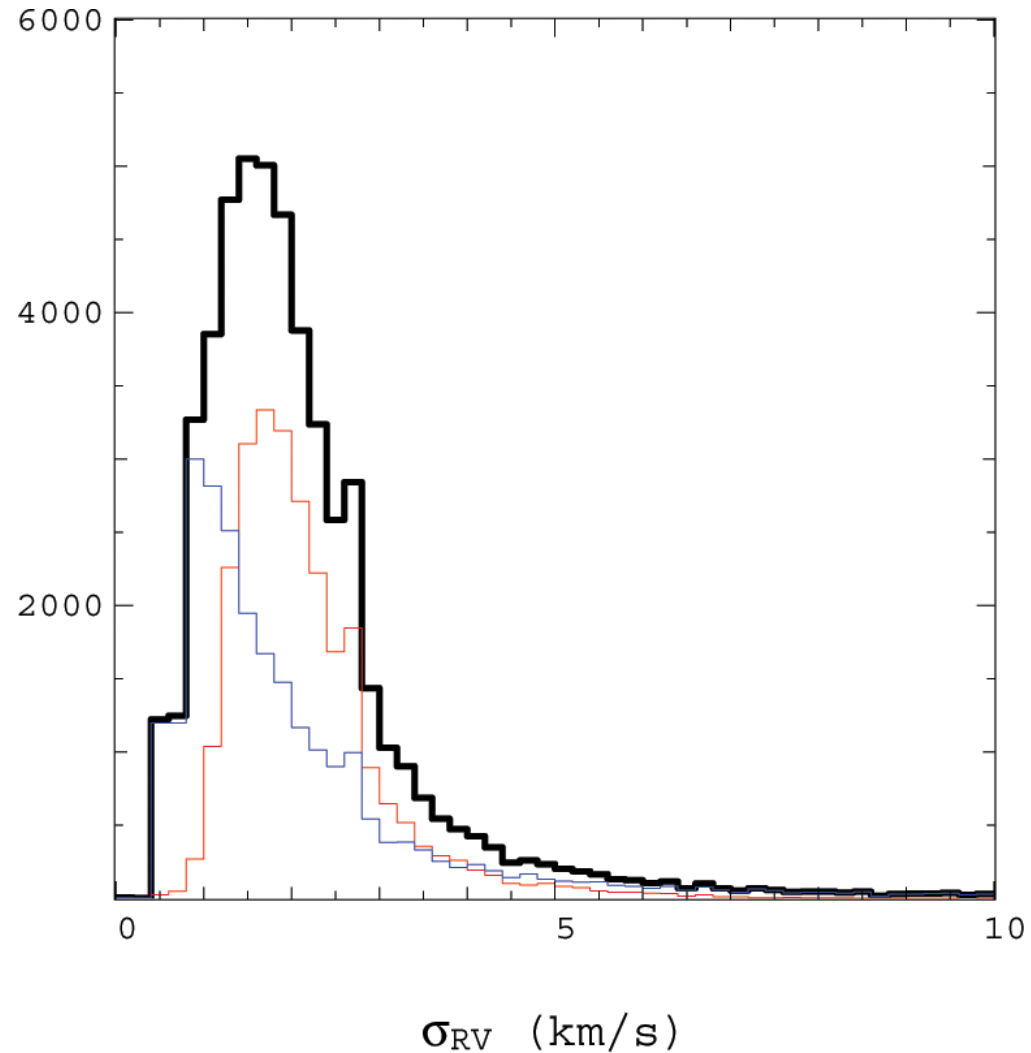
Peak : 0.9km/s

DR2

Mean : 2.2km/s

Median : 1.8km/s

Peak : 1.5km/s



Zwitter et al., 2008





AIP

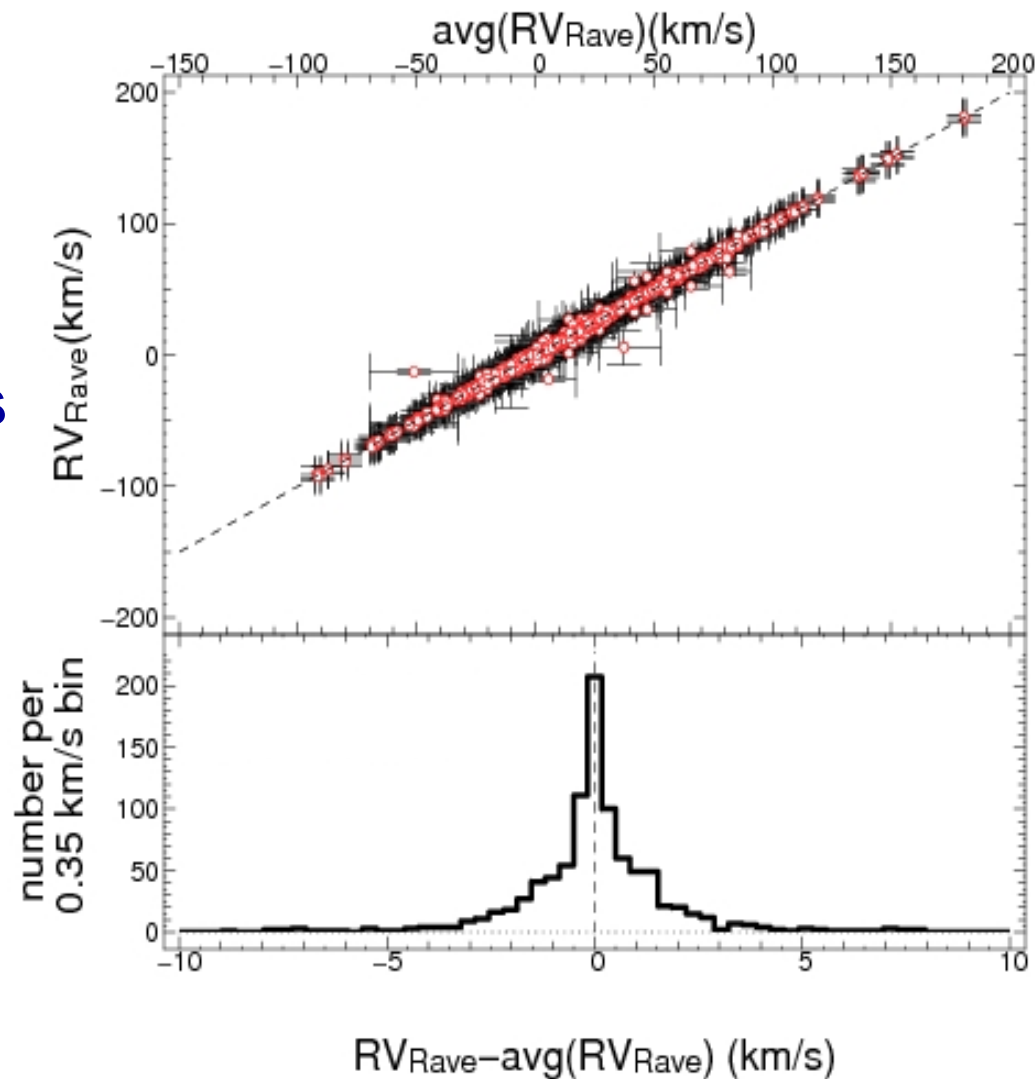
Stability of Radial Velocities



Based on 840 re-observed targets:

mean diff = -0.02 km/s
rms = 2.83 km/s

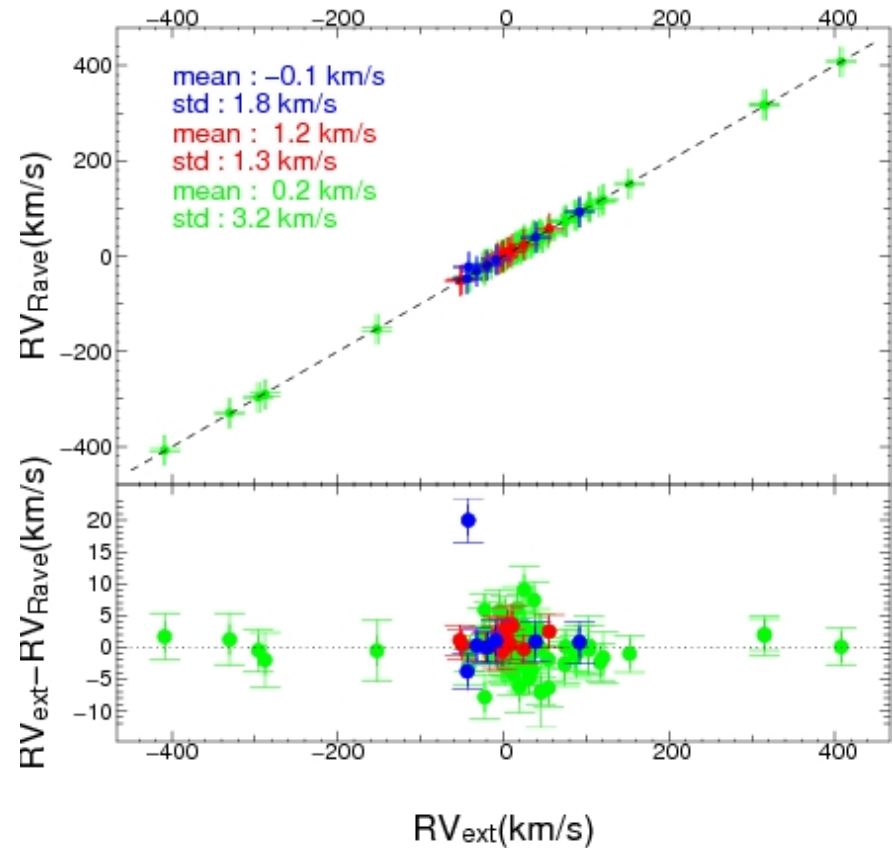
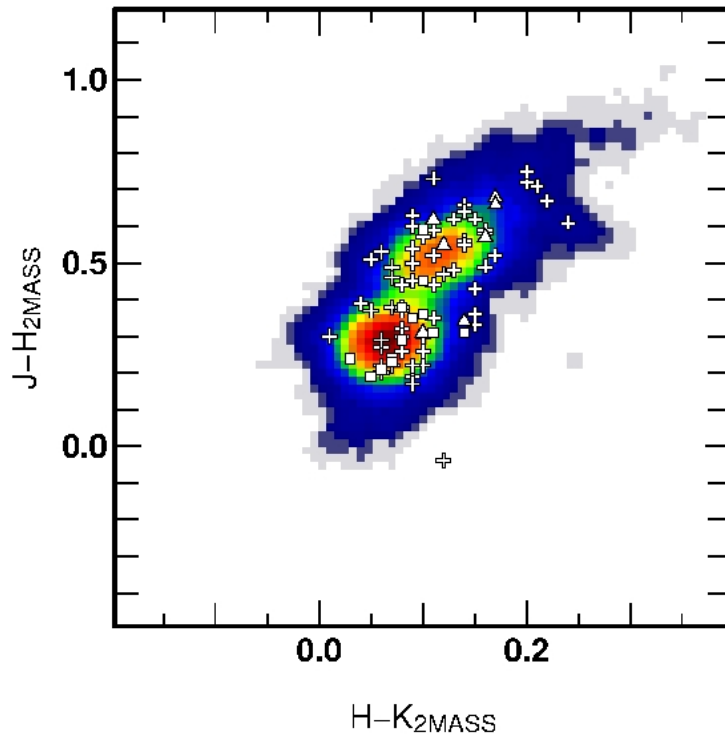
Good stability of solution with time



Steinmetz et al., 2006

Comparison to “Standards”

- 3 external sources:
- Elodie (high resolution)
 - 2.3m (long slit, medium resolution)
 - Geneva-Copenhagen (CORAVEL)

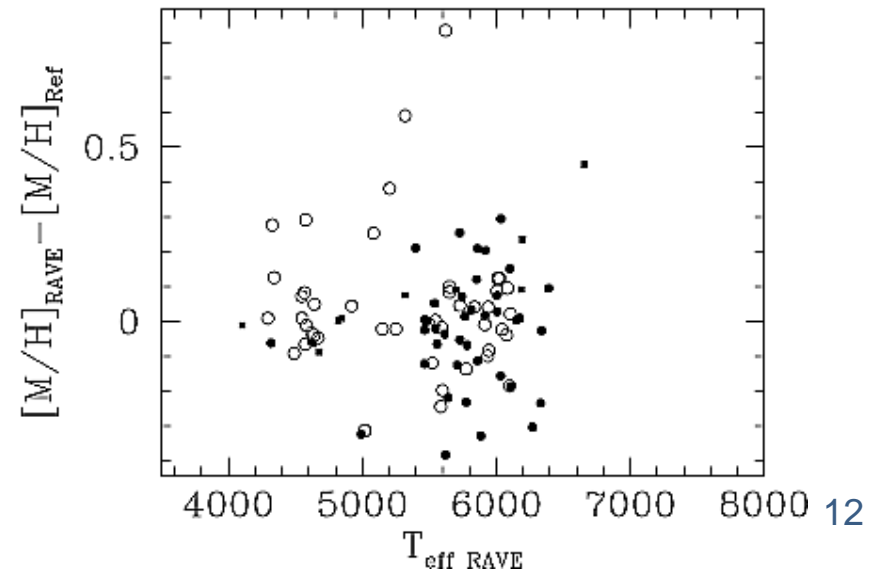
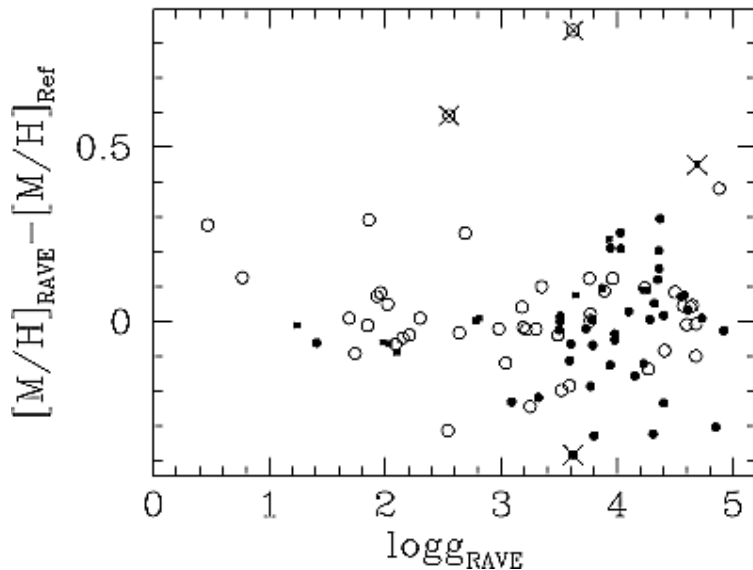
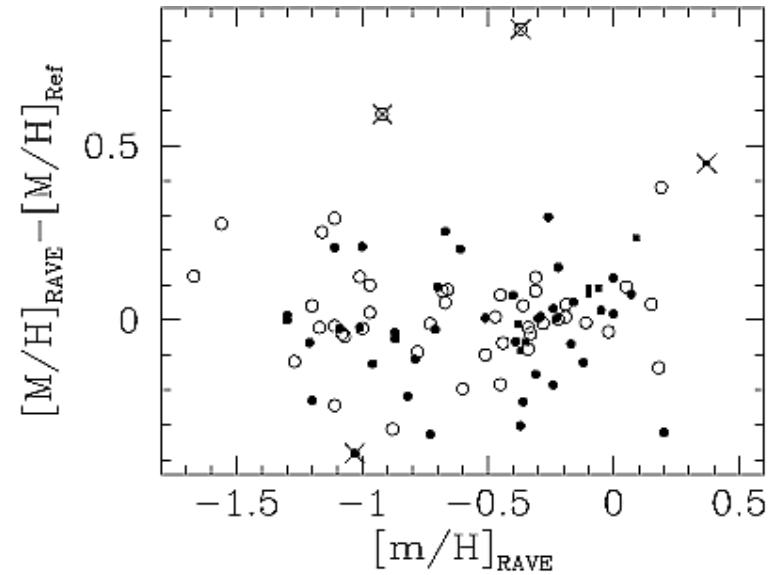
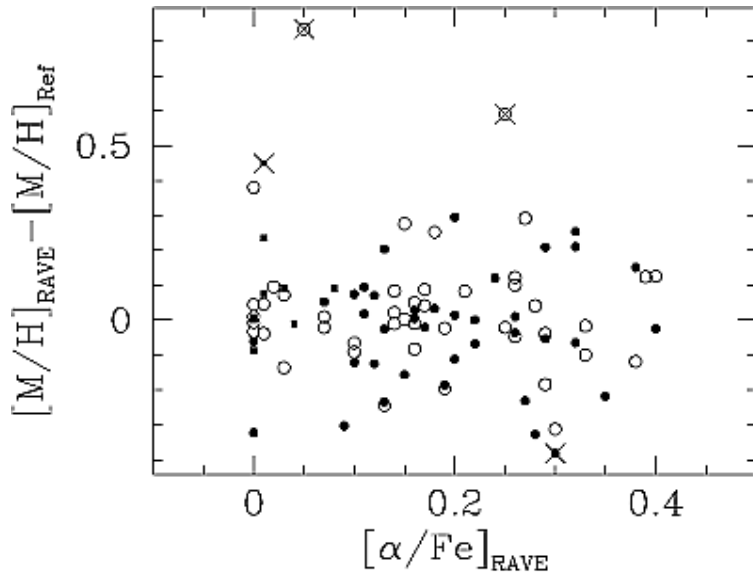


Steinmetz et al., 2006

Metallicity by template fitting (DR2)



Zwitter et al., 2008



Survey Design



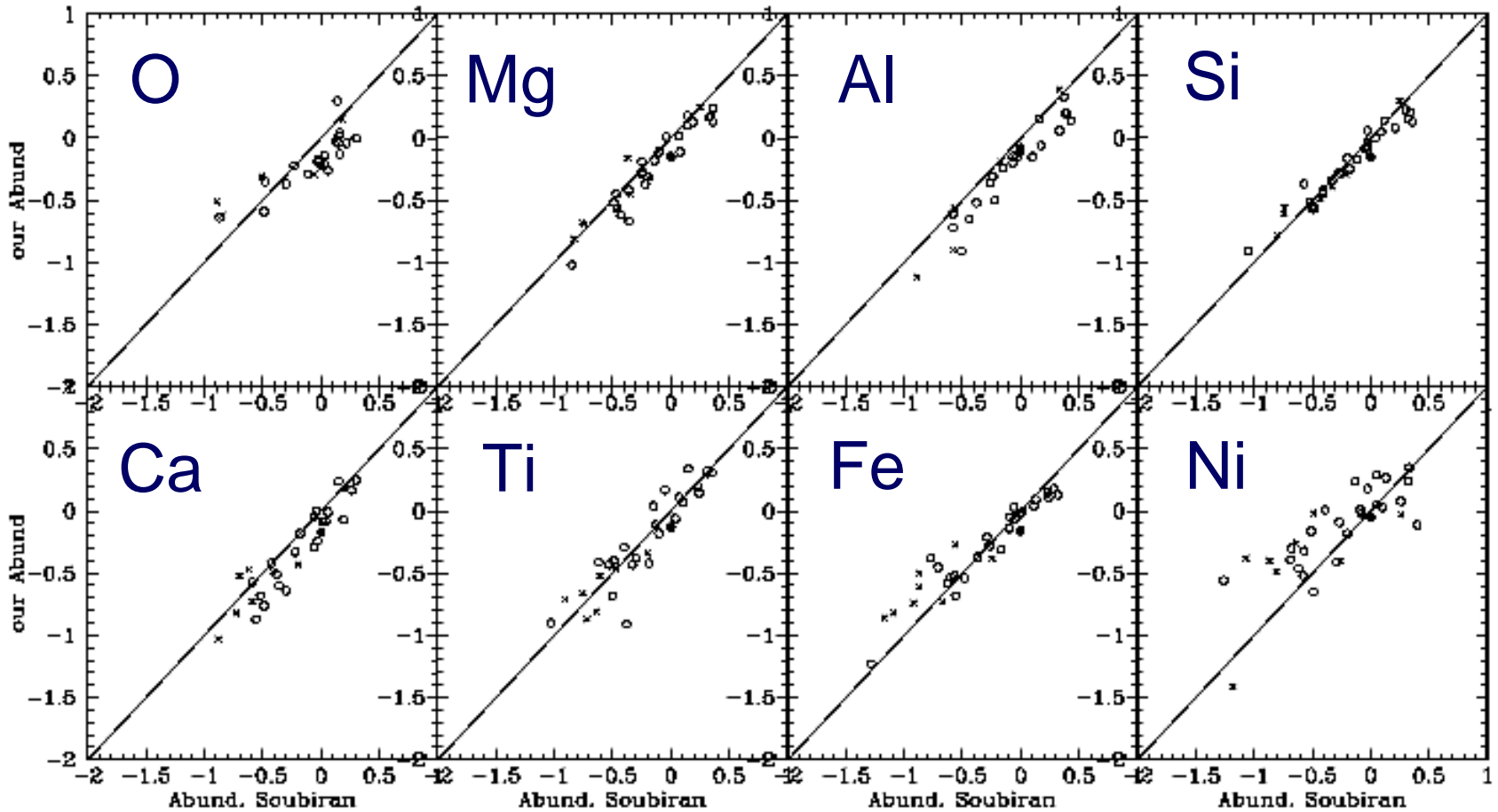
Besides the CaII triplet:

Calcium triplet region contains a wealth of chemical information (need for good resolution to measure some of those lines)

Also gravity and metallicity tracers

	K0 III	A7 IV
HI		5
CI	1	1
NI		11
MgI	11	7
Sil	23	14
SI	5	14
Cal	2	
CaII	3	3
TiI	18	
CrI	7	
MnI	7	
Fel	60	19
FelI		3
CoI	3	
Nil	4	

Abundances

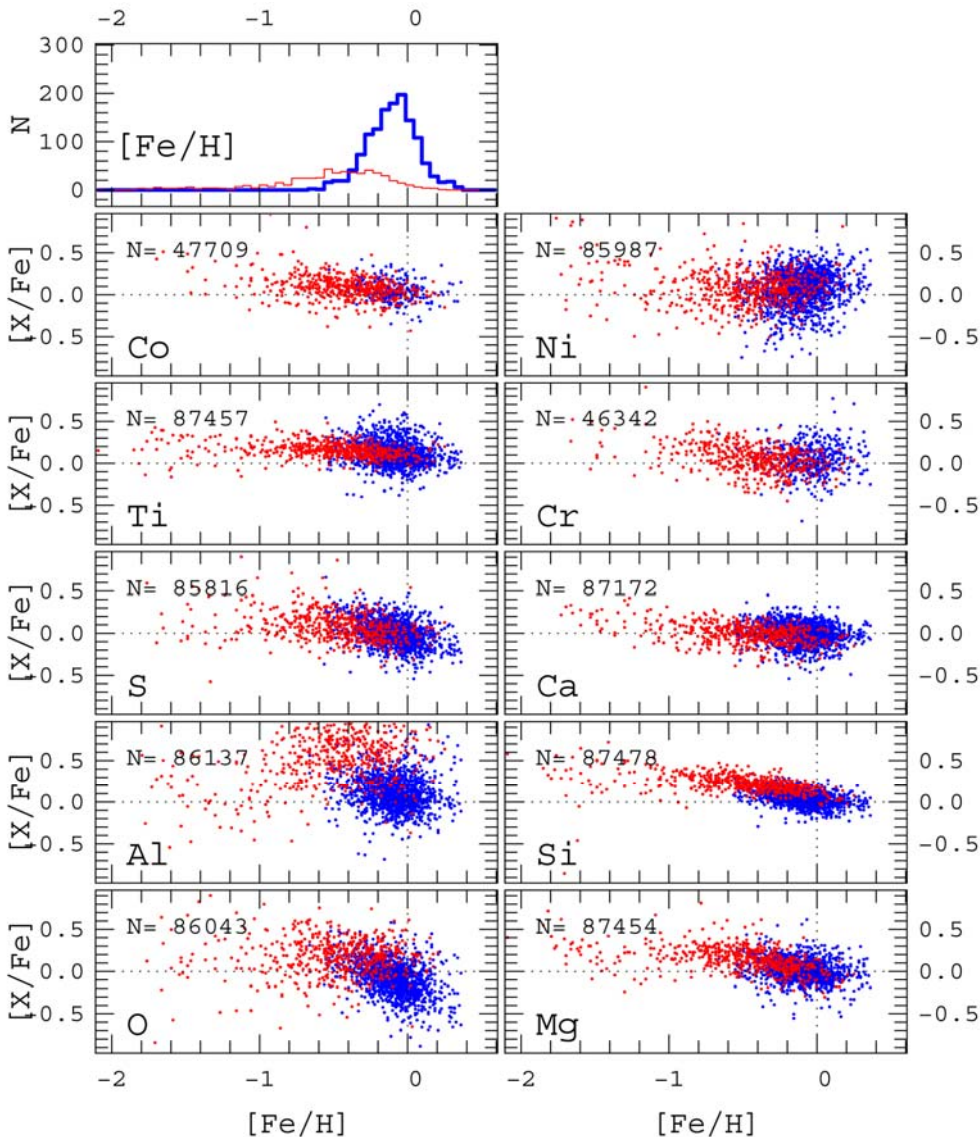


Asplund et al. (2005) solar abundances

- spectra with $S/N \geq 100$
- × spectra with $S/N < 100$
- Moon spectrum

Comparison to Soubiran & Girard

abundances: thin and thick disk stars (Boeche et al 08)



out of 87515 stars with distances, we select $S/N > 70$ and:

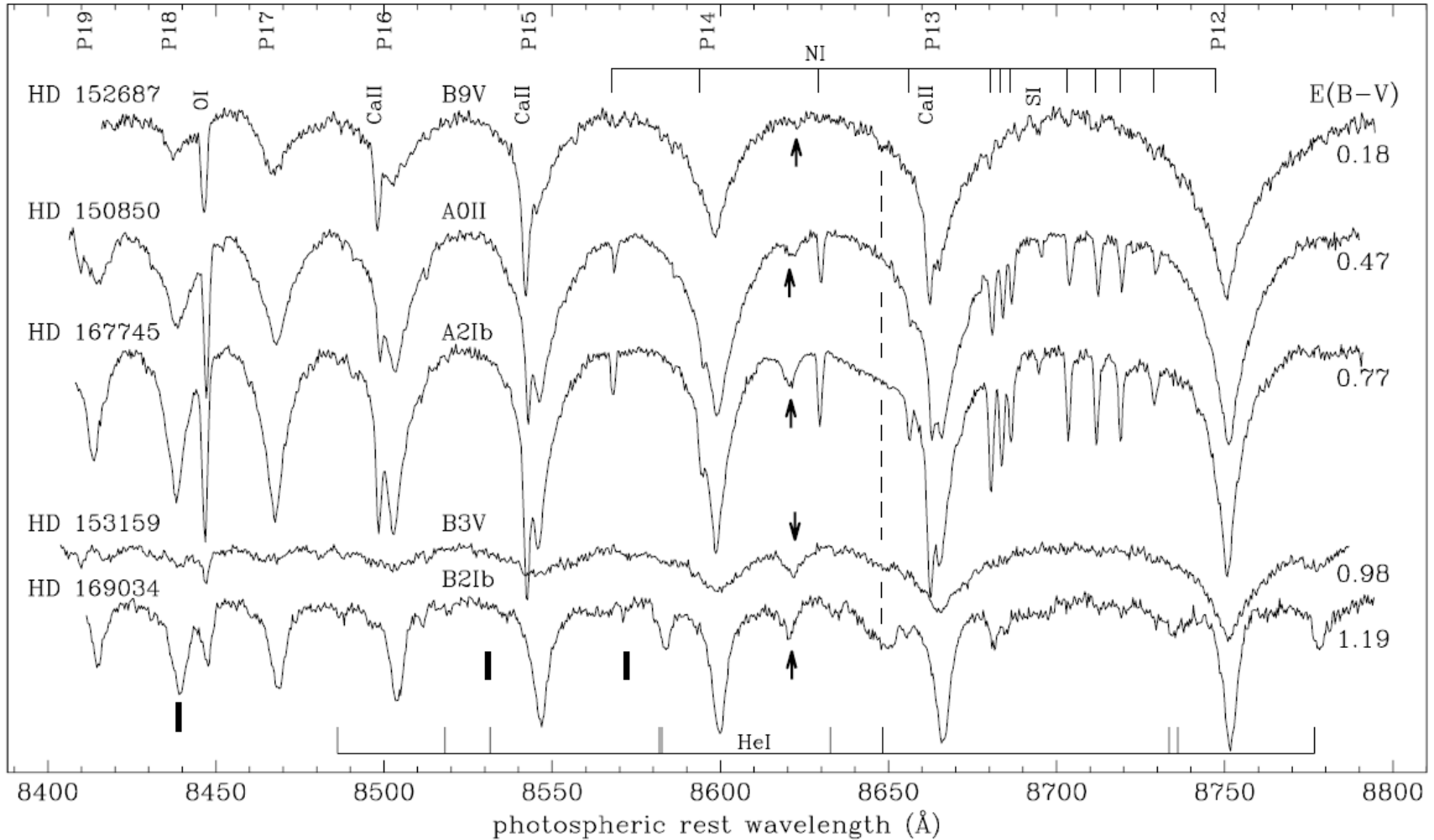
551 thick disk stars

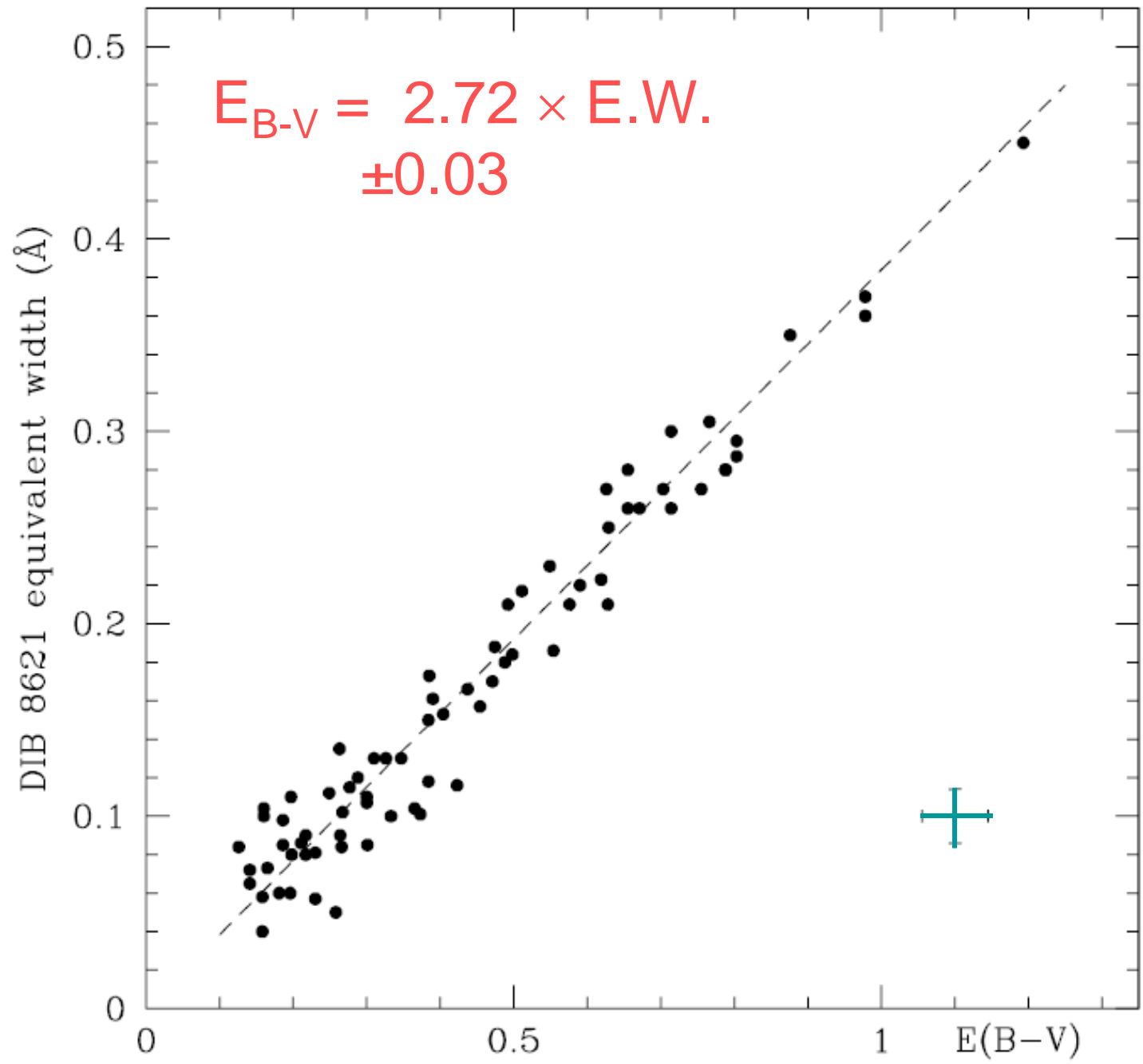
$V < -100$ km/sec,
 $abs(W) > 50$ km/sec,

1227 thin disk stars

$abs(V) < 20$ km/sec,
 $abs(W) < 16$ km/sec,
 $abs(z_{Gal}) < 0.3$ Kpc

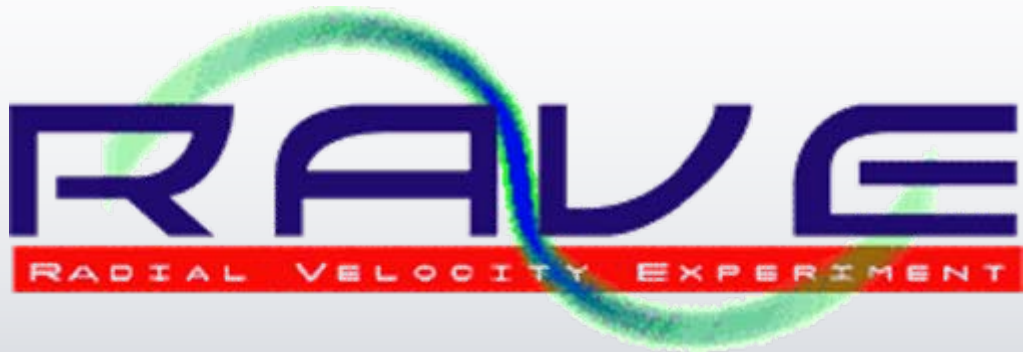
Extinction measurement with DIBs







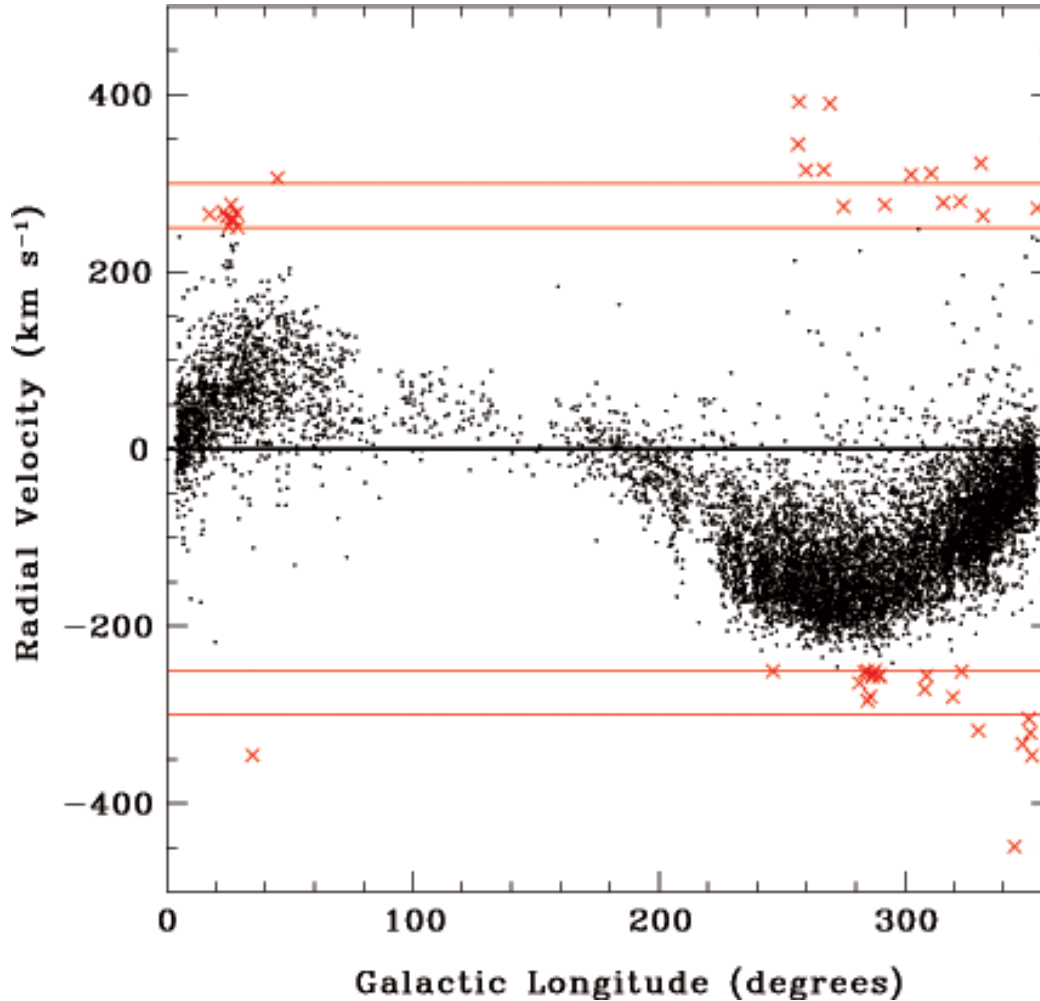
AIP



Scientific Results

The Escape Speed of the Milky-Way

Smith, Rutchi et al 2007



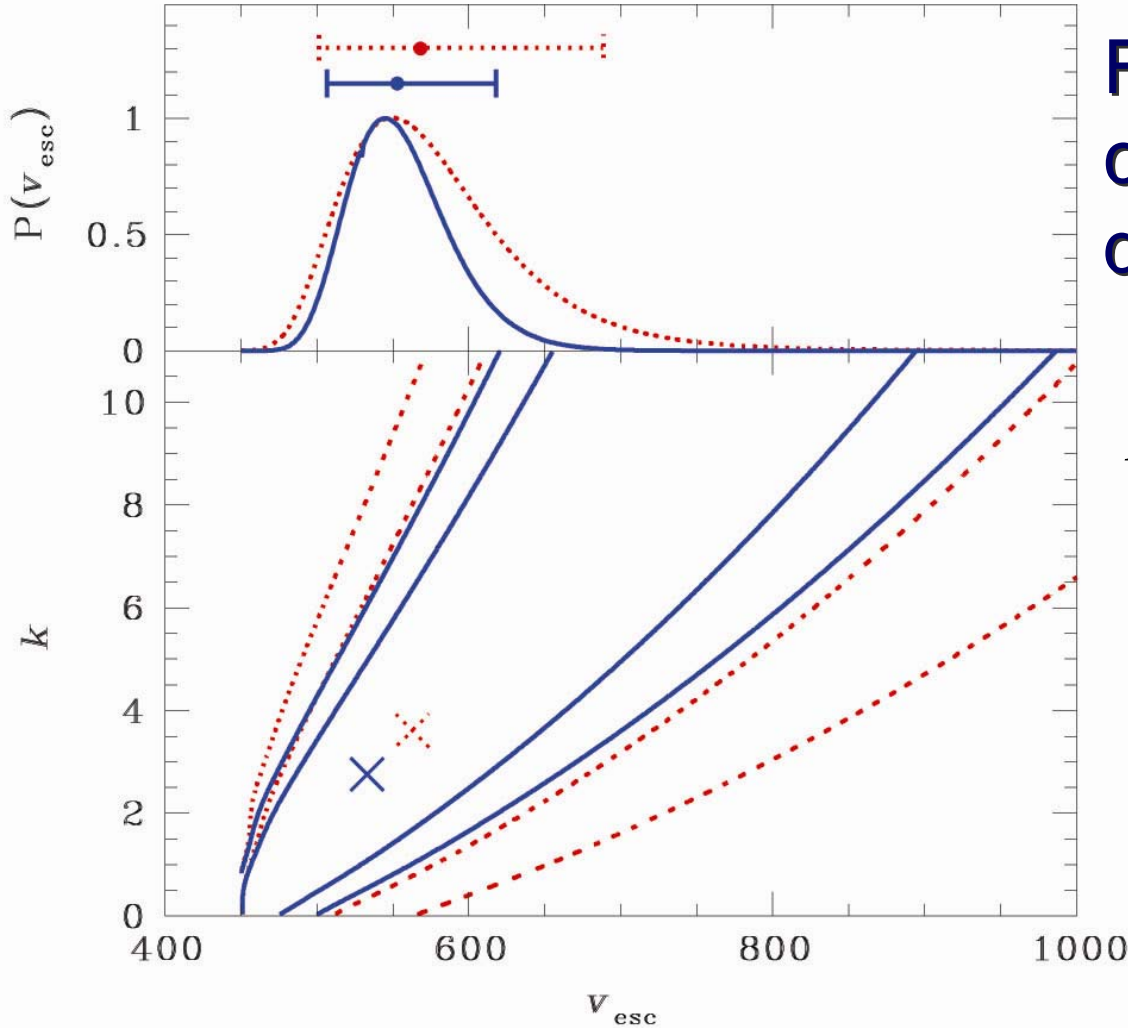
Leonard & Tremaine (1990):

near escape velocity:

$$f(\varepsilon) \propto \varepsilon^k$$

$$\varepsilon = (v_e^2 - v^2)$$

The Escape Velocity of the Milky-Way



For an adiabatically contracted NFW dark halo:

$$M_{MW} = 1.42^{+1.14}_{-0.54} \times 10^{12} M_{\odot}$$

$$v_{vir} \approx 142 \text{ km/s}$$

Smith et al
2007

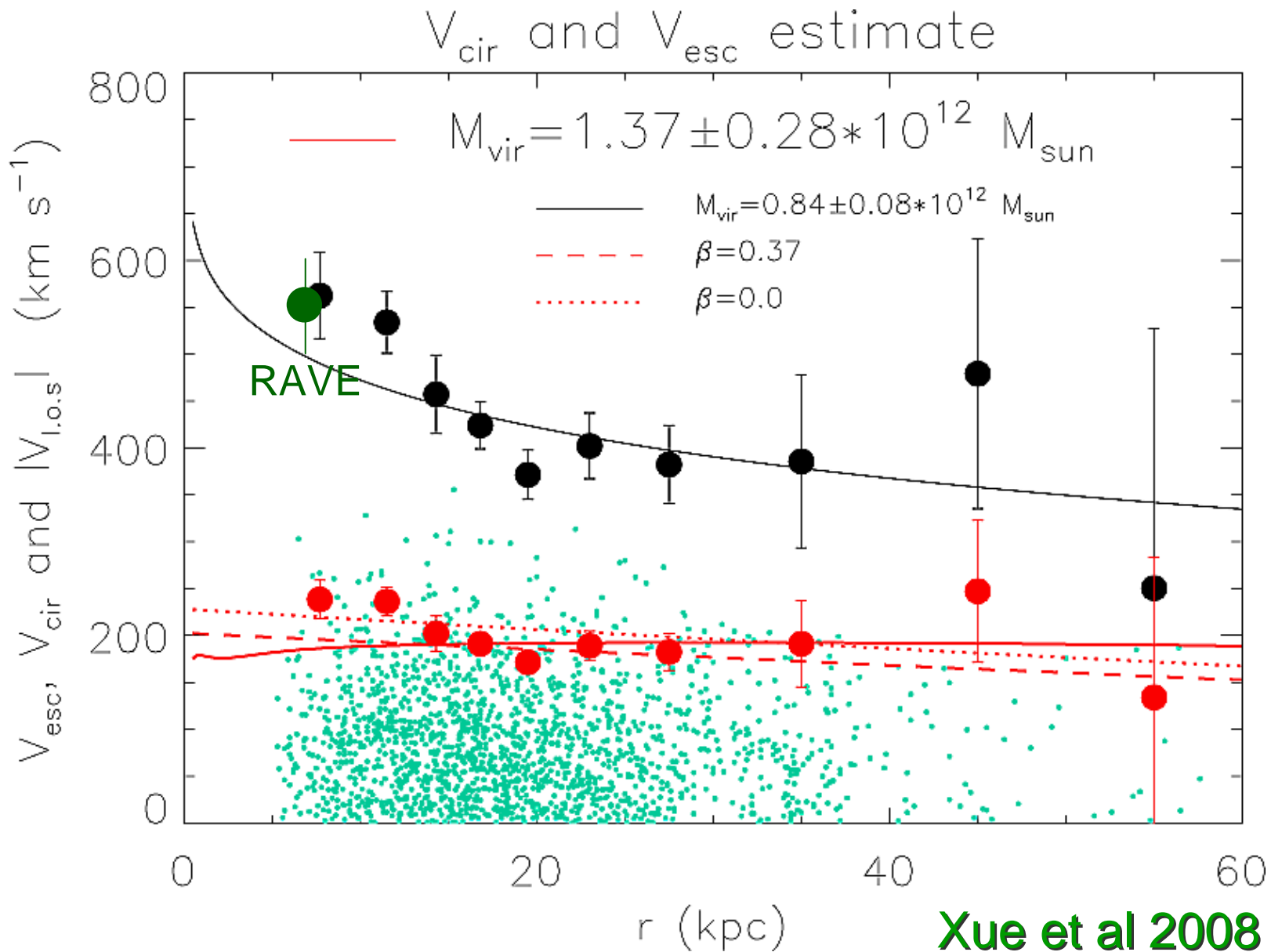
V_{circ} and V_{esc} from SDSS



AIP

ESO Spectroscopic Survey Workshop

Mar 10
2009



What does that mean for the MW as a typical LCDM galaxy?

- $V_c = 220$ km/s (as favored by SAMs)
 - ◆ Luminosity function + TF relation
 - ◆ Only ~20% of halos suitable hosts
 - ◆ 90% of the baryons in the MW unaccounted for
 - ◆ Disk size: access to the full angular momentum reservoir
- $V_c = 140$ km/s
 - ◆ MW would rather untypical or over abundant



AIP

Tidal streams in the Solar neighborhood (Seabroke et al 07)



AIP

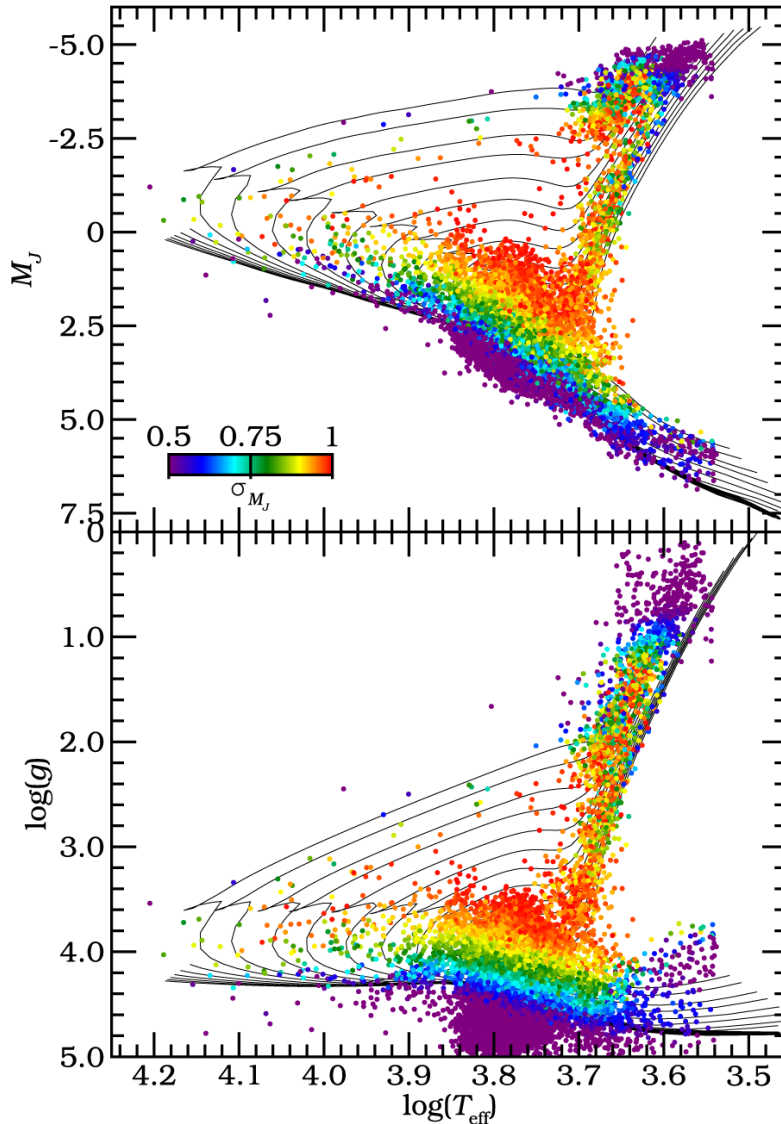
ESO Spectroscopic Survey Workshop

Mar 10 2009

- Vertical tidal stream in solar neighborhood
 \Rightarrow coherent +W (or -W) vertical velocity
- Kuiper test to measure symmetry of vertical velocity distribution of CORAVEL and RAVE stars above and below the plane
- No sign of coherent large scale motion as would be produced e.g. by Sagittarius or the Virgo Over Density

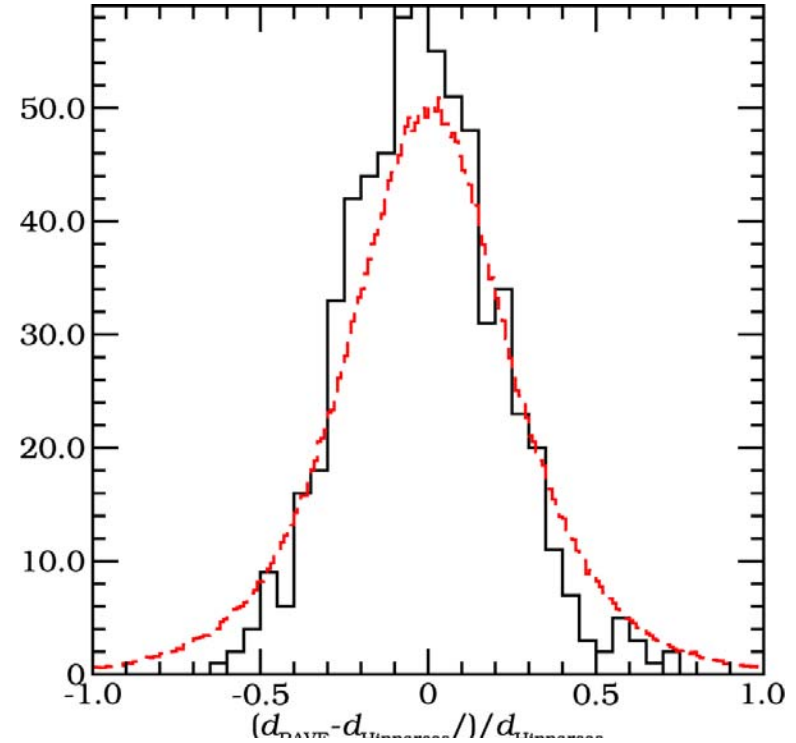
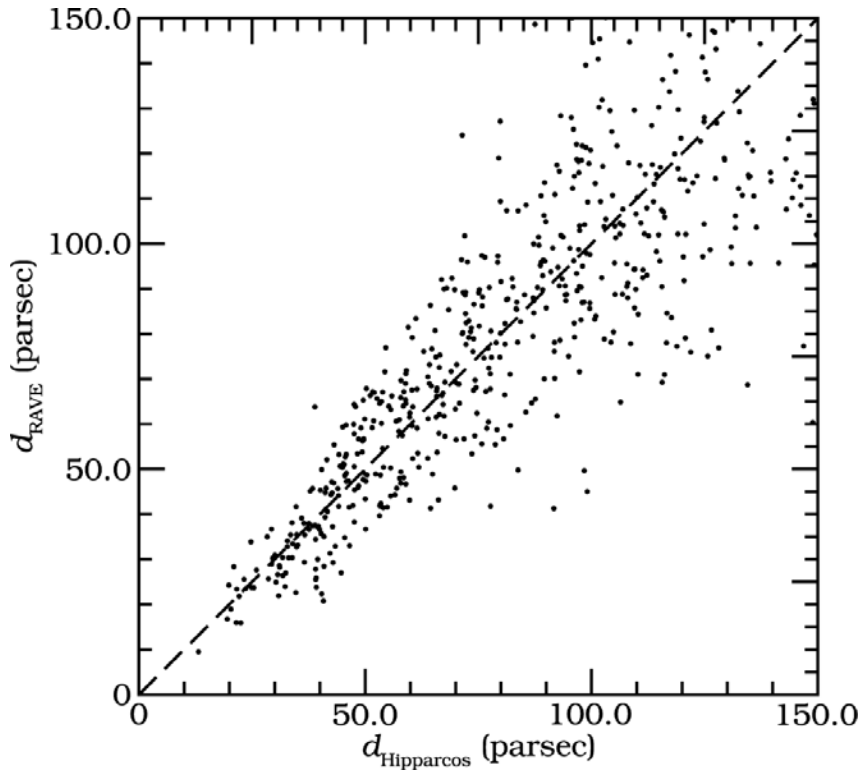
Sample	CORAVEL		RAVE	
	Dwarfs	Giants		
Section	2.5	3.4	4.6	
V (kpc ³)	0.0003	0.0511	7.9052	
N_s (low)	200	200	300	
N_s (high)	600	800	600	
VC (%)	100	100	5	15
ρ_s (low)	0.7×10^6	4000	800	300
ρ_s (high)	2.2×10^6	16 000	1500	500
N Sgr (low)	0.1 (n)	10 (n)	80 (n)	250 (?)
N Sgr (high)	0.4 (n)	80 (n)	590 (y)	1800 (y)
N VOD	30 (n)	6000 (y)	48 000 (y)	144 000 (y)

Going 6D: Distances of RAVE stars

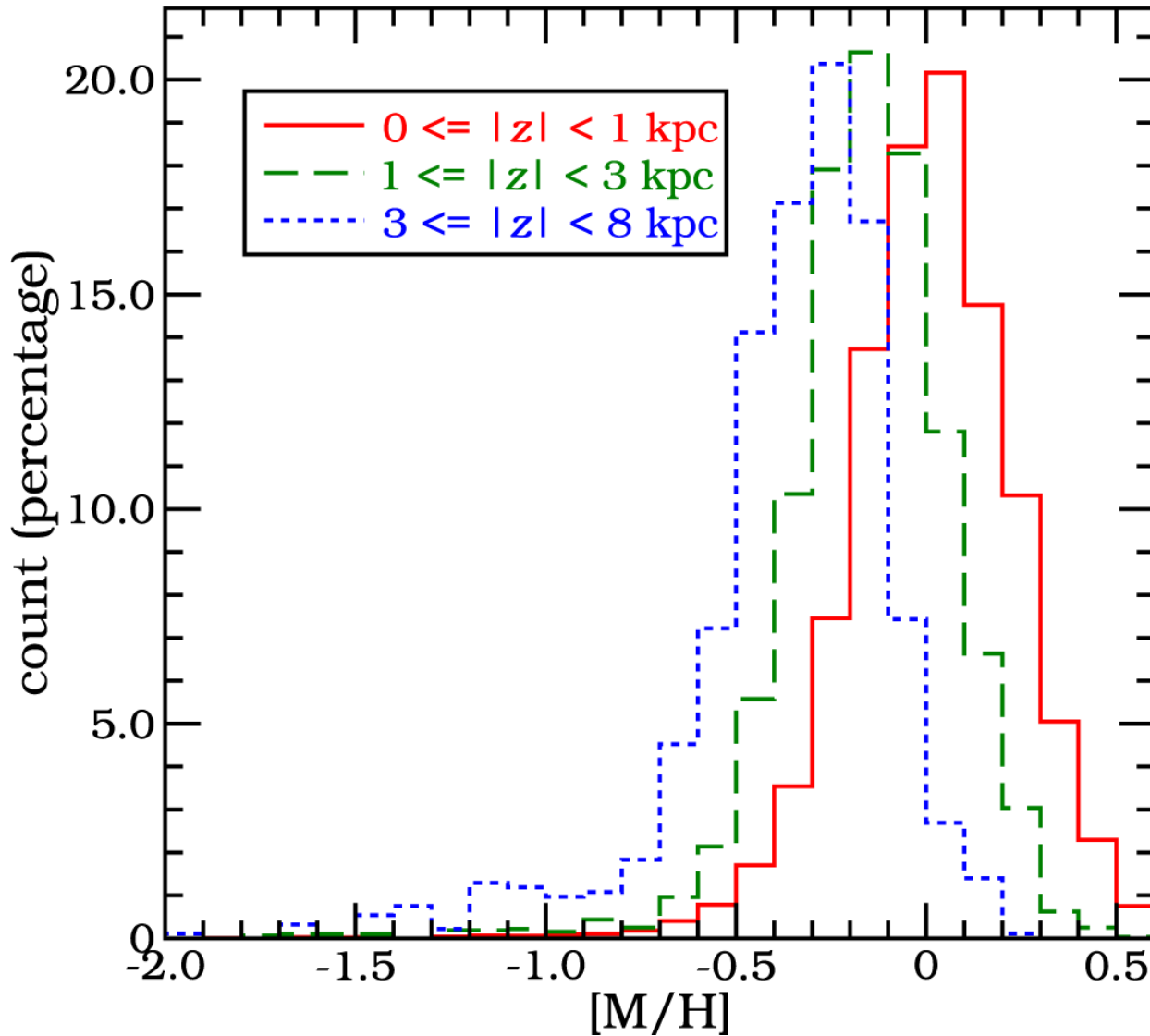


- Fit Y^2 -isochrones (Demarque et al 04) to RAVE data/deduced stellar parameters + J-K colors
 - ◆ J-Magnitude
 - ◆ Error in J-Magnitude
- Check by Monte-Carlo Sampling
- Result: out of 16663 stars in DR2
 - ◆ 2067 better 25%
 - ◆ 5294 better 37.5%
 - ◆ 12701 better 50%

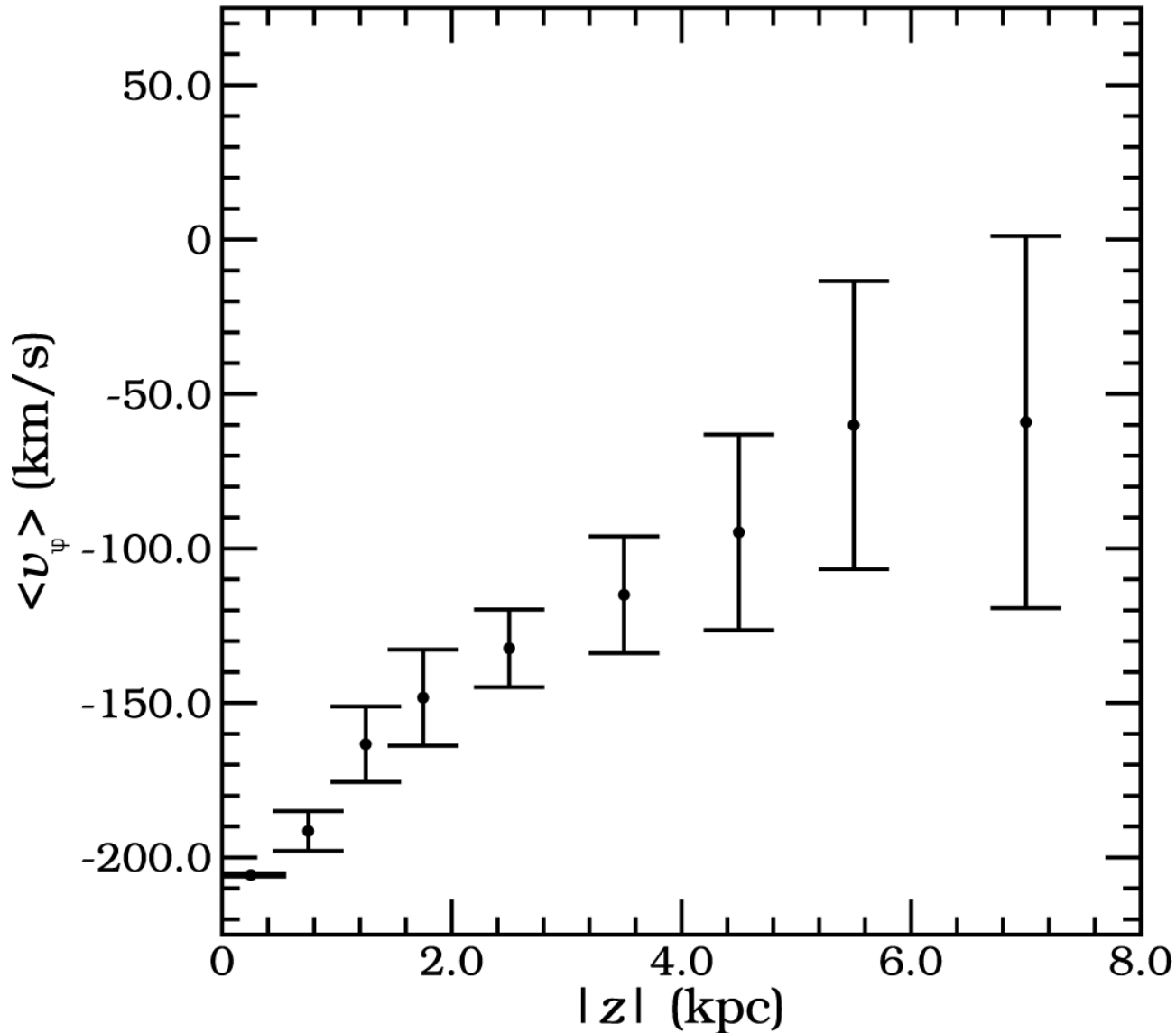
Verification for stars with Hipparcos distances



Abundances vs height



Rotation velocity vs height



Summary

- *RAVE continues to produce exquisite data with various applications in the area of galactic structure and evolution. Future releases also include abundance information*

- *First applications: depth of the galactic potential, the vertical structure of the disk, substructure (or lack thereof) in the solar neighborhood*

