

Subdwarfs and white dwarfs from
the 2MASS, Tycho-2, XPM and UCAC3
catalogues:
halo and thick disk stars within 2 kpc

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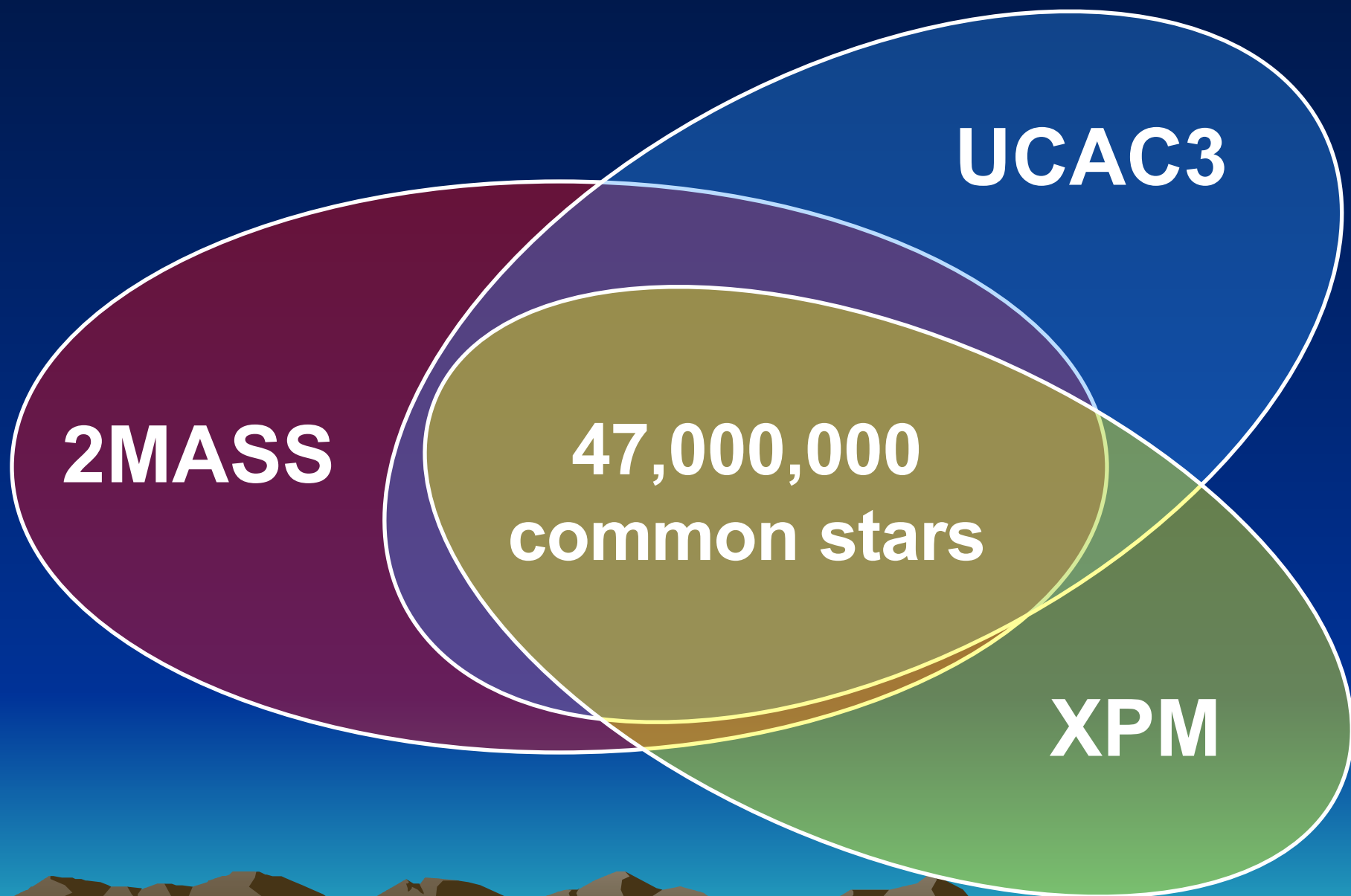
Given:

1. **proper motions** from UCAC3, XPM (Kharkov catalogue) and Tycho-2,
2. **photometry** (J, H, Ks, RUCAC, Bsc, Rsc, Isc, Bt, Vt) from 2MASS, UCAC3, SuperCosmos, Tycho-2

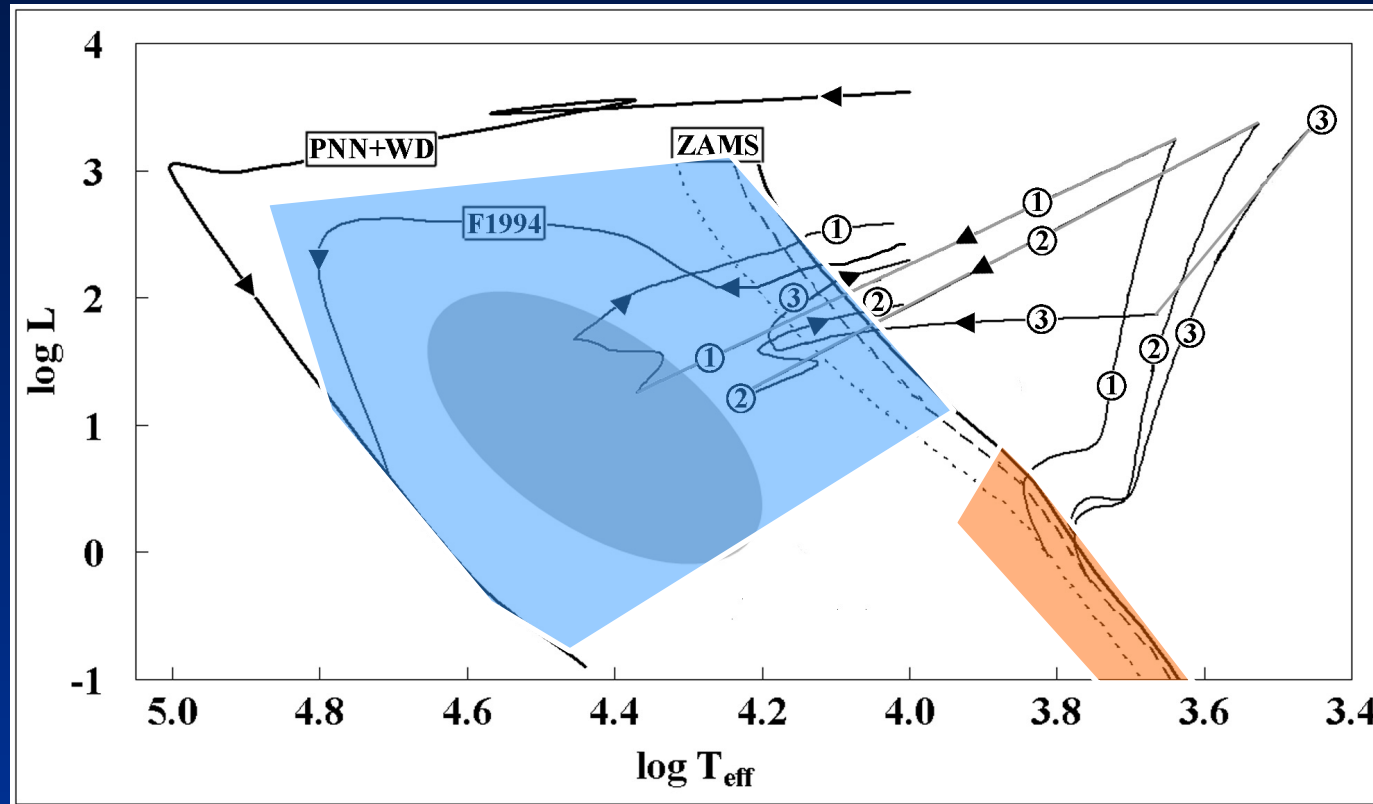
transferred into
color indices (CI) and

reduced proper motions (RPM) $M'_{Ks} = Ks + 5 + \lg(\mu)$

to select subdwarfs (SDs) and white dwarfs (WDs)
on the CI-RPM diagrams
and look at their 3D distribution and motion.



Examples of theoretical evolutionary tracks to be a subdwarf:



ZAMS for $Z=0.019$, 0.008 and 0.0004 ;

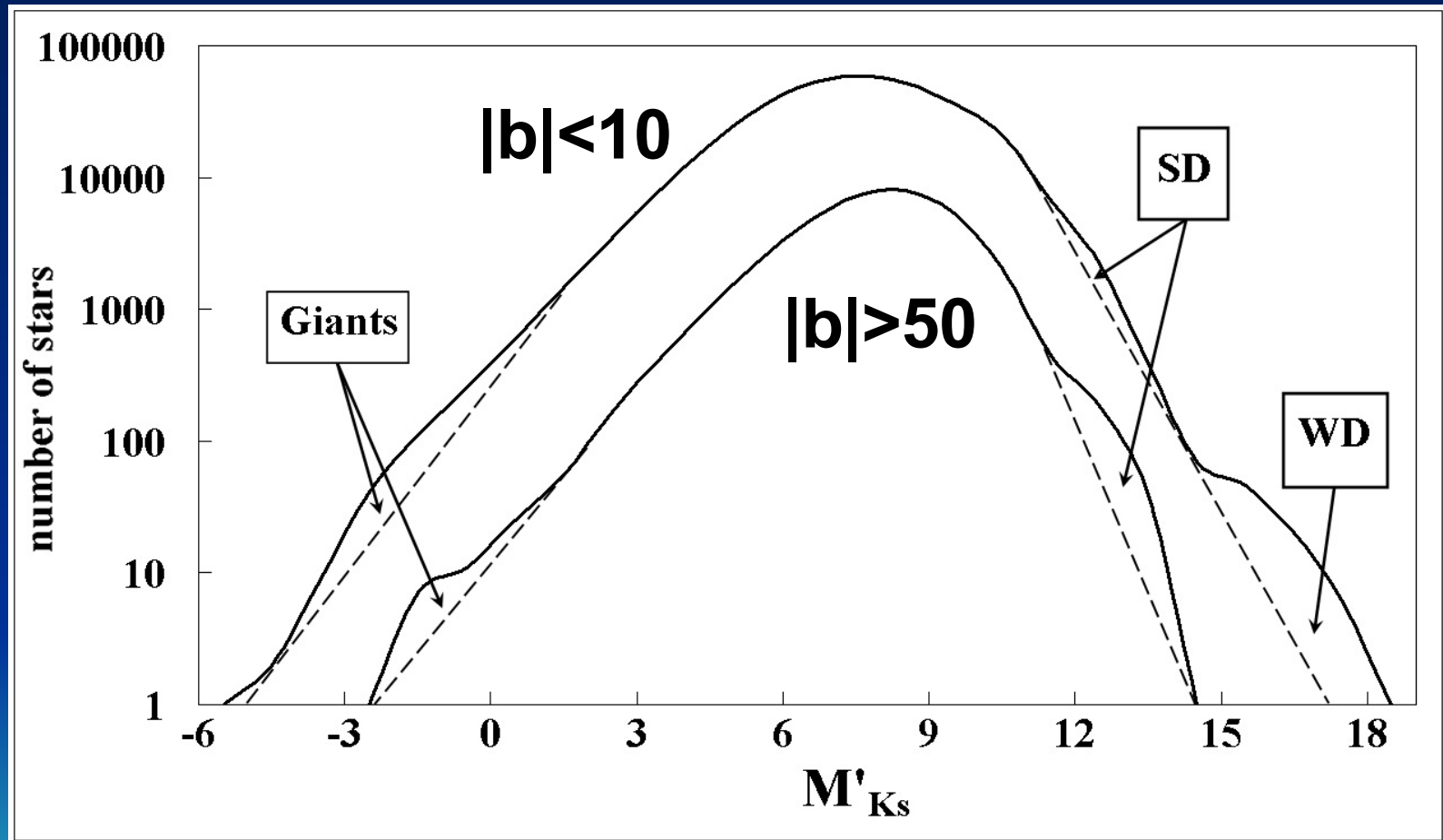
3 evolutionary tracks for $0.9M$ before and $0.5M$ after helium flash for $Z=0.0004/Y=0.23$, $Z=0.008/Y=0.25$ and $Z=0.04/Y=0.46$ (**convective overshooting**);

PN nucleus + white dwarf tracks for $0.9M$, $Z=0.004$ and for $0.5M$, $Z=0.05/Y=0.35$;

the grey ellipse = the domain of subdwarfs generated after evolution in close binaries;

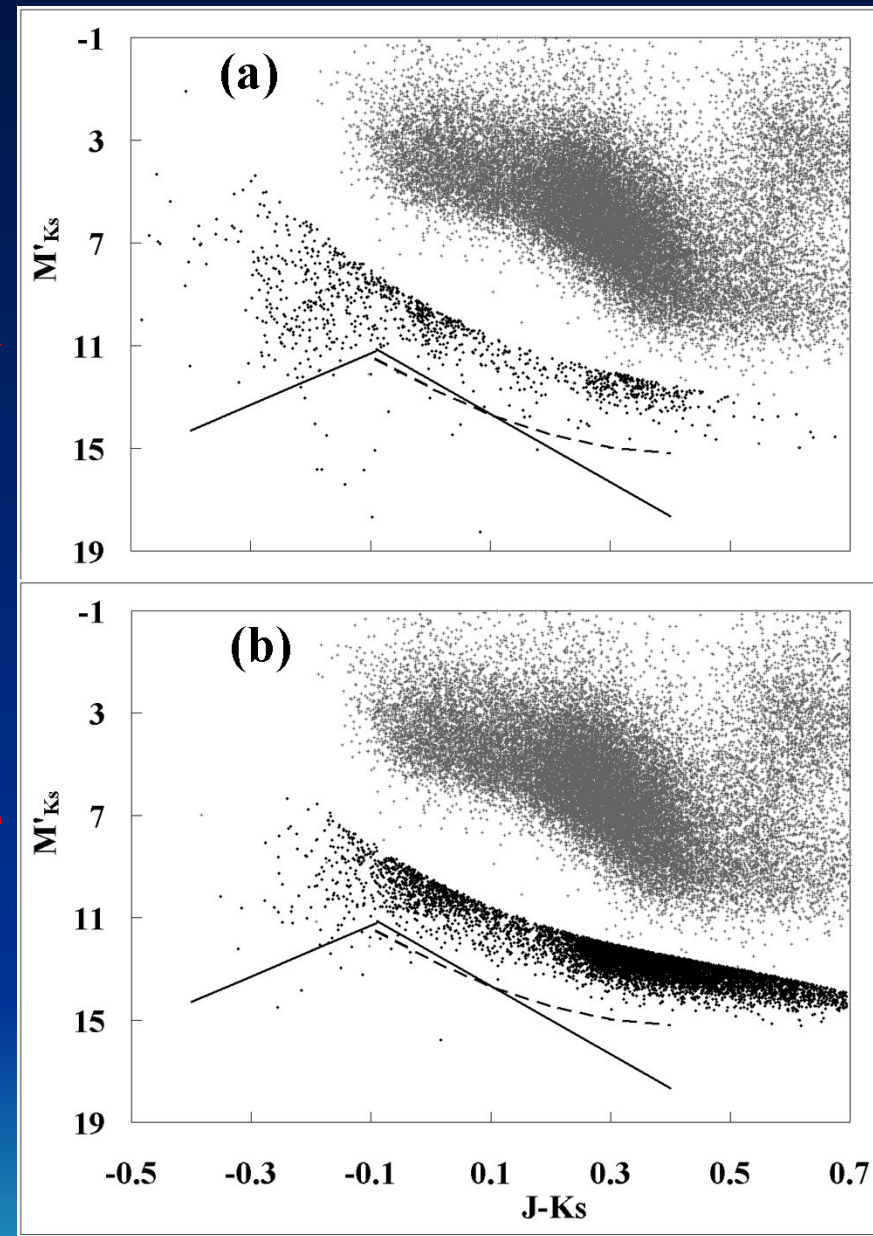
An example: the distribution of the XPM stars along RPM
for $0.34 < (J-K_s) < 0.35$.

The deviations of the curves from the dashed gaussians
are **giants**, **subdwarfs (SDs)** and **white dwarfs (WDs)**.

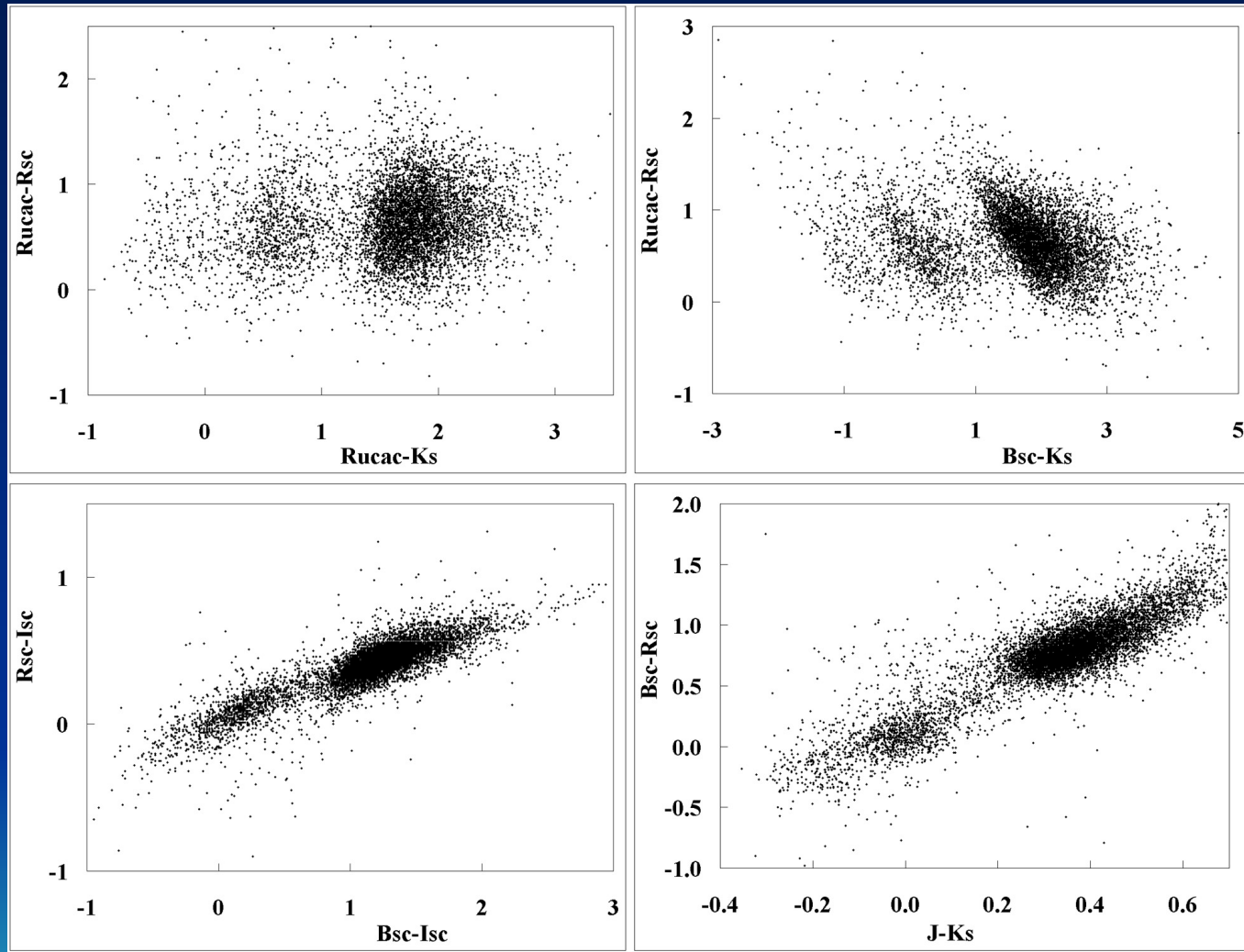


Etalon Hipparcos stars with parallax
relative error less than 0.3
(grey points)
together with selected
(a) 1040 Tycho-2,
(b) 8759 XPM-UCAC3 stars
(black diamonds).

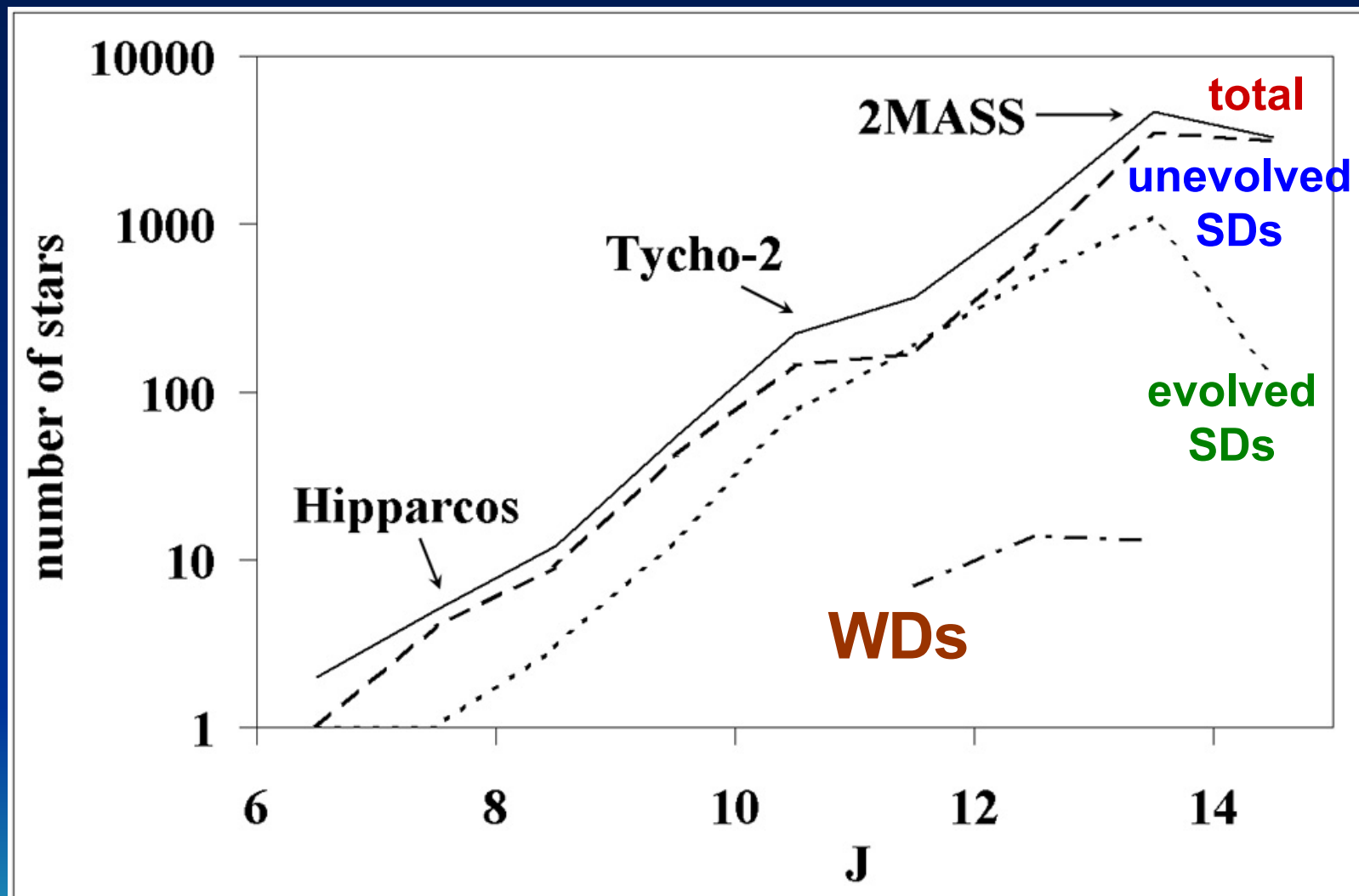
Lines:
theoretical and accepted
SD-WD cut
(WDs are a by-product
of this research).



Single evolved SD / evolved SD + late dwarf / unevvolved SD separation by color-color diagrams

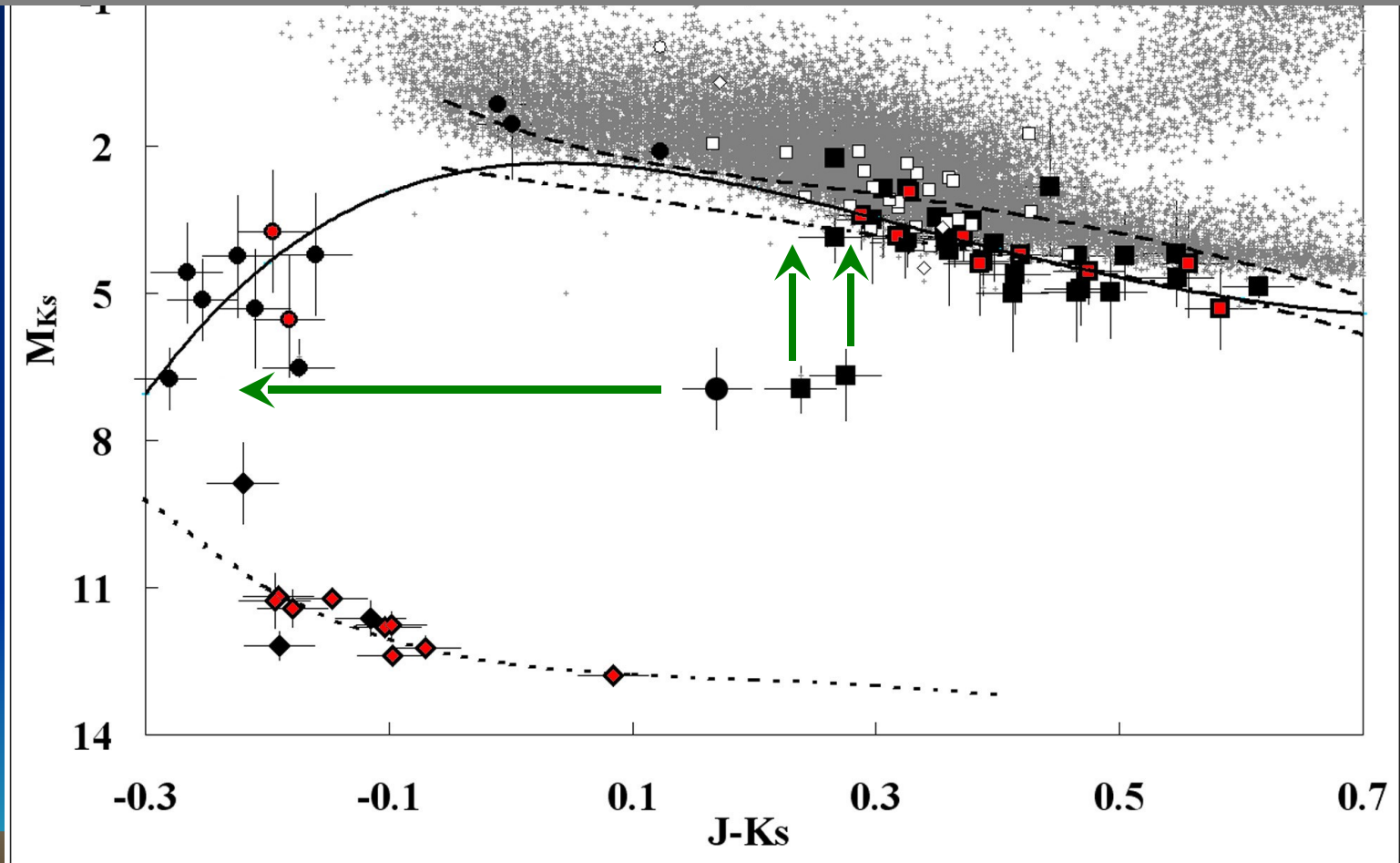


The distribution of the selected stars on J magnitude: some overdensities due to catalogue maxima are marked.

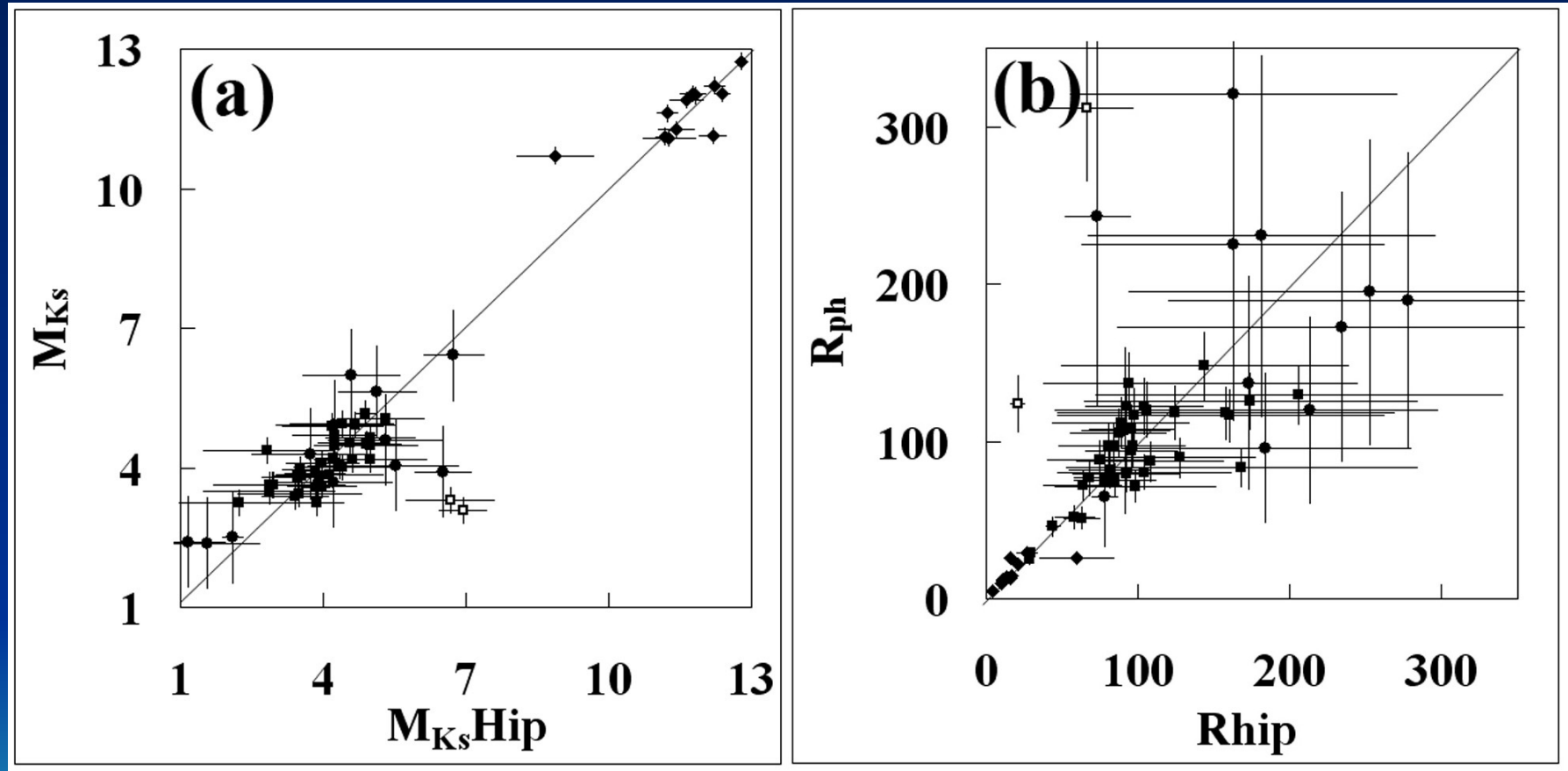


(J-Ks) vs. M_{Ks} :

etalon Hipparcos stars (grey points) together with WDs and SDs -
selected known - red diamonds and circles,
selected new - black symbols, not selected known - white symbols.
+ isochrones for $Z=0.001$ and $Z=0.019$ and accepted calibration lines.



The comparison of Hipparcos's and obtained absolute magnitudes and distances for selected stars with precise parallaxes.



Selected stars on the celestial sphere in galactic coordinates.

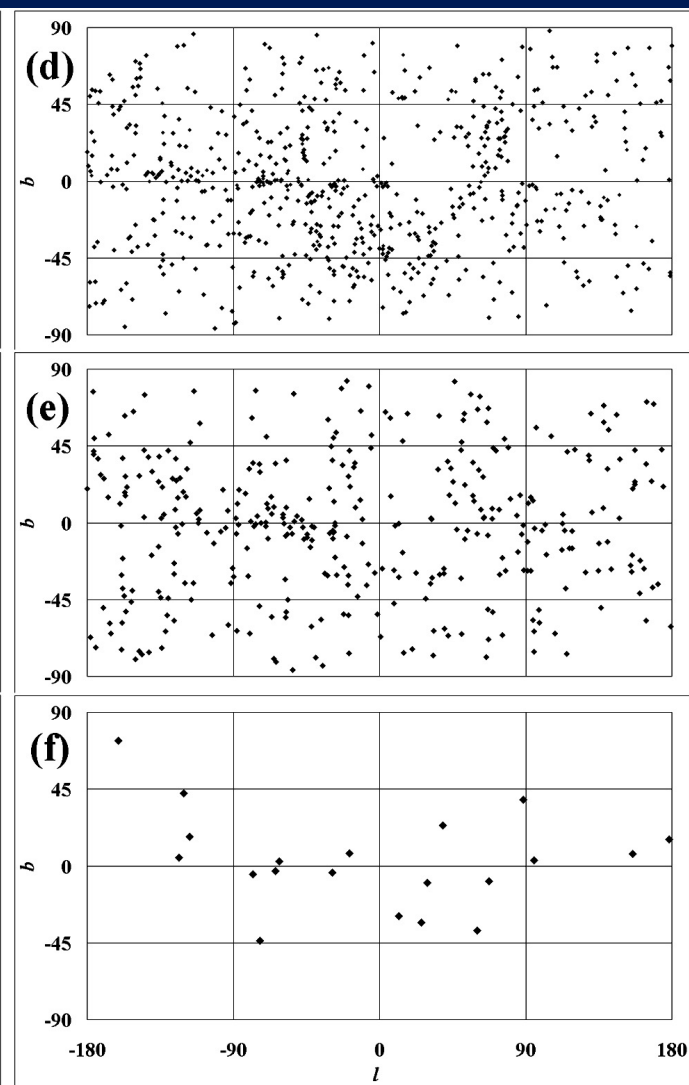
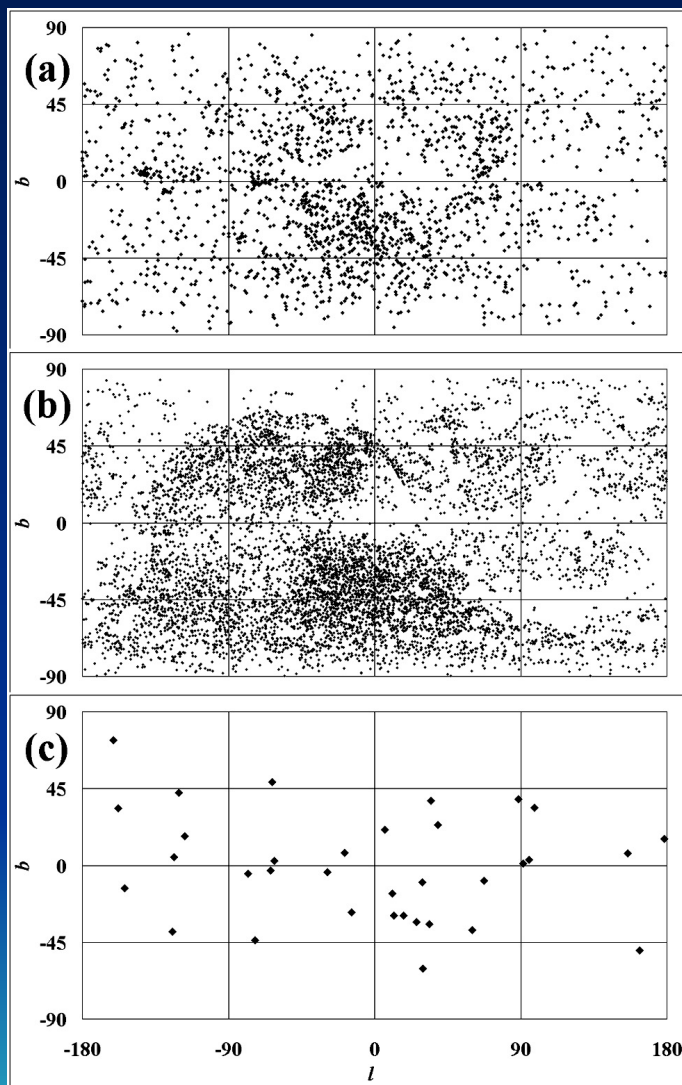
UCAC3+XPM

Tycho-2

evolved SDs

unevolved SDs

WDs

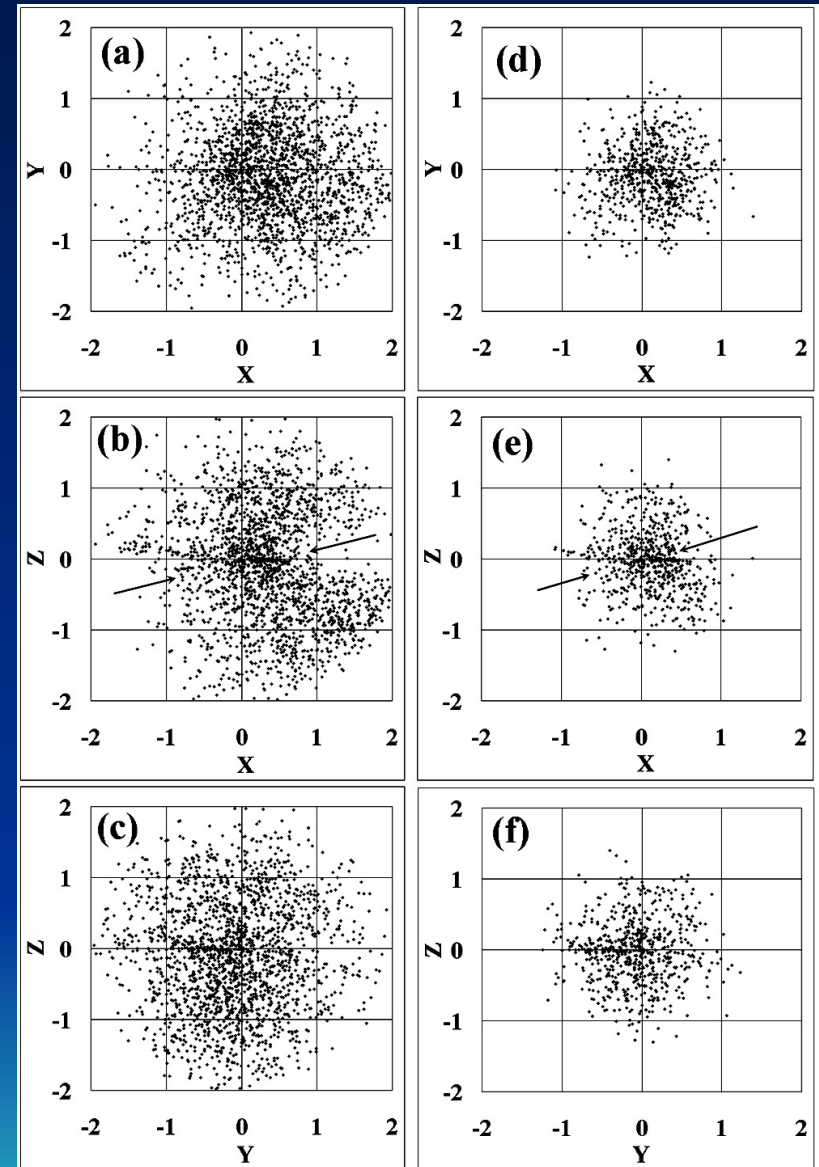


UCAC3+XPM

Tycho-2

The distribution of
evolved SDs
projected into the
XY, XZ, YZ planes (in kpc).

Arrows: extinction in Gould belt

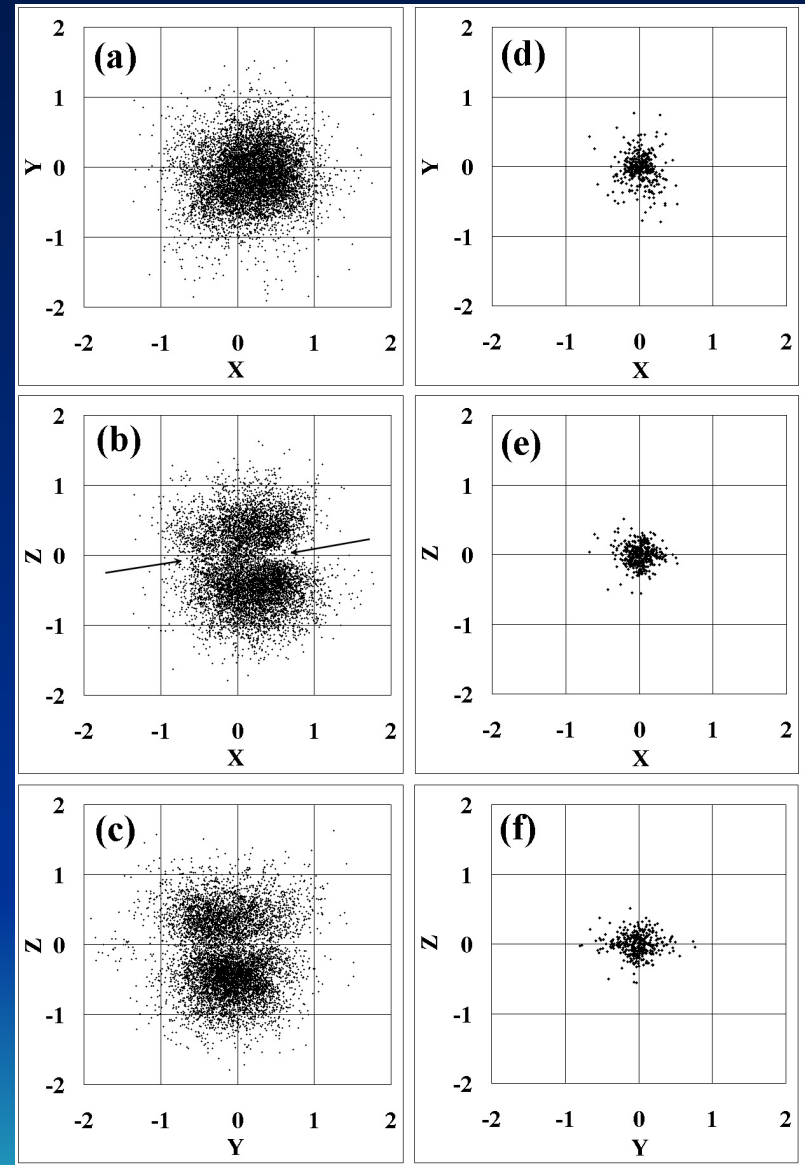


UCAC3+XPM

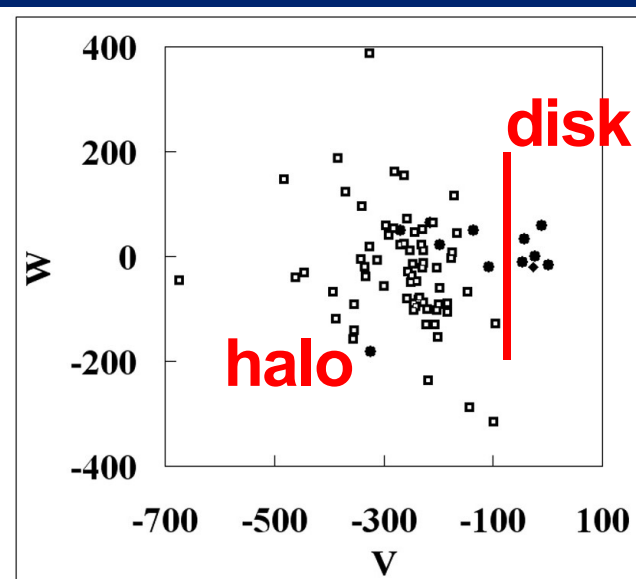
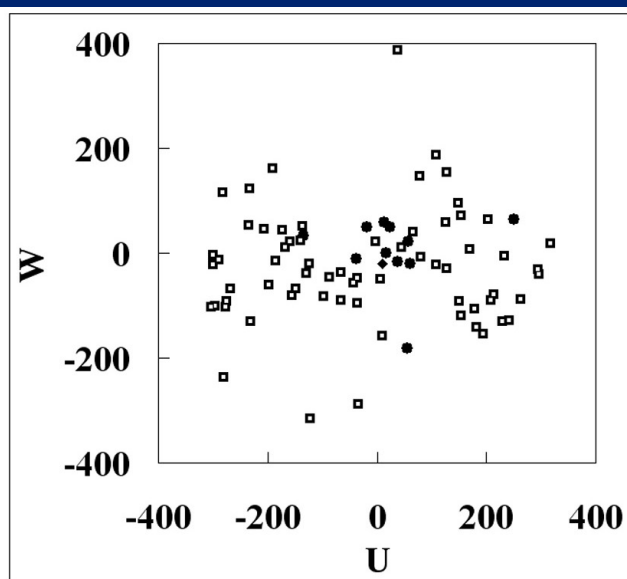
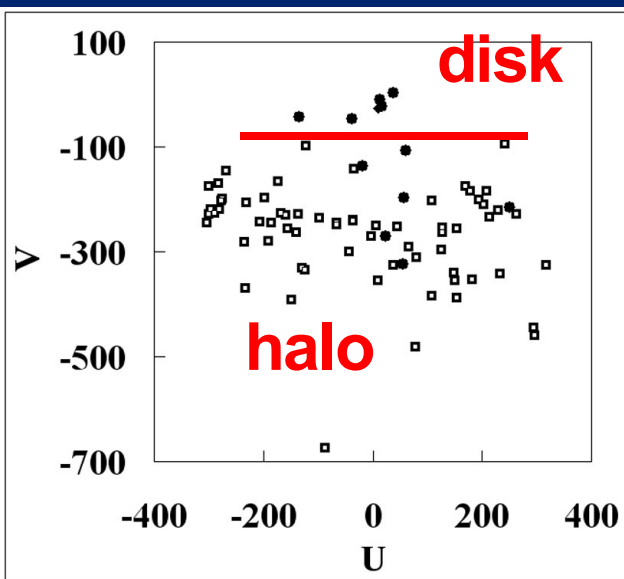
Tycho-2

The distribution of
unevolved SDs
projected into the
XY, XZ, YZ planes (in kpc).

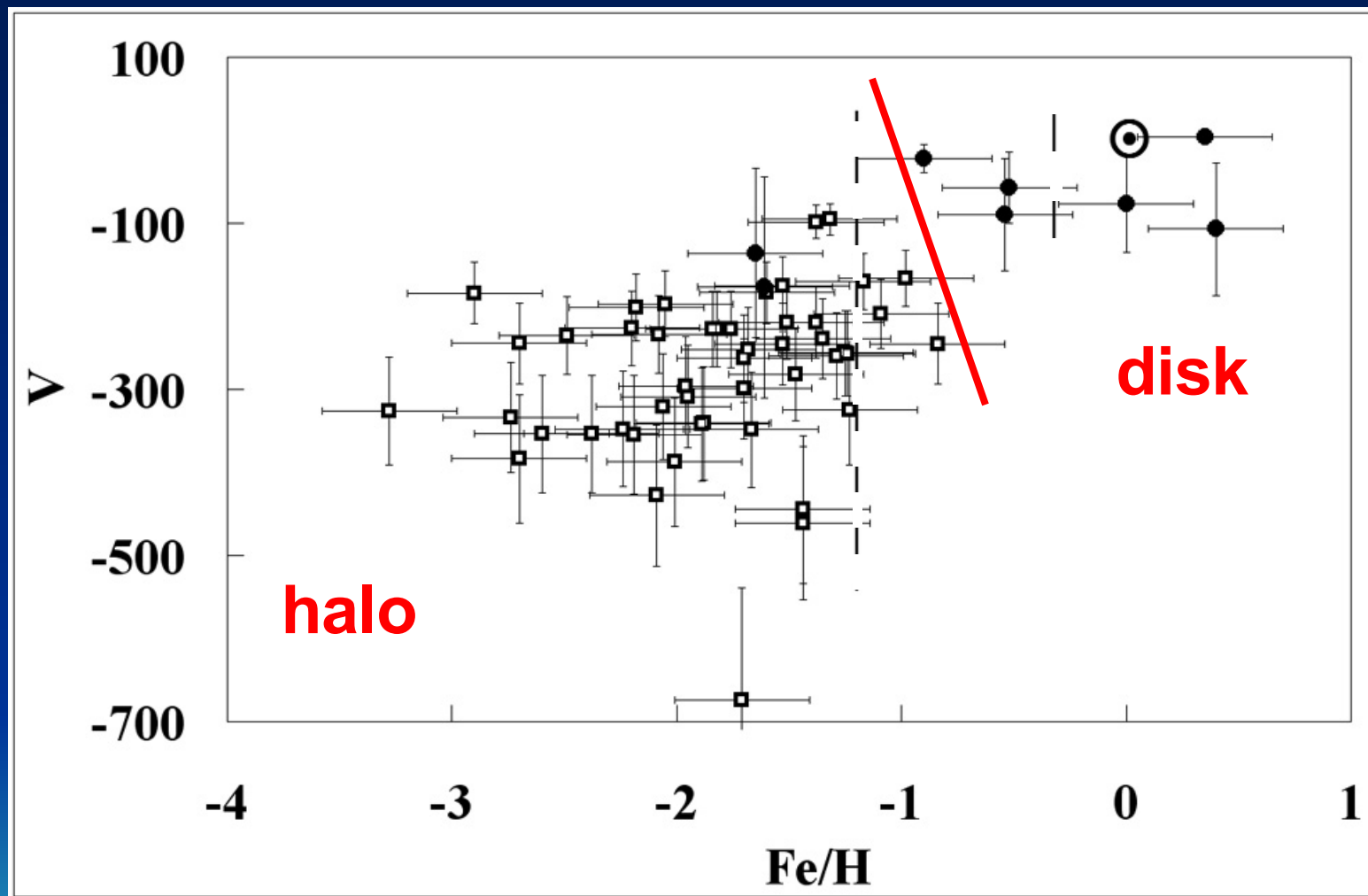
Arrows: extinction in Gould belt



Selected stars with precise **radial velocities** from the **Pulkovo Compilation of Radial Velocities (PCRV)** catalogue in the projection to UV, UW and VW planes (in km/s):
11 evolved SDs (circles),
66 unevolved SDs (open squares).

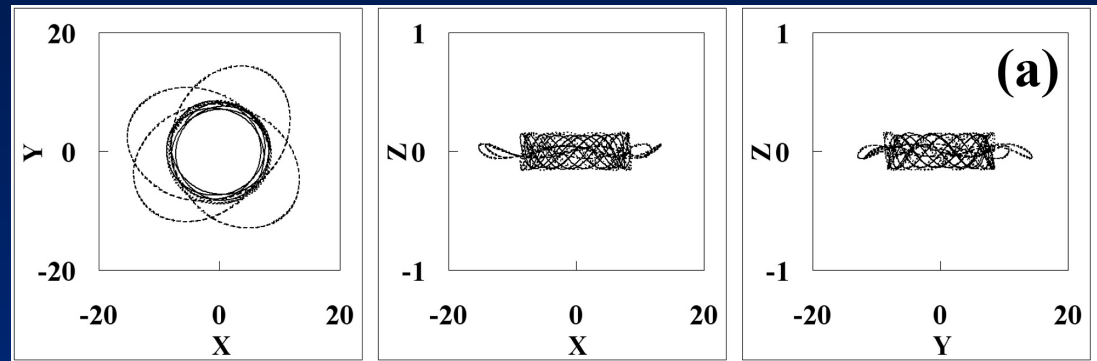


Fe/H versus velocity component V (asymmetric drift) for evolved SDs (circles) and unevvolved SDs (open squares).

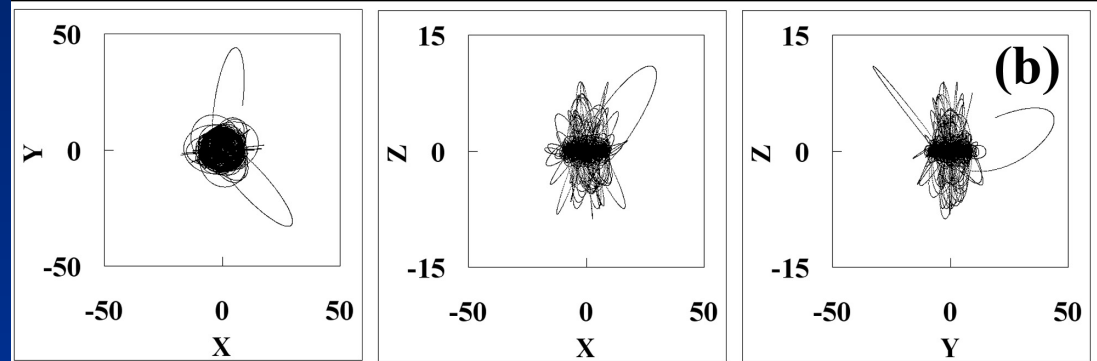


The projections of the orbits into XY, XZ and YZ planes. The scales (in kpc) are different!

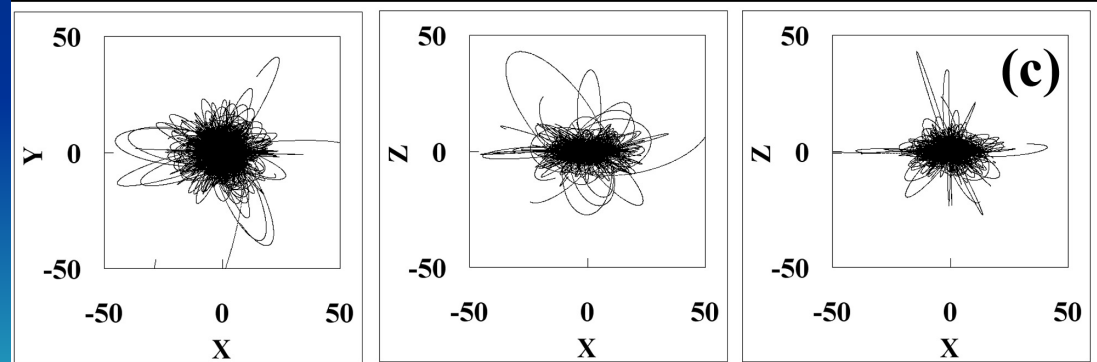
3 WDs:
thin disk orbits



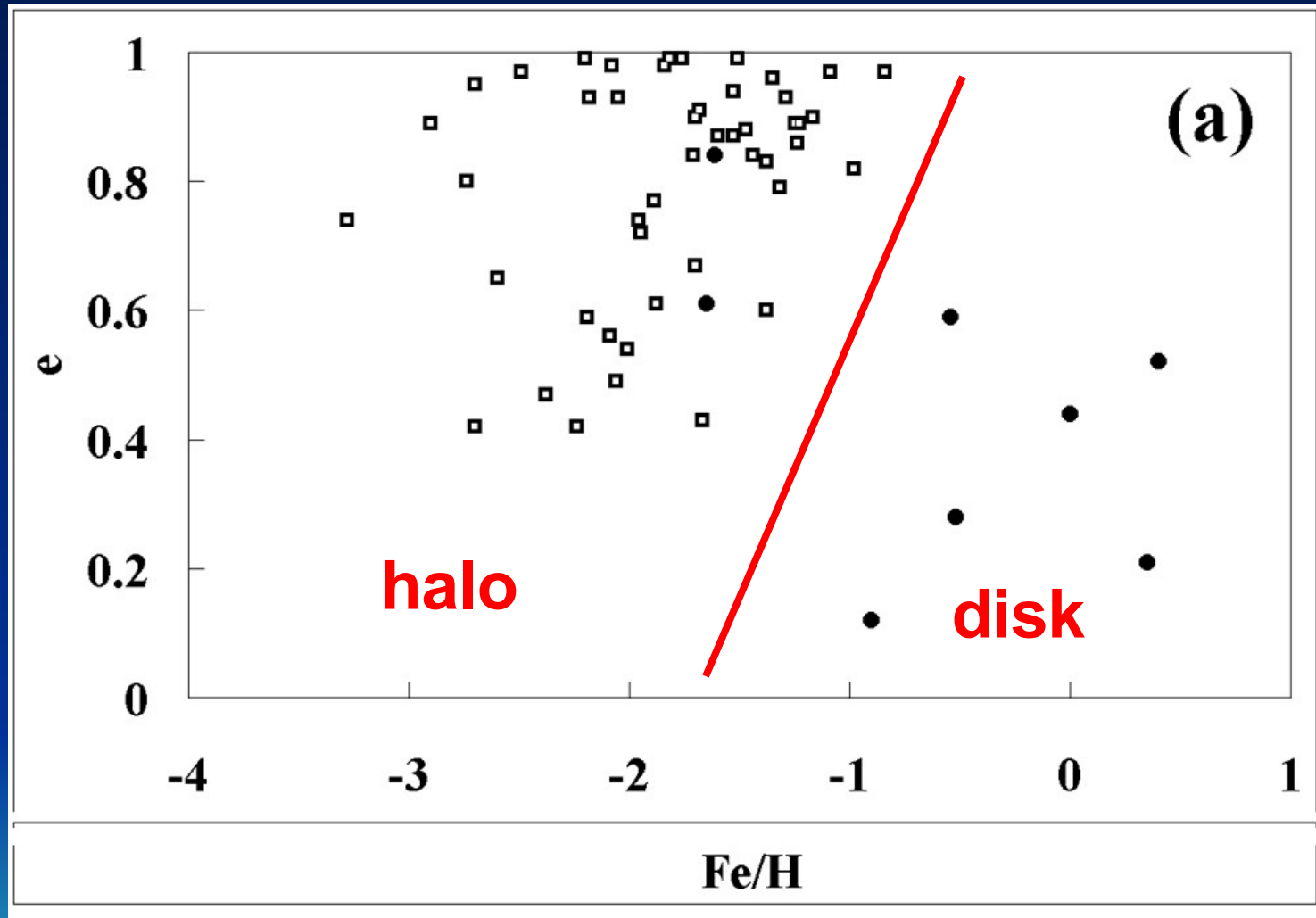
41 evolved SDs:
thick disk orbits



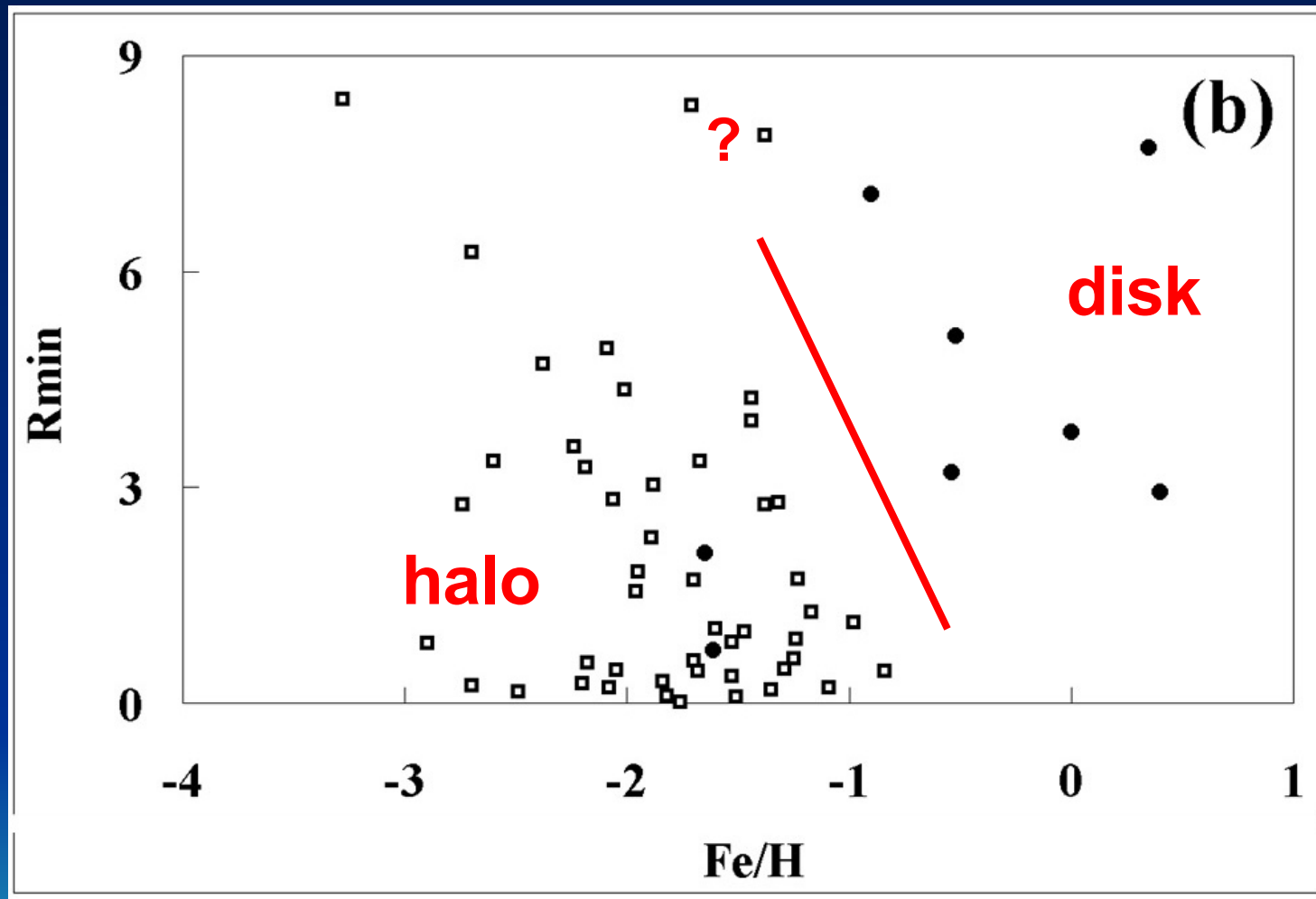
139 unevolved SDs:
halo orbits



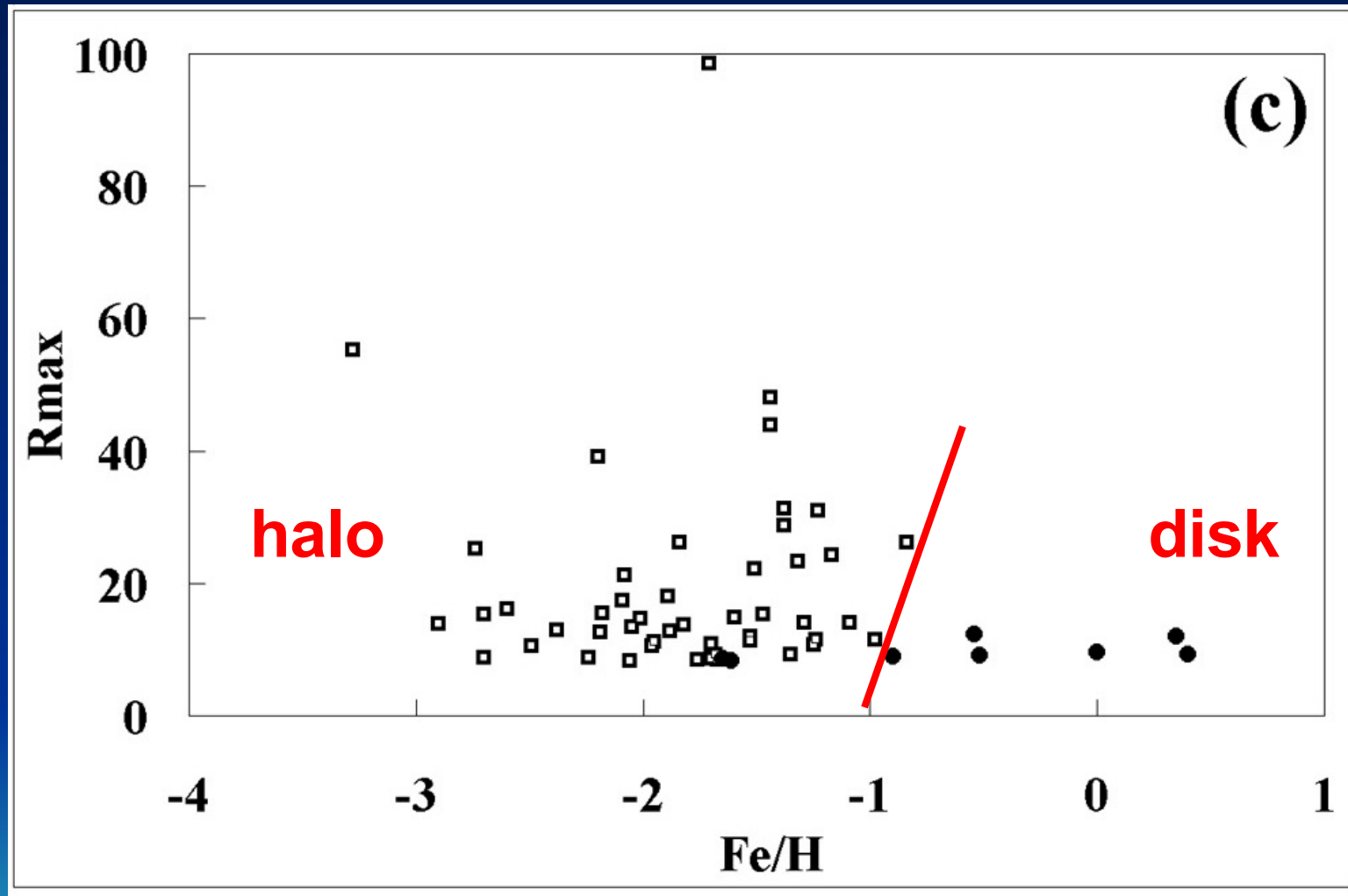
Fe/H versus eccentricity for evolved (circles) and unevvolved (open squares) SDs.



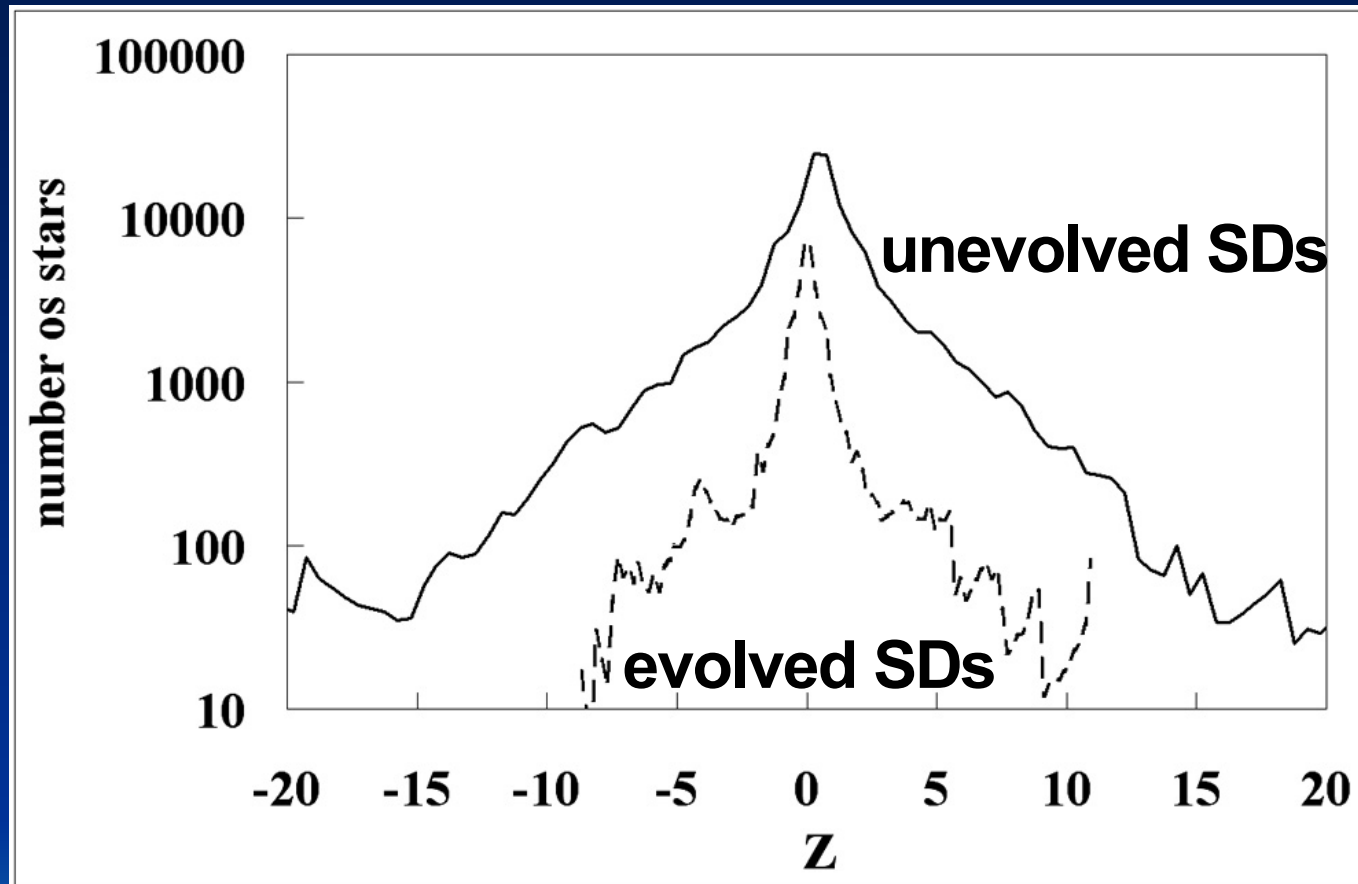
**Fe/H versus perigalactic distance (in kpc)
for evolved (circles) and unevvolved (open squares) SDs.**



**Fe/H versus apogalactic distance (in kpc)
for evolved (circles) and unevvolved (open squares) SDs.**



The average spatial distribution of selected SDs on Z distance (in kpc) based on their orbits.



Obtained thick disk scale height = 1.25 ± 0.1 kpc,
unevolved SDs (halo) scale height = 8 ± 1 kpc.

Results:

1. A sample of 1996 evolved and 7769 unevolved subdwarf candidates is selected by use of all-sky astrometric and photometric surveys to be confirmed by spectroscopy because ~95% of the stars are classified for the first time.
2. The sample is not complete and shows biases in favor to faster stars. It would be fixed by proper motion surveys with 1 mas/year precision.
3. The "color index vs. absolute magnitude" and "reduced proper motion vs. absolute magnitude" calibrations made with the best Hipparcos stars give us distances and 3D distribution.
4. All subdwarfs show concentration to galactic centre hemisphere with voids because of Gould belt extinction.
Evolved ones show some spatial overdensities of yet unknown nature.
5. The Fe/H and PCRV radial velocities give us 3D motions and metallicity-velocity relations.
6. Unevolved subdwarfs are population II low metallicity high asymmetric drift stars from halo with the scale height of 8 ± 1 kpc.
7. Evolved subdwarfs are heterogeneous population from disk and halo. Most of them are thick disk stars with the scale height of 1.25 ± 0.1 kpc.

A stylized, dark brown silhouette of a mountain range with several peaks, positioned along the bottom edge of the slide. The background is a solid dark blue, and the text is white.

Gontcharov (Pulkovo) Subdwarfs 4 June 2010