Auxiliary science in Galactic archaeology surveys

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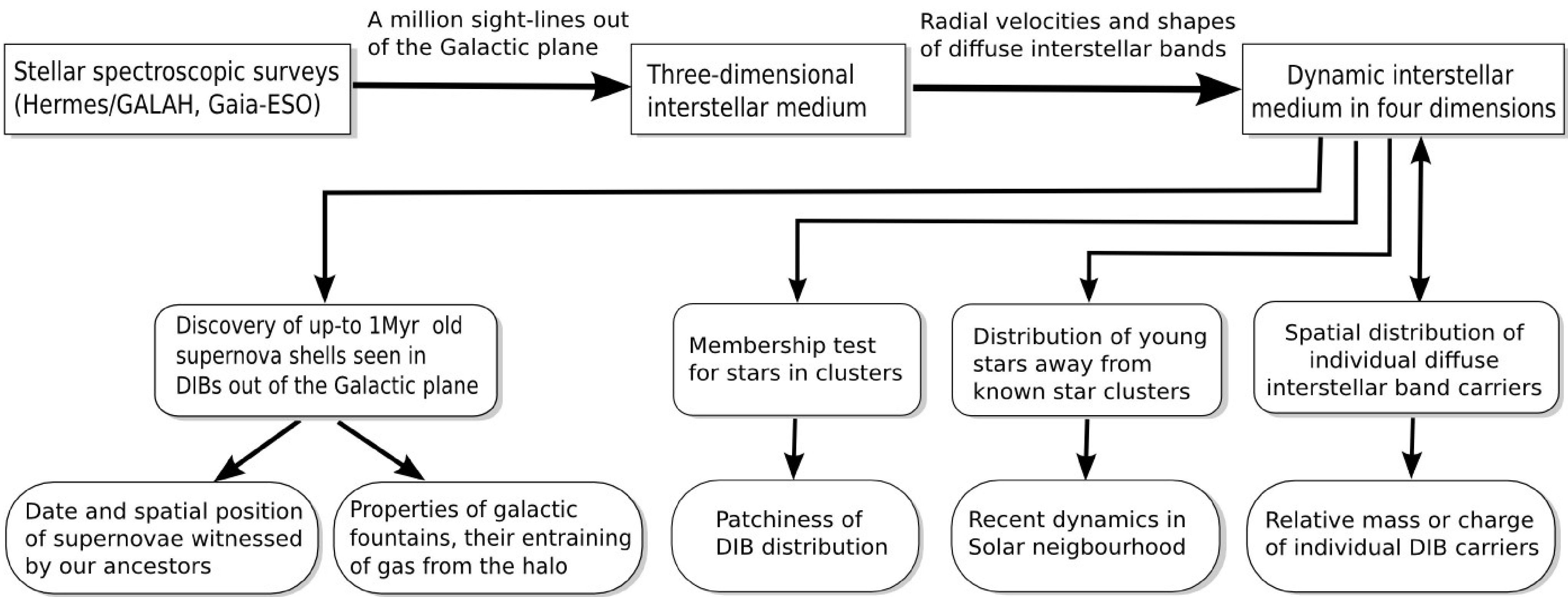
Plan of the talk:

I. Dynamical interstellar medium.
II. Young stars in the field.
III. Very low mass stars in binaries.

Dynamics of the interstellar medium

	Bands/lines in optical	3-D position	Radial velocity
Dust absorptions	≥ 1	yes	no
Interstellar emission lines	a few	no	yes
Interstellar absorption lines	a few	yes	yes
Diffuse interstellar absorption bands (DIBs)	up to ~400	yes	yes

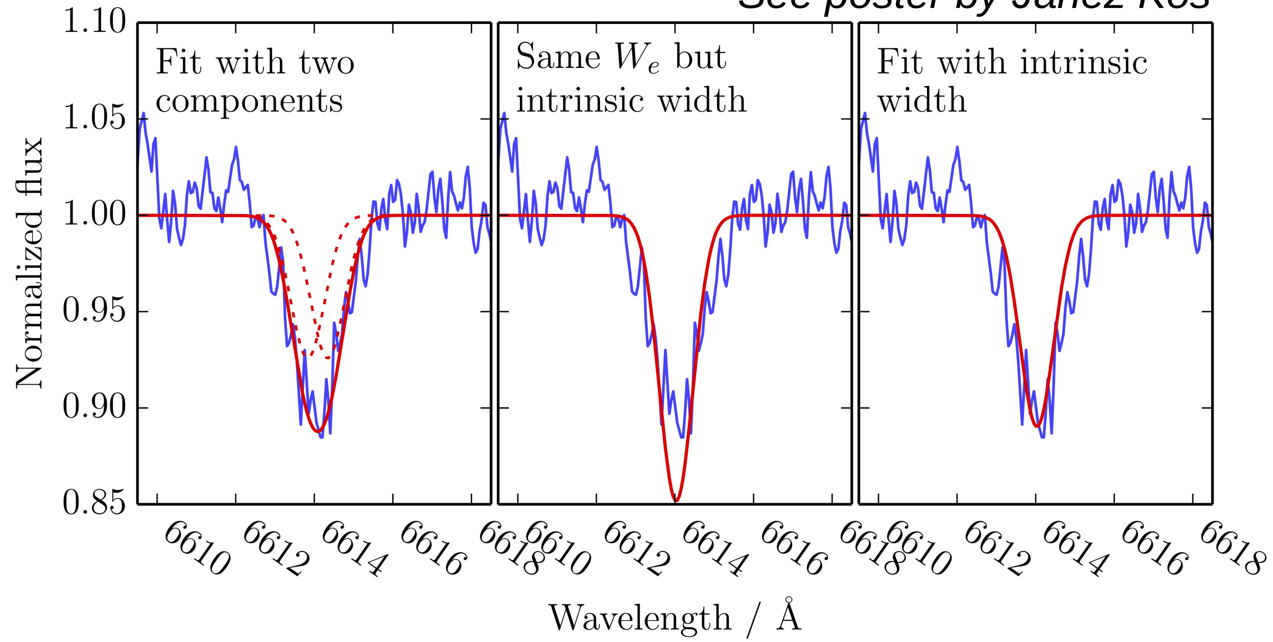


DIBs in: RAVE, Gaia-ESO, GALAH

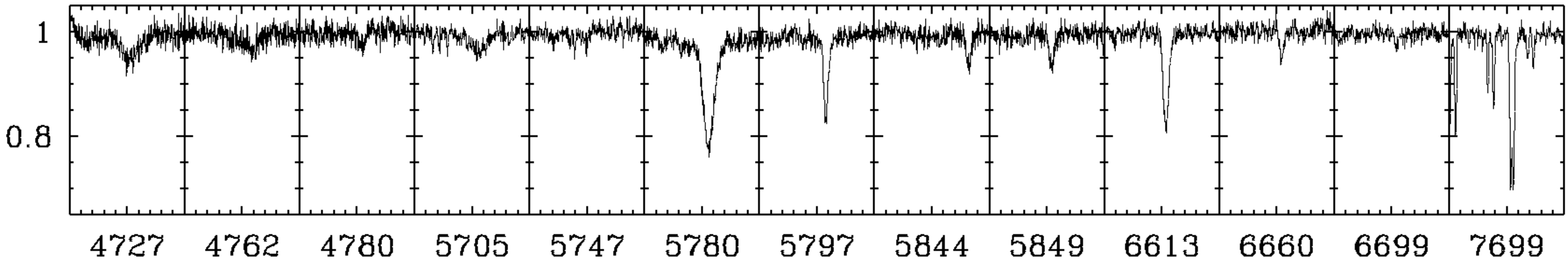
- **RAVE**: ~500.000 spectra, one strong DIB at 8620 Å.

See poster by Janez Kos

- **Gaia-ESO**:
  5 strong DIBs, some of them with multiple components. ►

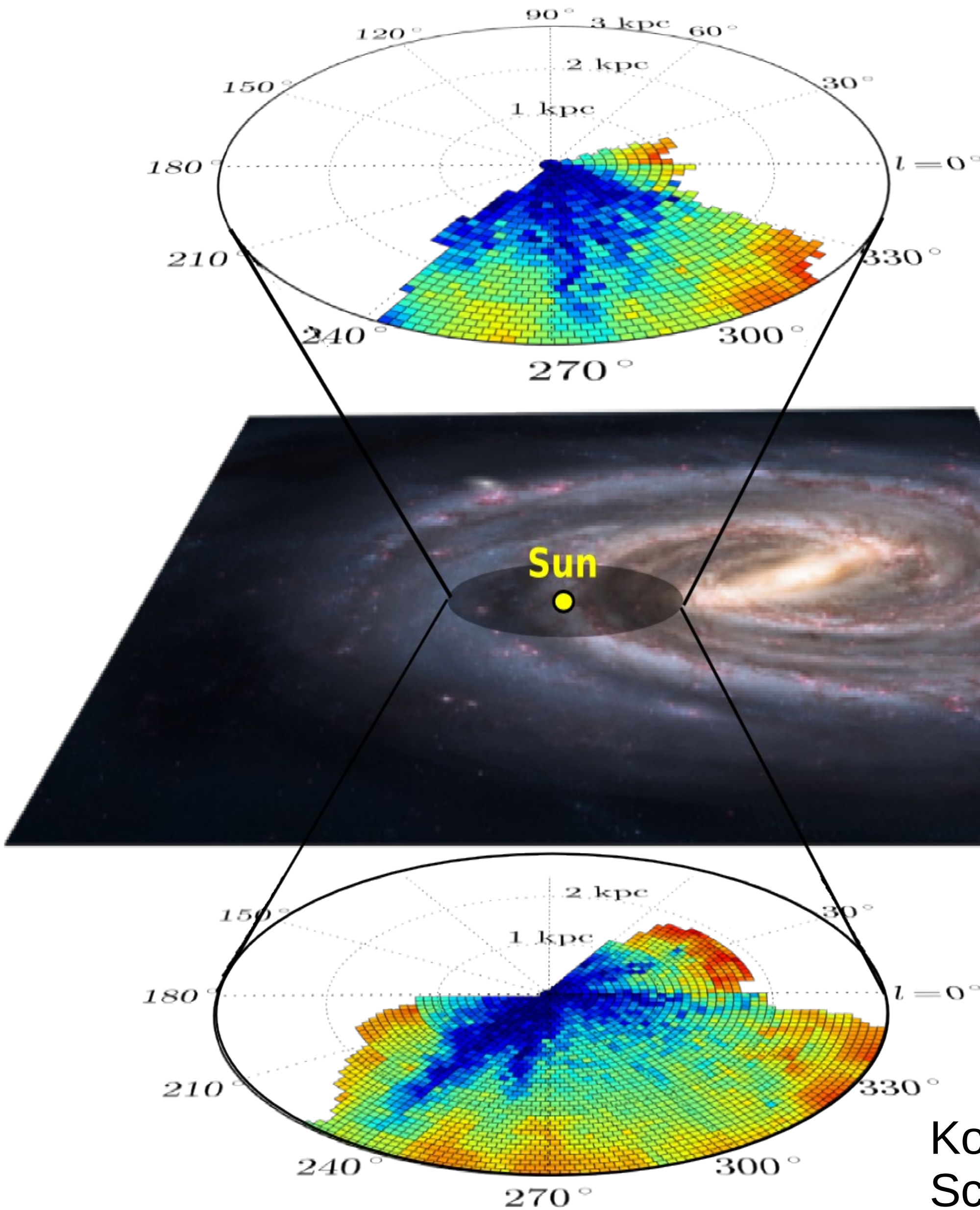


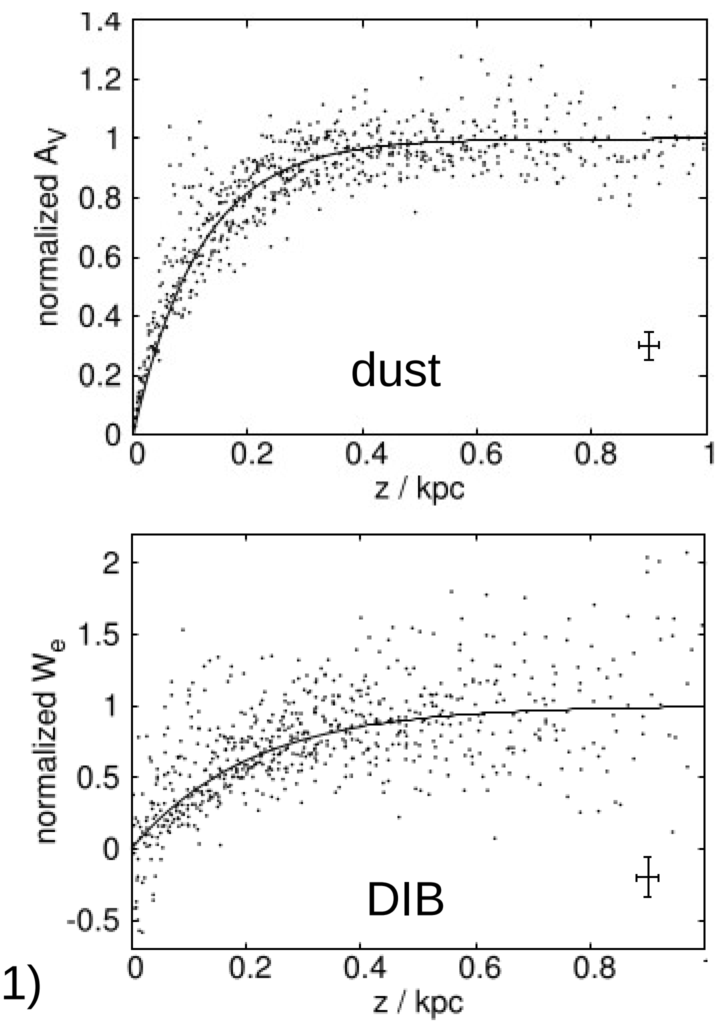
- **GALAH**: 12 strong DIBs plus the K I absorption at 7699 Å. ▼



RAVE – the first 3-D map of a DIB

Vertical scale-height larger for the diffuse interstellar band than for dust.





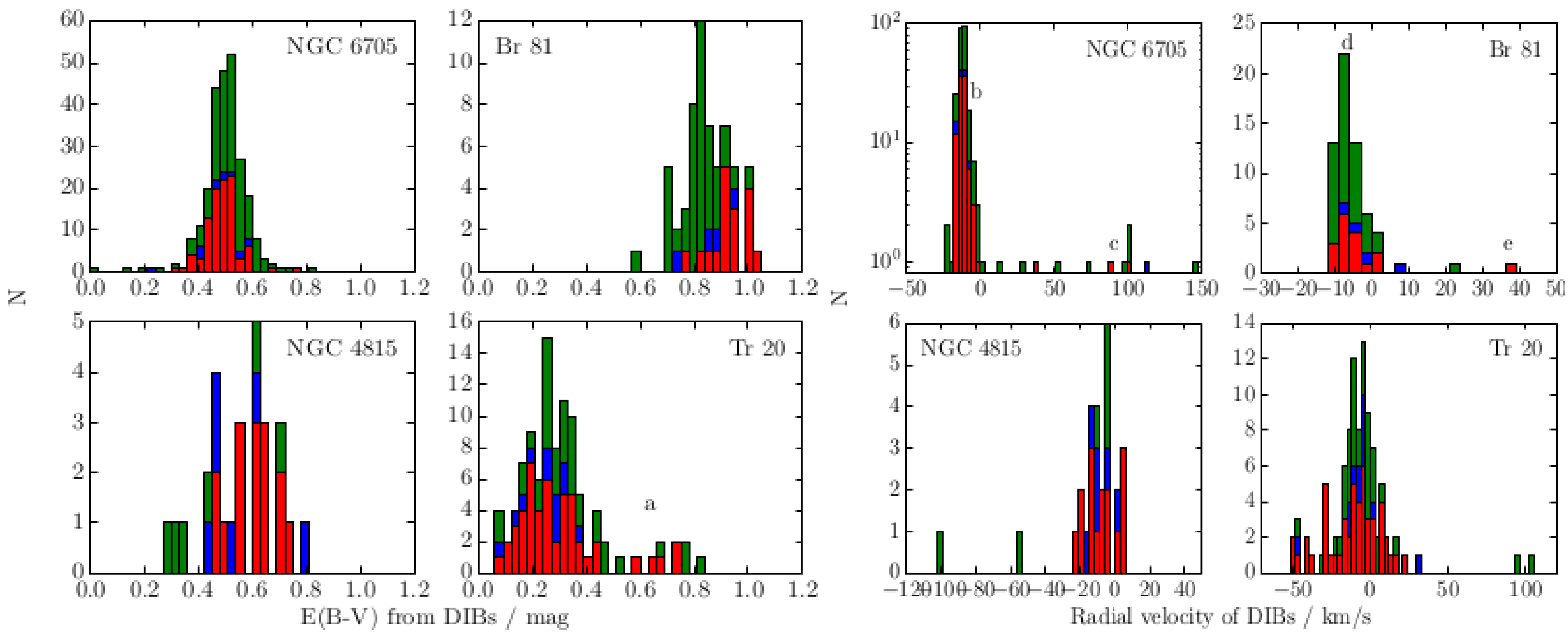
Kos et al. (2014, Science, 345, 791)

Open cluster membership (Gaia-ESO)

Cluster membership of a star can be questioned if a discordant

strength and/or radial velocity of DIBs is seen.

Kos et al. (2015)

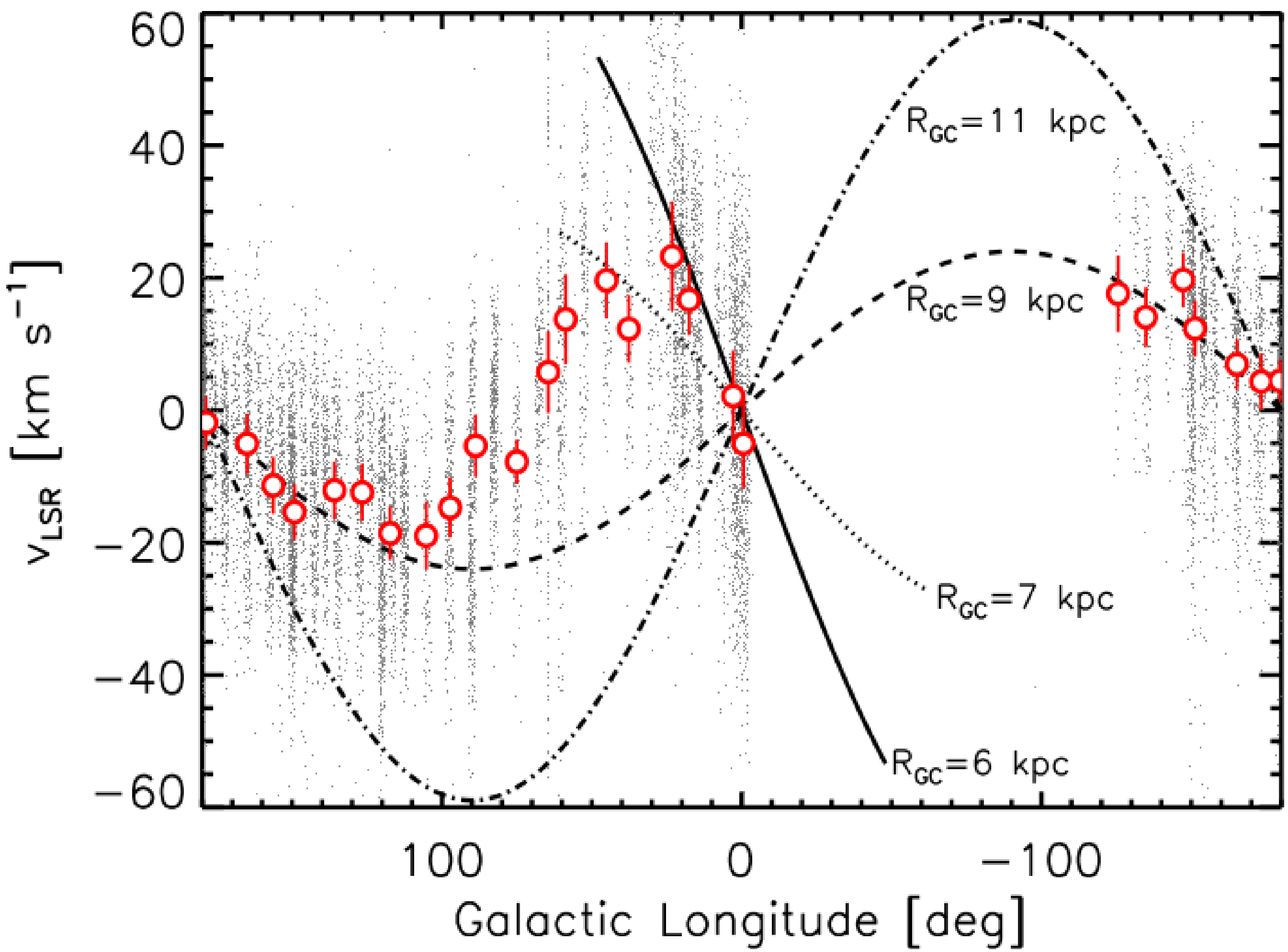


Red: likely members according to standard membership tests.

Dynamics in the plane (Apogee)

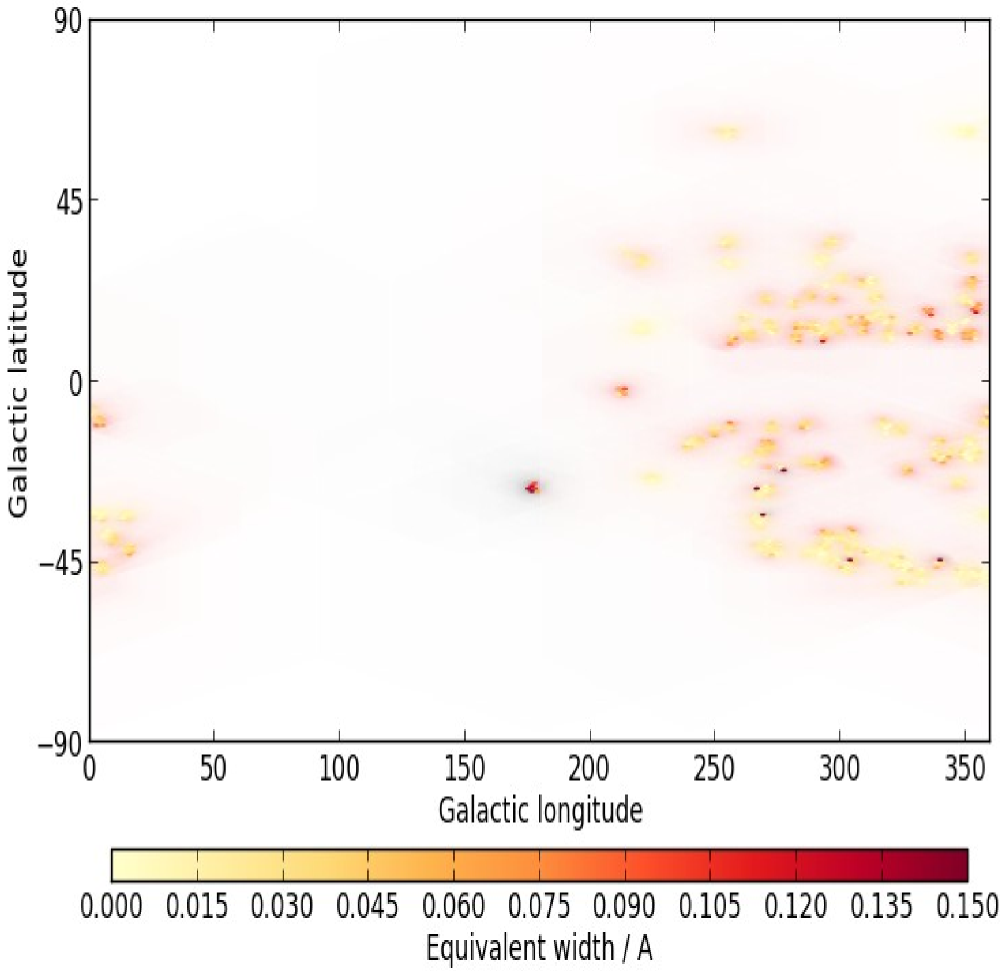
Galactic longitude-velocity diagram of the DIB @ 1.5272μm (Zasowski et al. 2014).

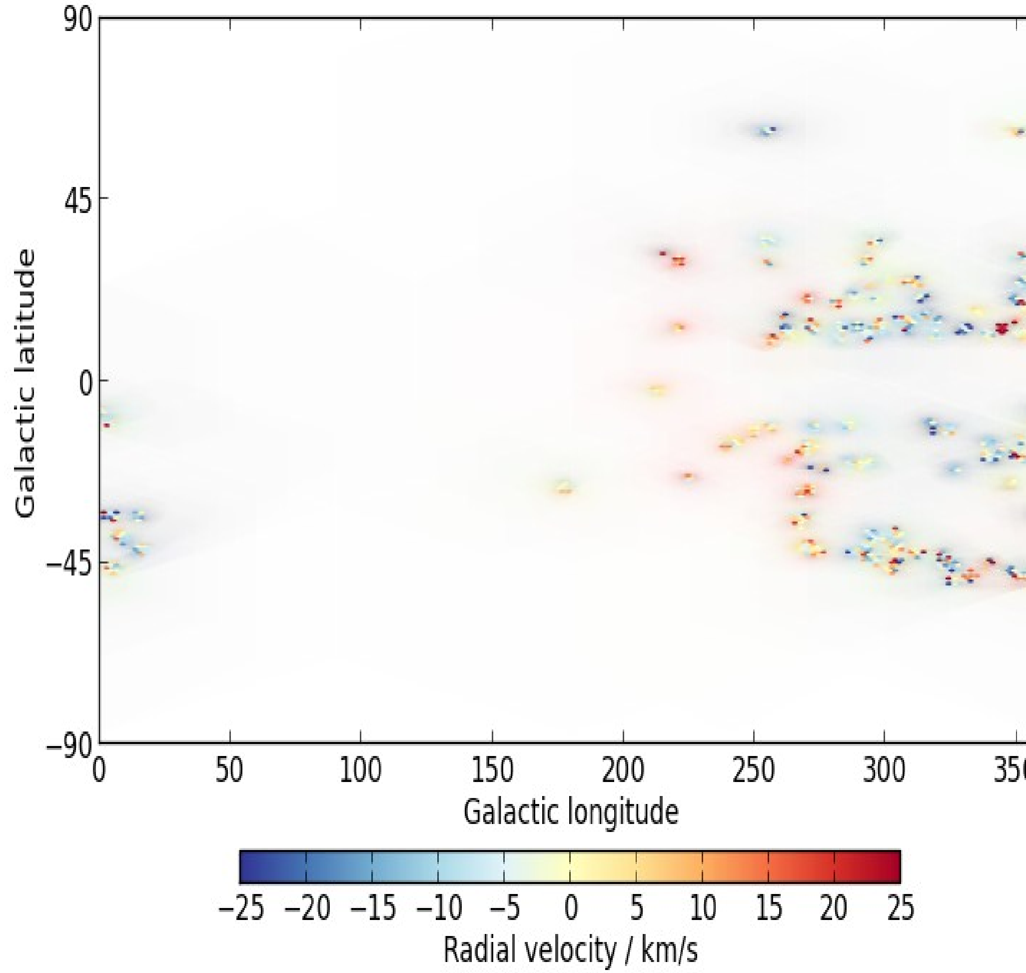
Gray points are individual measurements and red circles are medians in 10^{O} steps. Velocity curves for different Galactocentric radii are over-plotted.

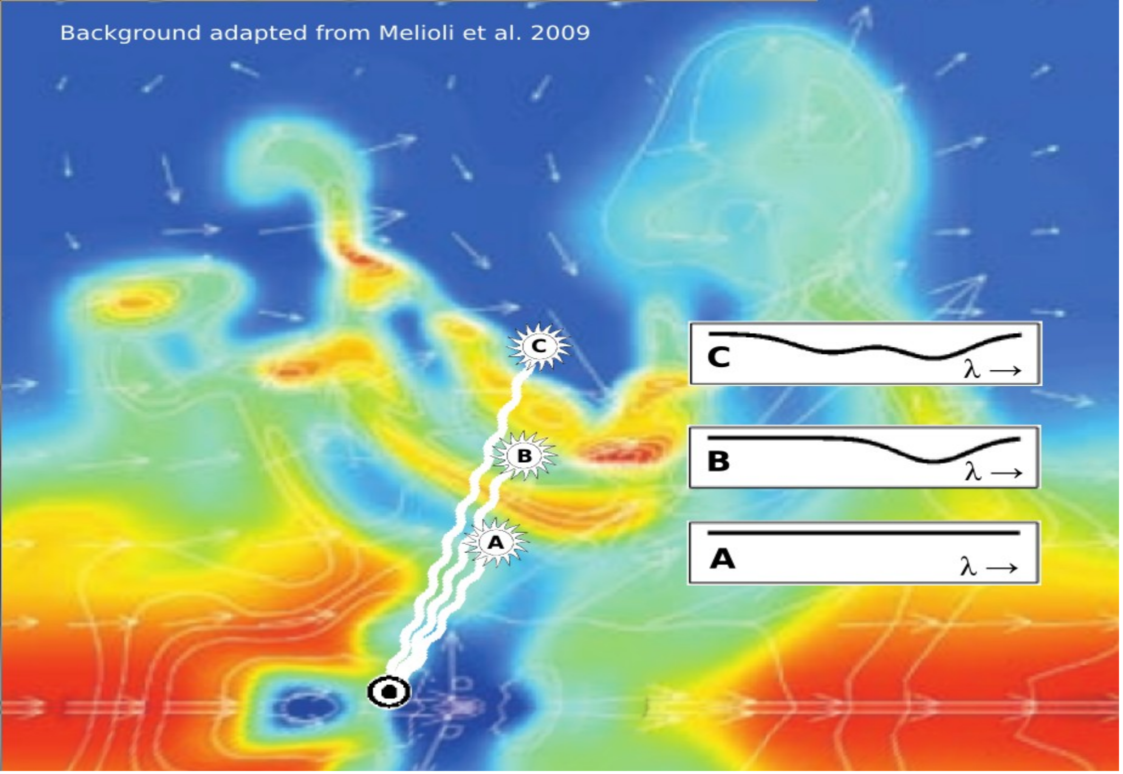


GALAH – a preliminary intensity and radial velocity map

Radial velocity and equivalent width of the DIB @ 6613 Å in GALAH spectra. LSR is removed from the radial velocity map. A rest wavelength of 6613.7 Å is assumed. Spectra within 0.25 square degrees were averaged to measure the position of the DIB. *See poster by Janez Kos.*



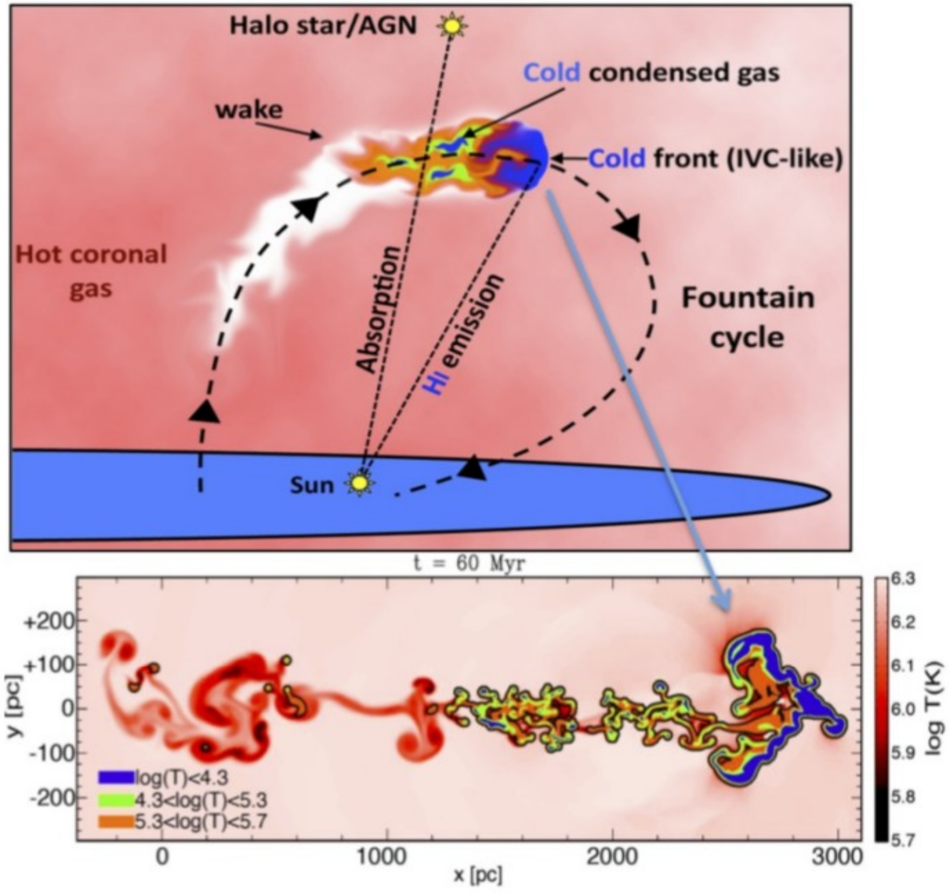




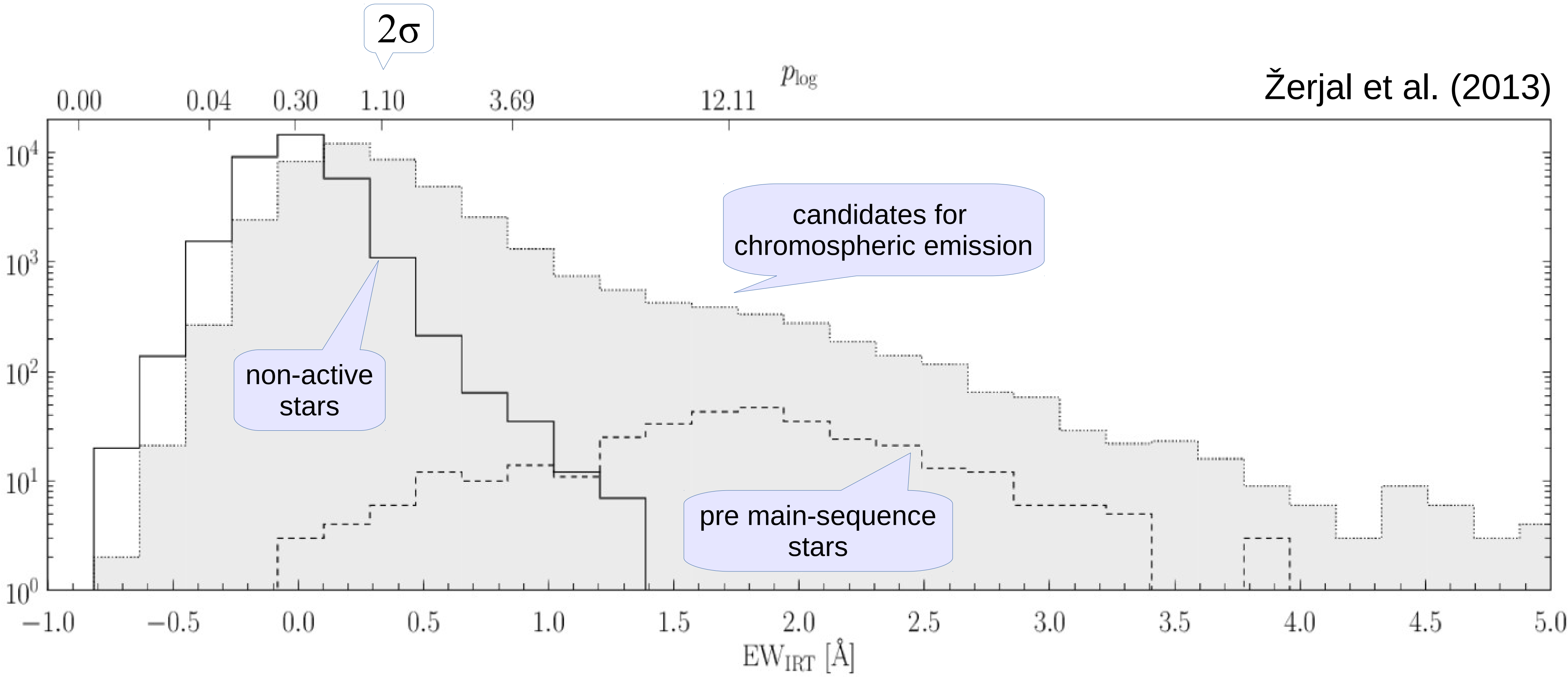
Future: 6-dimensional dynamics of the *young* interstellar medium through diffuse interstellar bands

- DIB distribution is different on either side of the Galactic plane, a witness to asymmetries in placement of recent explosions of supernovae and to incomplete vertical mixing.
- With DIBs we can identify dynamic voids, shells and Galactic fountains blown away by these SNe.
- Possibly it can place and date them by modelling of dynamics.
- Such explosions sustain star formation in the disk by entraining fresh gas from the halo.

Galactic fountain (Fraternali 2014)



Detection of candidates for chromospheric emission (and so of a young star population) in RAVE



From 456.676 spectra obtained by RAVE:
~18.000 (~4% of all stars) have emission detected at a 2σ level.

Hα emission from young stars

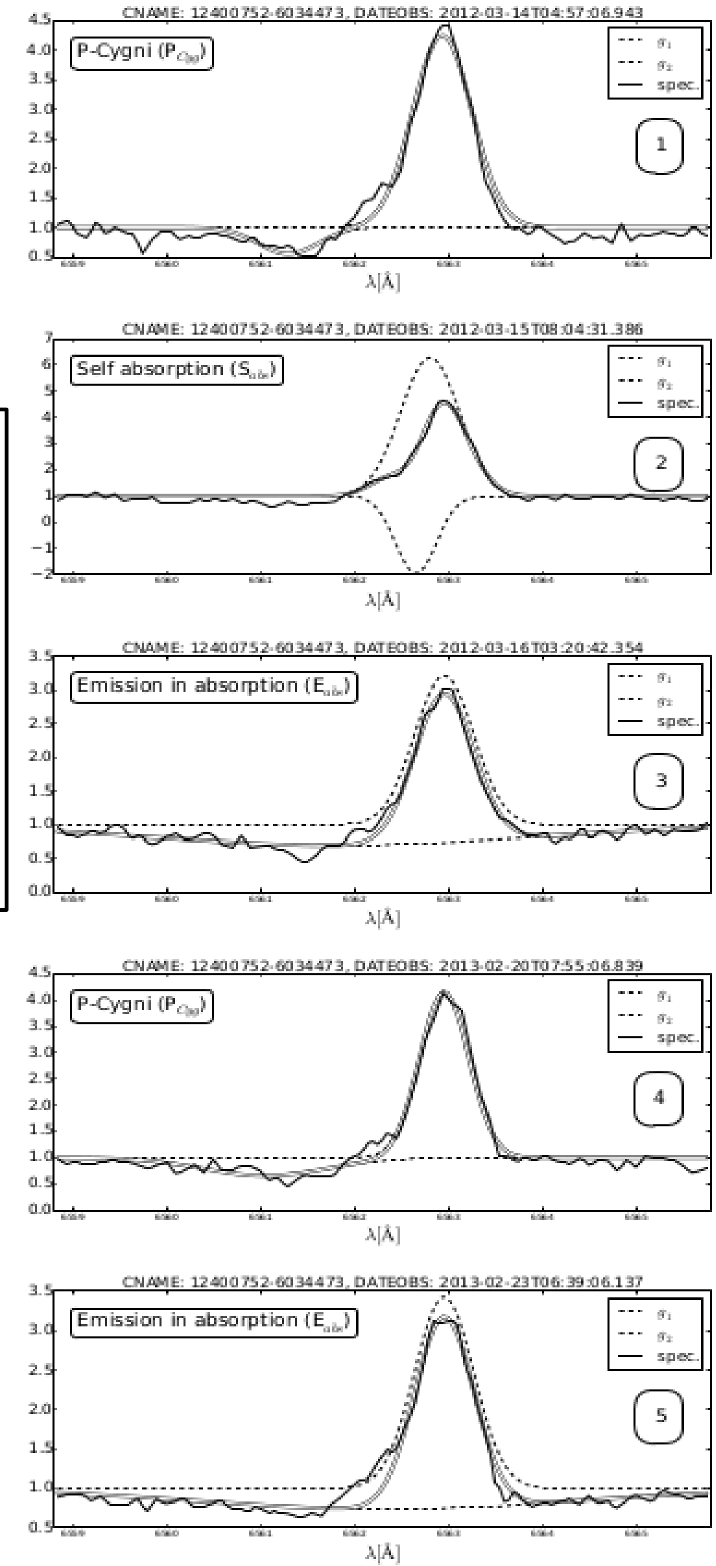
Gaia-ESO:

- 36.8% of objects in open clusters feature Hα in emission.
- In 25% of these their emission nature was known before.
- Morphological properties of emission stay stable in ~78% of emission objects, but not in all (see →).

GALAH:

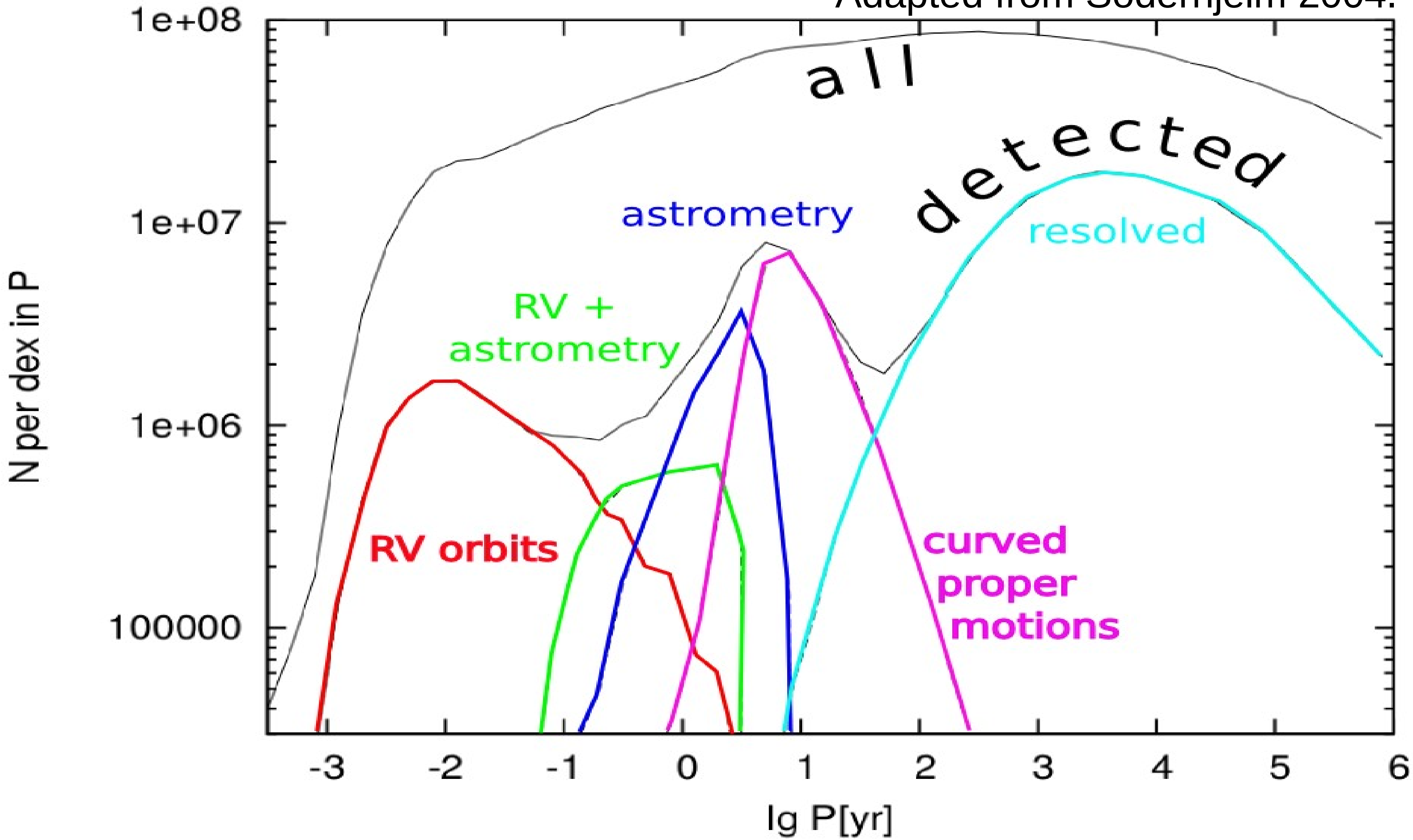
- *Both* Hα and Hβ are observed.
- Work in progress: are ~ 4% of field stars young?

Traven et al. (2015)



Binary census of Gaia

Adapted from Söderhjelm 2004.



"Gaia peak" of astrometric binaries at orbital periods ~ 1 year and distances ~1 kpc.

Binaries in Gaia: measuring mass and abundances of the unseen

Söderhjelm 2004.

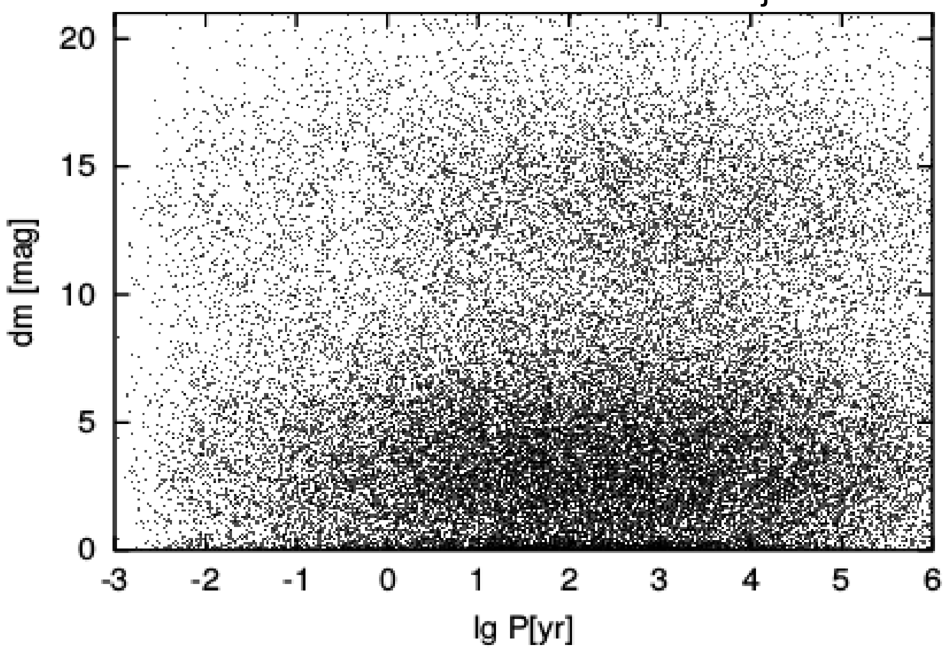


Figure 2. Because of the many faint white- and brown-dwarf components, the period/Δm-plane is rather uniformly filled. (Each barely visible dot corresponds to some 10 000 binaries).

- Astrometry gives orbit of the brighter component and its position in the HR diagram.
- With **spectroscopic** abundances we can use isochrones to get the mass of the bright star.
- So the mass function can be turned into **mass of the unseen** low-mass component, for which we know it has the same **chemical abundances** as the brighter one.
- A similar trick as for exoplanets.
- So the horizon for very red and brown dwarfs increased from ~10 pc (Scholz's star) to 1 kpc.
- Low-mass IMF, abundances & Galactic orbits for **the most numerous stars in the Universe** :-)

- Many binaries with a huge Δm of their components.
- Extremely red or brown dwarf in a P~1 yr orbit causes a ~0.1 a.u. orbit of a G-type companion.