Survey of Surveys:
Homogeneous Radial Velocities of 11 million stars

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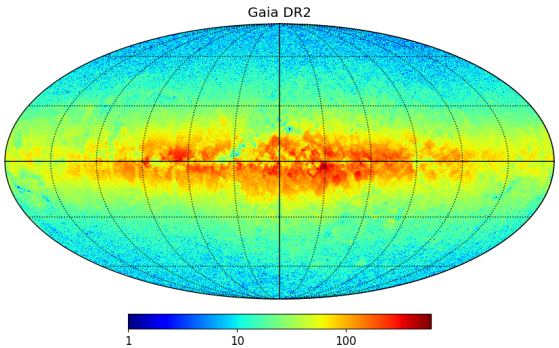
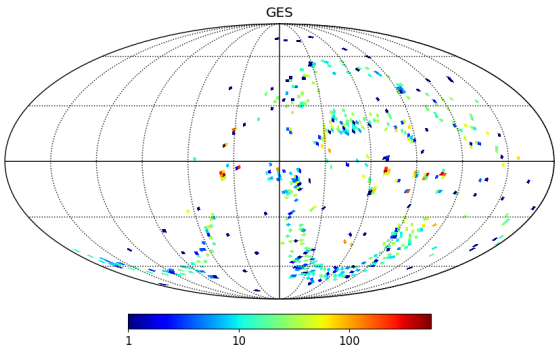
Motivation

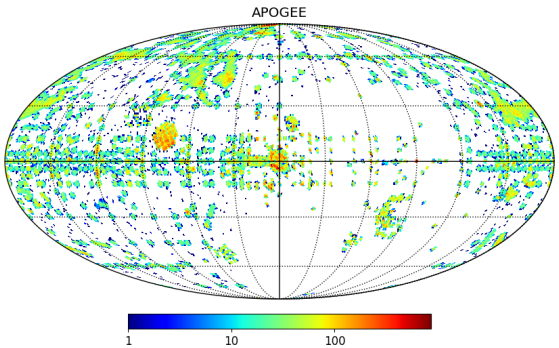
- Combine the main parameters of the largest surveys:
  $T_{\rm eff}$, $\log g$, metallicity, radial velocities (RV), abundances, etc.



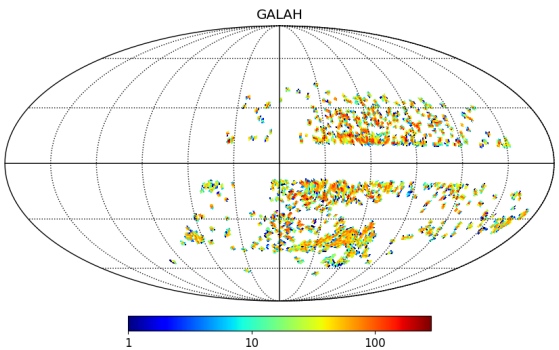
Gaia: 7.2M



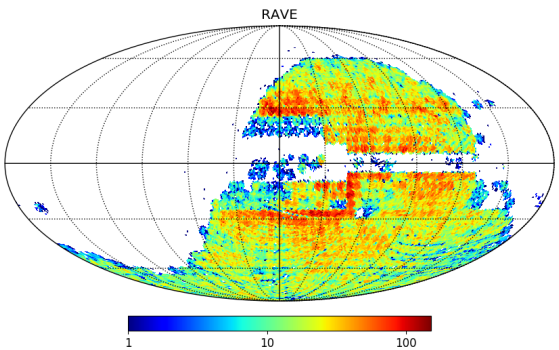
GES: 22K



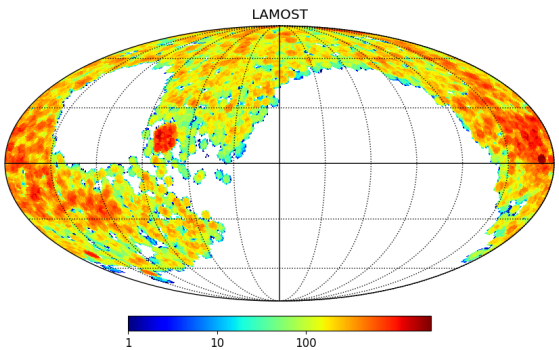
APOGEE: 473K



GALAH: 343K



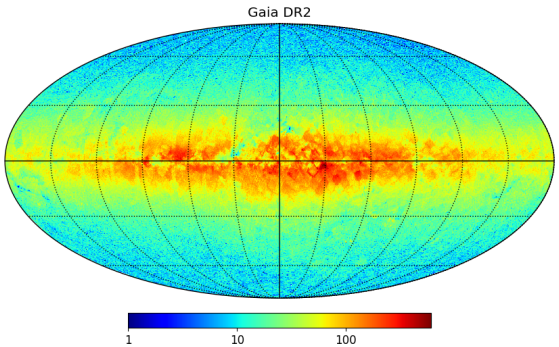
RAVE: 518K



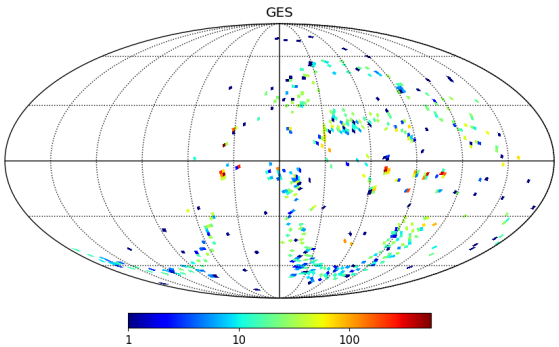
LAMOST: 5.3M

Motivation

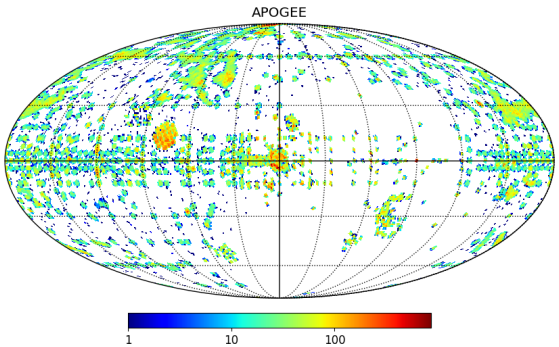
- SoS I pilot study: RV homogenization



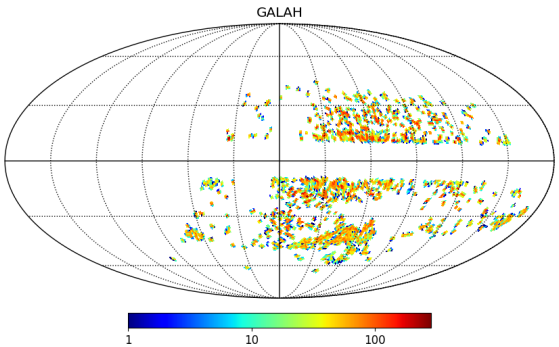
Gaia: 7.2M



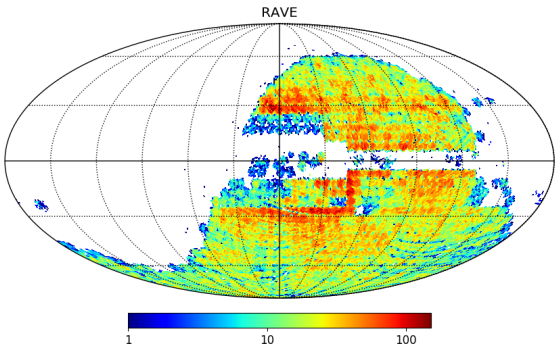
GES: 22K



APOGEE: 473K



GALAH: 343K



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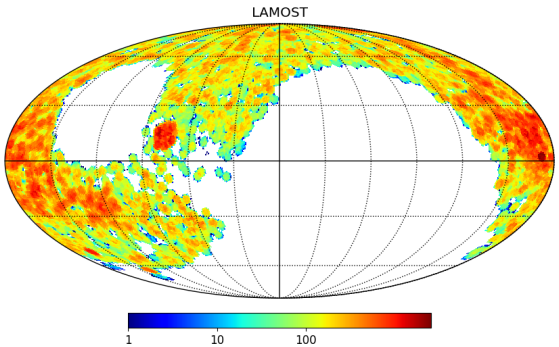
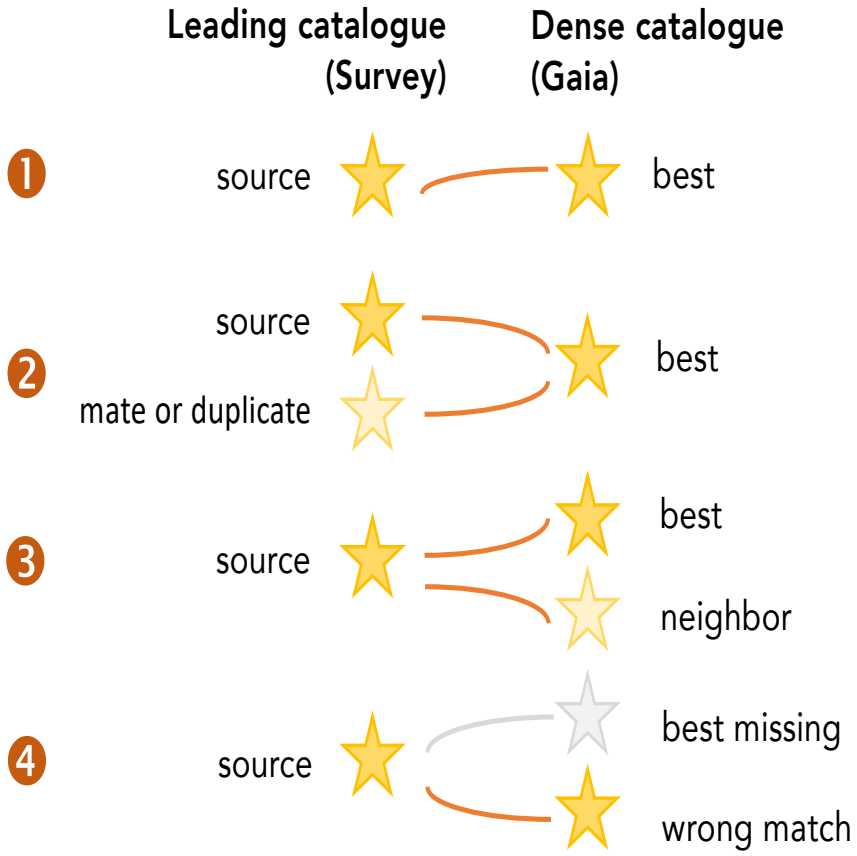


LAMOST: 5.3M

1. XM of external catalogues with Gaia

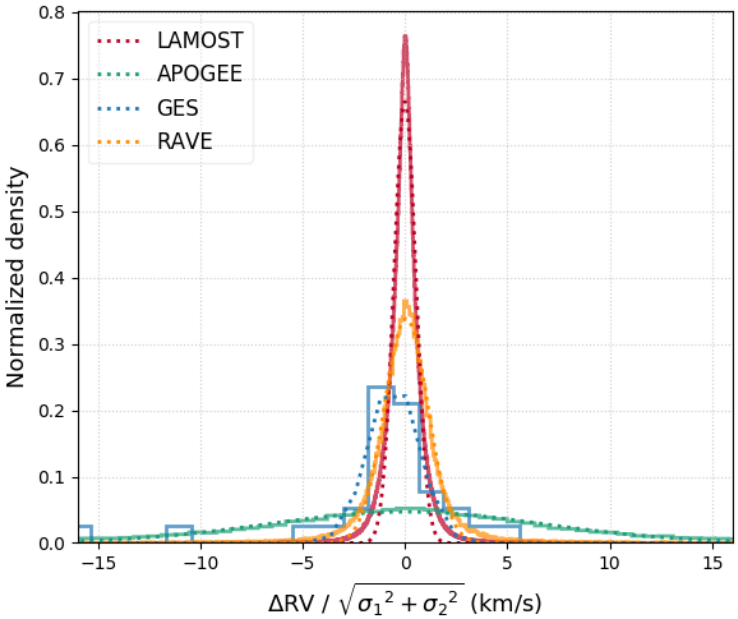


Maresse et al. (2017, 2019)

`gaiaportal.asdc.asi.it`

2. Error normalization

A. Duplicates



Survey	factor	Method
APOGEE	5.9	dupl
GES	0.8	avg
RAVE	0.8	dupl
LAMOST	0.4	dupl

B. three-cornered-hat method (TCH)

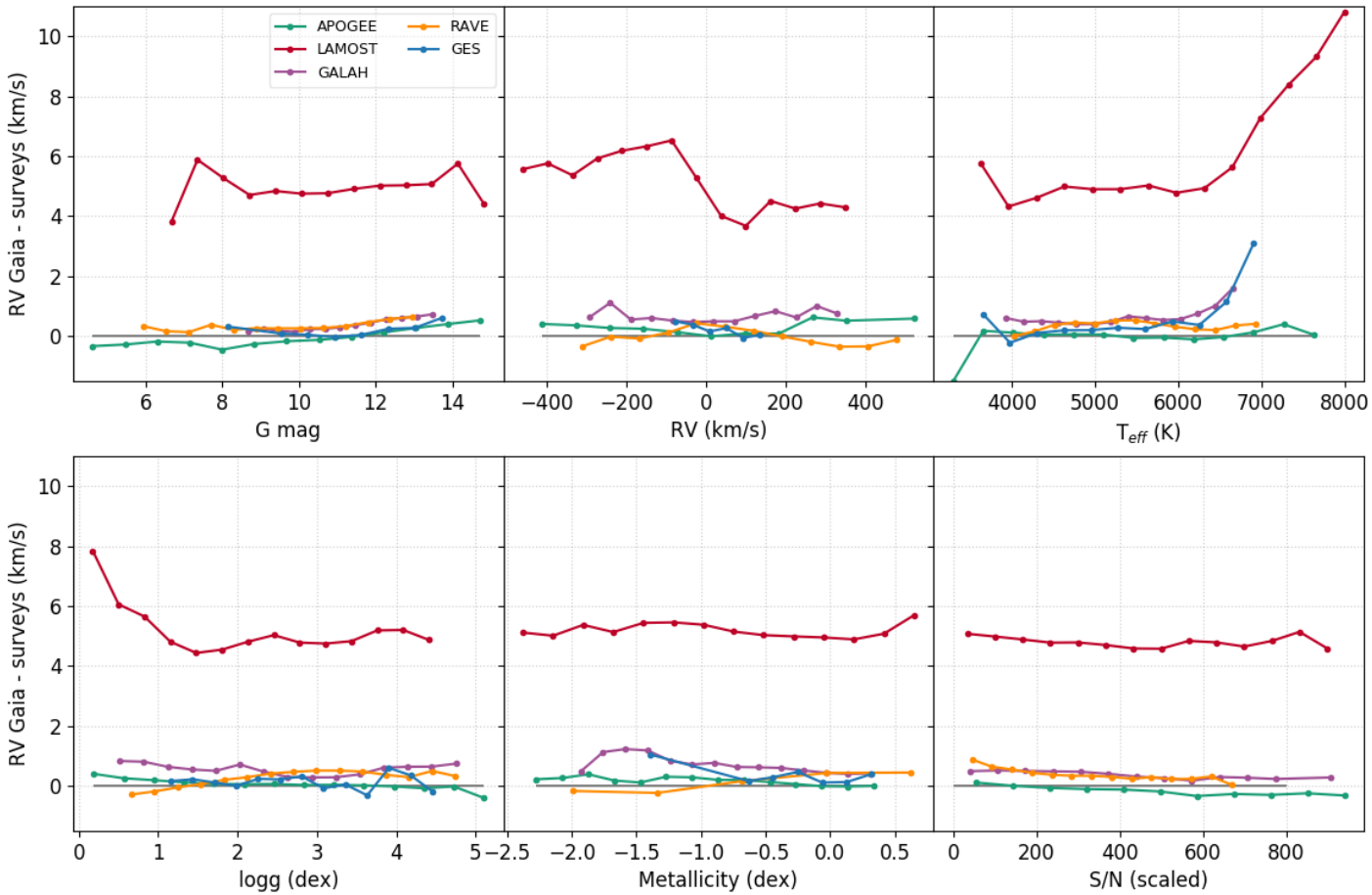
$$\sigma_{12}^2 = \sigma_1^2 + \sigma_2^2,$$
$$\sigma_{13}^2 = \sigma_1^2 + \sigma_3^2,$$
$$\sigma_{23}^2 = \sigma_2^2 + \sigma_3^2$$

with the solution:

$$\sigma_1^2 = (\sigma_{12}^2 + \sigma_{13}^2 - \sigma_{23}^2)/2$$
$$\sigma_2^2 = (\sigma_{12}^2 + \sigma_{23}^2 - \sigma_{13}^2)/2$$
$$\sigma_3^2 = (\sigma_{13}^2 + \sigma_{23}^2 - \sigma_{12}^2)/2$$

Survey	factor	Method
Gaia	1.5	TCH
GALAH	2.0	TCH
GES	0.8	avg

3. Removing trends from Gaia RVs



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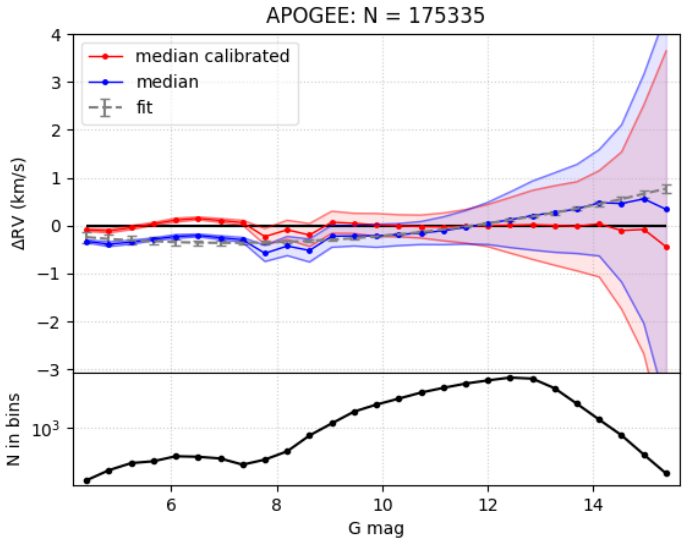
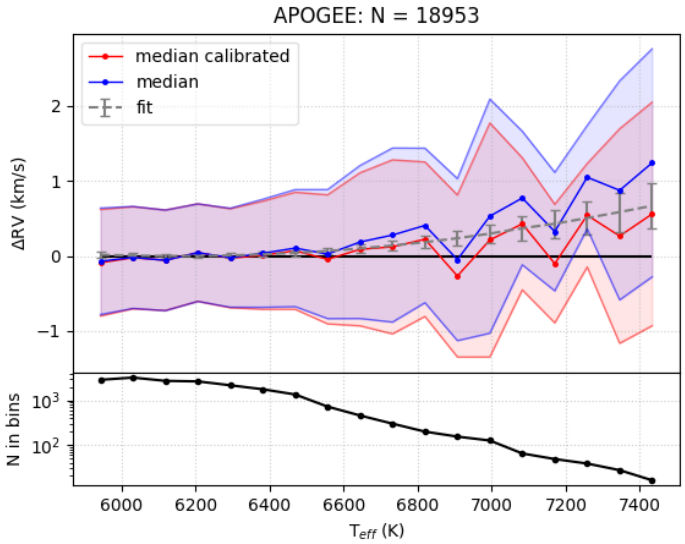
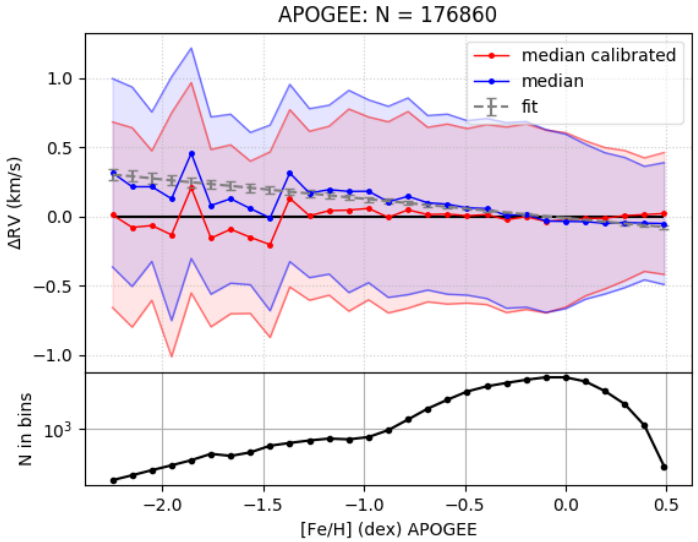


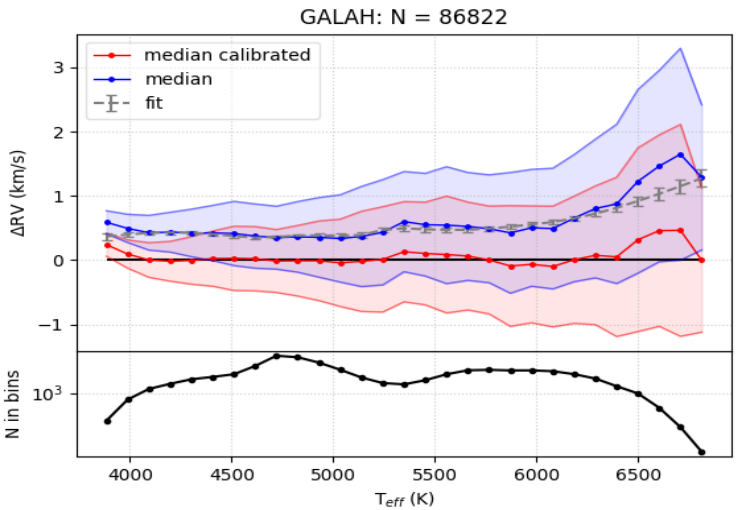


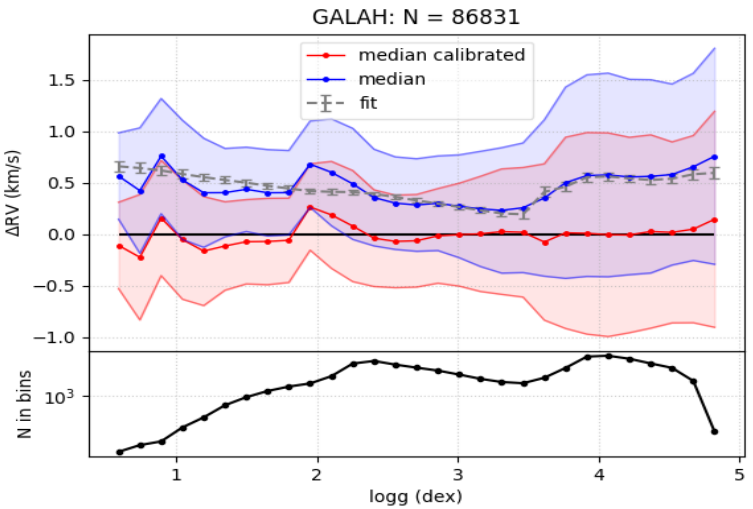


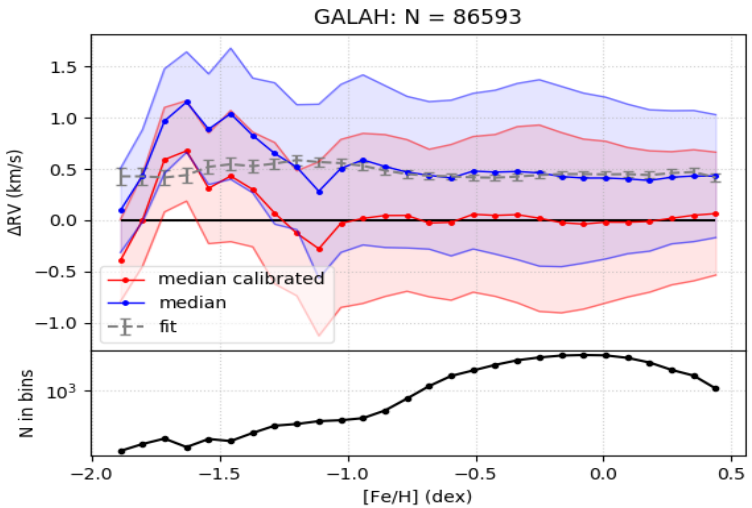
- Define global coefficients from the high-resolution surveys
- Calibrate RVs in Gaia DR2

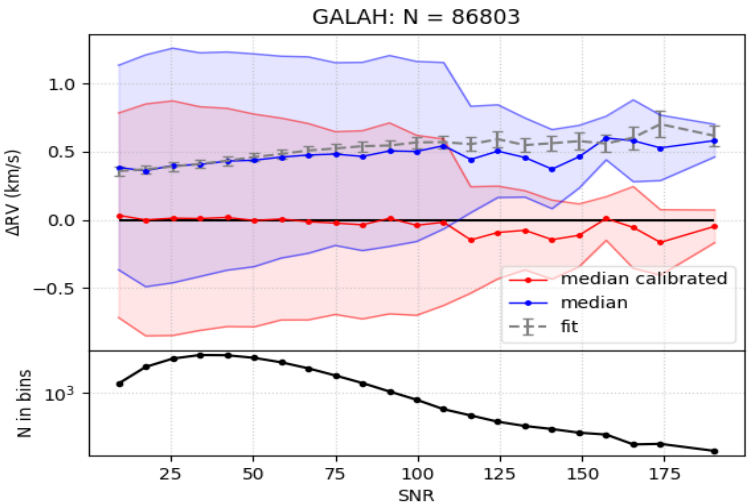
4. Removing trends from spectroscopic RVs

$$\Delta RV = \alpha T_{\rm eff}^2 + \beta T_{\rm eff} + \gamma \log g + \delta [Fe/H] + \epsilon S/N + \zeta$$

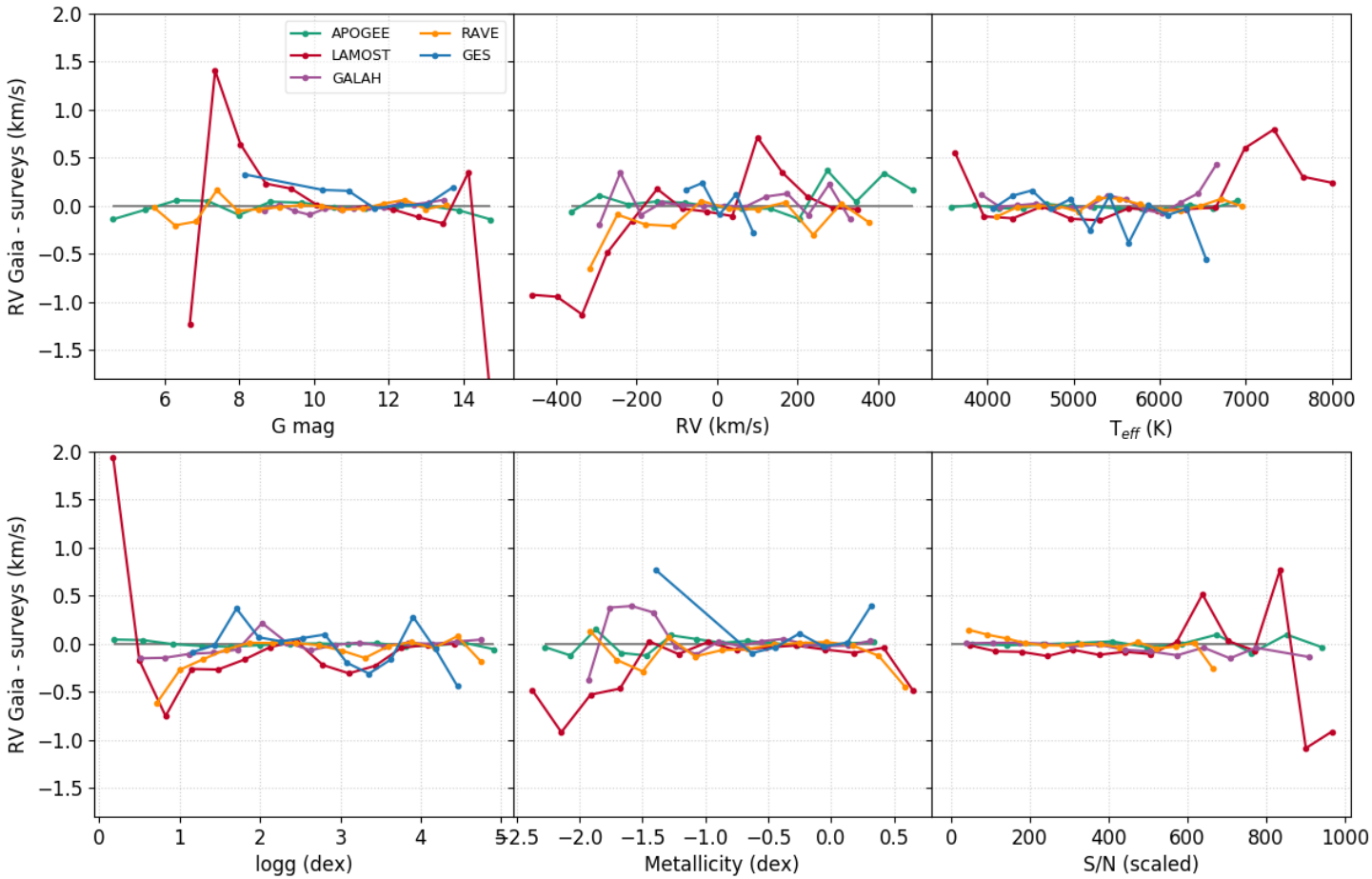








5. The SoS I: final RVs



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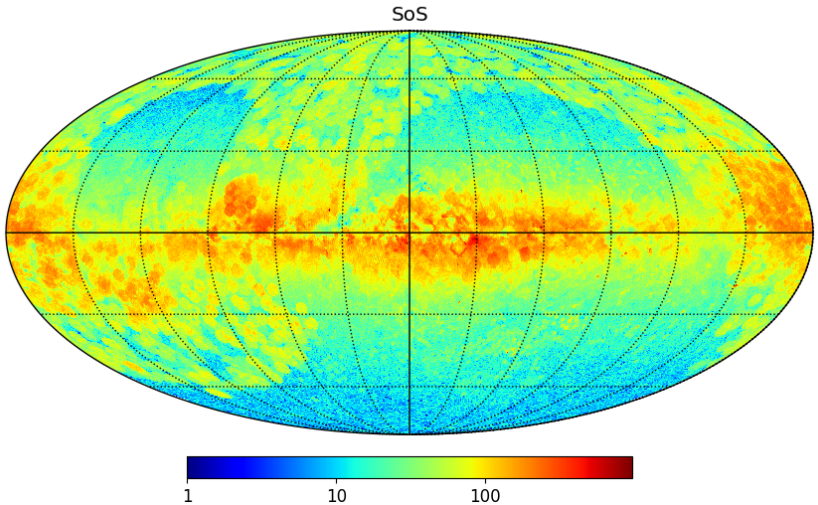
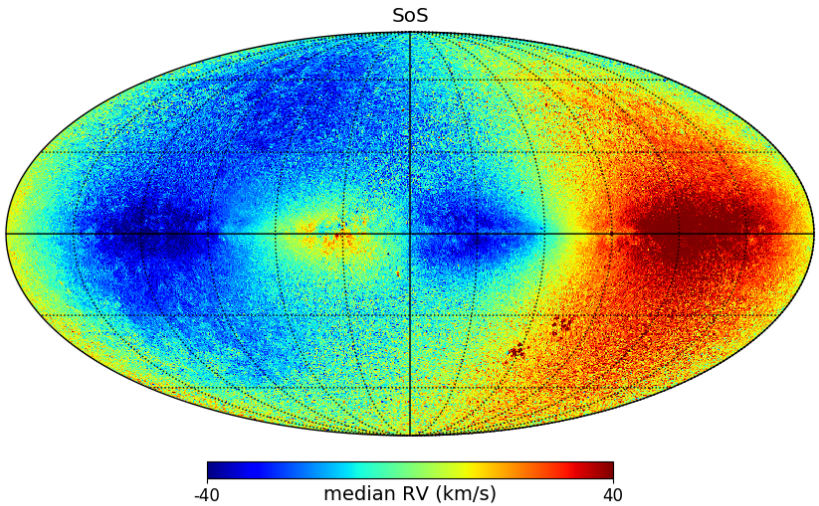
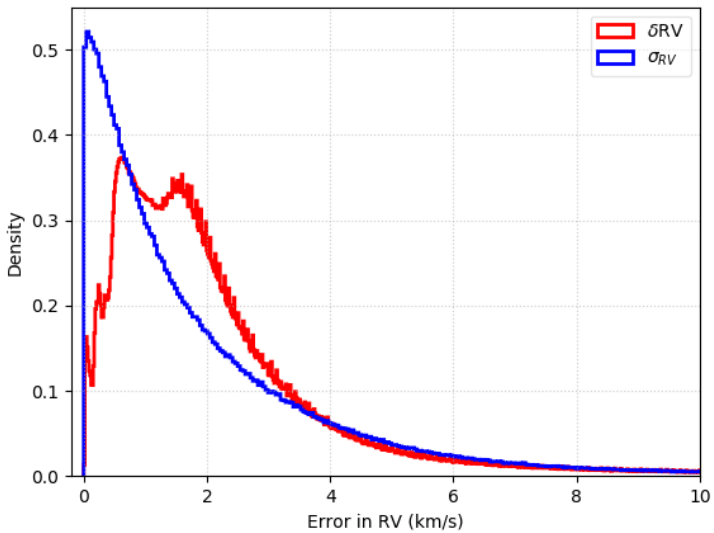
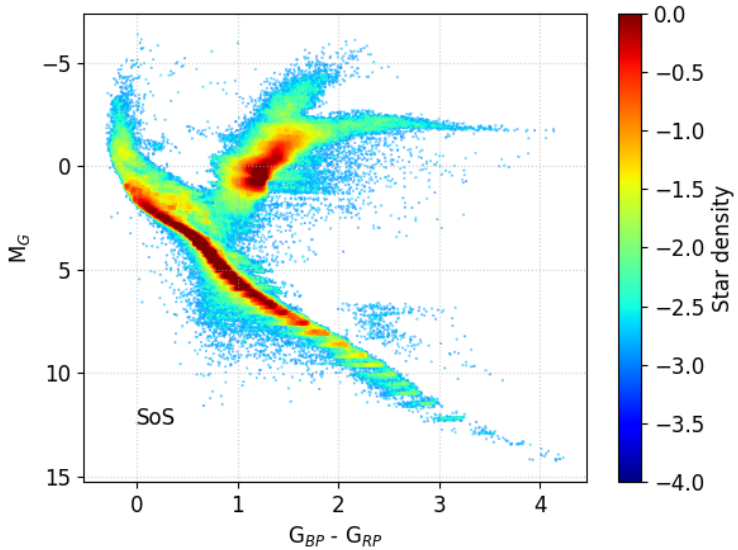




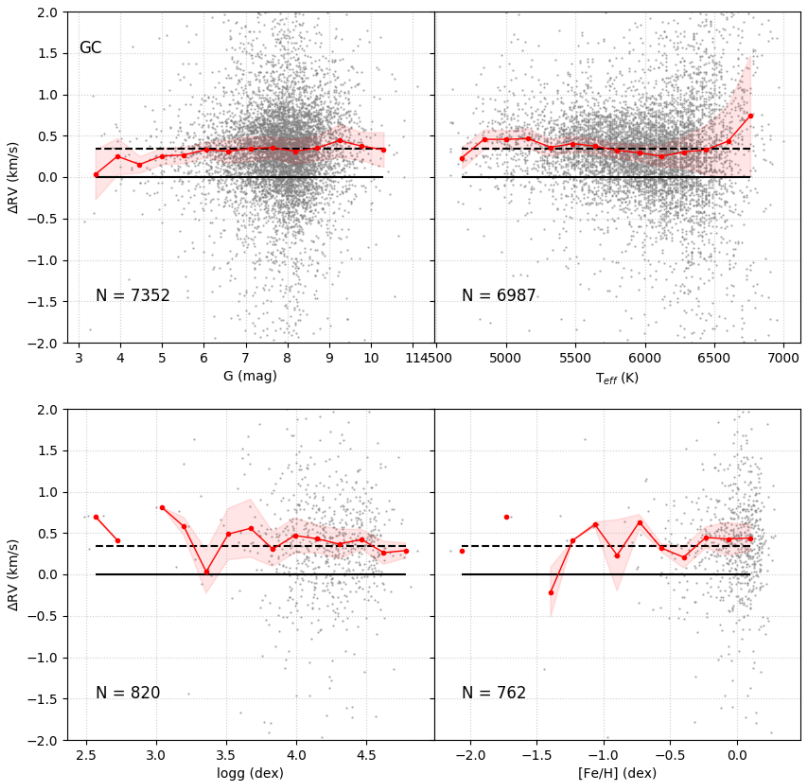


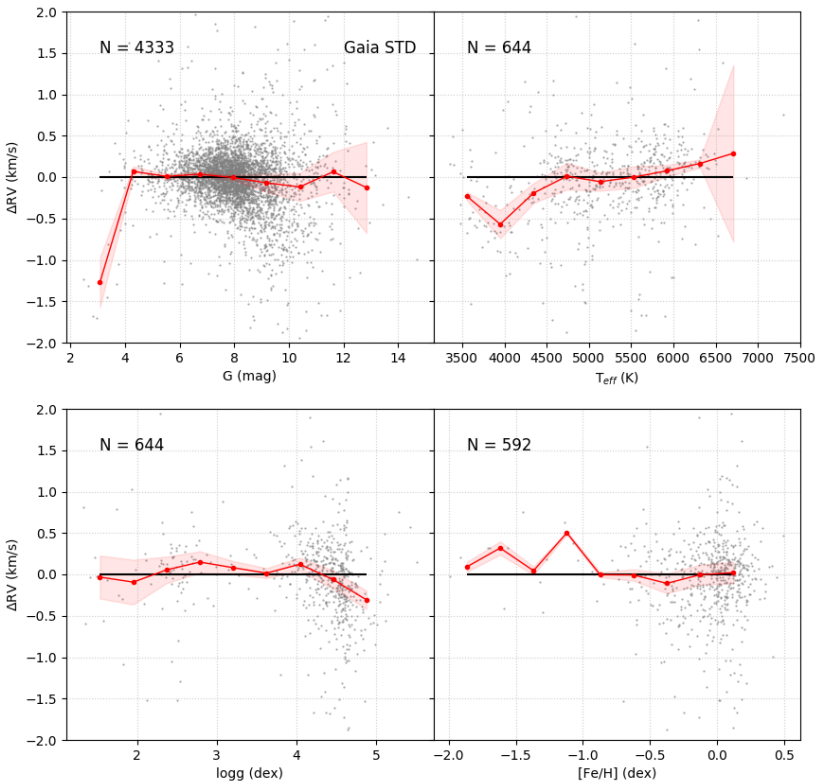


6. Technical validation

Geneva-Copenhagen survey
(Nordström+04)
MAD = 0.31km/s

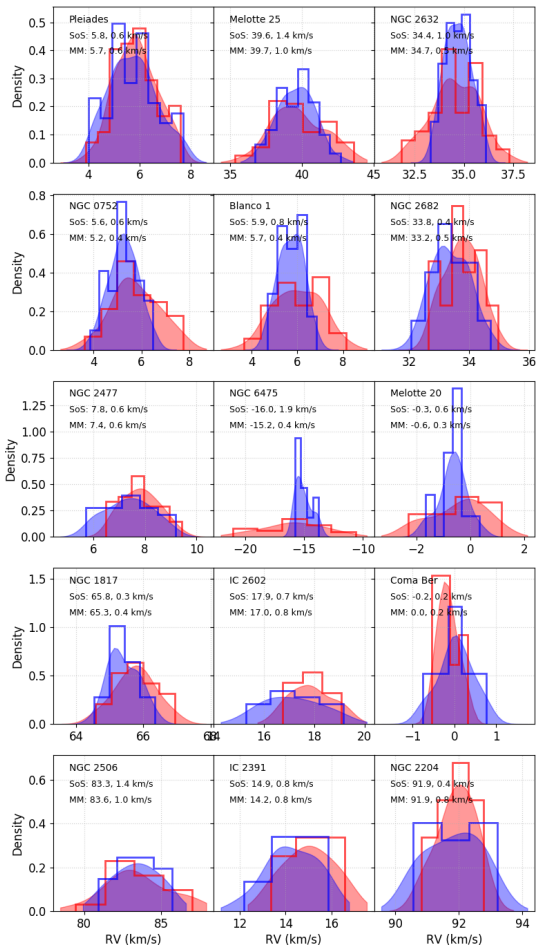
Gaia RV standards
(Soubiran+18)
MAD = 0.16km/s

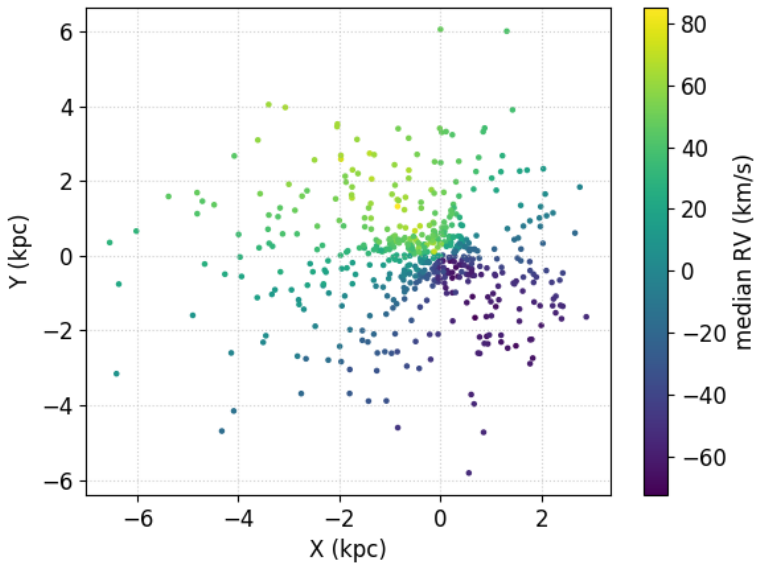




7. Science validation with OCs

Comparison of OCs from Mermilliod+08,09:
$\Delta RV_{OC} = 0.16\,km/s$, MAD=0.26 km/s





Spatial distribution of 532 OCs observed with *Gaia* (Cantat+ 2020) using the median RVs from SoS.

Summary

SoS: homogeneous RV, T_{eff}, $\log g$, $[Fe/H]$

- ✓ RV homogenization for 11M stars (Tsantaki+ 21)
- ✓ RV validation with RV standards & clusters (Tsantaki+ 21)

TODO T_{eff} validation from photometry & high resolution spectroscopy

TODO $\log g$ validation from asteroseismology

TODO $[Fe/H]$ validation from high resolution spectroscopy

–> Golden calibration samples