Survey of Surveys: homogeneous RVs for 10 million stars

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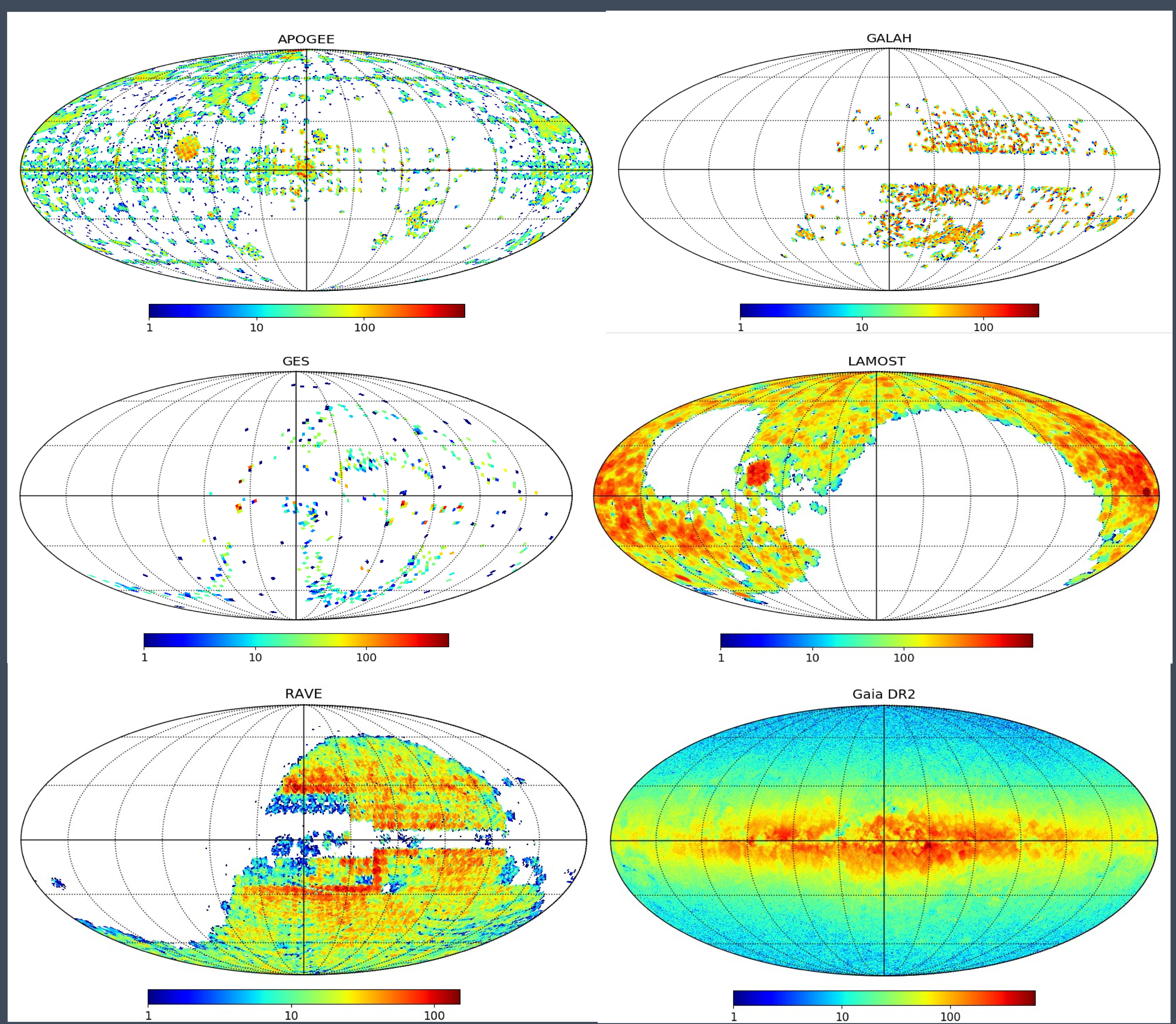
Intoduction

We present a comprehensive catalogue, the Survey of Surveys (SoS), built by homogeneously merging the radial velocity (RV) determinations of the largest ground-based spectroscopic surveys to date, such as APOGEE, GALAH, Gaia-ESO, RAVE, and LAMOST, using Gaia as reference. This pilot study serves to prove the concept and to test the methodology that we plan to apply in the future to the stellar parameters and abundance ratios as well.

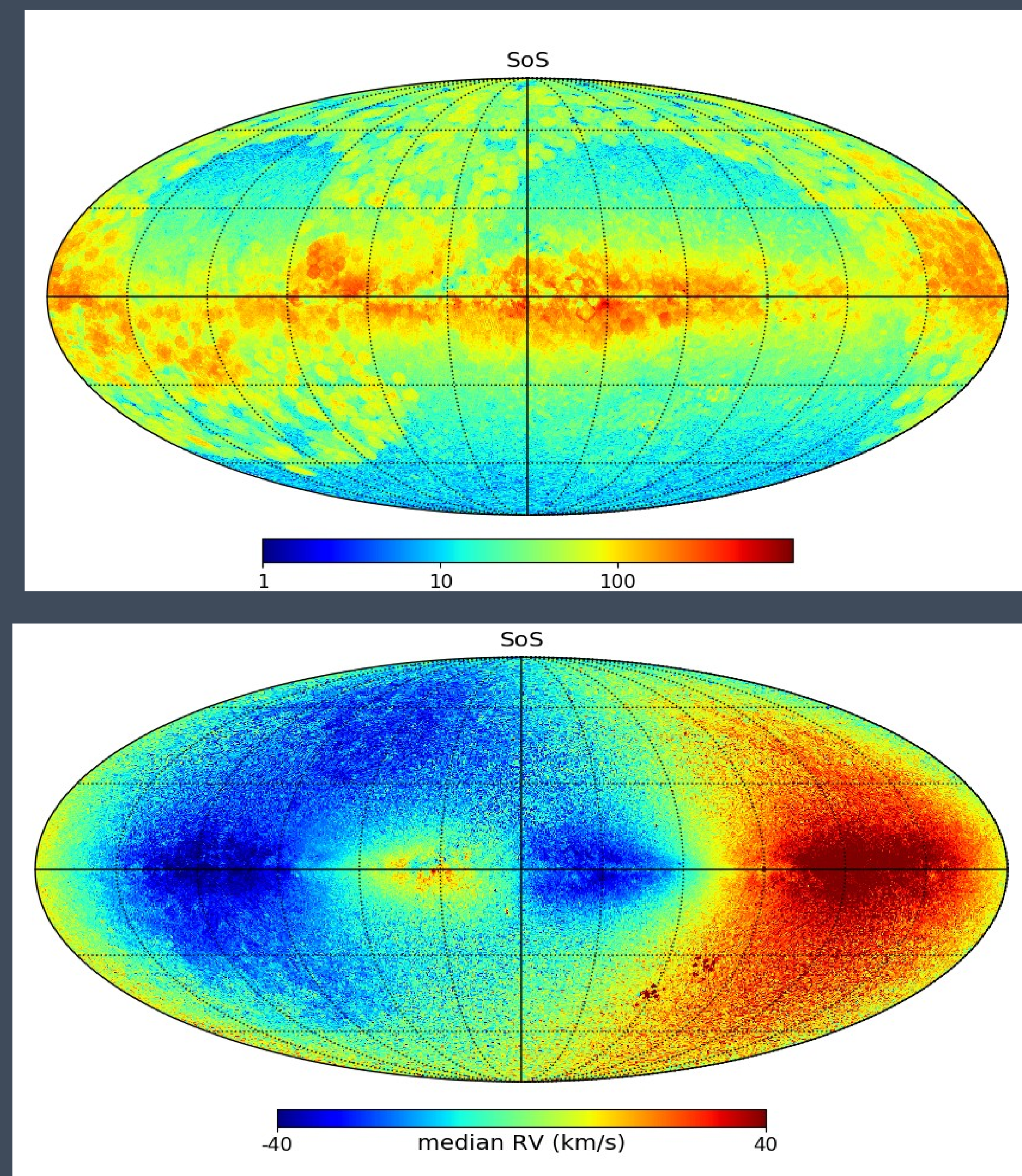


Methodology

Steps for the homogenization of the RVs:
i) the cross match between Gaia and the spectroscopic surveys using the official Gaia cross-match algorithm (Marrese et al. 2017,2019)
ii) the normalization of uncertainties using repeated measurements or the three-cornered hat method
iii) the cross calibration of the RVs as a function of the main parameters: magnitude, effective temperature, surface gravity, metallicity, and signal-to-noise ratio to remove trends and zero point offsets
iv) the comparison with external high-resolution samples, such as the Gaia RV standards and the Geneva-Copenhagen survey, to validate the homogenization procedure and to calibrate the RV zero-point

Results

The final catalogue contains around 11 million unique stars which amounts to the largest catalogue of RV measurements published so far. In this catalogue, we have combined around 5.1 million stars with RVs from the ground-based spectroscopic surveys and 7.2 million stars with Gaia RVs. We provide a quality flag to facilitate the scientific exploration of the SoS catalogue.



Top panel: Surface density distribution in Molleview projection for the stars in SoS in logarithmic scale. Bottom panel: Same as left panel but color coded to the final SoS RVs (median RV per pixel) for stars with $|RV|<40$ km s^{-1}. Both plots are in Galactic coordinates with pixel size of ~ 0.46 degrees.

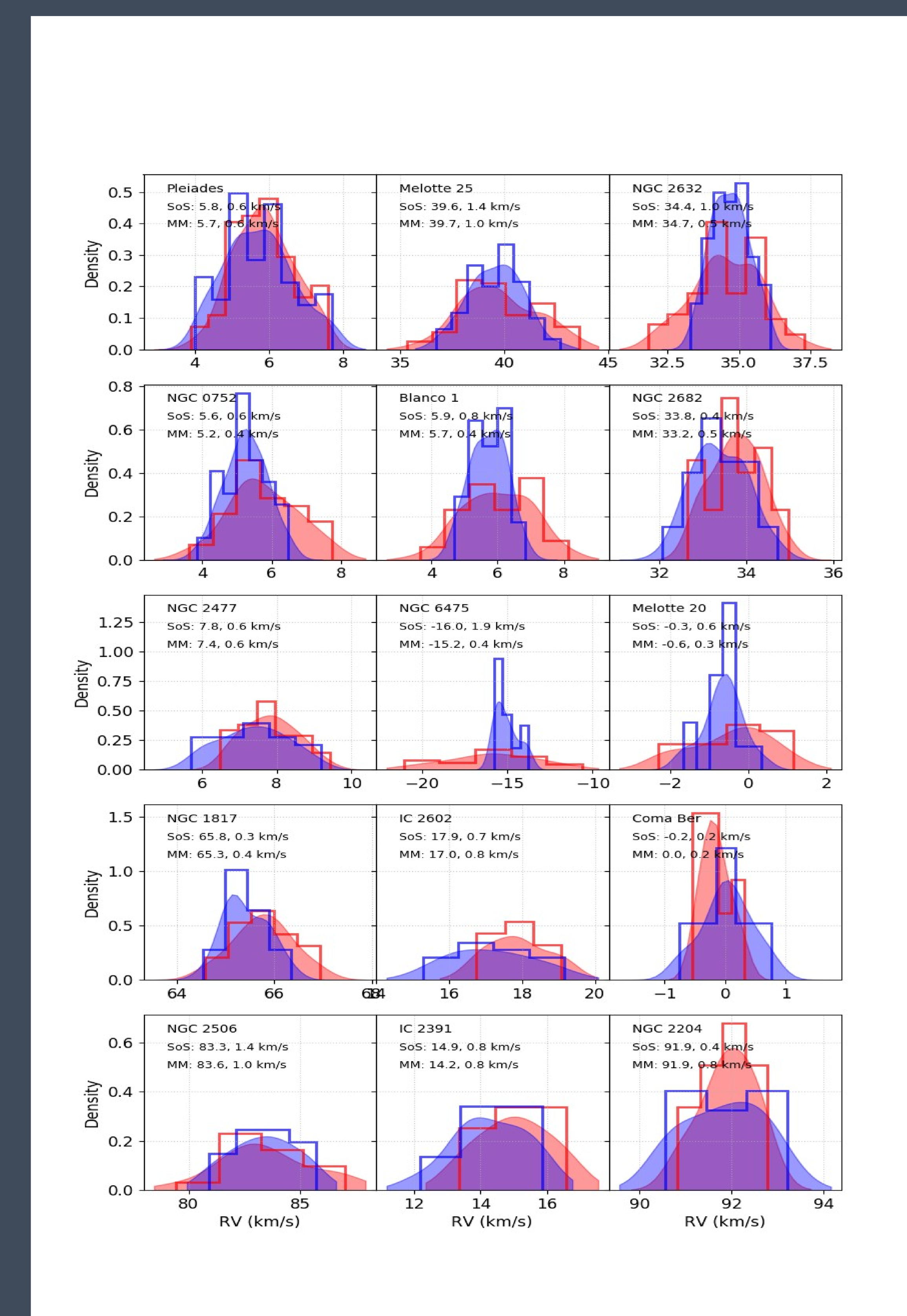
– The external zero point is set from the comparison to the Gaia RV standard stars.
– We further validate the accuracy of SoS by comparing with the Geneva-Copenhaghen survey to be at 0.31 km/s.

References

Tsantaki et al. 2021 A&A
Marrese et al. 2019, 621, A144, A&A
We acknowledge the use of the public data products from Gaia, APOGEE, GALAH, GES, RAVE & LAMOST, the funding from MIUR Premiale "Gaia-ESO survey", MIUR Premiale "MiTiC", the ASI-INAF contract 2014-049-R.O, Fondazione Cassa di Risparmio di Firenze (Know the star, know the planet), and Progetto Main Stream INAF: "Chemo-dynamics of globular clusters: the Gaia revolution.

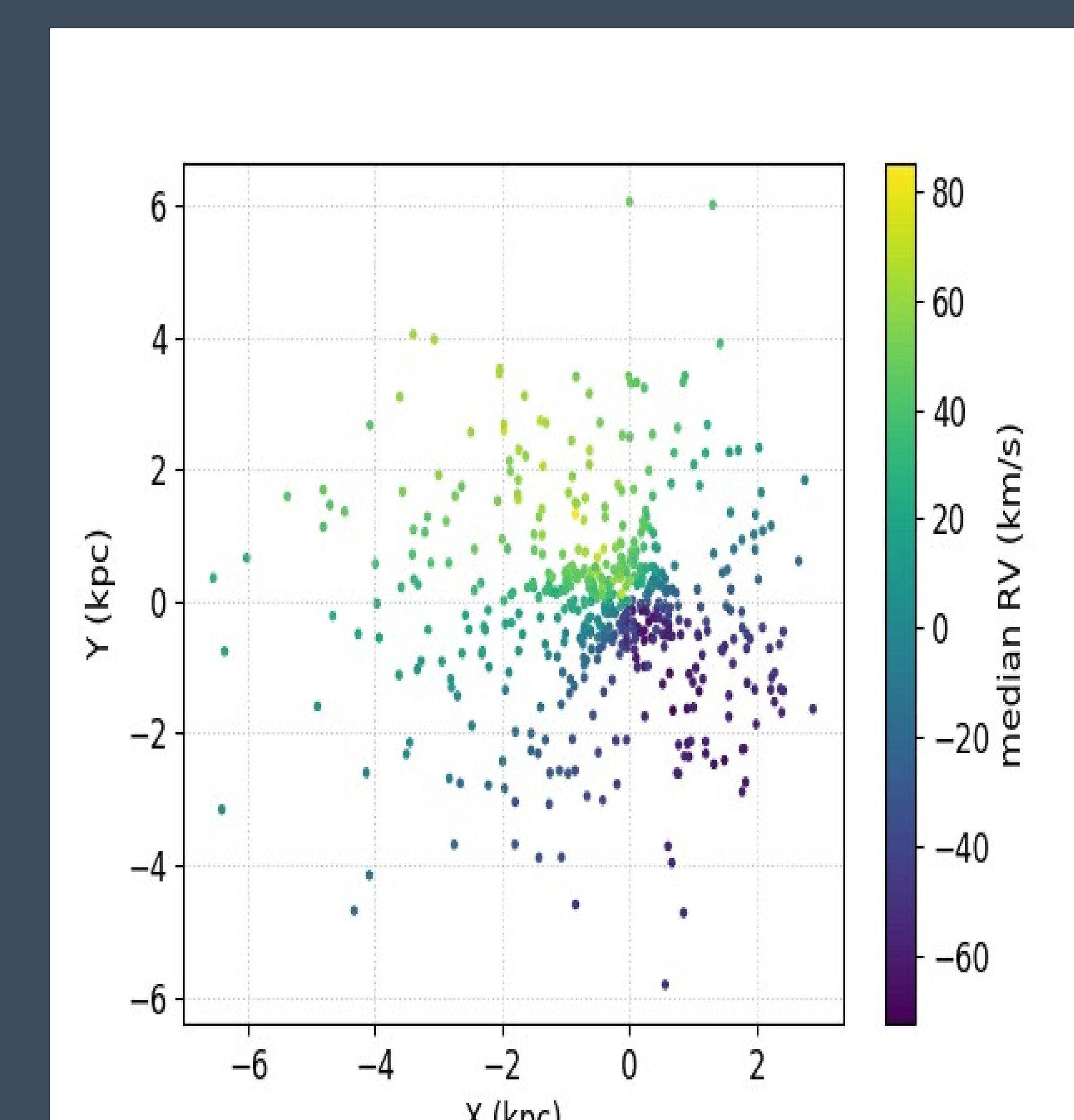
Application to OCs

Mermilliod et al. (2008, 2009), hereafetr MM, present 1309 red giants in 166 OCs and 2565 solar-type dwarfs in 179 nearby OCs, from high resolution spectrographs.
A comparison between homogeneous and independent literature analyses of OCs with SoS will demonstrate the precision and accuracy of our results. The average difference of RV_OC between SoS and MM is 0.21 km/s and the MAD of 0.26 km/s.



RV distributions of 15 clusters from MM with more than 15 stars in common. Red histograms represent the SoS results and blue the MM. The Gaussian kernel-density is plotted as shaded areas. There is also the information on the median and MAD values after the 3σ outlier removal for both samples.

The field of open clusters studies has received a tremendous boost thanks to Gaia data using astrometric and kinematic criteria (e.g. Cantat-Gaudin et al. 2018; Liu & Pang 2019; Castro-Ginard et al. 2020) providing catalogues with more than 2000 different clusters with hundreds of them newly discovered and have yet to be characterised.
SoS can significant contribute to this effort by investigating their kinematics for a sample of a few thousands OCs from Gaia data with an accuracy of 0.26 km/s in the RV_OC.
We select the recent sample of Cantat-Gaudin & Anders (2020) comprising of 2014 OCs with member probability higher than 70%. From this sample, we select clusters with more than 3 stars in common with SoS amounting to 532 OCs.



The spatial distribution of the 532 OCs observed with Gaia using the median RVs from SoS in color.