Chemo-kinematic studies with Gaia and APOGEE

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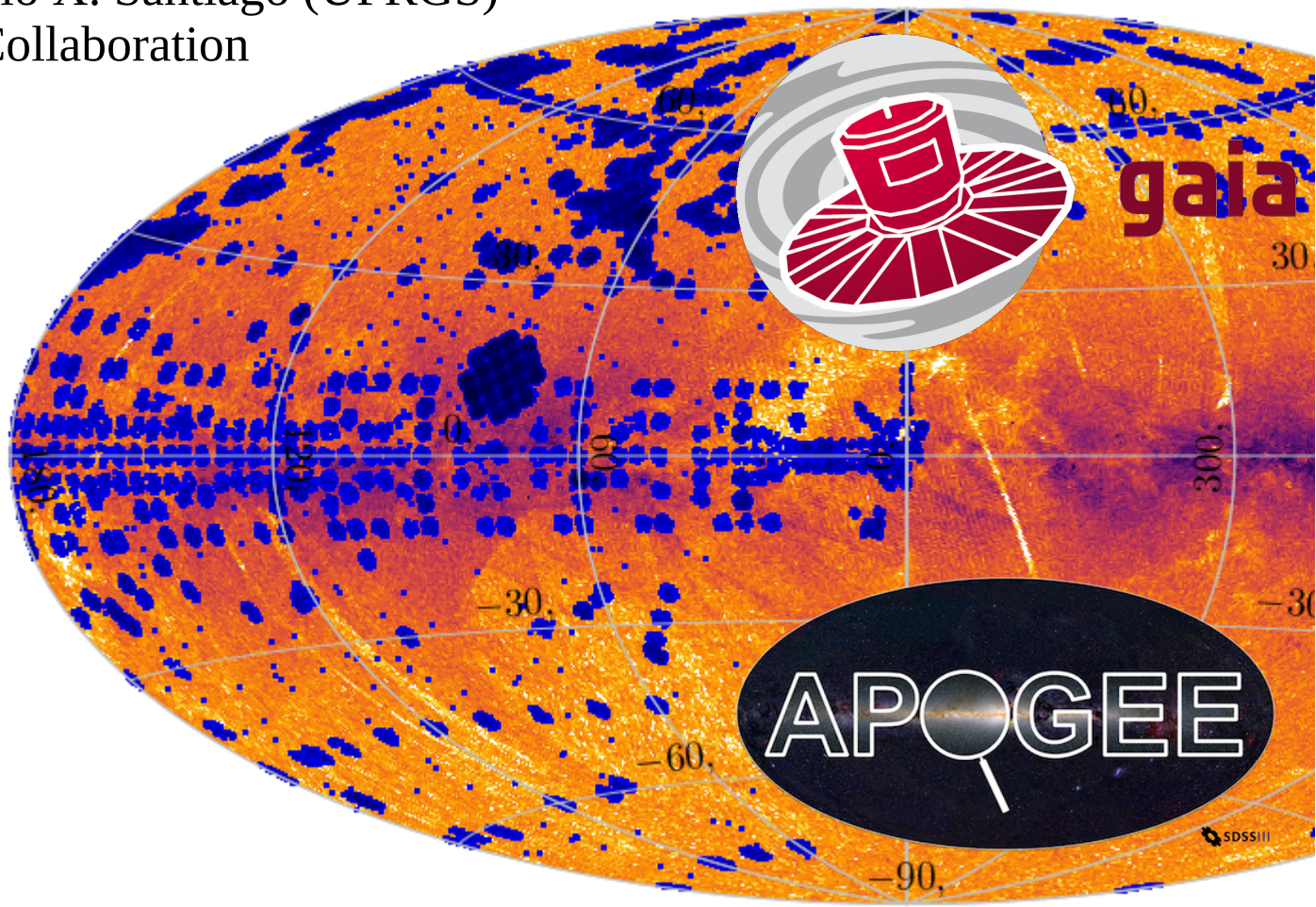
SDSS/APOGEE Collaboration



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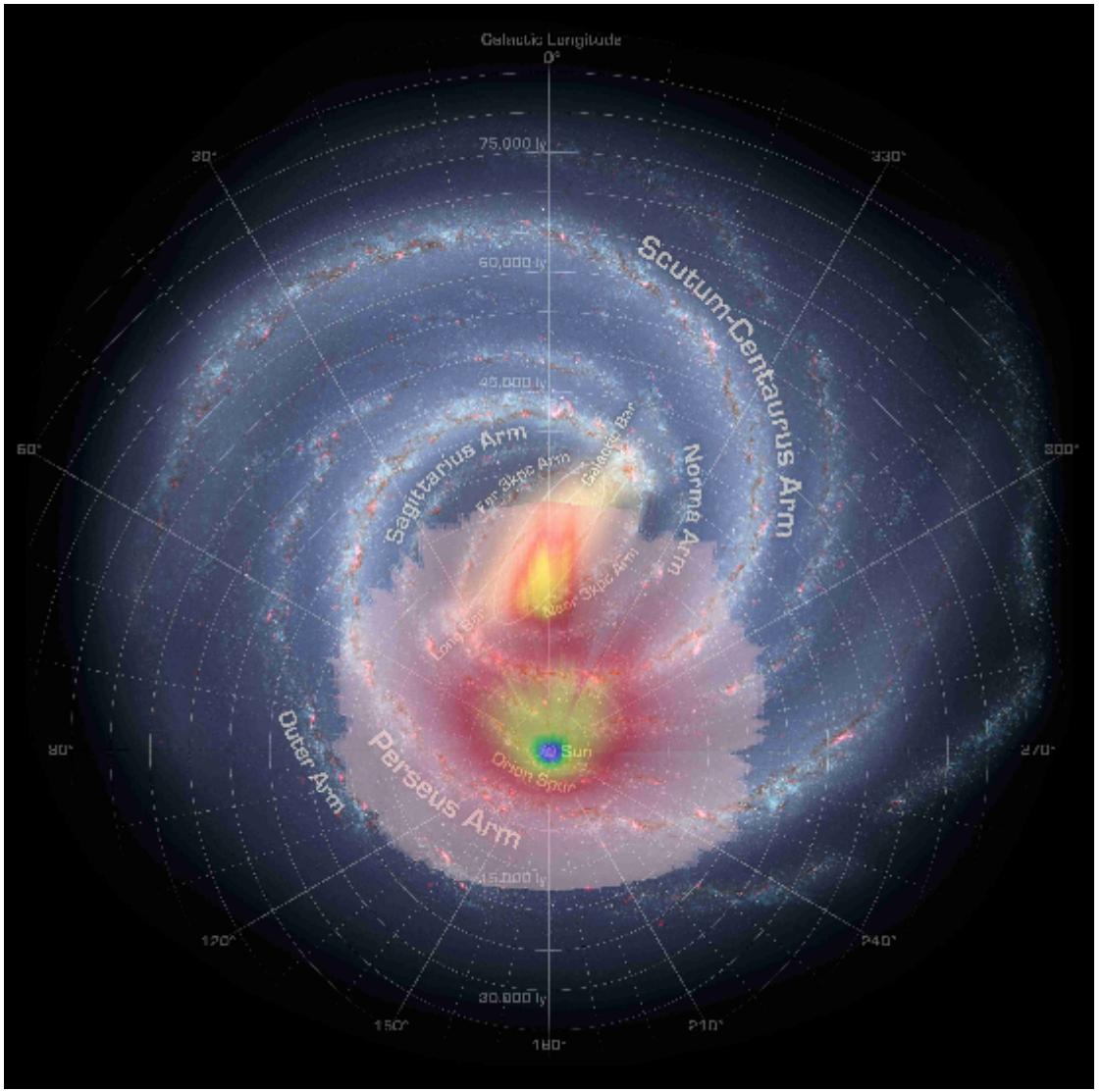
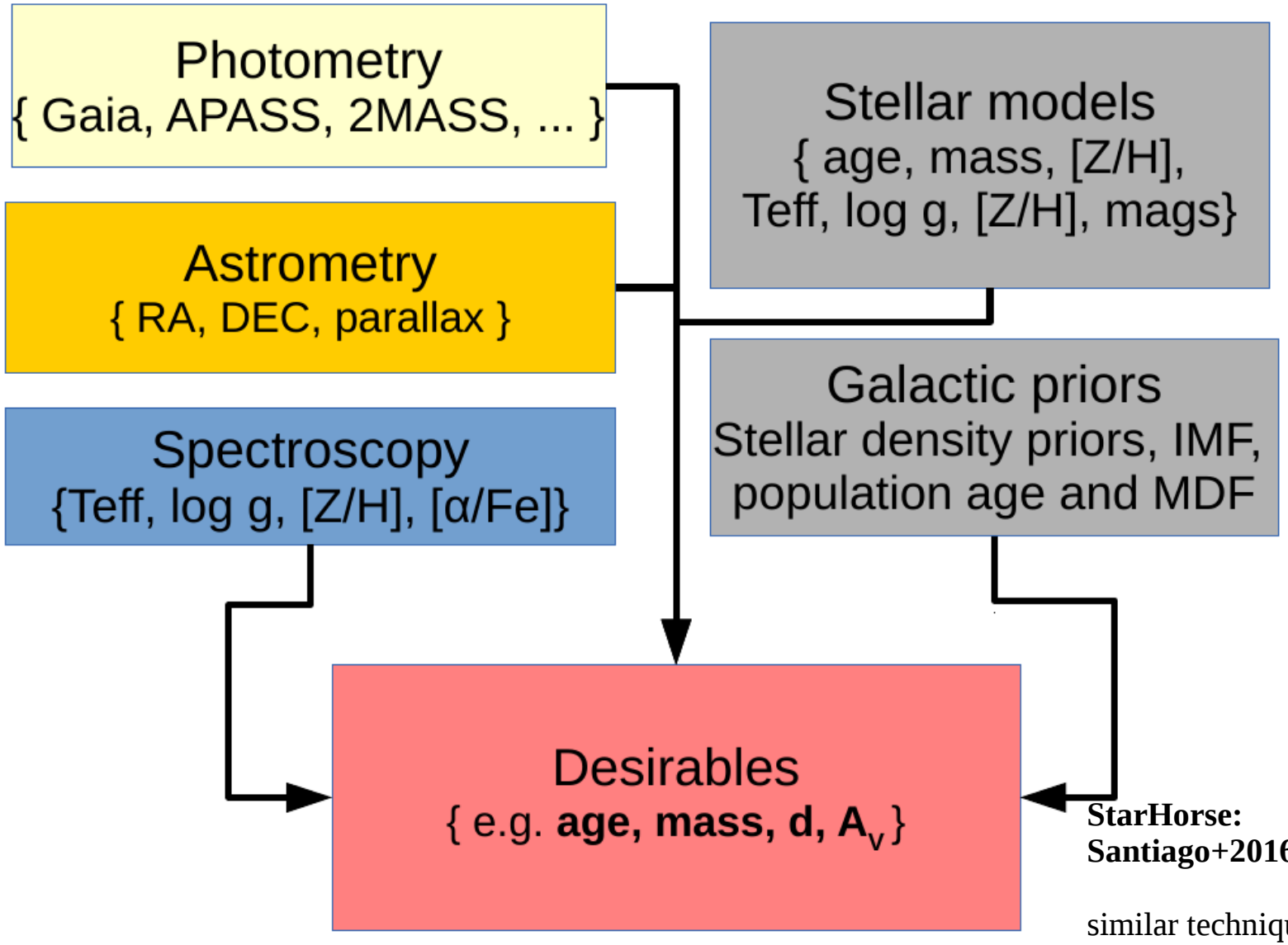
Combining spectroscopy, photometry and astrometry



Credit: X. Luri/ A. Robin

- Extension of the Gaia parallax horizon:
  Precise distances for stars without precise parallaxes
- Masses and age estimates for stars with good parallaxes
- Better HRDs, more precise chemo-dynamics, stellar orbits, etc.

Spectro-photo-astrometric inference



StarHorse:
Santiago+2016, Queiroz+2018

similar techniques used by Binney+2014, McMillan 2017, Mints&Hekker 2017, ...
Simpler techniques used by Gaia DPAC, Astraatmadja+2016, Bailer-Jones+2018..

Spectro-photo-astrometric parameters

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Início Sobre Ciência Data Center

StarHorse: A Bayesian tool for determining stellar masses, ages, distances, and extinctions for field stars

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LIneA » Data Center » Acesso à dados » Spectrophotometric Distances and Extinction

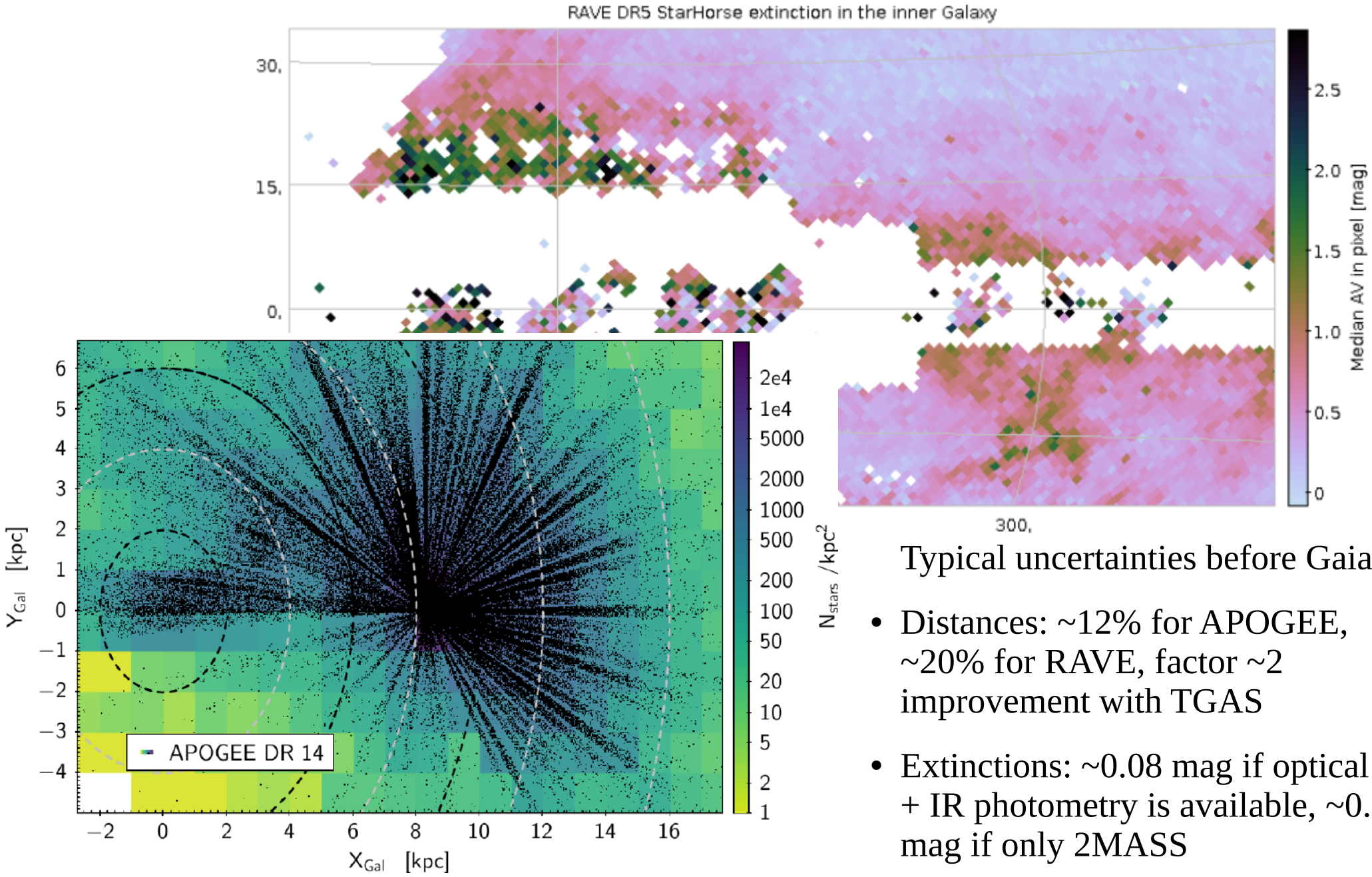
Spectrophotometric Distances and Extinction

This page contains the list of value-added catalogues from different surveys for which Queiroz et computed distance and extinction values using the StarHorse code, a joint effort by the SDSS Bra AIP/Potsdam. Just click on the desired sample to download the catalogue and the accompanying 6 of the submitted paper [1] for more information. There are two versions available in this domai recommended is Version 1.

Version: 1 Last updated 01/16/2018

Catalogue	Fits	CSV
GAIA ESO Survey	GES_DR3_StarHorse_v1.fits	GES_DR3_StarHorse_v1.csv
GALAH	GALAH_DR1_StarHorse_v1.fits	GALAH_DR1_StarHorse_v1.csv
RAVE-SC	RAVE_SC_StarHorse_v1.fits	RAVE_SC_StarHorse_v1.csv
RAVE-ON	RAVE_ON_StarHorse_v1.fits	RAVE_ON_StarHorse_v1.csv
RAVE-DR5	RAVE_DR5_StarHorse_v1.fits	RAVE_DR5_StarHorse_v1.csv
APOGEE-DR14	APOGEE_DR14_StarHorse_v1.fits	APOGEE_DR14_StarHorse_v1.csv

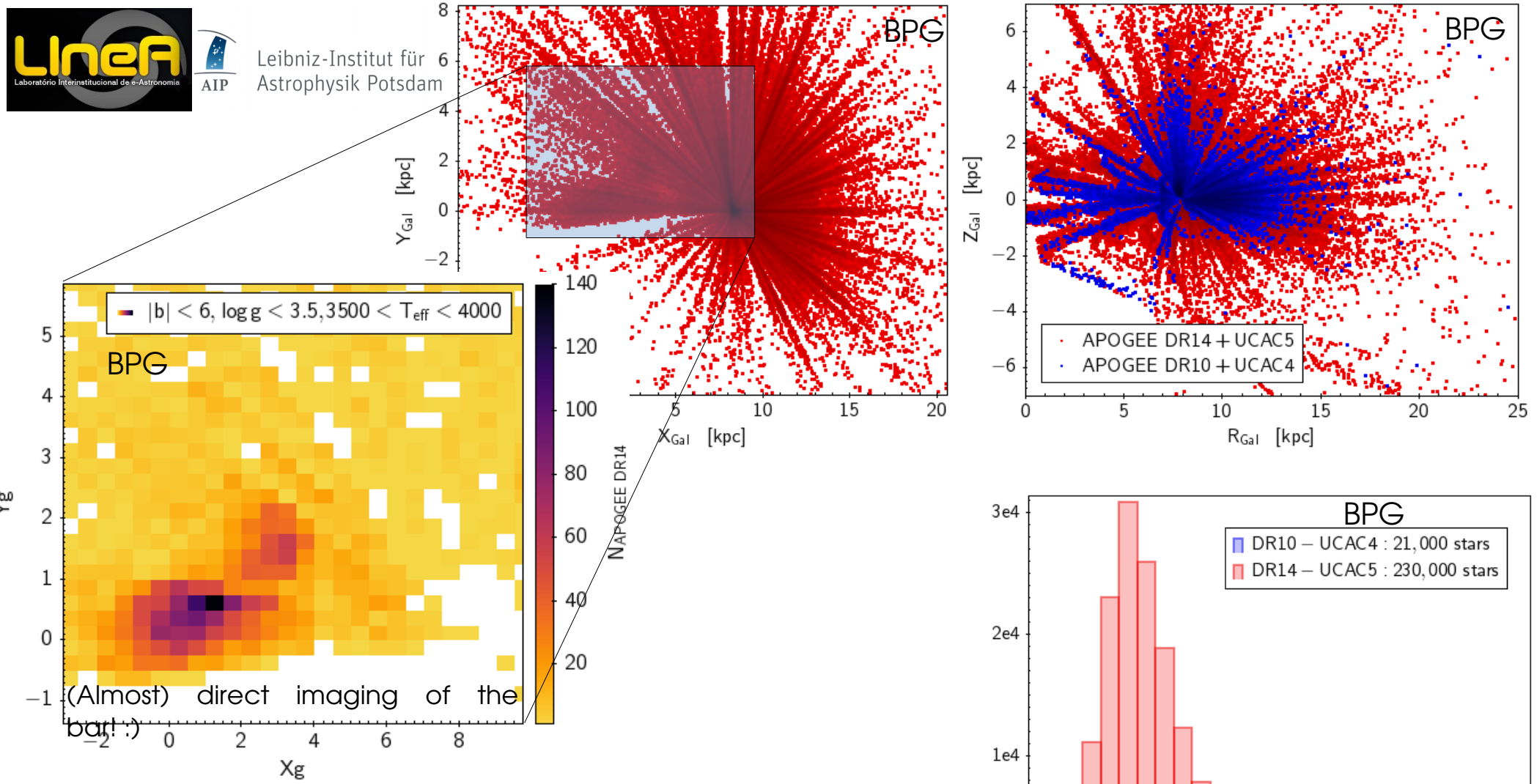
Spectro-photo-astrometric parameters



Typical uncertainties before Gaia:

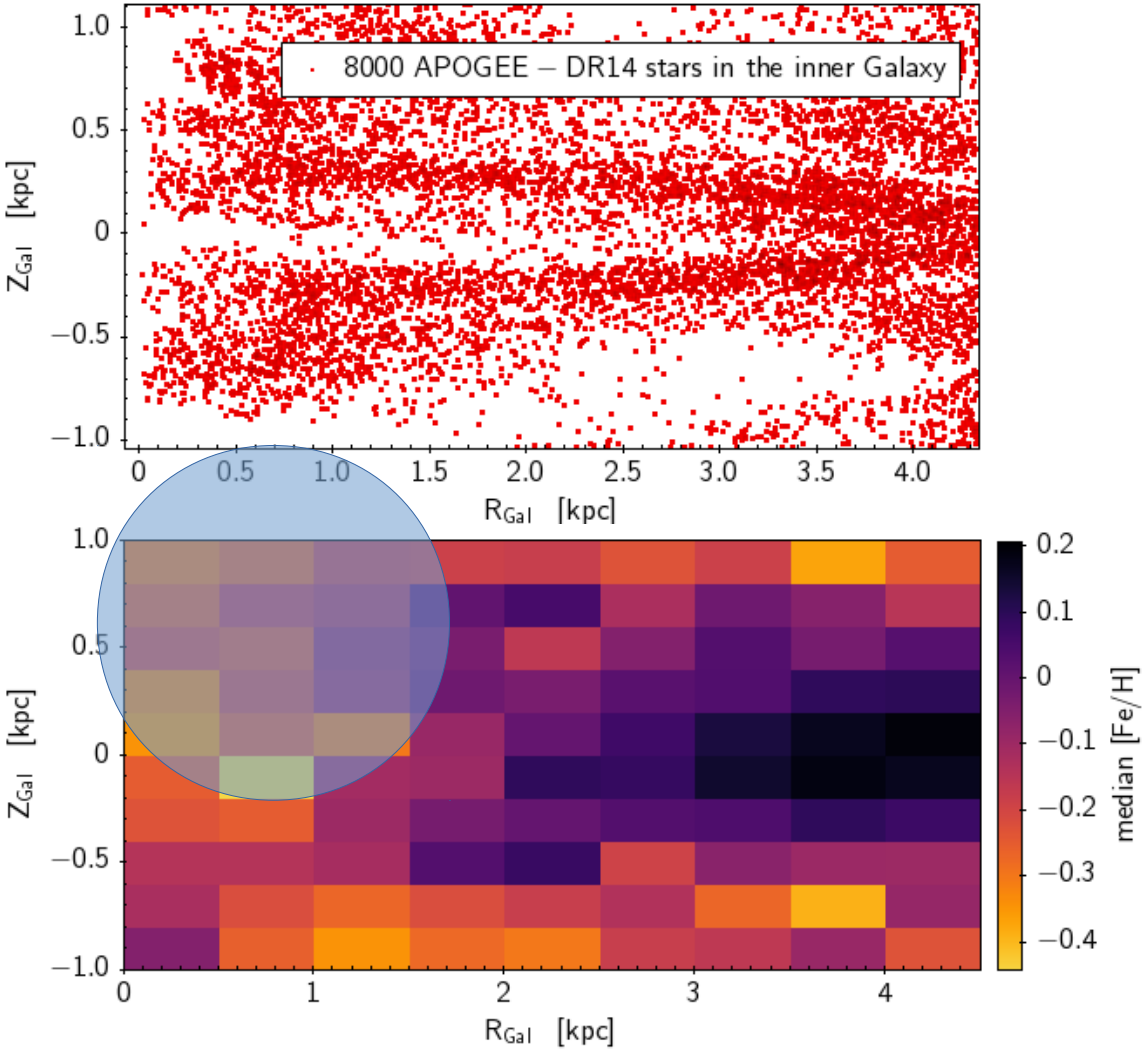
- Distances: ~12% for APOGEE, ~20% for RAVE, factor ~2 improvement with TGAS
- Extinctions: ~0.08 mag if optical + IR photometry is available, ~0.2 mag if only 2MASS

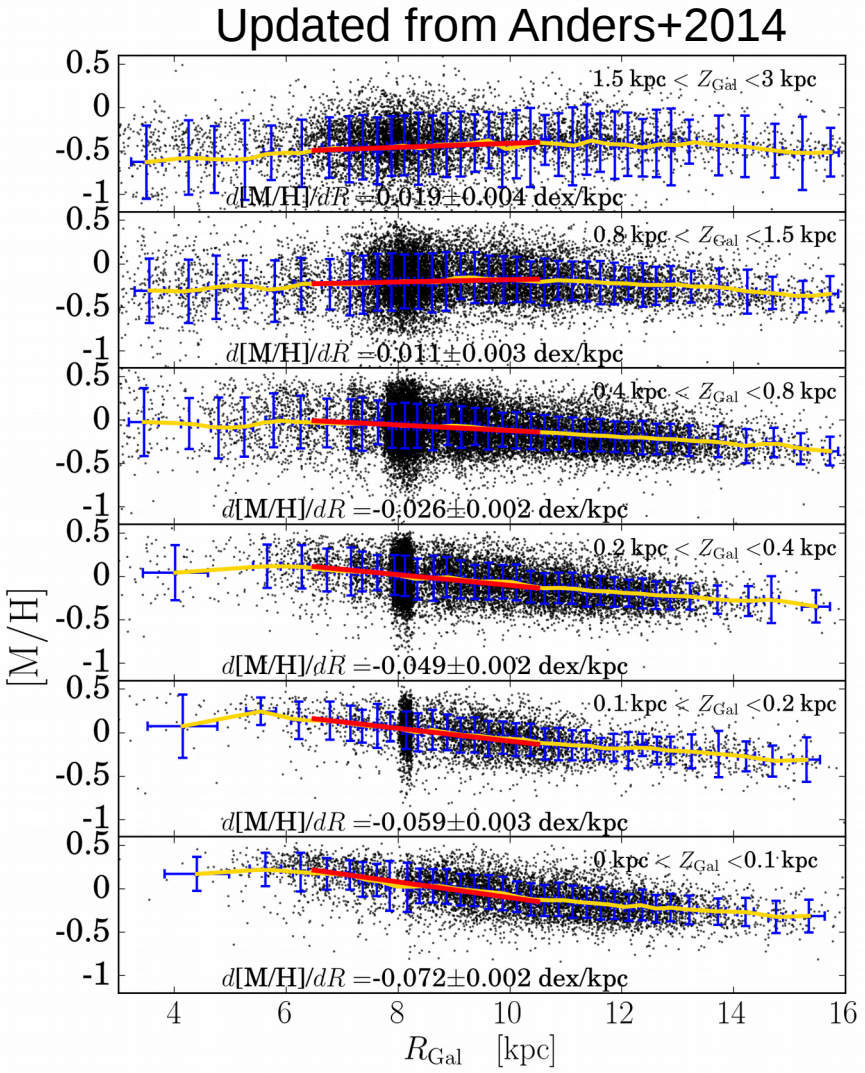
The APOGEE DR14-GDR2 Sample



- DR14 yields distances+extinctions for > **200,000 stars**
- Median precision for giants 12% in distance, 0.07 mag in A(V)

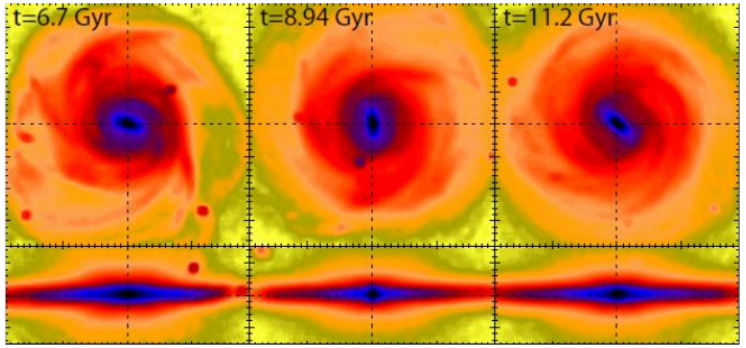
The APOGEE DR14 view of the Inner MW

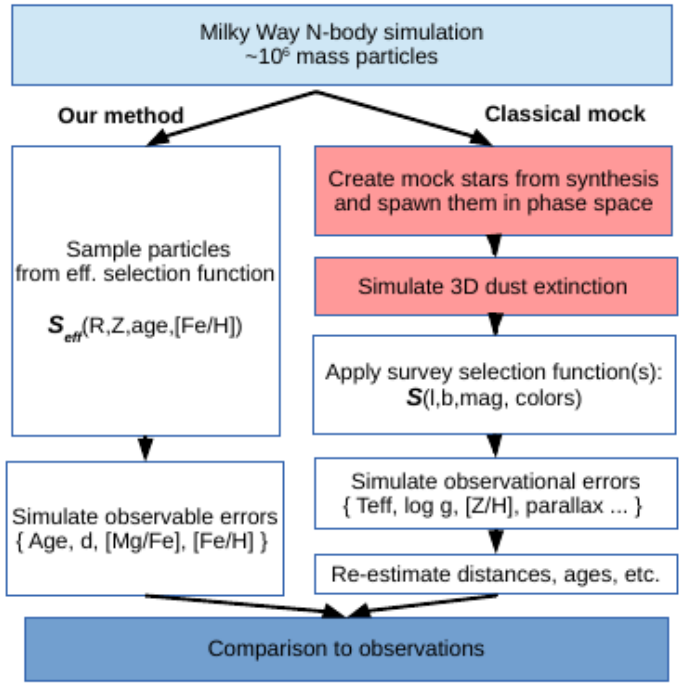


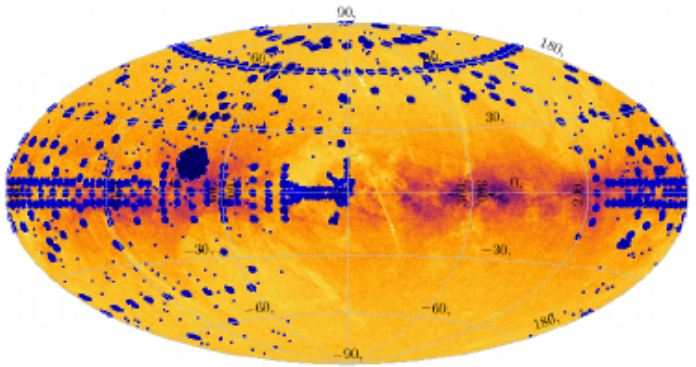


- APOGEE can now trace the turnover of the [Fe/H] gradient in the Inner Galaxy

Simulating APOGEE DR14 + GDR2





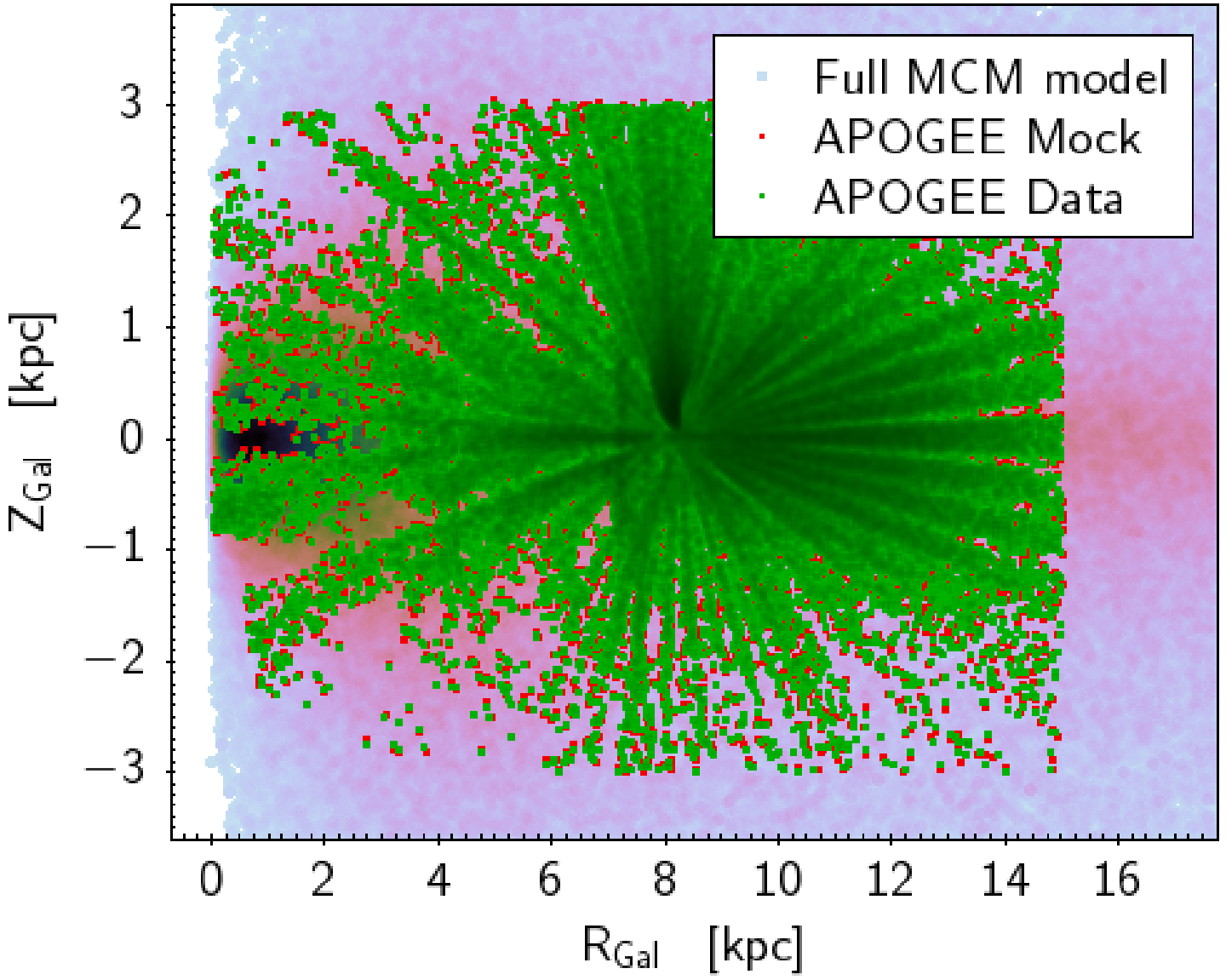


Recipe

- Classic forward modelling in the Galactic Plane is *hard* (see e.g. CoRoT-APOGEE, Anders+2017)
- Simple forward modelling is easier and yields good results (Anders+2016, Nandakumar+2017)
- Fragkoudi+2018 have also shown (using APOGEE) that the most important selection effects in the Inner Galaxy are due to the distance sampling - easily accounted for

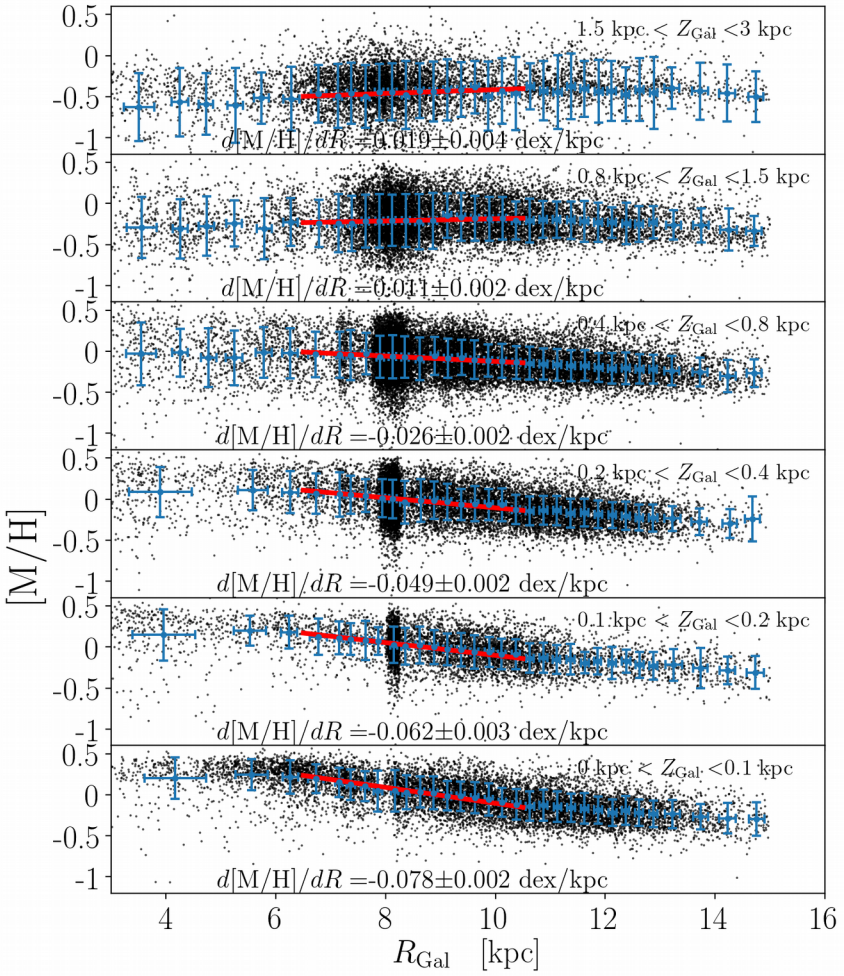
- Recipe to get a simple mock from an N-body model: SF = S(R,Z) * S(age)
- Aim: correct/account for heaviest selection effects on the MDFs in the far discs

Mocking APOGEE DR14 + UCAC-5 (GDR2)

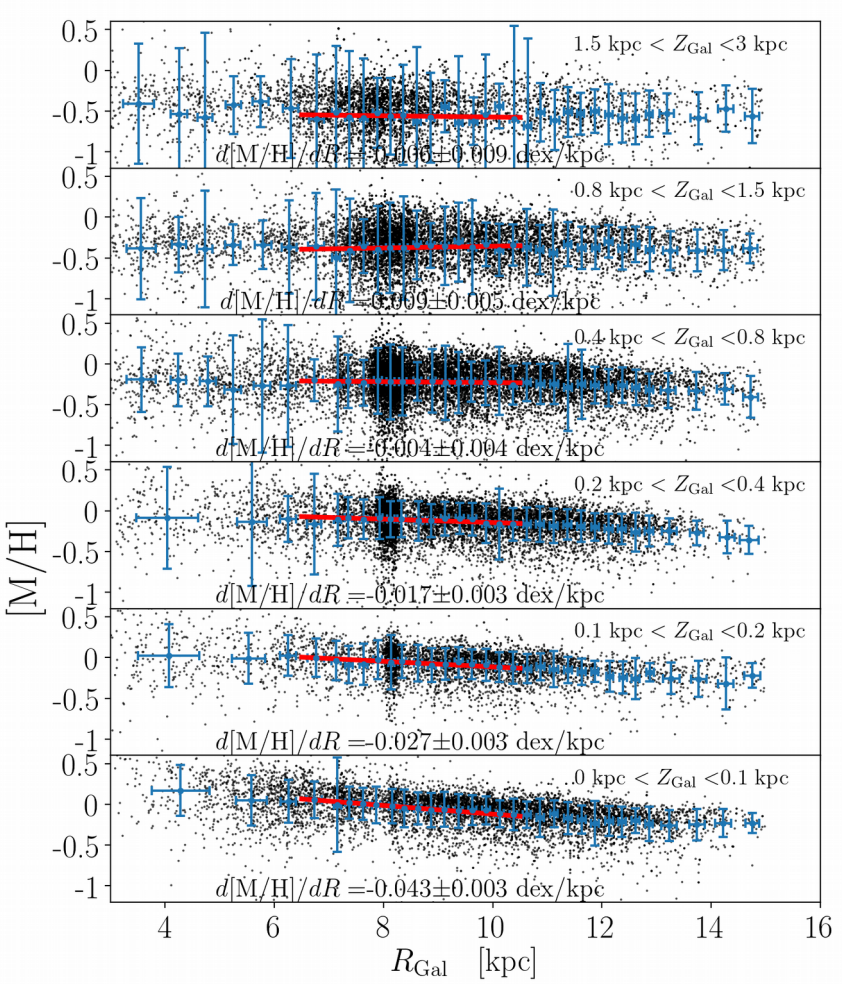


The radial [Fe/H] gradient in bins of Z

Updated from Anders+2014

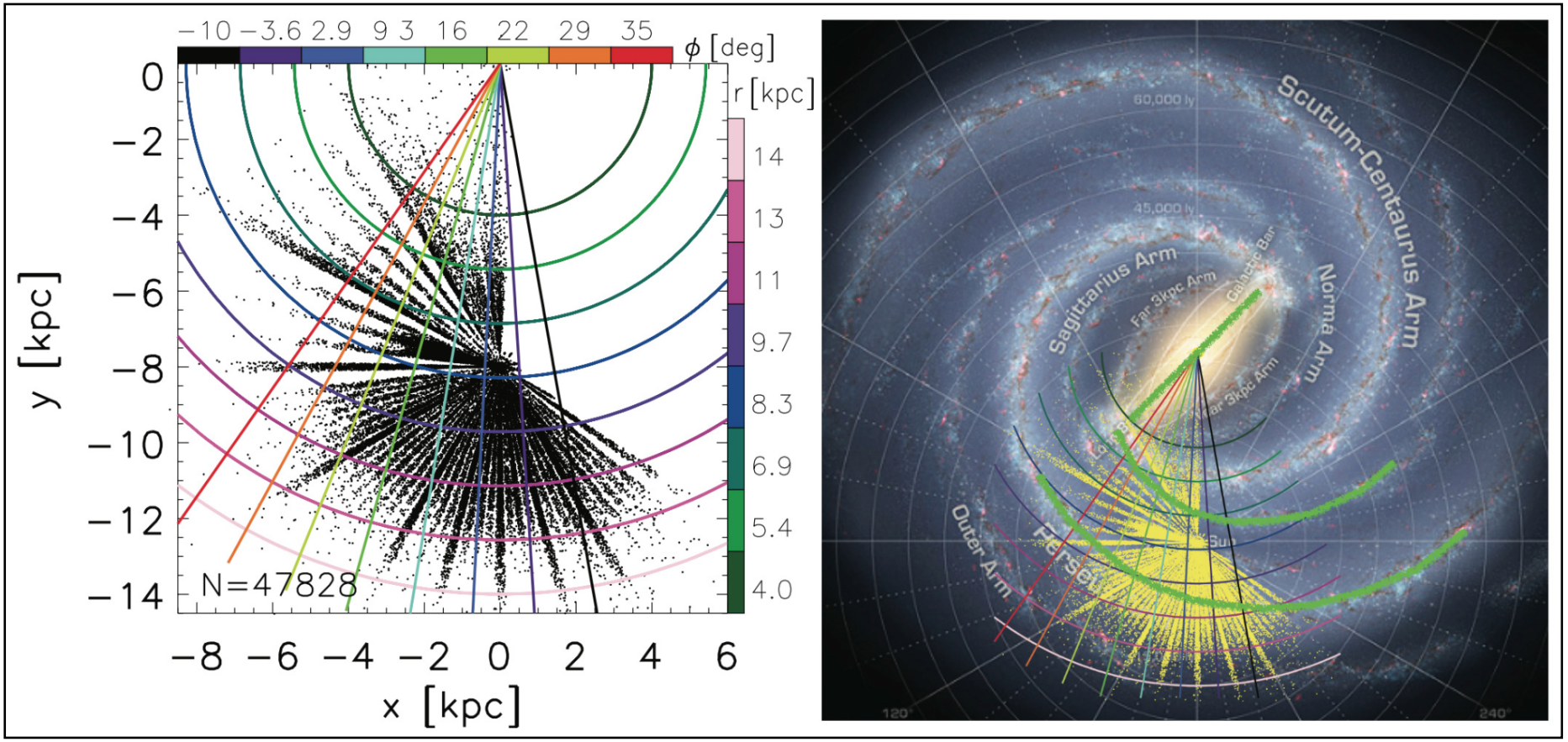


MCM Mock



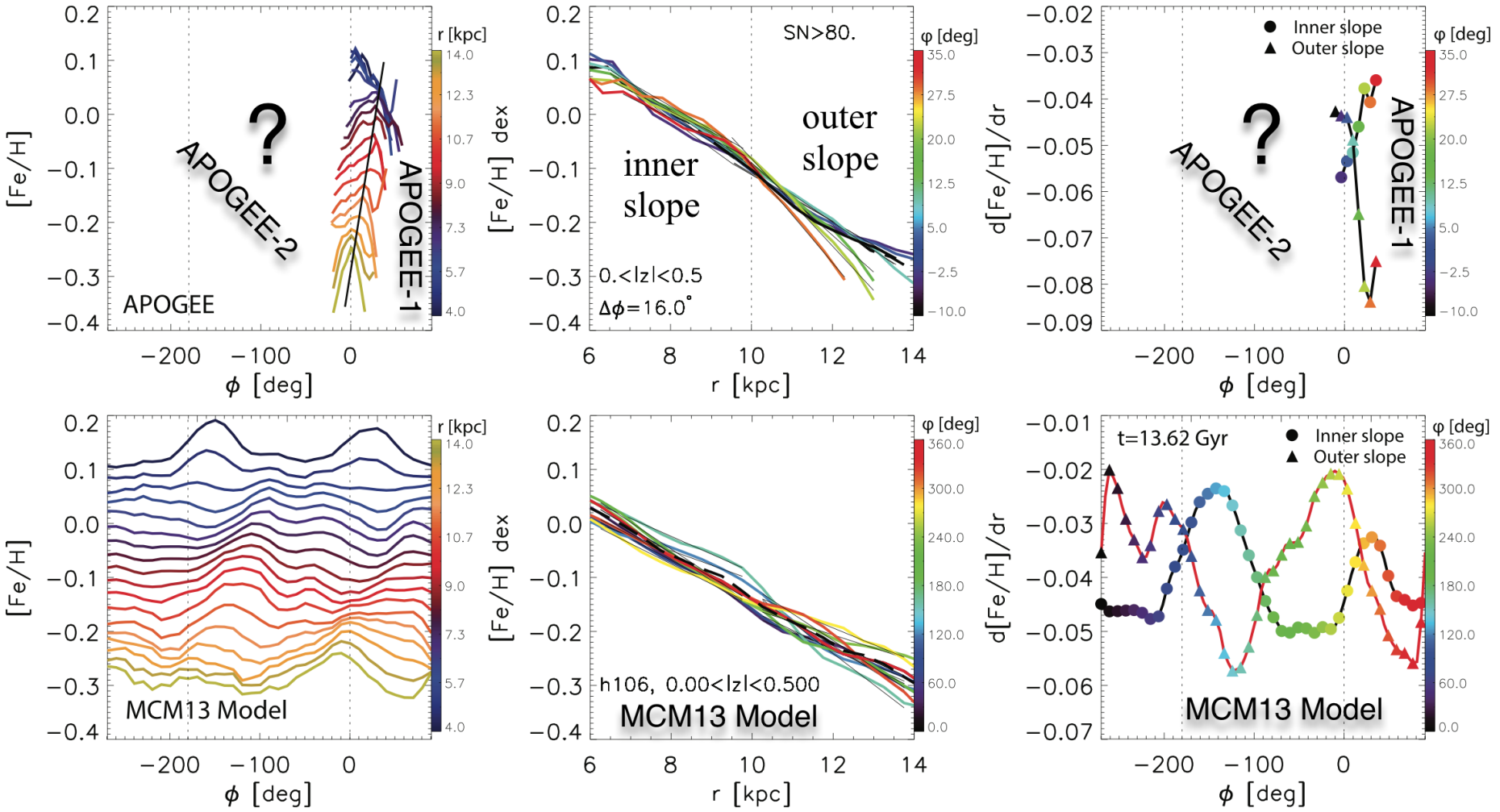
- APOGEE can now trace the turnover of the [Fe/H] gradient in the Inner Galaxy – we start to see how models can improve there

Another neglected variable: The azimuthal variation of the radial gradient (Minchev+ in prep)



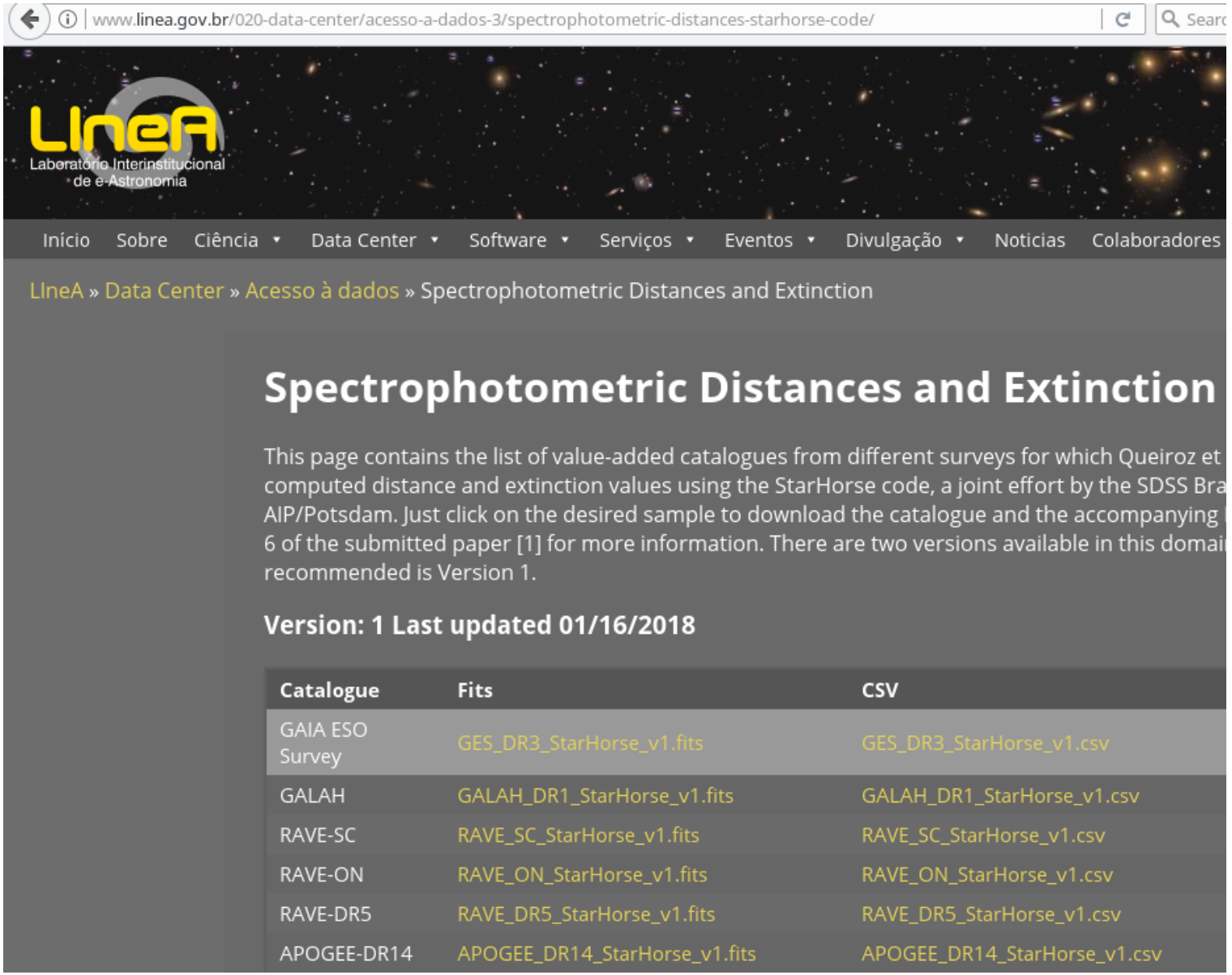
- APOGEE enables us to study the radial and azimuthal [Fe/H] profile simultaneously over a large range of R and Phi

The azimuthal variation of the radial gradient (Minchev+ in prep)



- The radial [Fe/H] gradient varies by +-0.15 dex/kpc as a function of azimuth, as predicted by chemo-dynamical models and seen in HII regions (Balser+2011, 2015)
- Also the flattening in the outer disc depends on azimuth
- Reason: spiral structure! APOGEE sample dominated by 1-4 Gyr stars.

Next: Gaia DR2
Spectro-photo-astrometric parameters



Looking forward!

- **Gaia DR2 + {APOGEE DR14, RAVE DR6, GALAH DR2, GES DR3, LAMOST}**
- **Gaia DR2 + photometry**

StarHorse roadmap for 2018

- **APOGEE + Gaia DR2**: (Ages,) masses, distances and extinctions for 400k stars
- **Gaia DR2 + {RAVE DR6, GALAH DR2, GES DR3, LAMOST}**: (Ages,) masses, distances & extinctions for 3M stars
- **Gaia DR2 + photometry**: more precise distances & extinctions for stars G < 18: Results will be provided to the community within a few months.

Limits

- Gaia DR2 (especially photometry) is almost too precise for this kind of code:) Stellar models & Bolometric corrections are more uncertain than Gaia DR2 magnitudes…
- Different stellar parameter scales for different surveys → different mass/age scales
- Age/mass uncertainties will also be limited by systematics in stellar models.
- Binary effects are not taken into account yet.

  As always: Caution with ages...