APOGEE & *Gaia*-DR2

Gail Zasowski
University of Utah
SDSS-V Spokesperson

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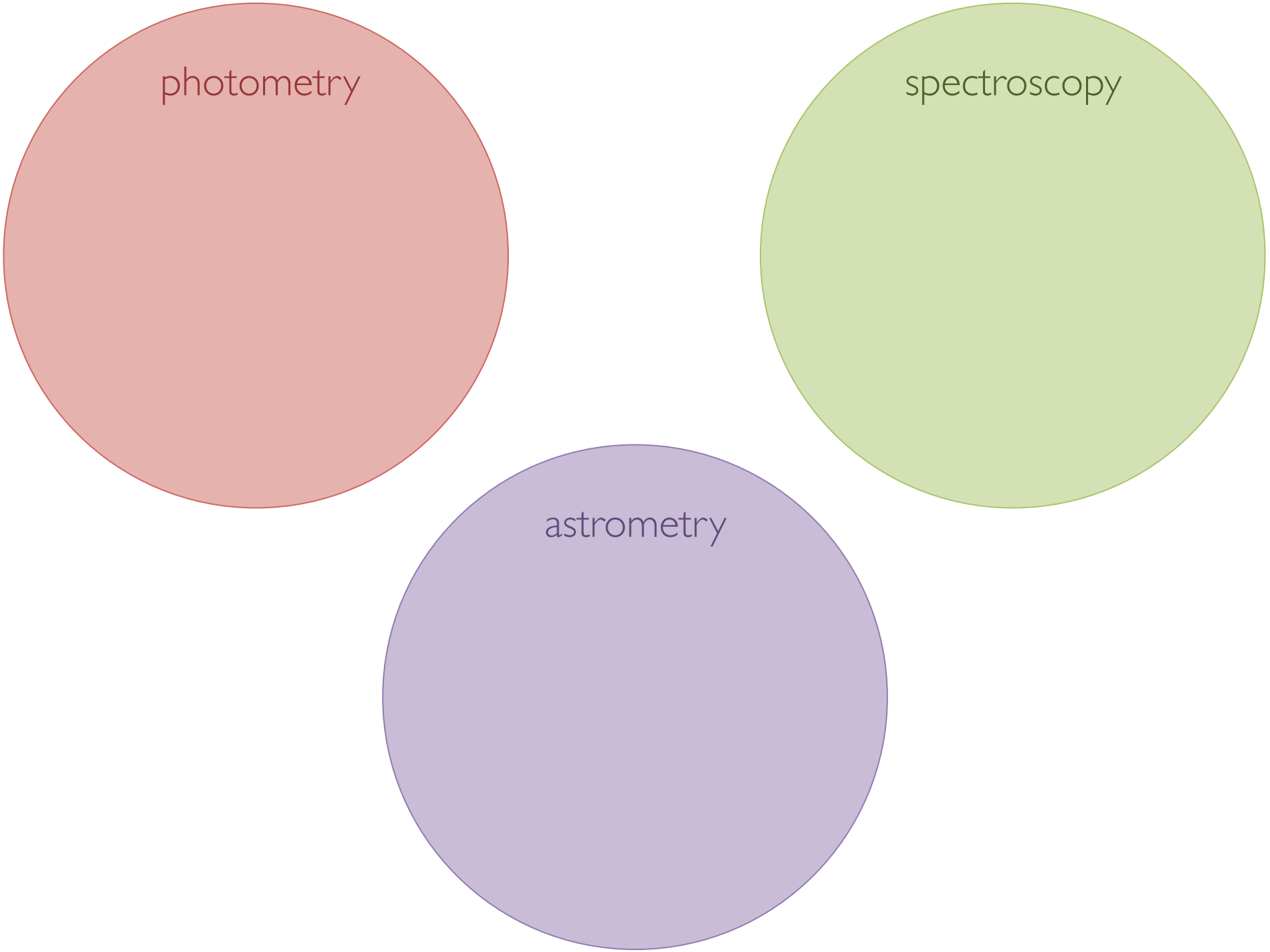
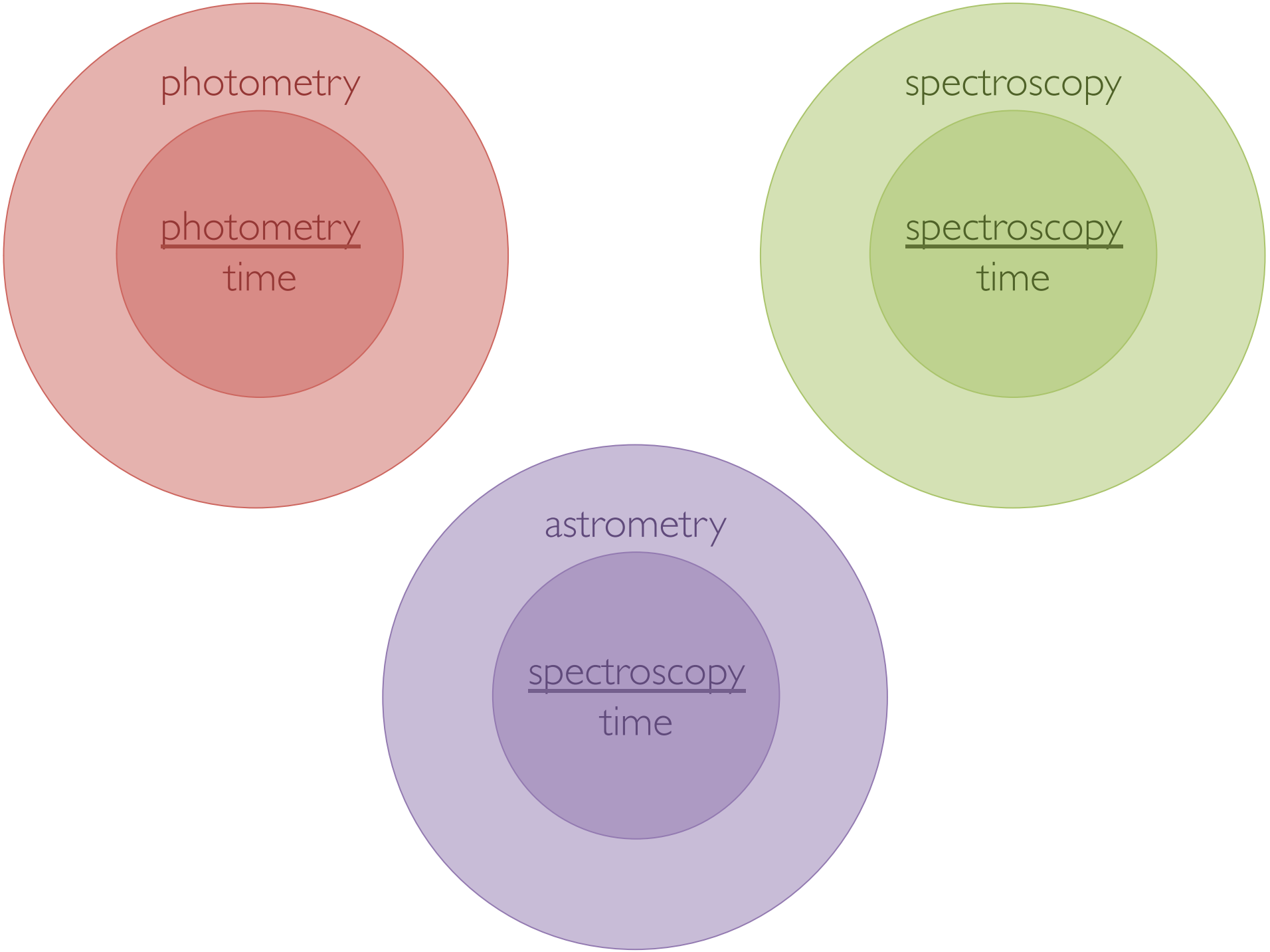
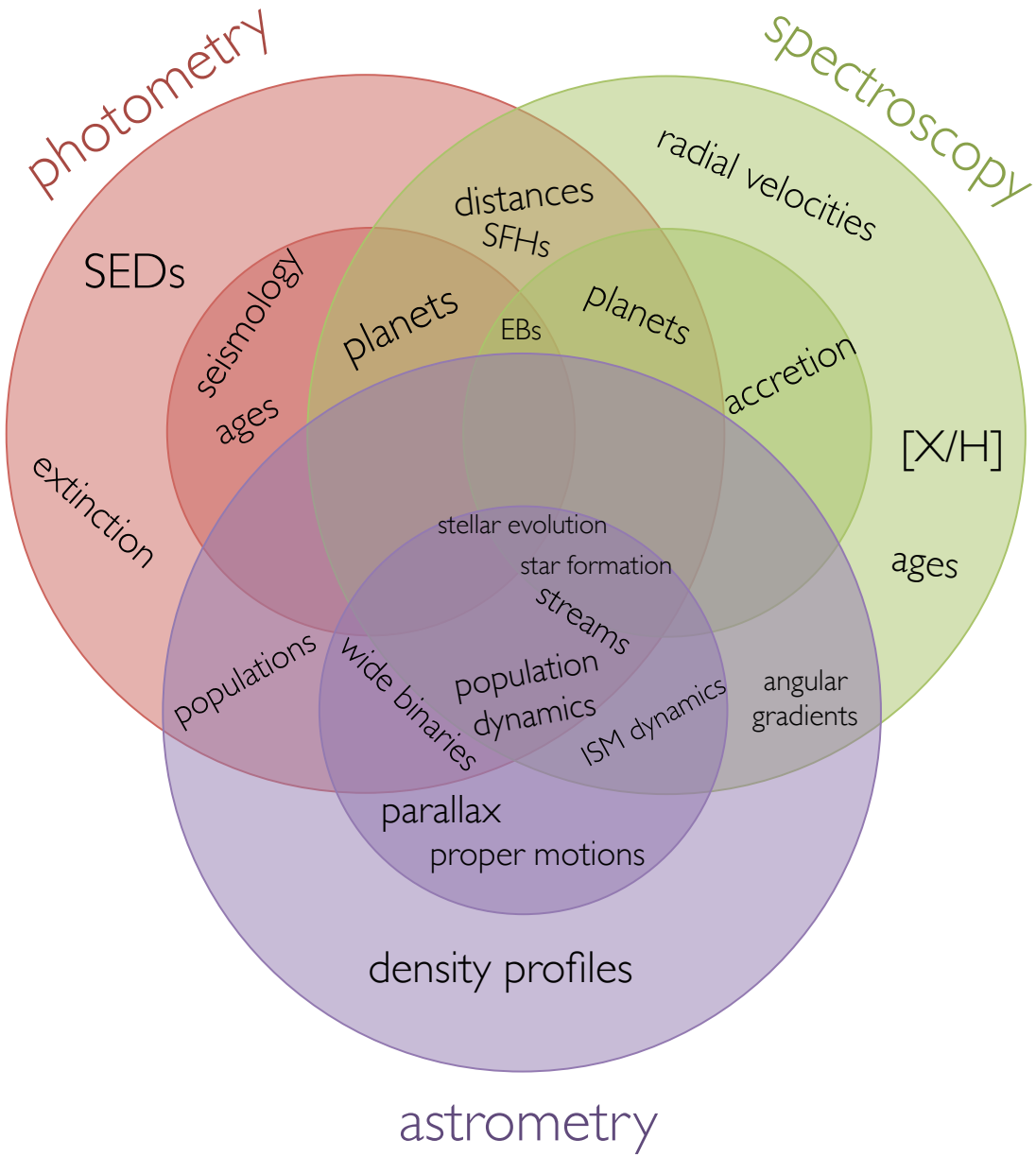
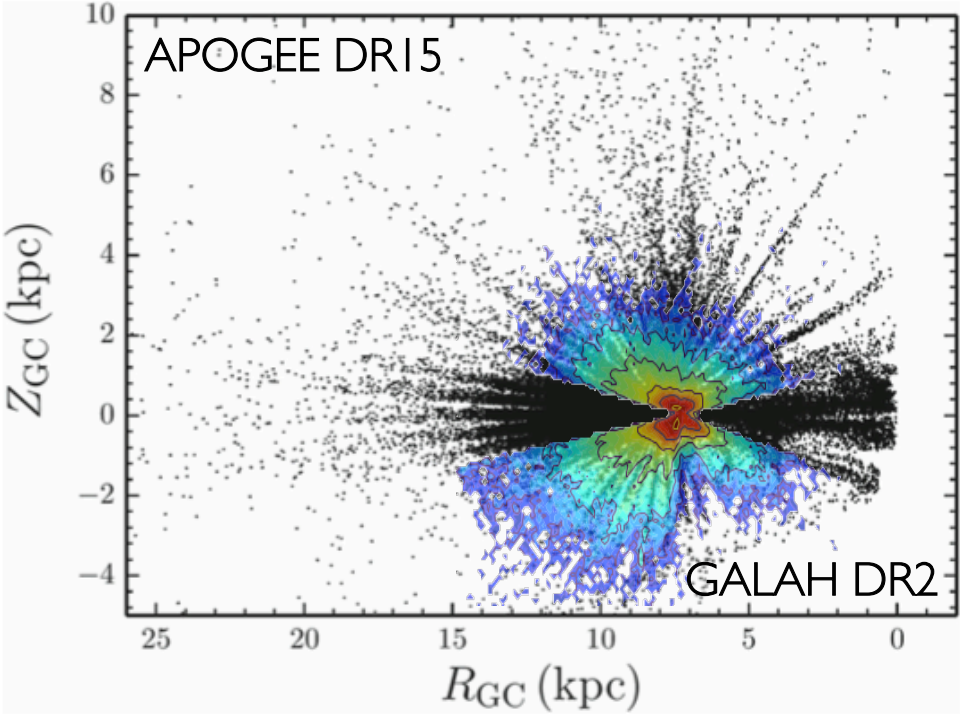
SDSS-V

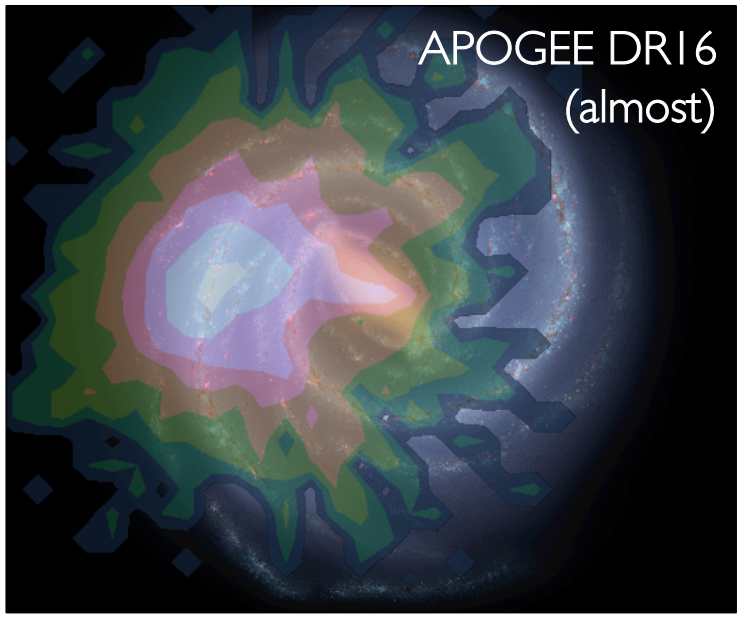

photometry
spectroscopy
astrometry


photometry
photometry
time
spectroscopy
spectroscopy
time
astrometry
spectroscopy
time


photometry
spectroscopy
astrometry
SEDs
extinction
seismology
ages
distances
SFHs
planets
EBs
planets
radial velocities
accretion
[X/H]
ages
stellar evolution
star formation
streams
populations
wide binaries
population
dynamics
ISM dynamics
angular
gradients
parallax
proper motions
density profiles

APOGEE (APOGEE-I + APOGEE-II)





✧ Part of SDSS-III and SDSS-IV

✧ R~22,500, *H*-band (1.5-1.7 μm), all areas of the Milky Way

✧ Public products: RVs, stellar parameters, up to 25 chemical species, the spectra themselves, and all targeting & meta data

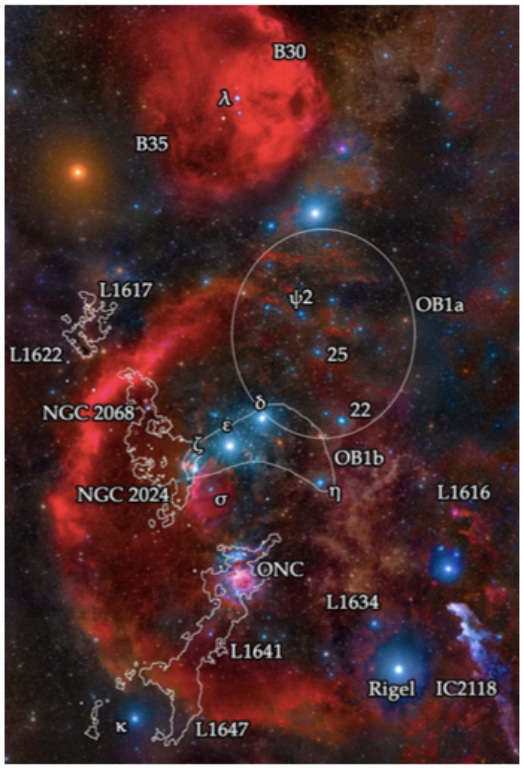
✧ 263,000 stars in DR15 (current public release: https://www.sdss.org/dr15/irspec/)

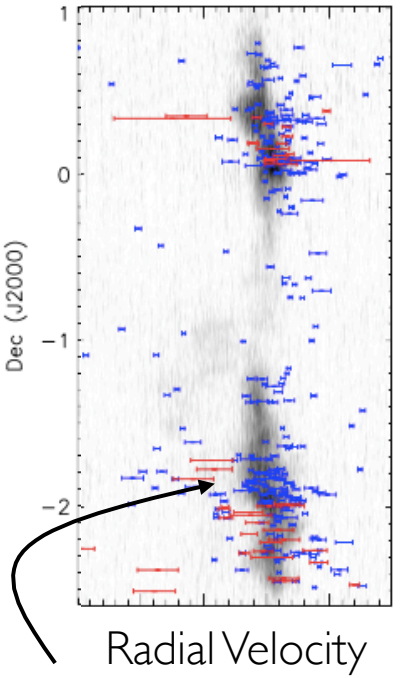
✧ 437,000 stars in DR16 (December 2019)

Majewski et al. 2017

Highlights: Stellar & Cluster Physics

- Nataf et al. 2019, *The Relationship Between Globular Cluster Mass, Metallicity, and Light Element Abundance Variations*
- Borissova et al. 2019, *G305 Star forming region: Newly classified hot stars*
- Kounkel et al. 2018, *The APOGEE-2 Survey of the Orion Star-forming Complex: Six-dimensional Structure*
- Birky et al. 2019, *Data-driven Physical Parameters for 10,000+ M dwarfs*
- Donor et al. 2018, The *Open Cluster Chemical Abundances and Mapping Survey.: Precision Cluster Abundances for APOGEE*
- Carrera et al. 2019, *Open clusters in APOGEE and GALAH. Combining Gaia and ground-based spectroscopic surveys*
- Andrews et al. 2019, *Using APOGEE Wide Binaries to Test Chemical Tagging with Dwarf Stars*
- Kos et al. 2018, *Discovery of a 21 Myr old stellar population in the Orion complex*
- Schiappacasse-Ulloa et al. 2018, *A Chemical and Kinematical Analysis of the Intermediate-age Open Cluster IC 166 from APOGEE and Gaia DR2*

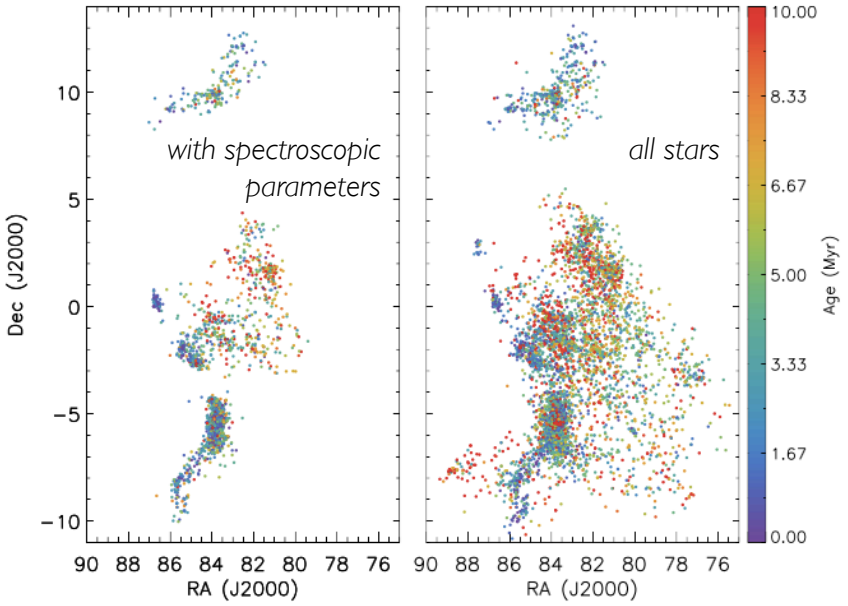




Radial Velocity

Associating the youngest stars with natal gas

Informing the stellar ages that can be inferred from CMDs



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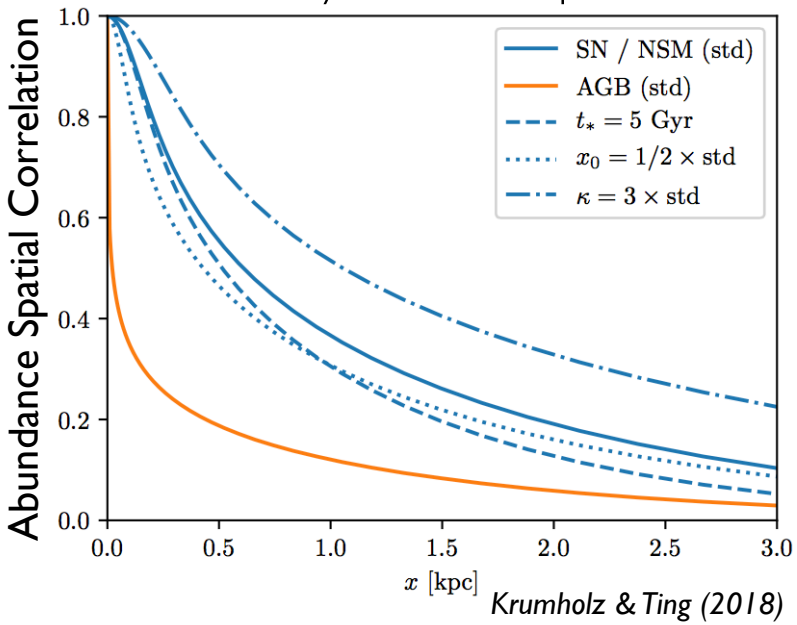
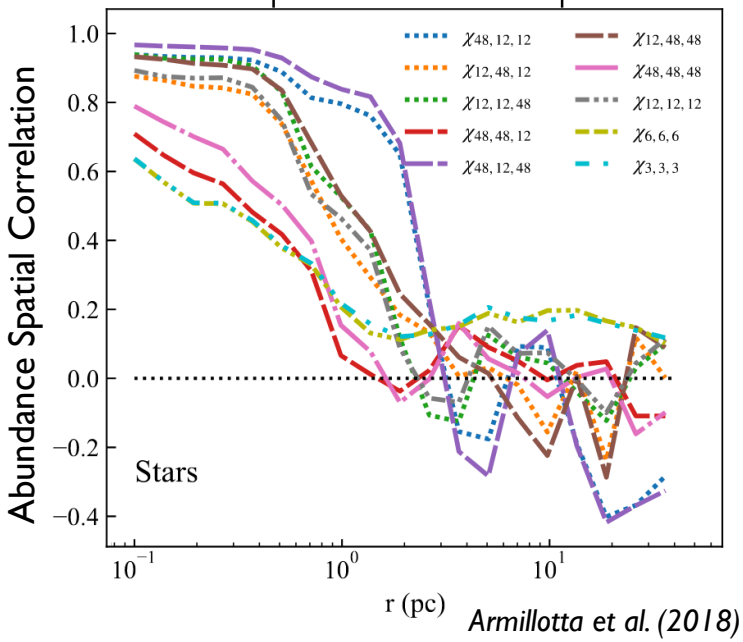
Do elements diffuse smoothly and consistently across ~kpc scales?



Krumholz & Ting (2018)

Does turbulence decouple abundance patterns on ~pc scales?

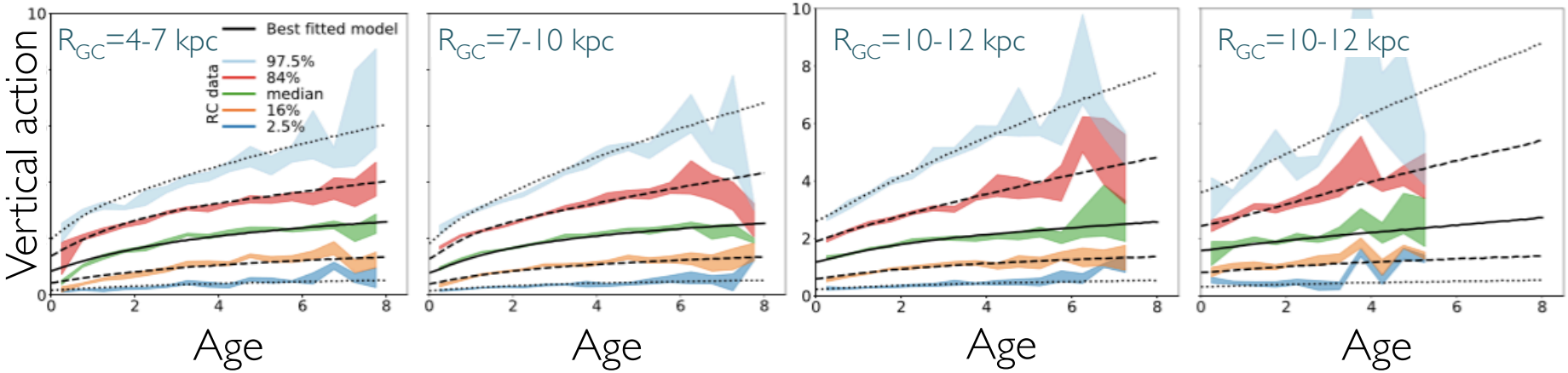


Armillotta et al. (2018)

Highlights: Galaxy Disk Chemodynamics

- Anders et al. 2019, *Photo-astrometric distances, extinctions, and astrophysical parameters for Gaia DR2 stars*
- Ting & Rix 2018, *The vertical motion history of disk stars throughout the Galaxy*
- Mackereth et al. 2019, *Dynamical heating across the Milky Way disc using APOGEE and Gaia*
- Eilers et al. 2019, *The Circular Velocity Curve of the Milky Way from 5 to 25 kpc*
- Hogg et al. 2018, *Spectrophotometric parallaxes with linear models: Accurate distances for luminous red-giant stars*
- *Feuillet et al. 2019, Spatial variations in the Milky Way disc metallicity-age relation*

What drives the disk's vertical structure over time?



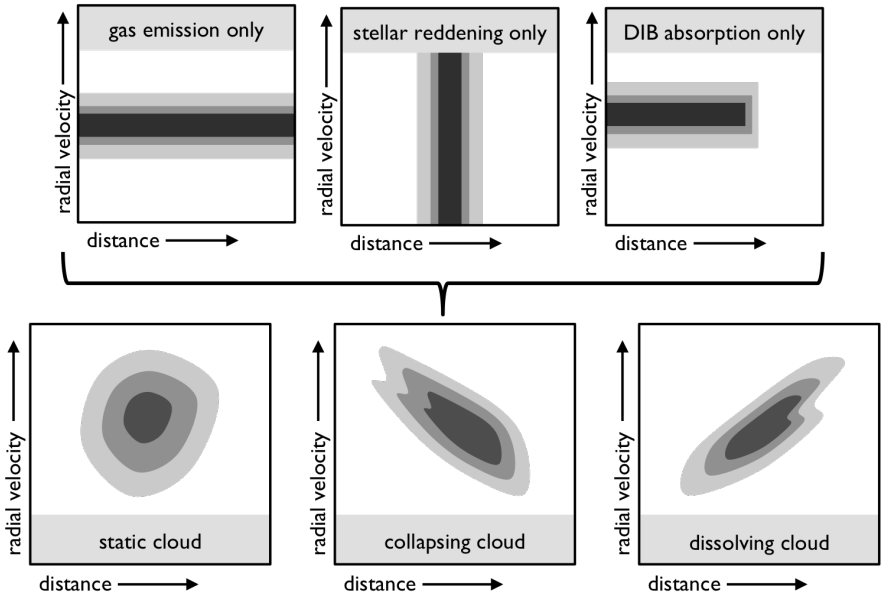
Highlights: The ISM

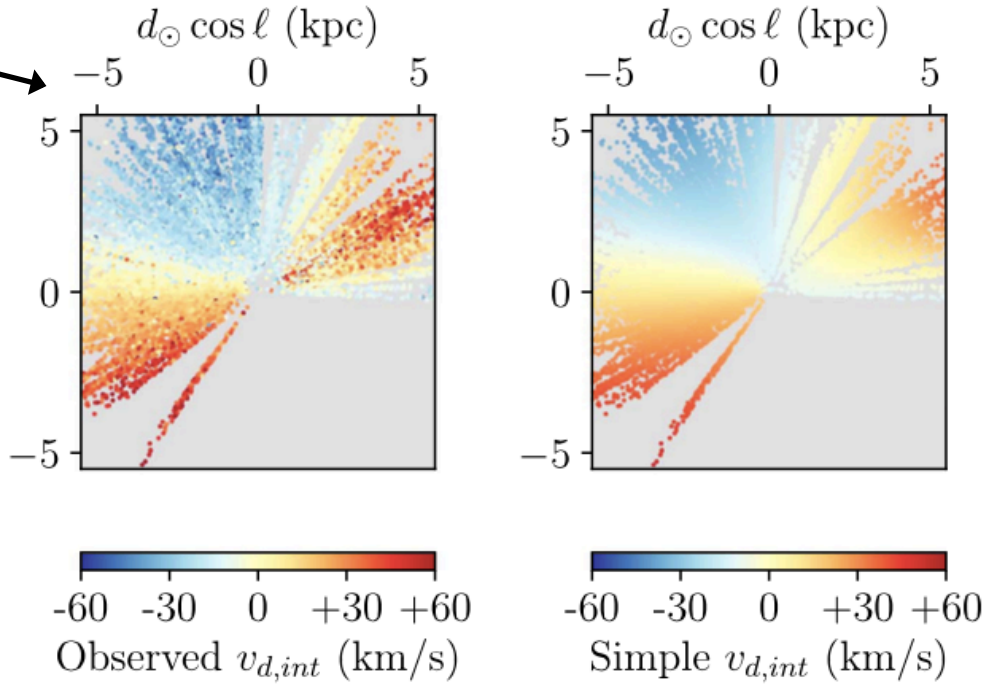
• Wang & Chen. 2019, *The Optical to Mid-infrared Extinction Law Based on the APOGEE, Gaia DR2, Pan-STARRS1, SDSS, APASS, 2MASS, and WISE Surveys*

•Tchernyshyov, Peek, & GZ 2018, *Kinetic Tomography. II. A Second Method for Mapping the Velocity Field of the Milky Way Interstellar Medium and a Comparison with Spiral Structure Models*

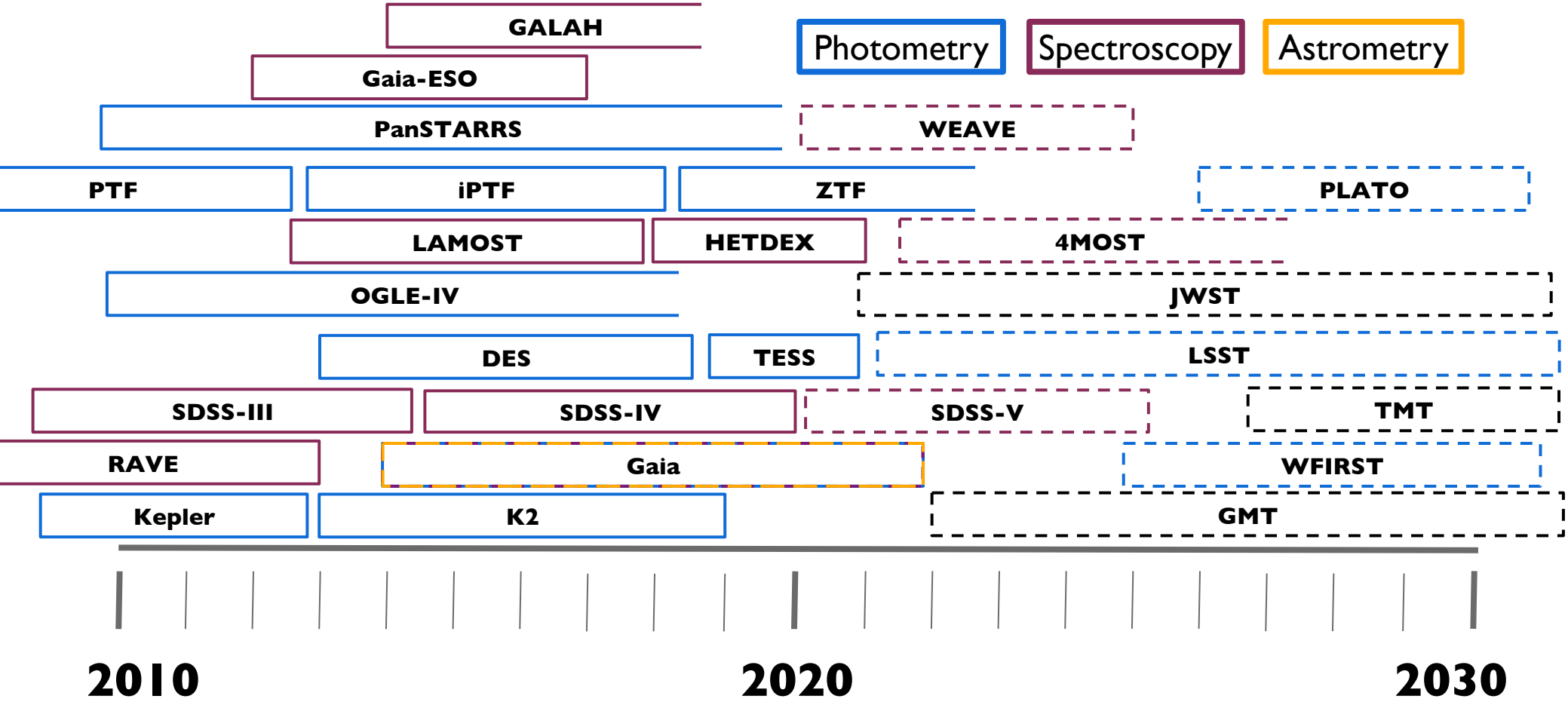
• Danielski et al. 2018, *The empirical Gaia G-band extinction coefficient*

Distance-resolved velocities reveal the evolution of molecular clouds and non-circular rotation in the ISM.





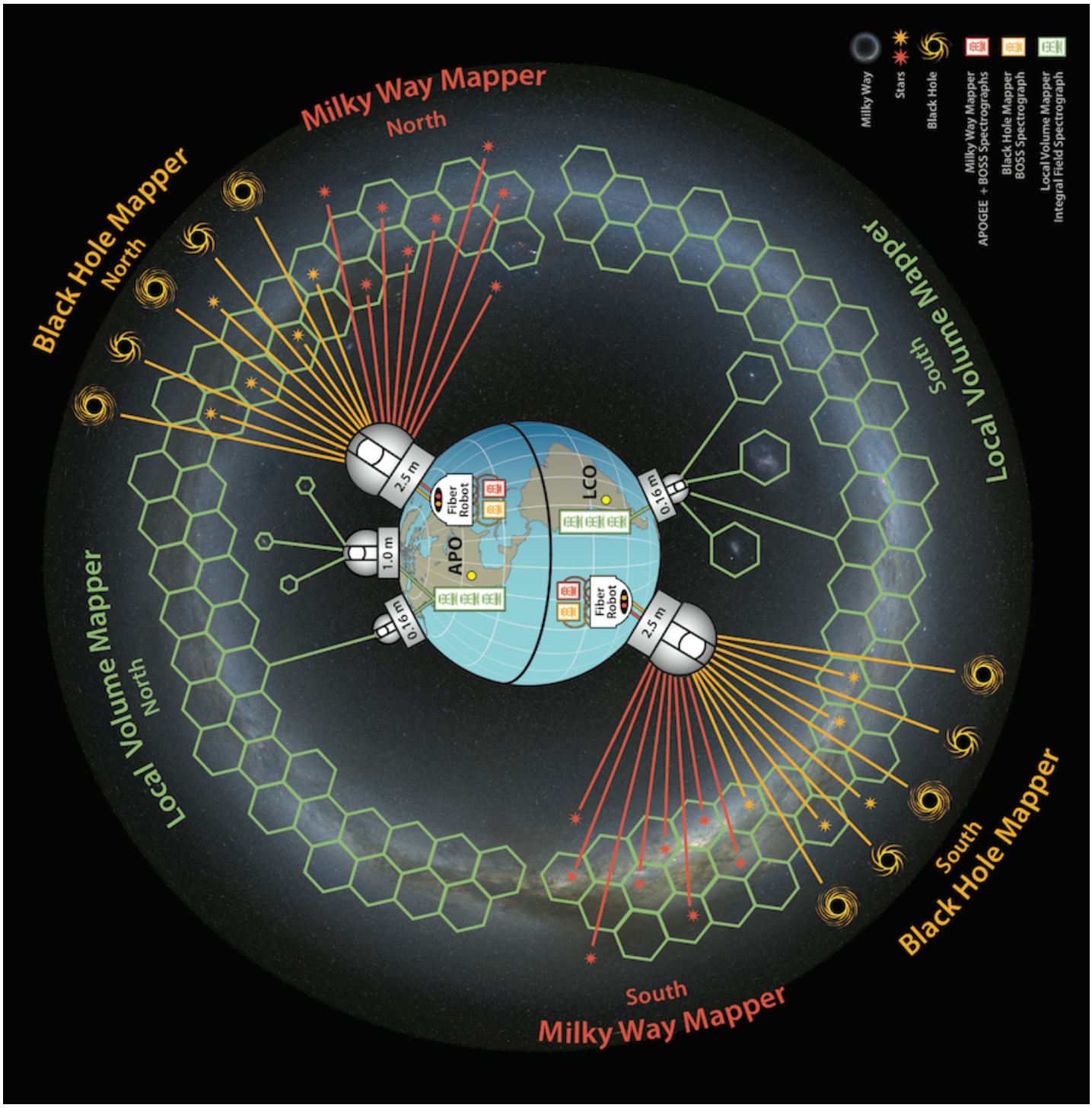
GZ et al. 2019



Stars with...	2010	2020
parallaxes	10^5	10^8
proper motions	10^5	10^9
time-series photometry (mmag)	10^1	10^8
asteroseismology	10^1	10^5
radial velocities	10^5	10^8
detailed [X/H] abundances	10^2	10^7

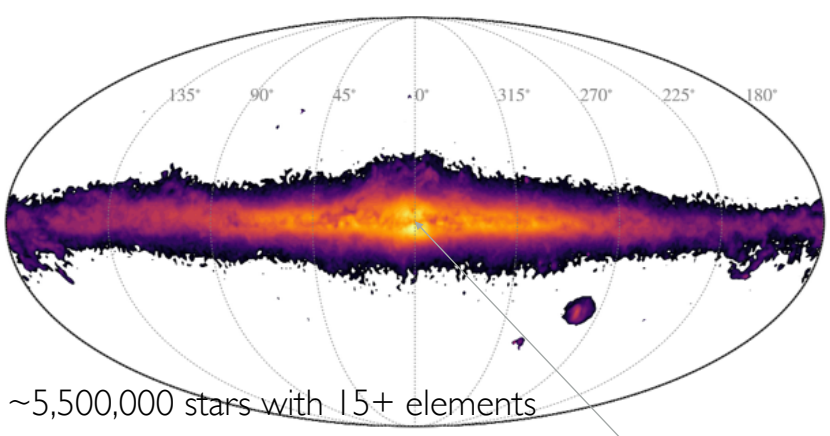
Based on Keivan Stassun

SDSS-V
2020-2025



Kollmeier, GZ, et al. 2017

SDSS-V
2020-2025

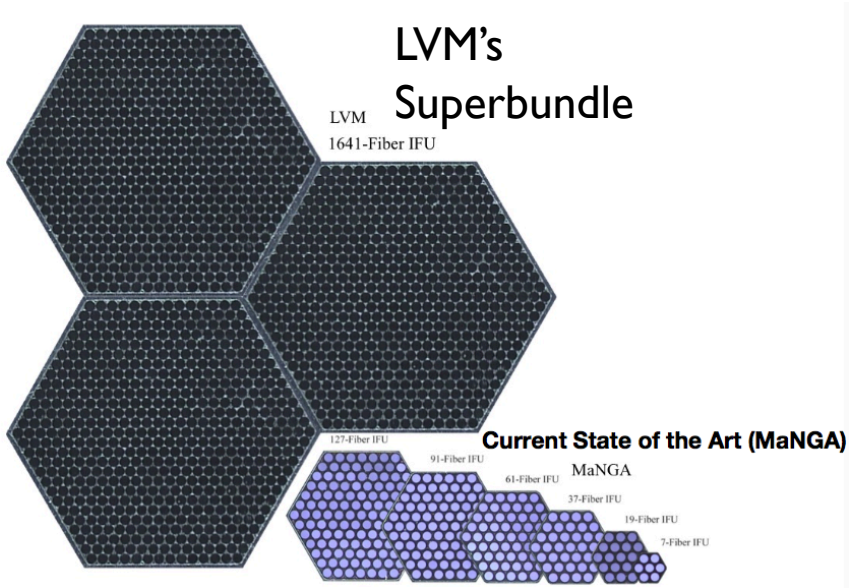


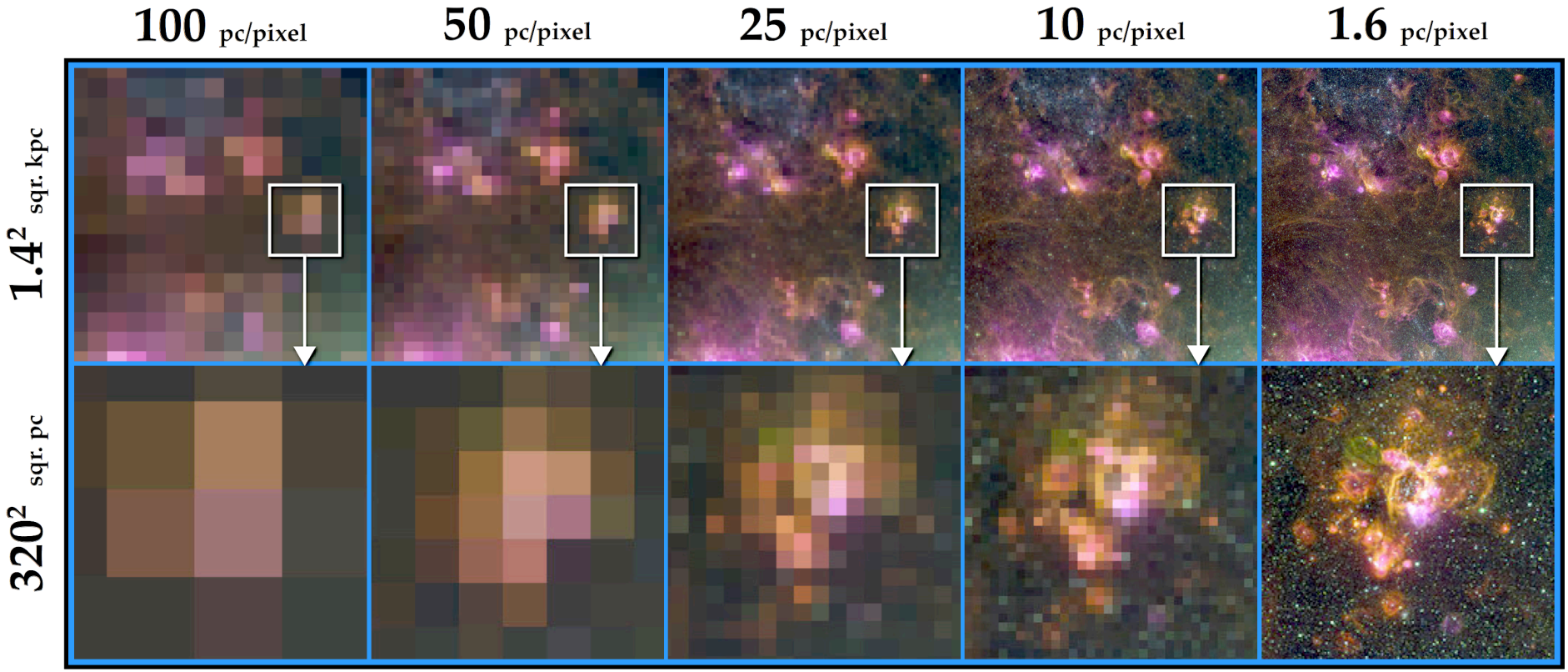
~5,500,000 stars with 15+ elements

Kollmeier, GZ, et al. 2017

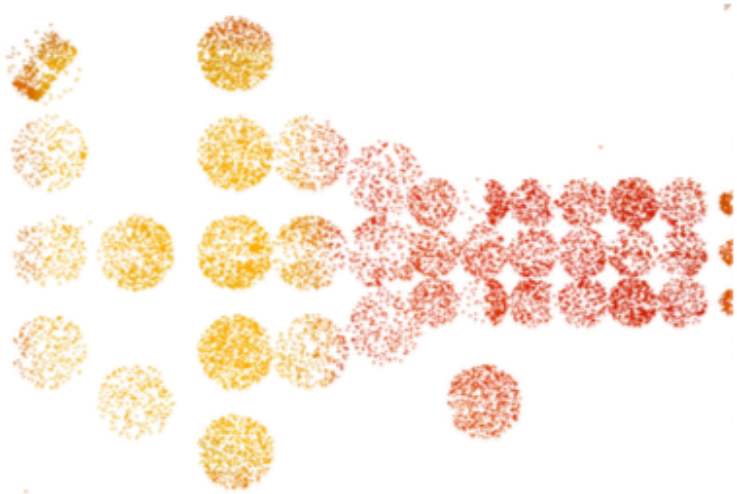
More than stars!

Spectra of 3000 deg^2

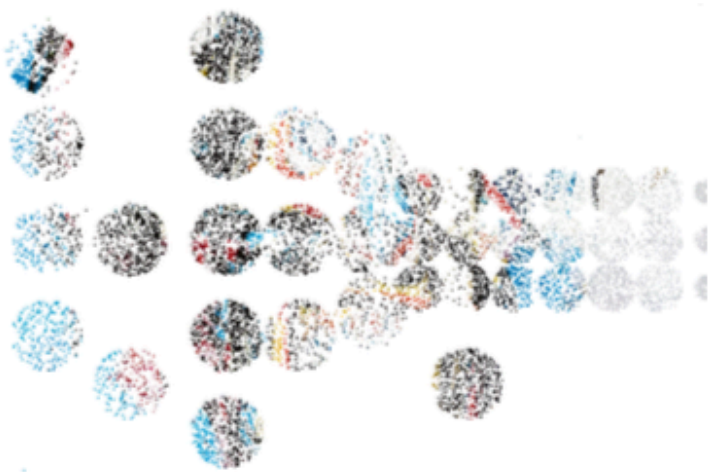




But also stars...Why does dense sampling matter?



Milky Way Model A



Milky Way Model B

Graphic by J. Bird

But also stars...Why does dense sampling matter?

Milky Way Model A

Mark Rothko, *Orange and Yellow*

Milky Way Model B

Jean-Michel Basquiat, *Untitled*

Graphic by J. Bird