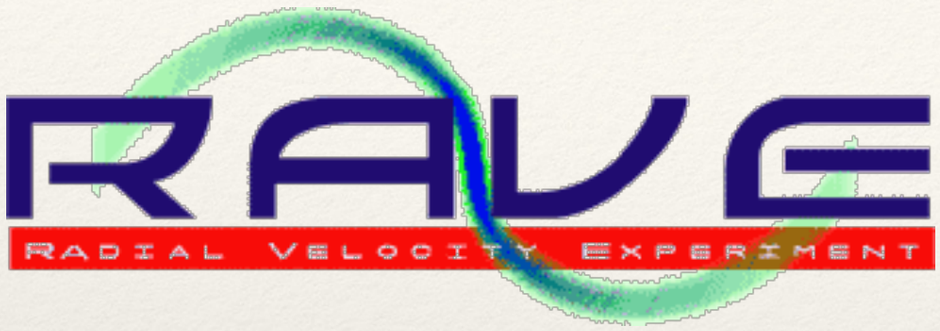

RAVE collaboration & Georges Kordopatis
Observatoire de la Côte d'Azur

RAVE post Gaia-DR2

Stars without borders:
A Galaxy in crisis

Ljubljana, June 2019

A brief history of RAVE

cf talk of M. Steinmetz

- RAVE is the first systematic (wide field coverage) spectroscopic Galactic Archeology survey, P.I.: Matthias Steinmetz
- Motivation: DIVA (DE, approved in 2001) & FAME (US)
  - astrometry of several million stars, but no RVs
- Around 2002: about 50 000 stars in CDS with radial velocities, but 1 million galaxy redshifts!
- RAVE originally set up as a pilot survey using the existing 6dF MOS at AAO, to observe 10^4 stars in ~180 unscheduled bright-time during the years 2003-2005
- RAVE 1st light in April 2003 (pre 2MASS, pre GCS)
  - there may be more in the data than just RV
- End of observations: April 2013


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10:50:00-00

RAVE survey design

Facility specs are given → adjust survey design to facility specs
(unlike 4MOST, WEAVE, APOGEE, LAMOST etc.)

- bright time → Ca triplet (but nice synergy with Gaia RVS)
- 7” fibres → avoid disk + bulge region
- fibre cross talk: configure targets of comparable magnitude
- “target density magic”:
  - configuration time: 60 min per field plate
  - exposure time to get SNR≈50 for I=10.5 is about 1h
  - still > 150 targets per field even in the Galactic polar region
- Magnitude range: 8<I<12 mag

RAVE Data Releases

- DR1 (Steinmetz et al. 2006): radial velocities — N=2.5 10^4
- DR2 (Zwitter et al. 2008): stellar parameters — N=5 10^4 / 2.2 10^4
- DR3 (Siebert et al. 2011) + CDR1 (Boeche et al. 2011) — N=7.7 10^4 / 4 10^4
  - full pilot survey
  - enhanced radial velocities, chemical abundances
- DR4 (Kordopatis et al. 2013)
  - enhanced stellar parameters, Bayesian distances — **N=0.425 10^6**
  - large fraction of main survey
- DR5 (Kunder et al. 2017) + McMillan et al. (2018) — N=0.457 10^6
  - full RAVE sample, enhanced calibration, K2 calibration
  - Gaia DR1

5

Final Data Release

The_Radial_Velocity_Experiment__RAVE___Sixth_Data_Release-1.pdf (page 1 of 73)

Draft version June 13, 2019
Typeset using LaTeX **preprint** style in AASTeX62

The Radial Velocity Experiment (Rave): Sixth Data Release

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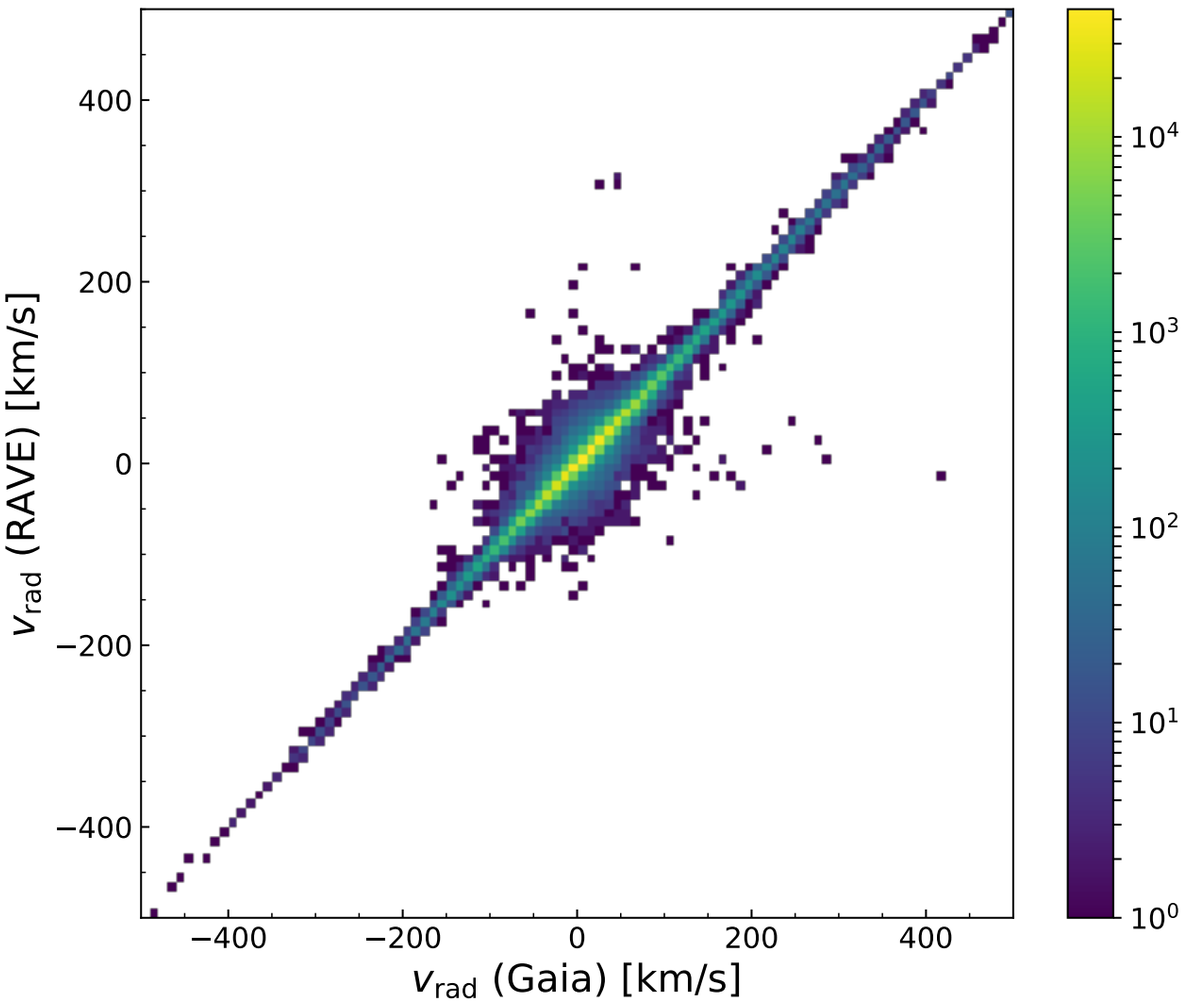
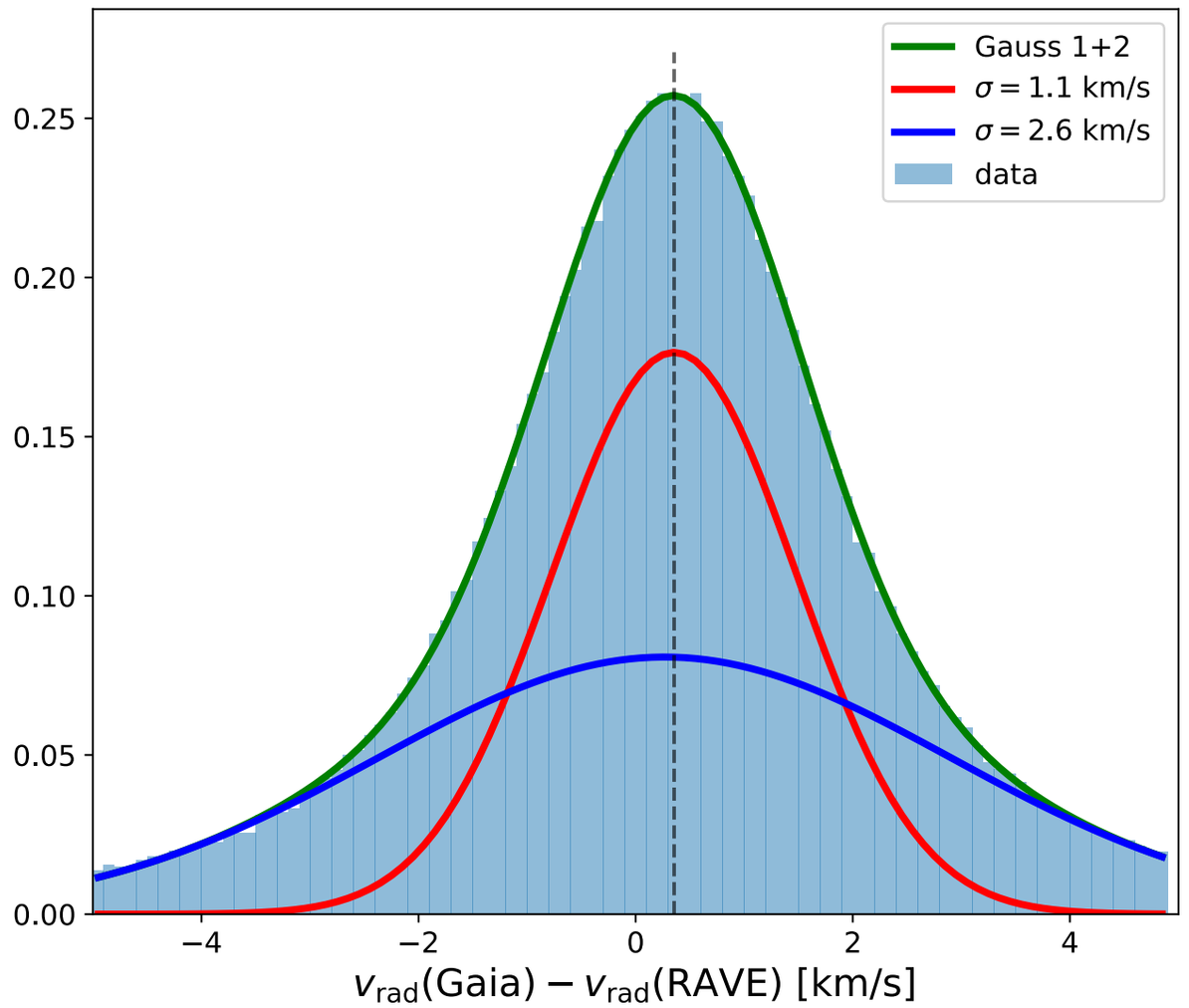
Georges Kordopatis,[3] Tomaž Zwitter,[4] Marica Valentini,[1] Cristina Chiappini,[1]
Luca Casagrande,[5] Jennifer Wojno,[6] Borja Anguiano,[7] Olivier Bienaymé,[8]
Albert Bijaoui,[3] Donna Burton,[9,10] Paul Cass,[9] Patrick de Laverny,[3] Kristin Fiegert,[9]
Kenneth Freeman,[5] Brad K. Gibson,[11] Gerard Gilmore,[12] Eva K. Grebel,[13] Amina Helmi,[14]
Andrea Kunder,[15] Ulisse Munari,[16] Julio F. Navarro,[17] Quentin Parker,[18,19]
Gregory R. Ruchti,[6,*] Alejandra Recio-Blanco,[3] Warren Reid,[20,21] G. M. Seabroke,[22]
Alessandro Siviero,[23] Arnaud Siebert,[8] Milorad Stupar,[9,24] Fred Watson,[25]
Mary E.K. Williams,[1] Rosemary F.G. Wyse,[6,26] Friedrich Anders,[27,1] Teresa Antoja,[28]
Joss Bland-Hawthorn,[29] Diego Bossini,[30] Rafael A. García,[31,32] Ismael Carrillo,[1]
William J. Chaplin,[33,34] Yvonne Elsworth,[35,34] Benoit Famaey,[8] Ortwin Gerhard,[36]
Paula Jofre,[37] Andreas Just,[13] Andrea Miglio,[35,34] Ivan Minchev,[1] Giacomo Monari,[1]
Benoit Mosser,[38] Andreas Ritter,[19] Thaise S. Rodrigues,[16] Ralf-Dieter Scholz,[1]
Sanjib Sharma,[29] and Kseniia Sysoliatina[13]
(The Rave collaboration)

Final data release (a.k.a. DR6)

- some book keeping
- Publication of the spectra + error spectra
- errors from repeat observations
- spectroscopically derived stellar parameters (as in DR5) with MADERA pipeline
- new abundance pipeline GAUGUIN
- temperatures using the infrared flux method
- stellar parameters & ages using the reverse distance pipeline BDASP + Gaia priors
- Distances & orbits
- Crossmatched with other catalogues
- updated astroseismic giant sample (based on ~490 K2 stars)
- *Goal: release DR6 in Q2/2019*

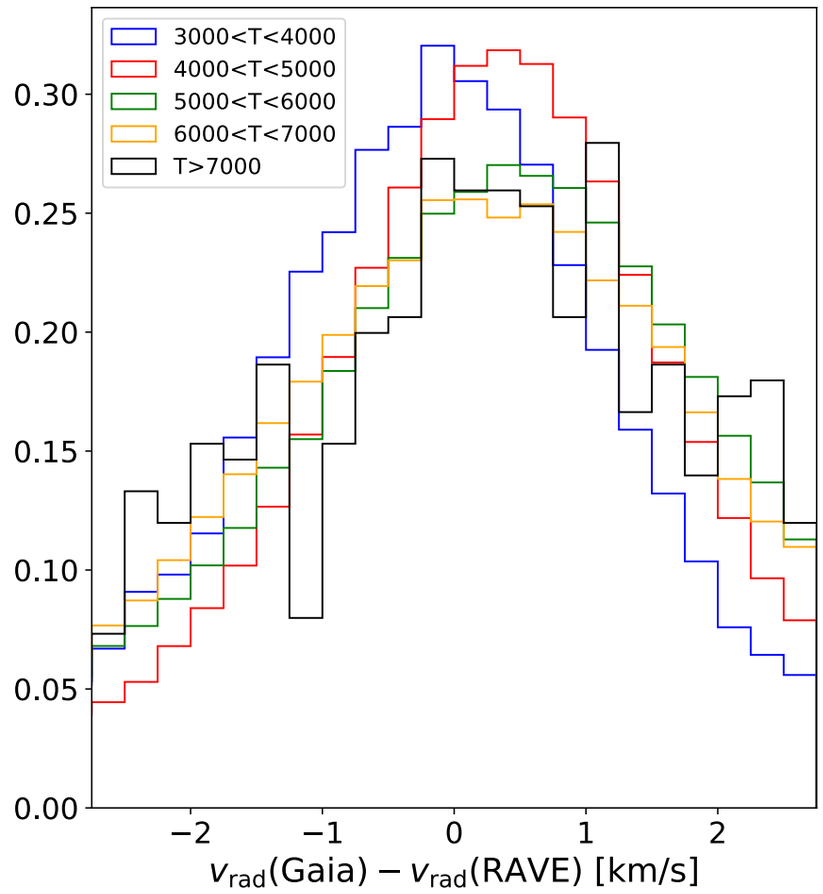
Line of sight velocities vs Gaia

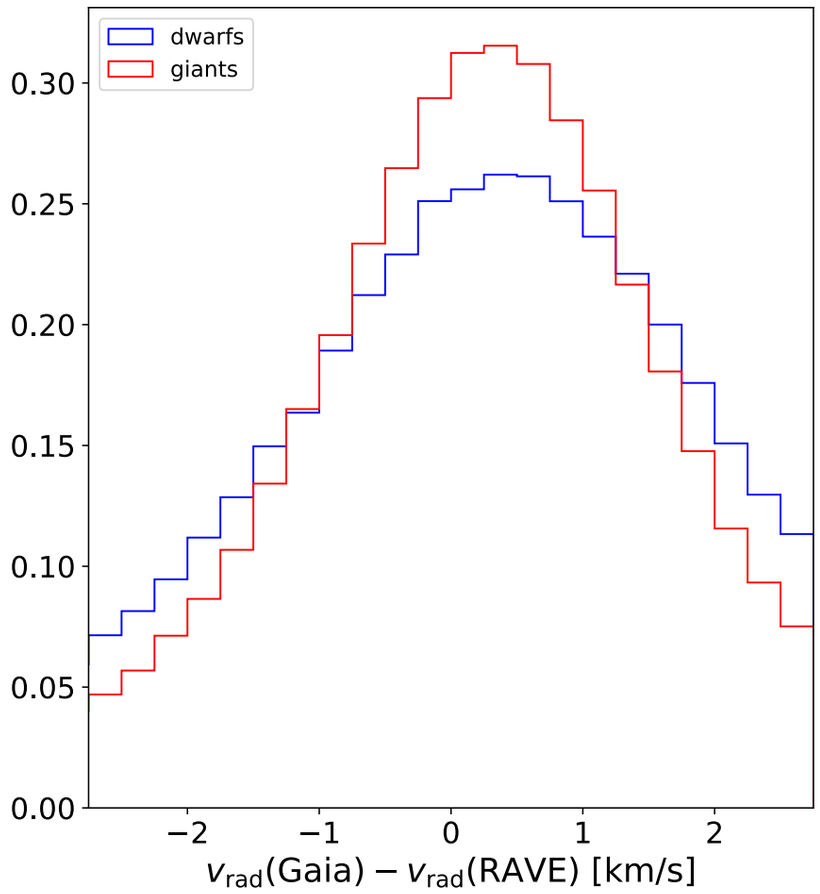


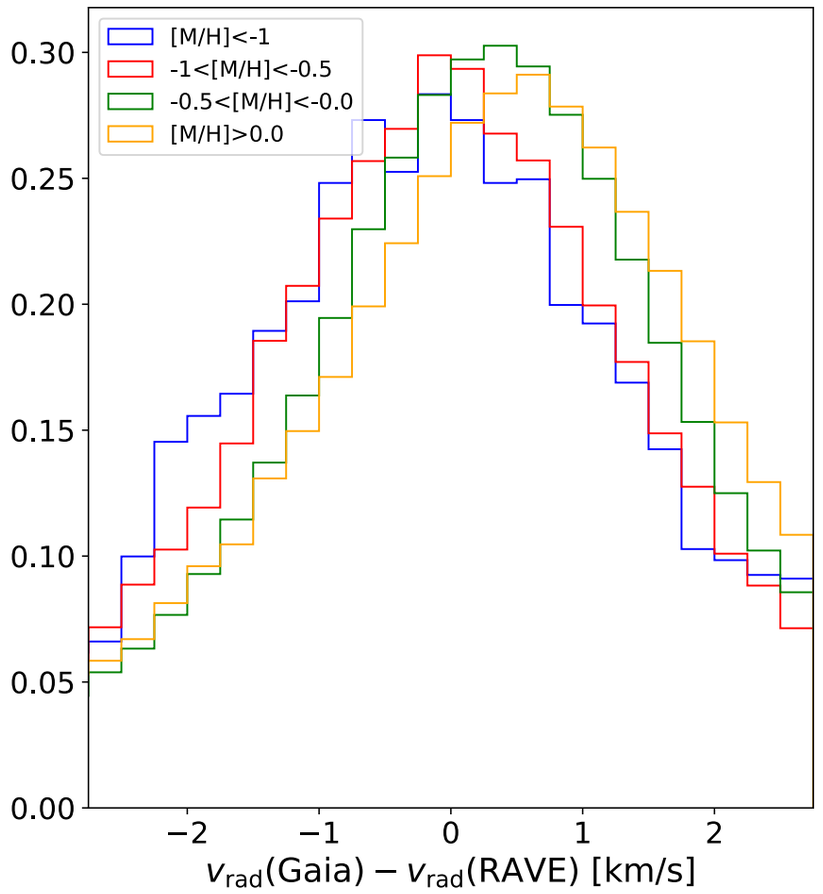


Wider component due to objects with intrinsically variable RVs, as observation epochs of RAVE and Gaia DR2 data are between 2 and 12 years apart.

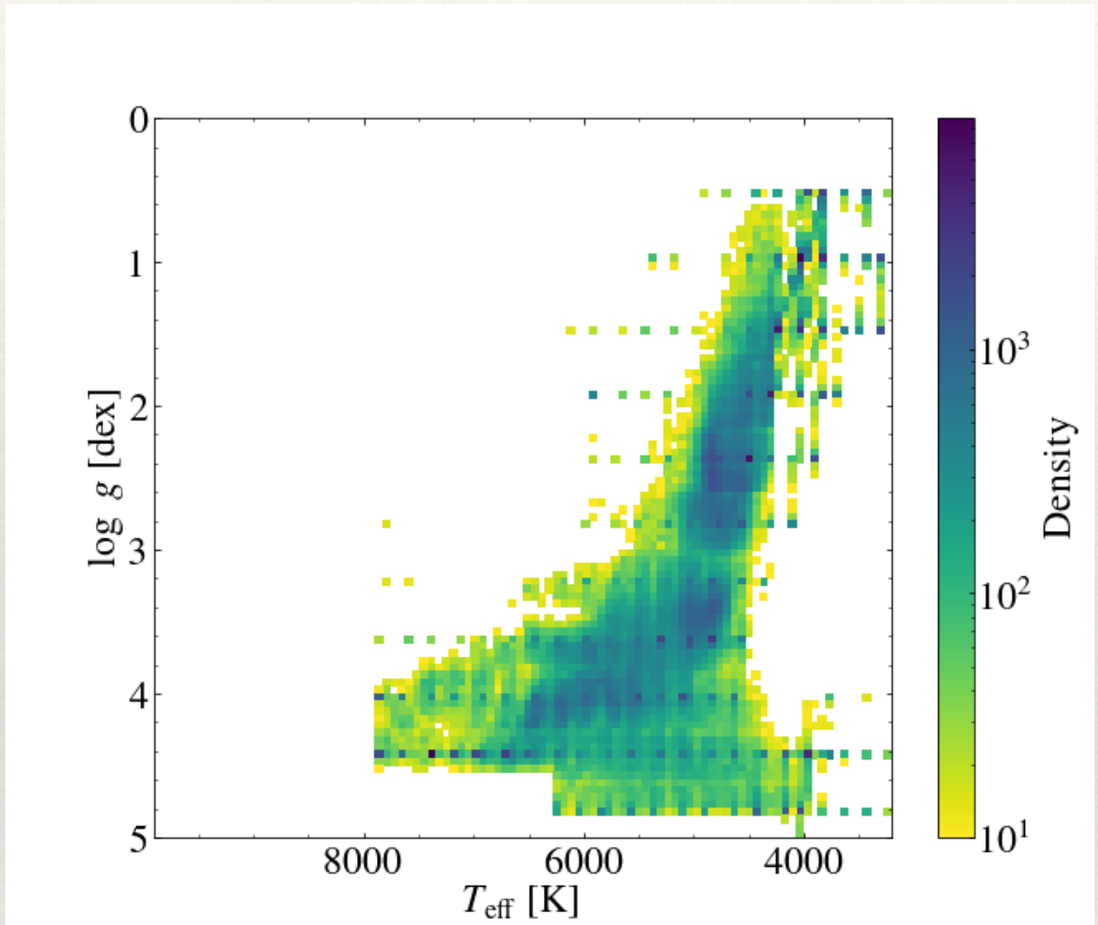
Line of sight velocities vs Gaia





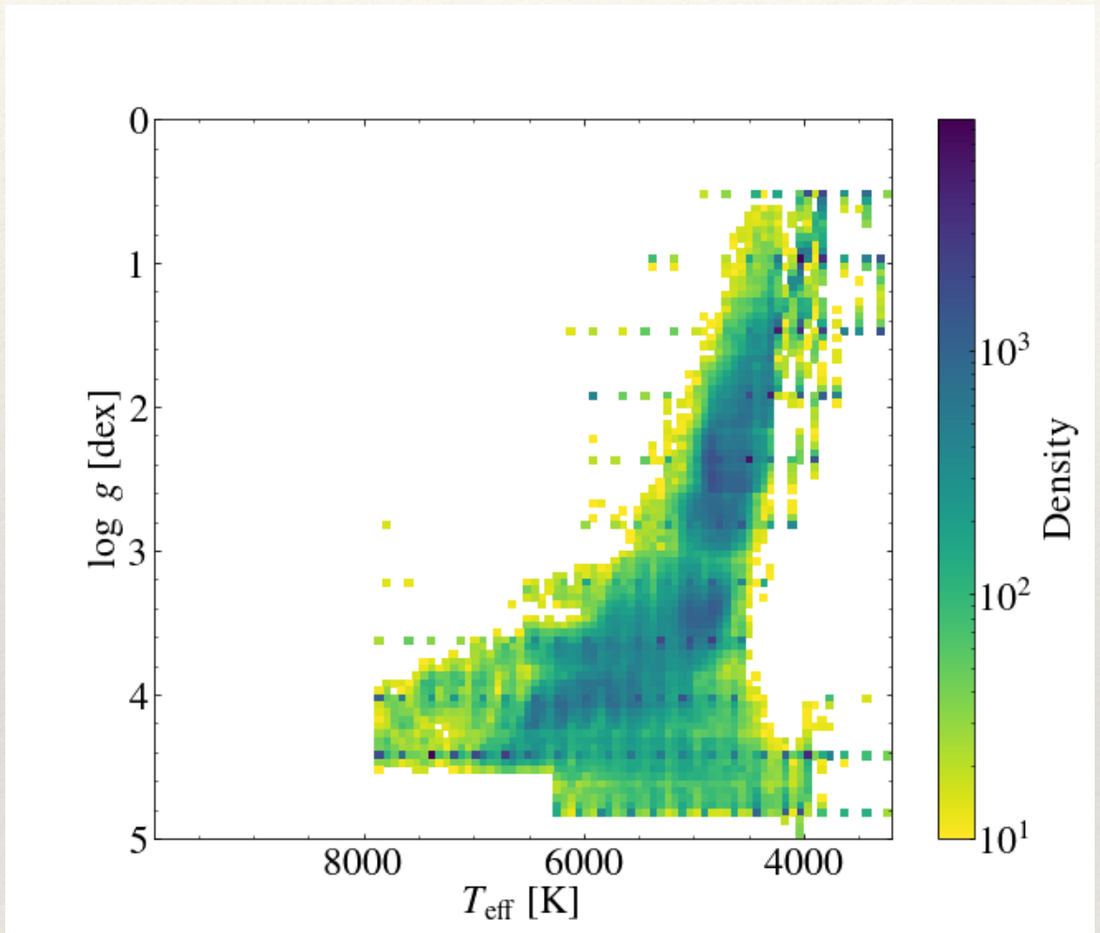


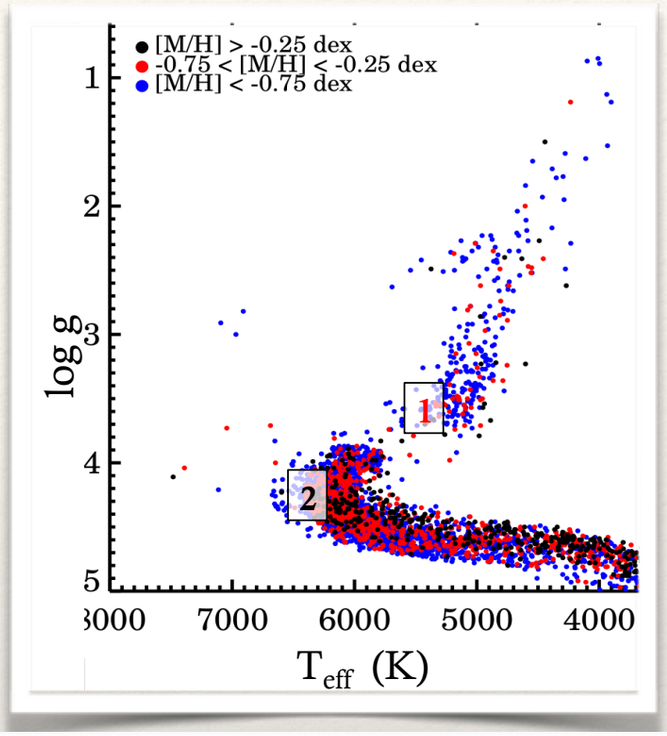
MADERA results

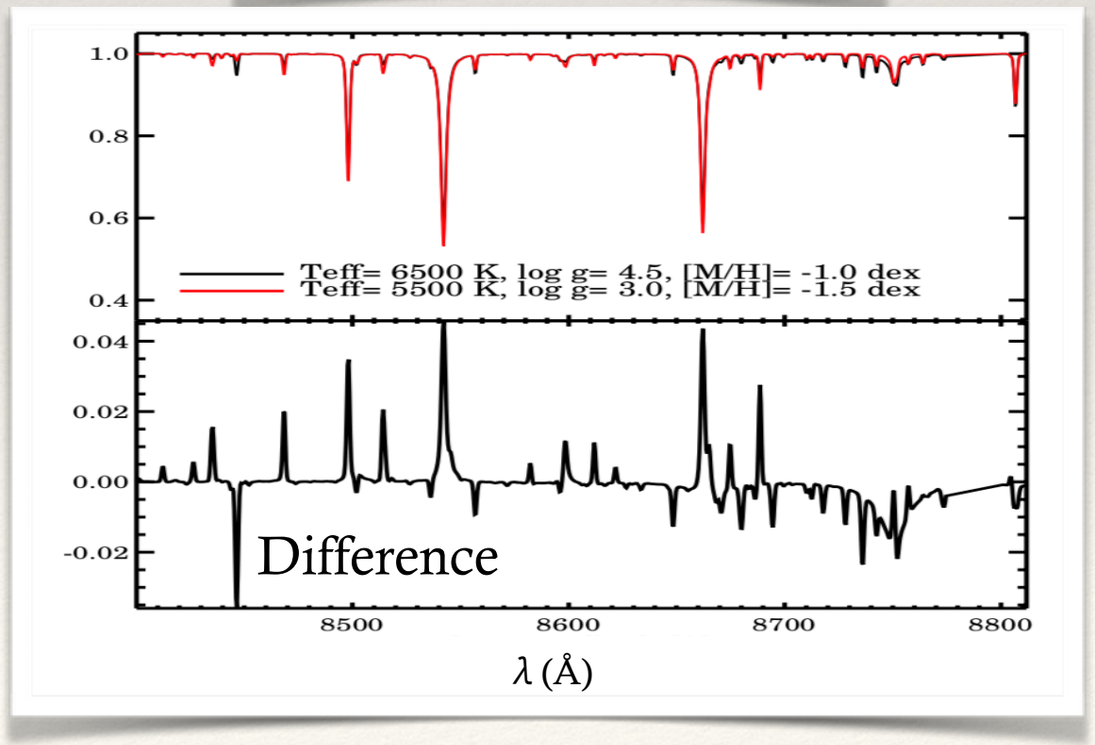


- MADERA: decision tree (DEGAS) + projection algorithm (MATISSE) + photometric T_{eff} prior (2MASS)

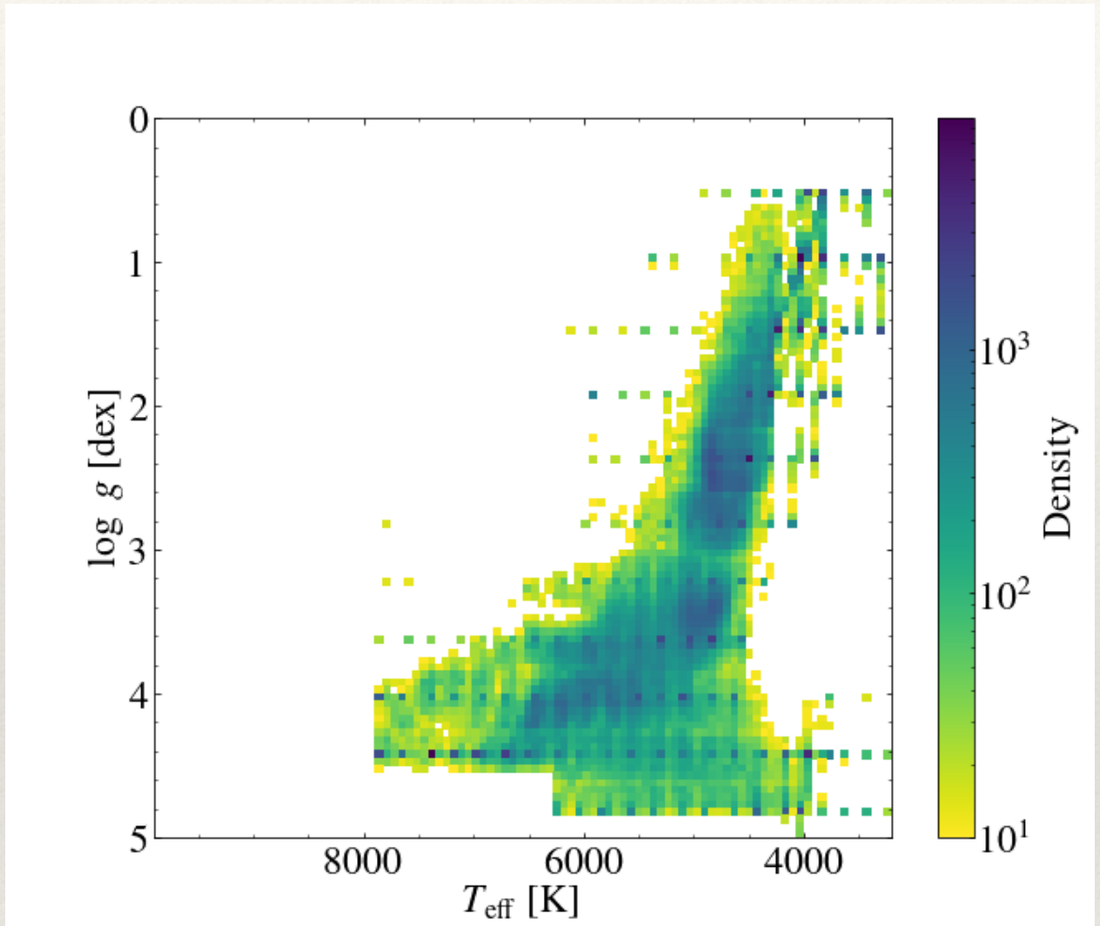
MADERA pipeline

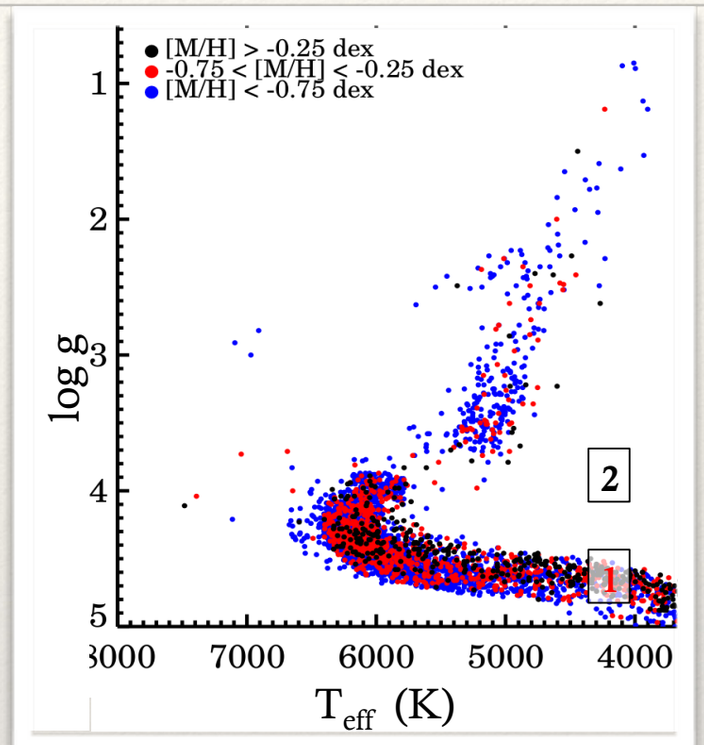


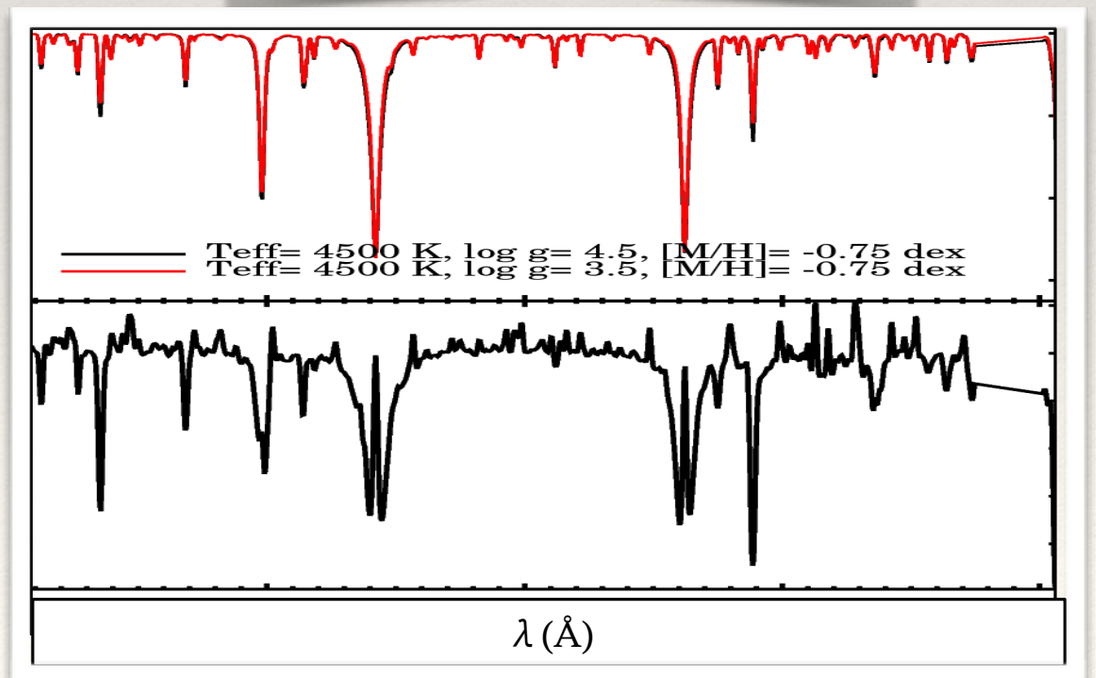




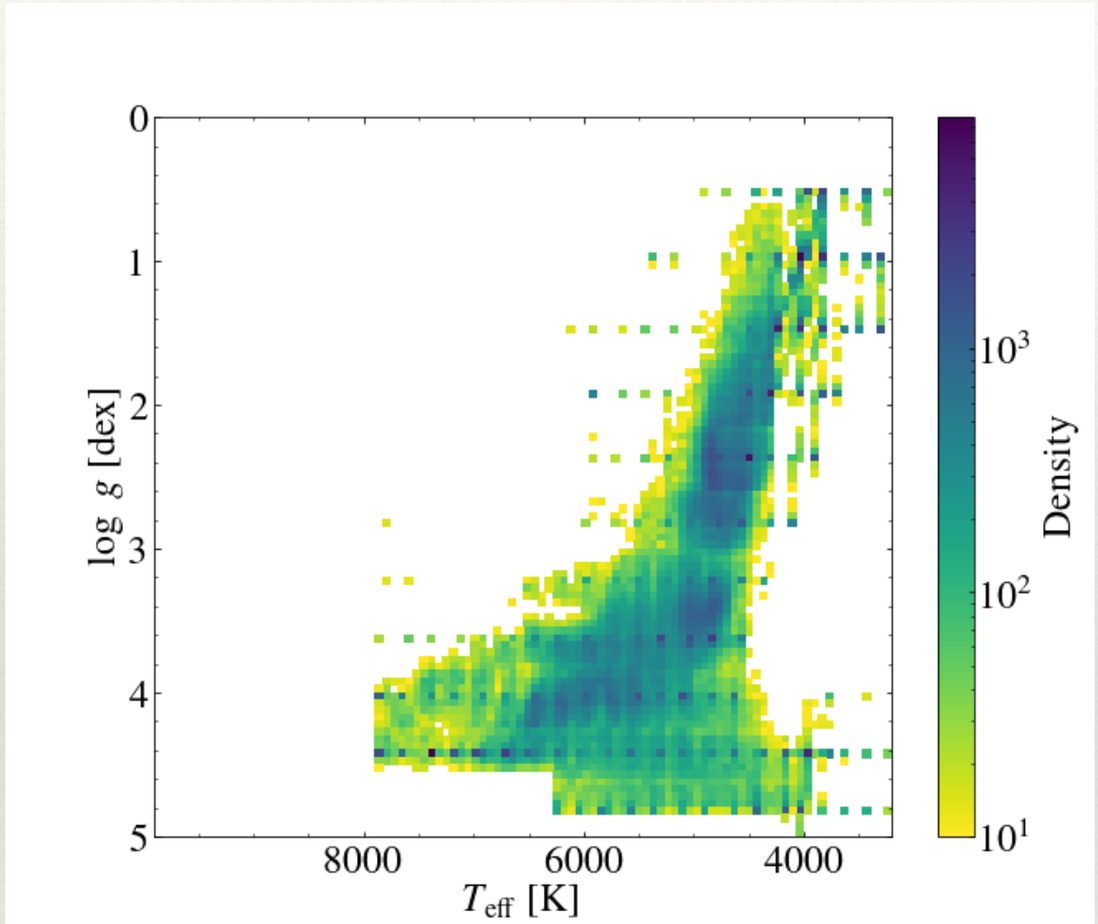
MADERA pipeline

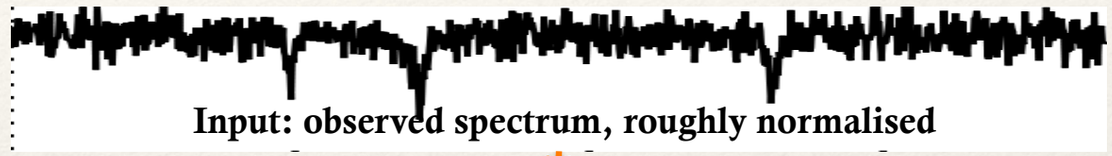






MADERA pipeline





Input: observed spectrum, roughly normalised

DEGAS with a rough estimate of the S/N + T_{eff} range prior

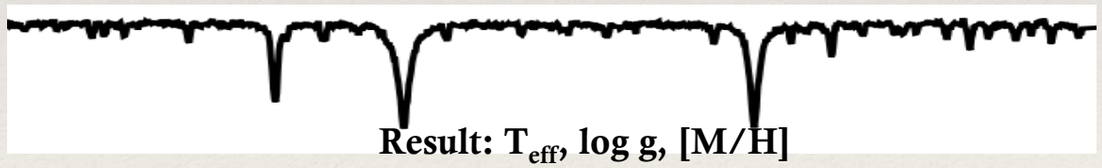
Application of DEGAS according to the new S/N estimate

Re-normalisations and new S/N estimates

Final normalised spectra and final S/N estimates

MATISSE — S/N > 35

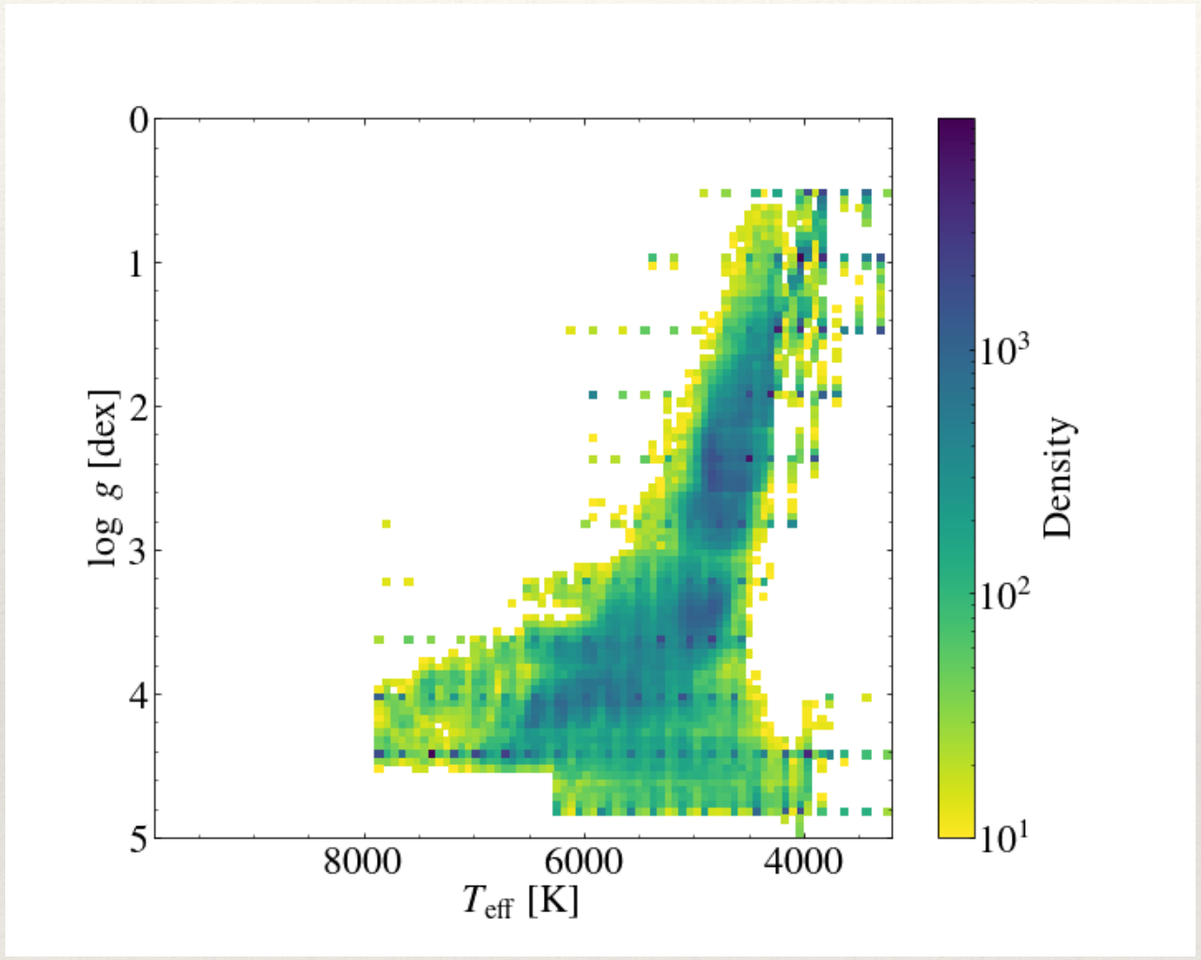
S/N < 35 — DEGAS

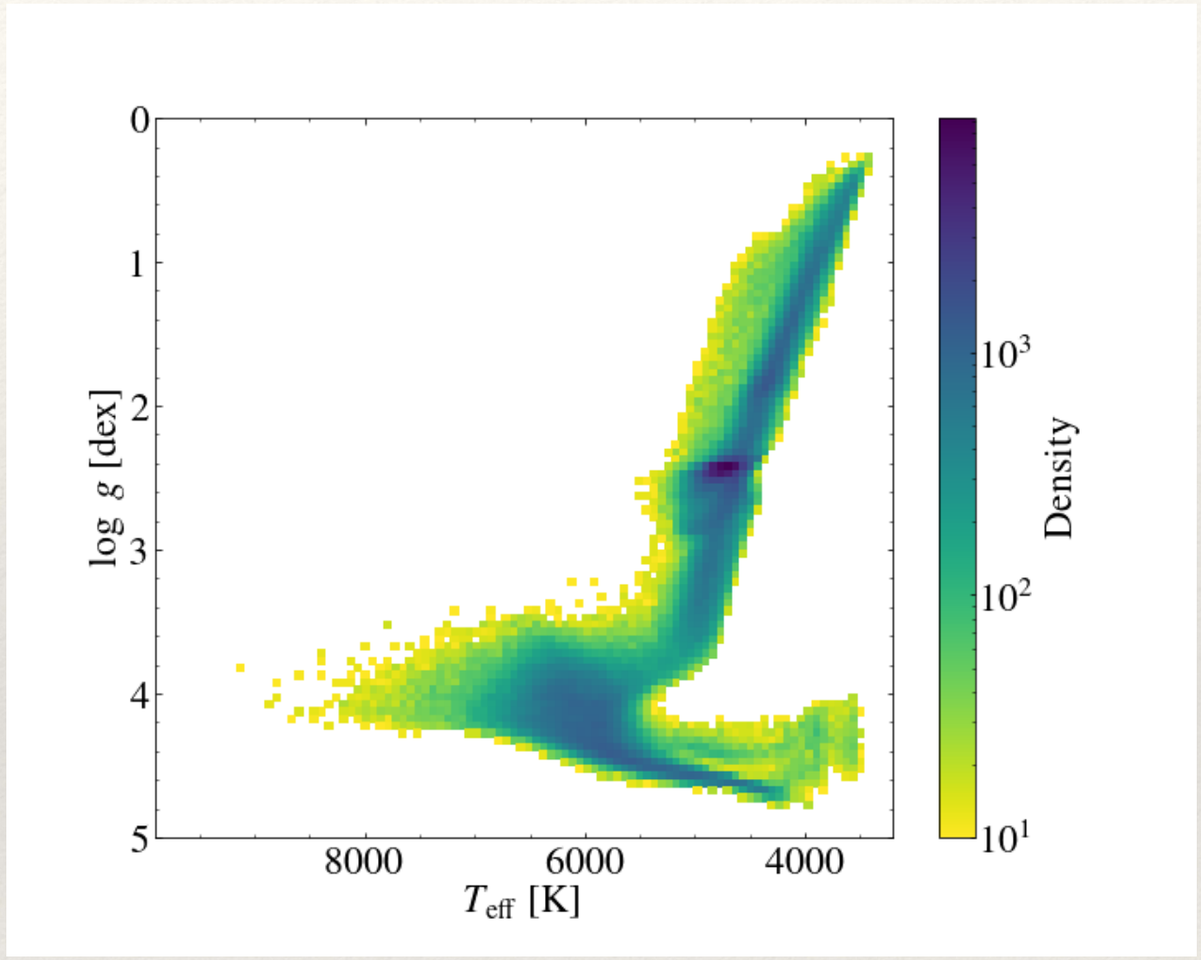


Result: T_{eff}, log g, [M/H]

MADERA & BDASP

Plots courtesy of P. McMillan

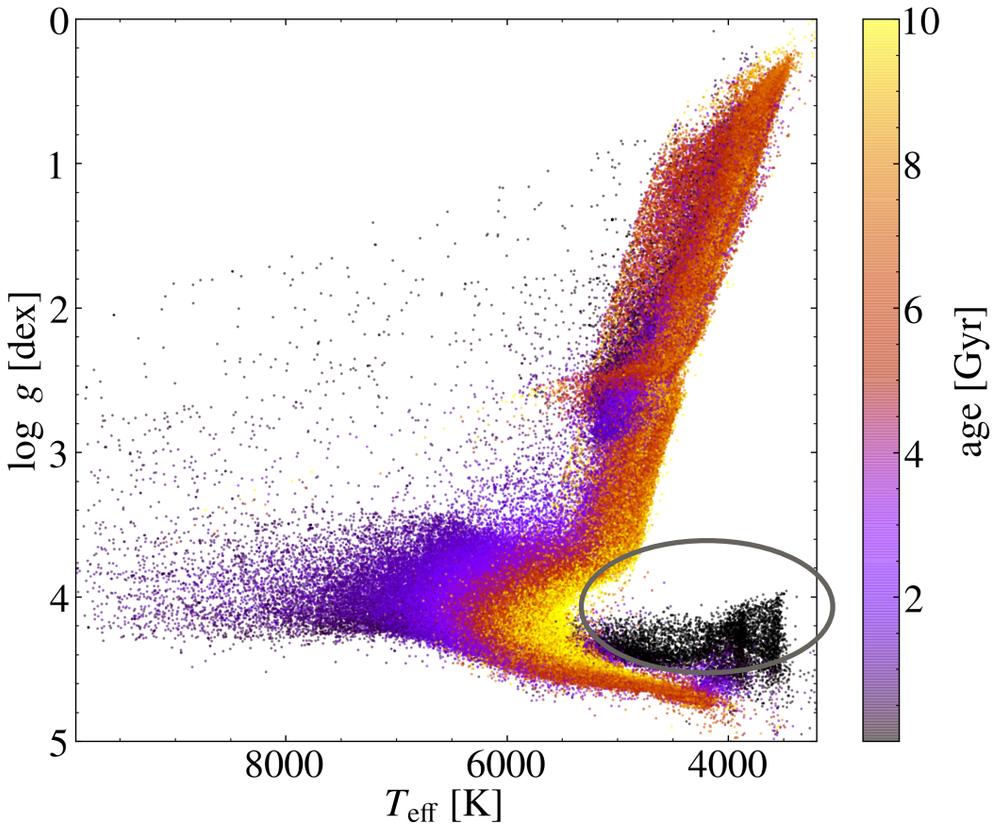


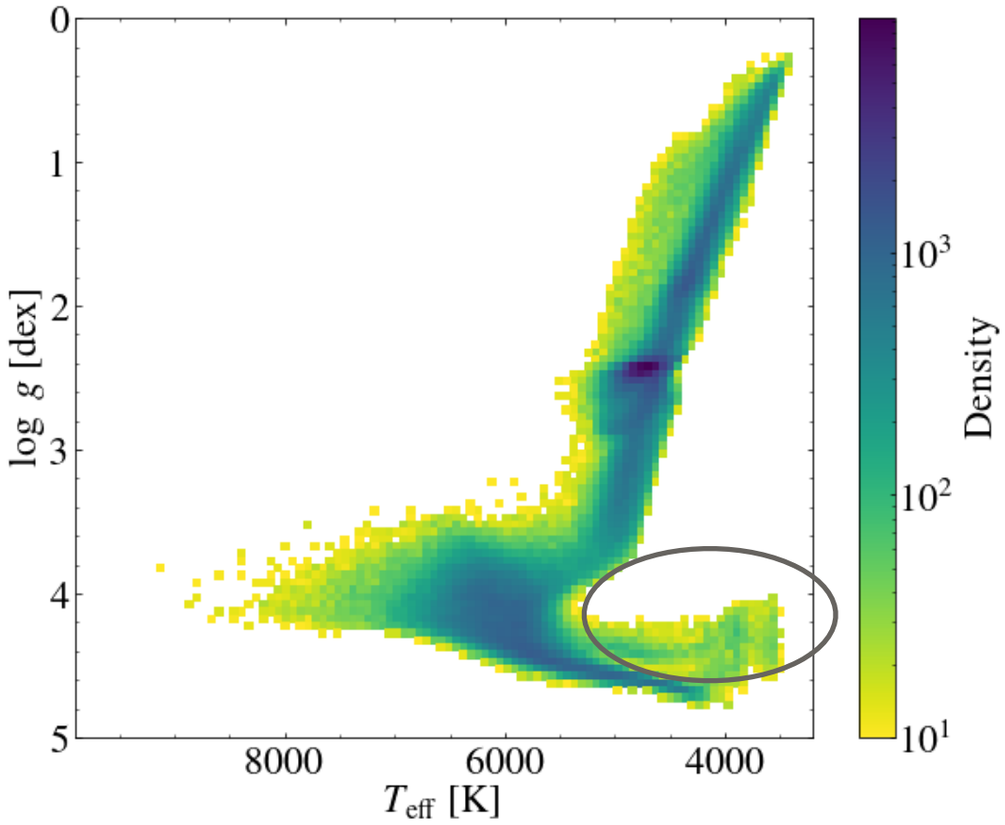


- BDASP: IFRM T_{eff} + MADERA {logg, [M/H]} + Gaia astrometry + photometry

BDASP

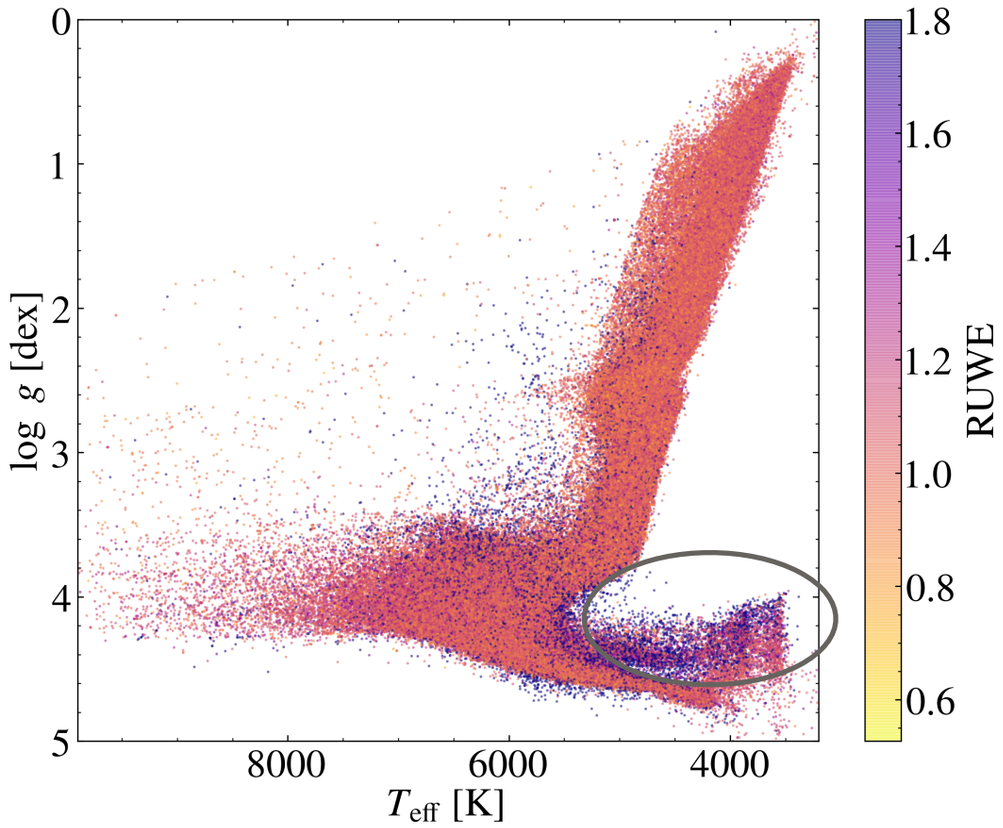
Plots courtesy of P. McMillan

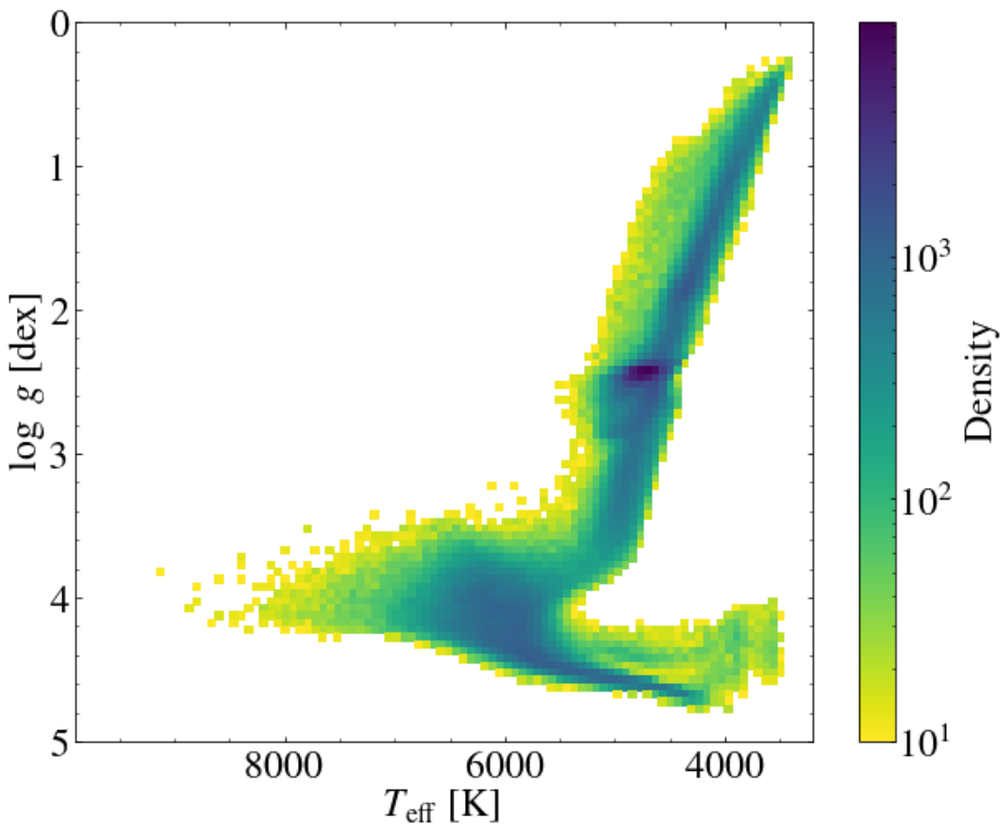




BDASP

Plots courtesy of P. McMillan

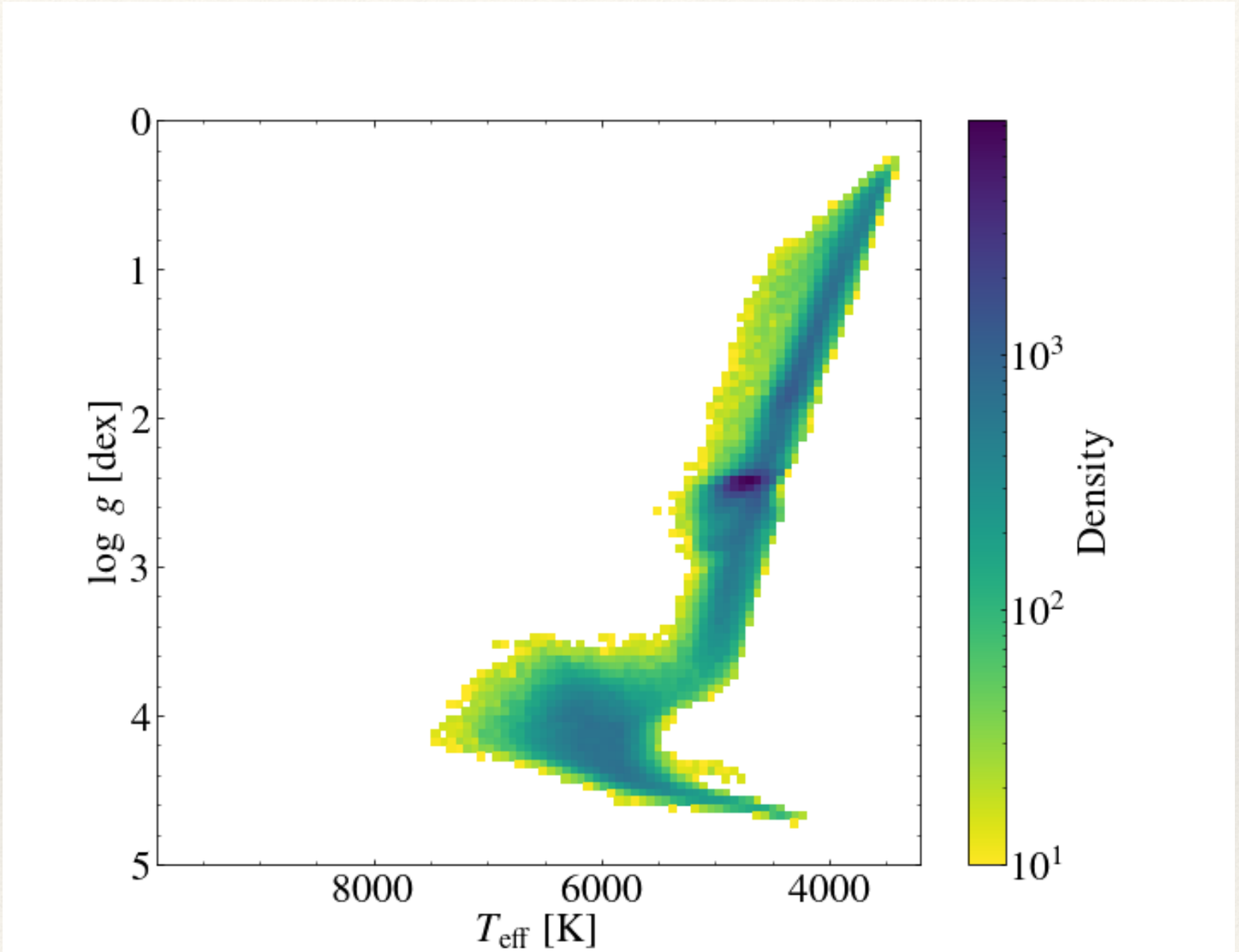




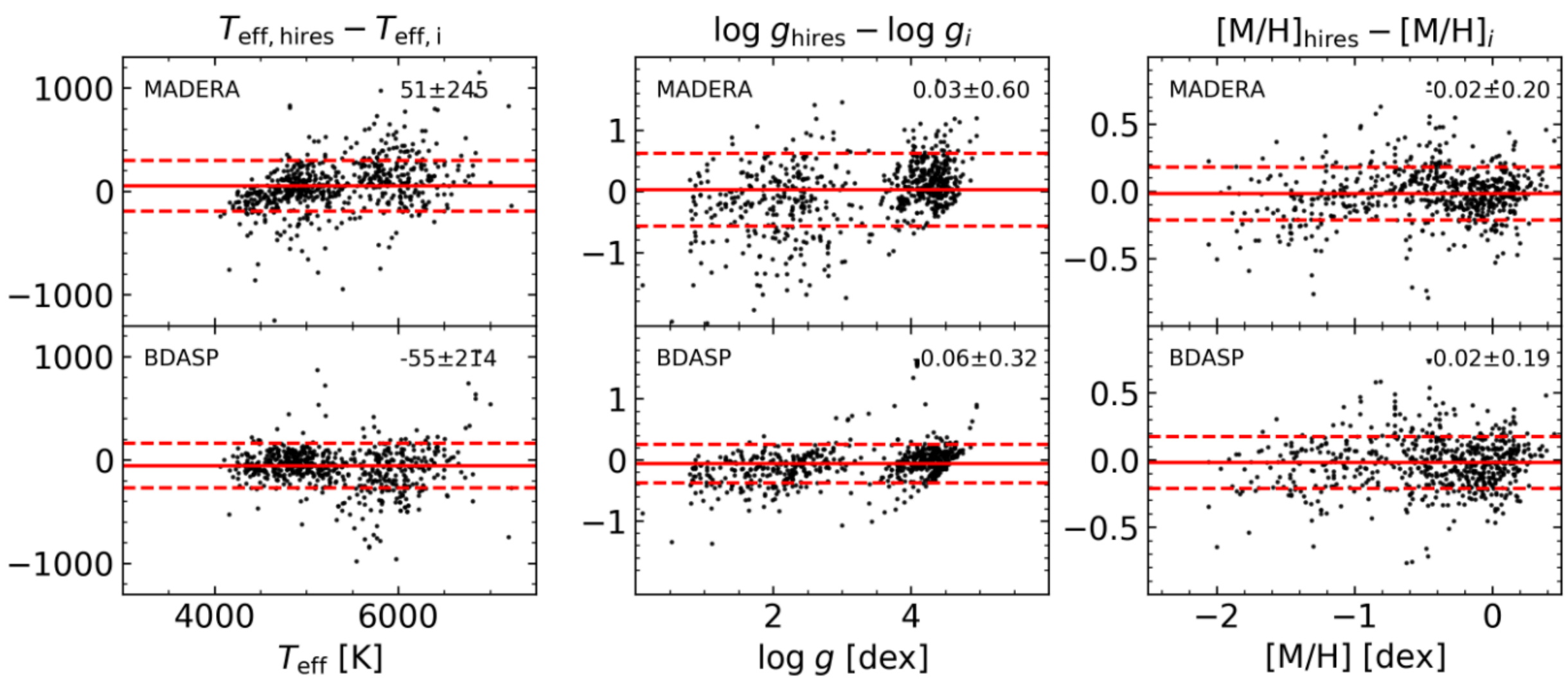
RUWE: renomalised unit weight error
(measure of the quality of the Gaia astrometric fit)
High RUWE ==> These are mostly binaries

“Normal” stars

Plots courtesy of P. McMillan

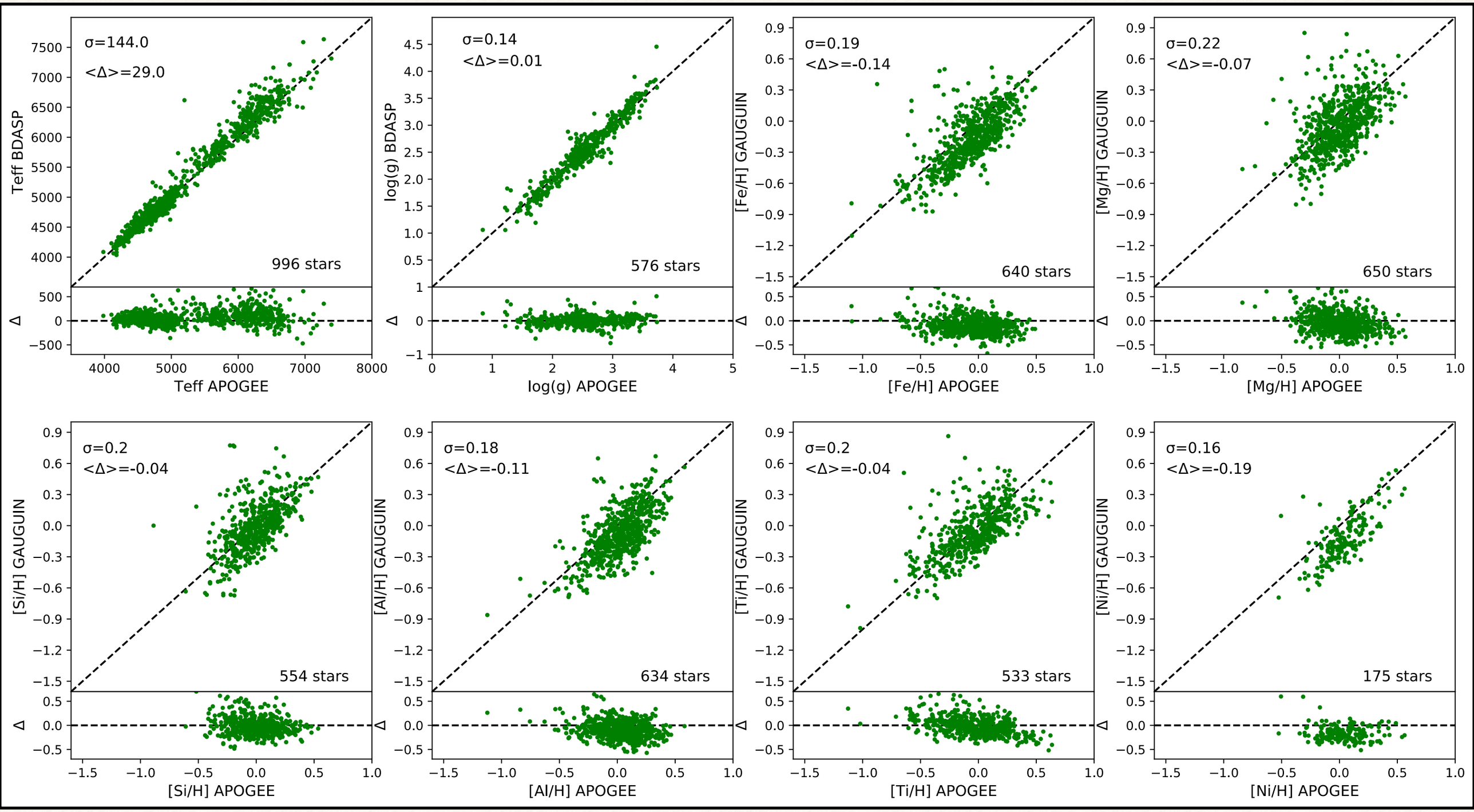


DR6 vs Literature



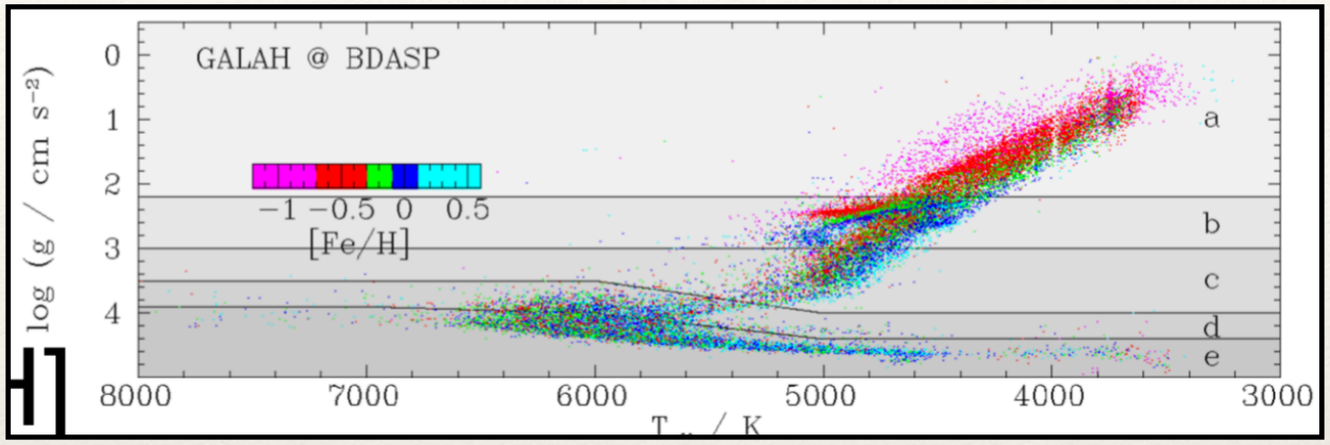
DR6 vs APOGEE DR14

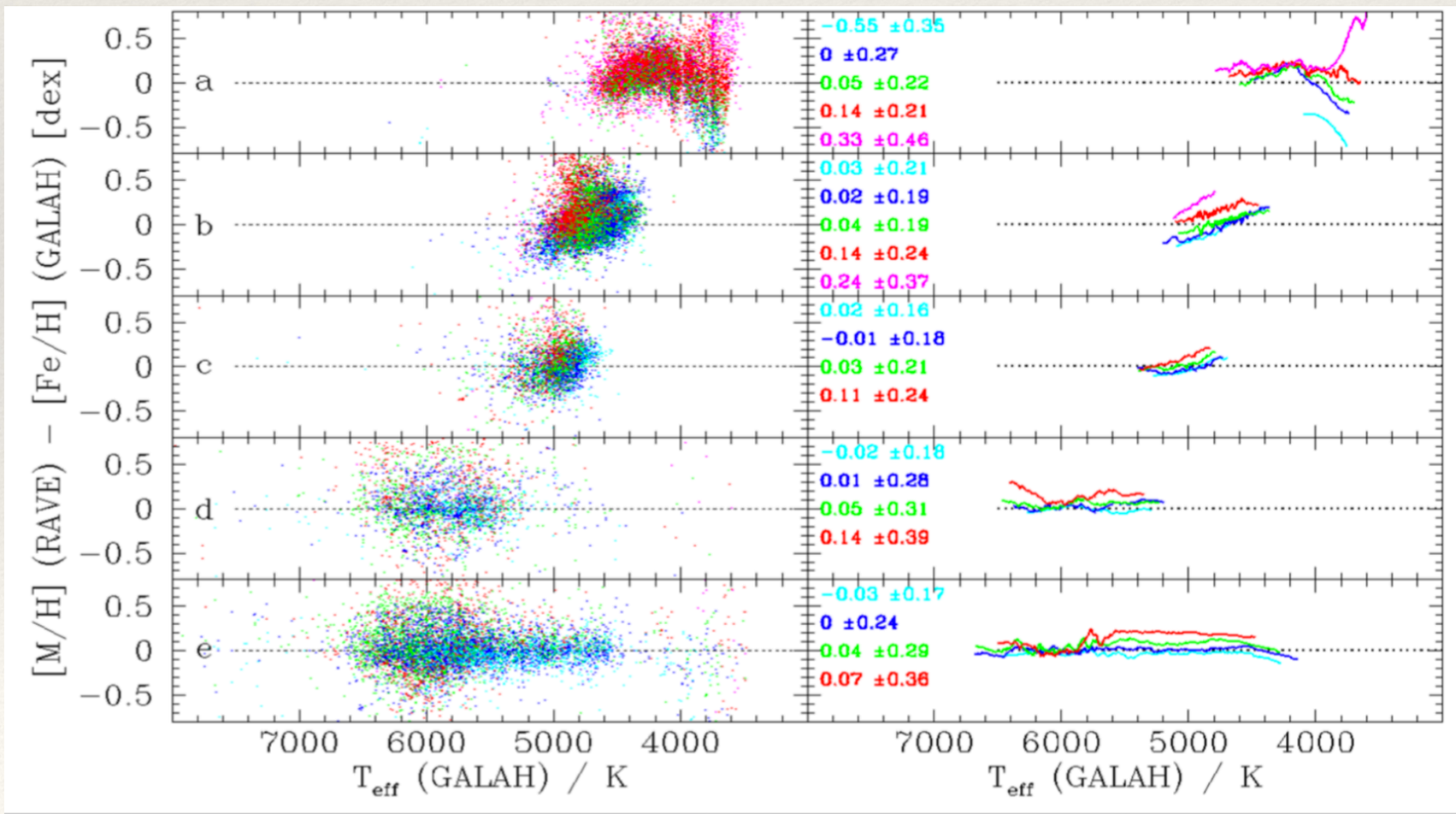
Preliminary

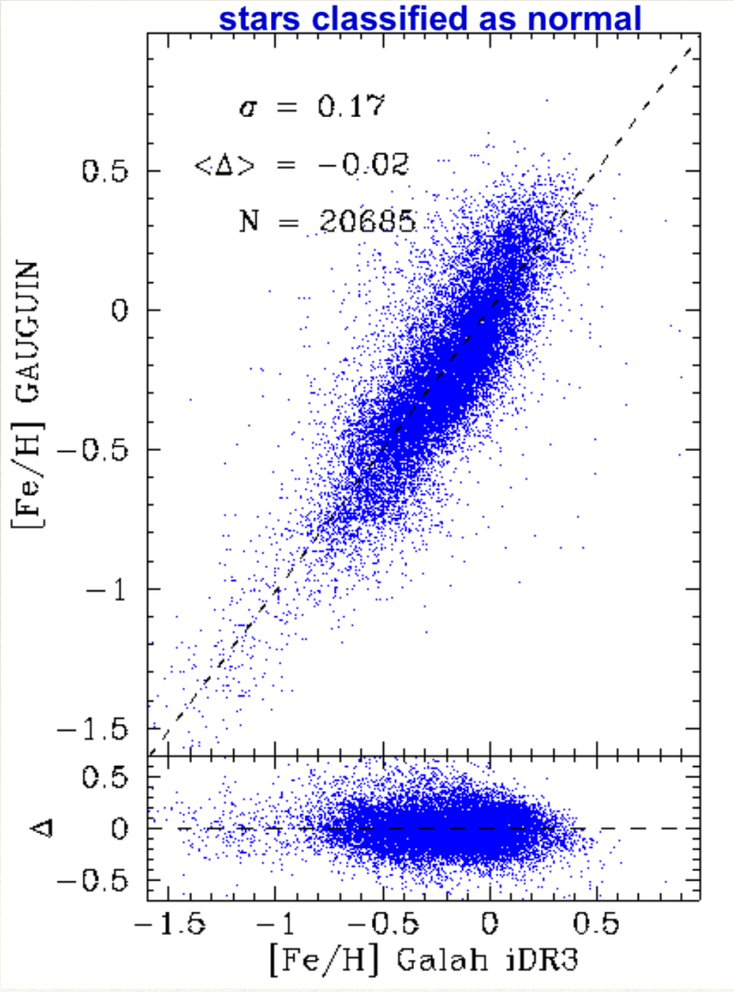


DR6 vs GALAH iDR3

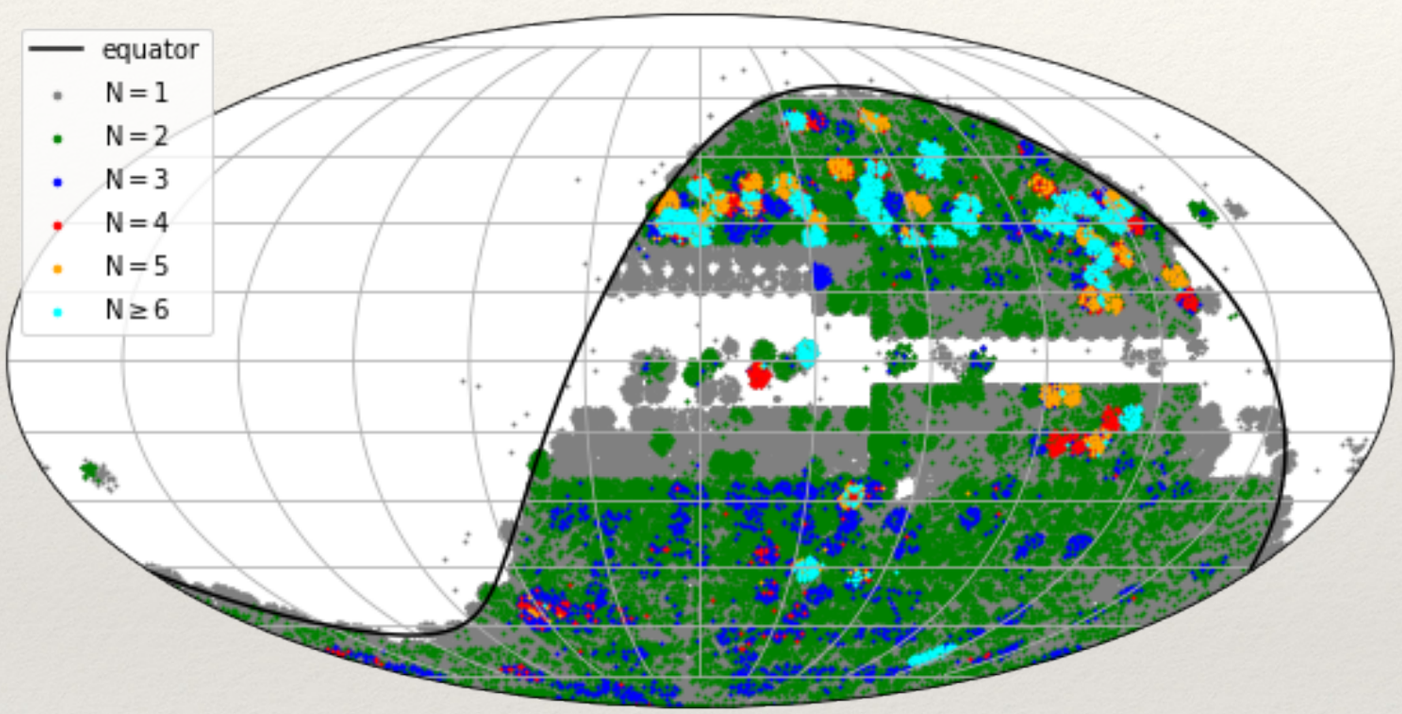
Plots courtesy of T. Zwitter

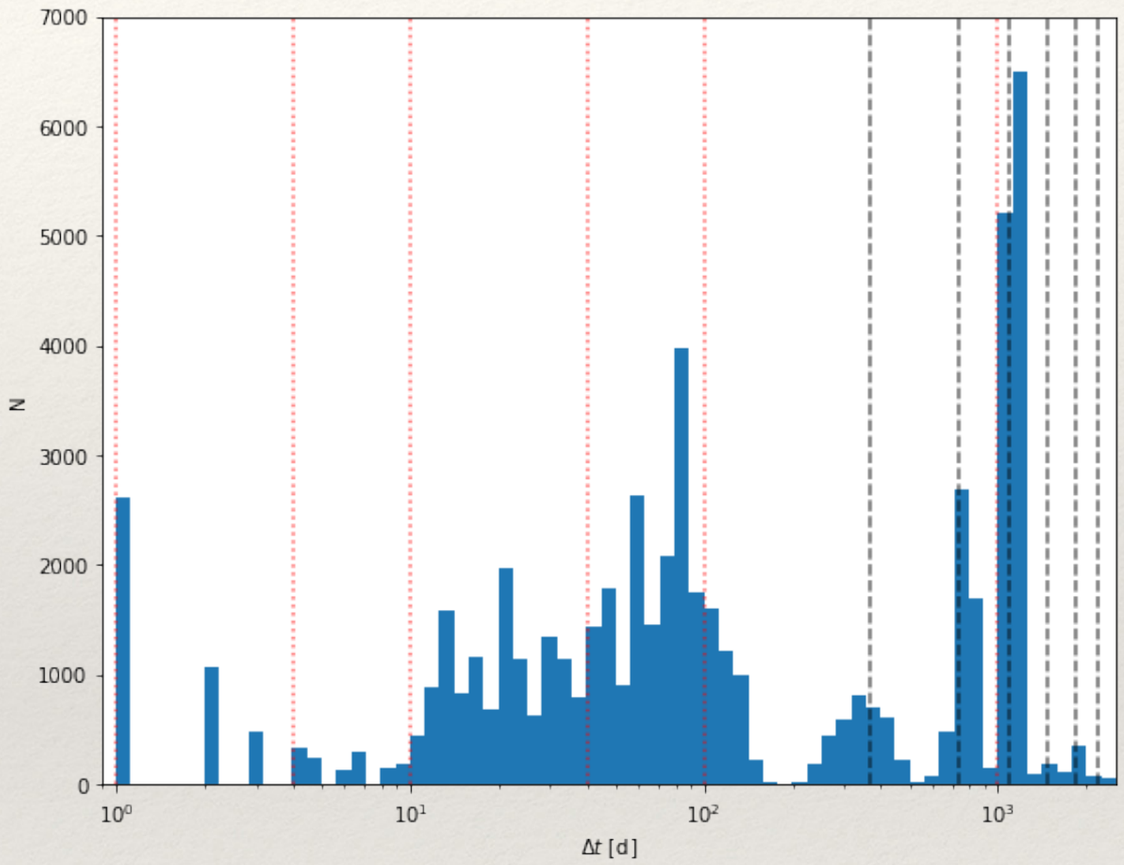






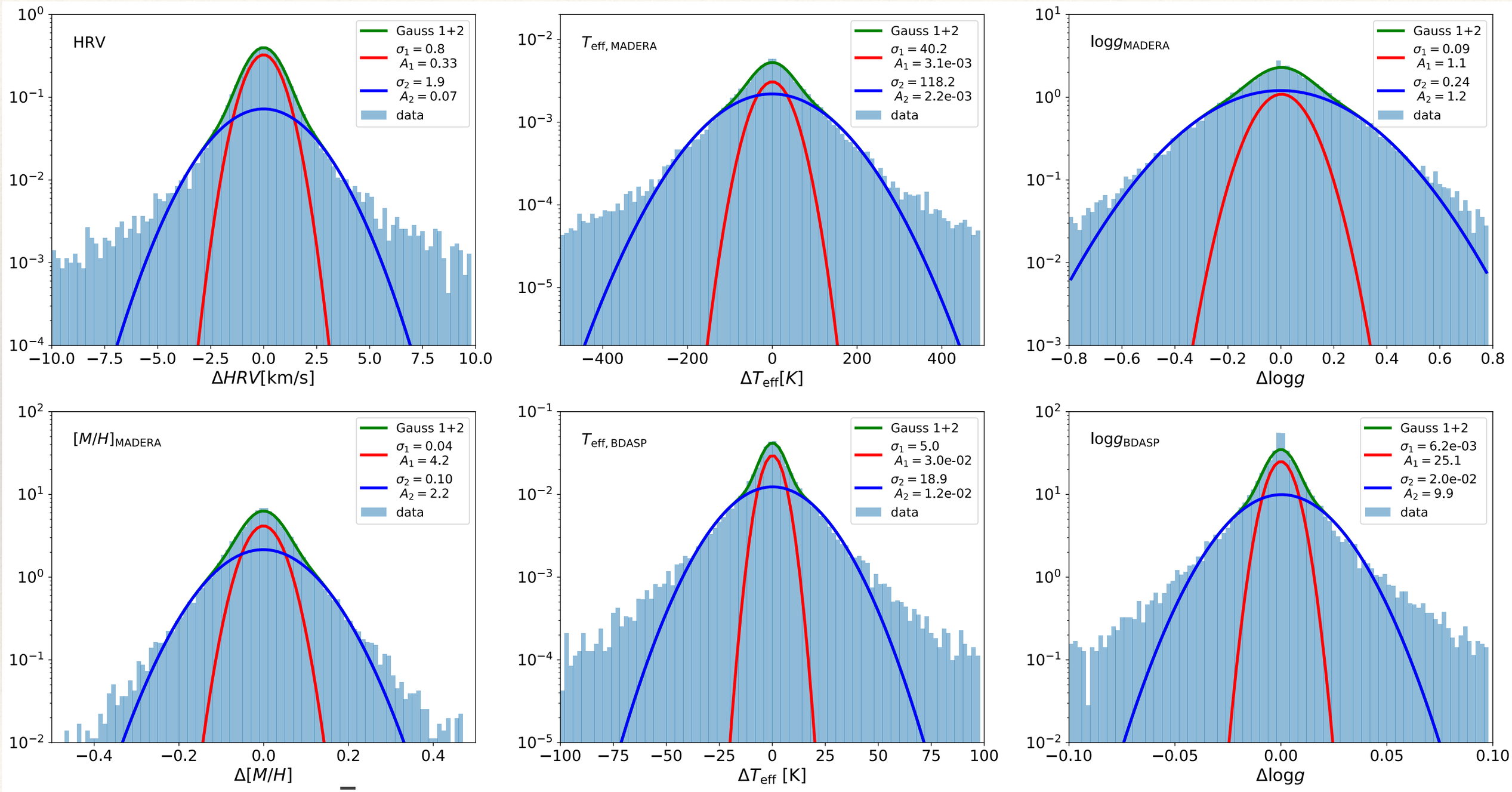
Repeats





Time interval between consecutive observations of stars with at least 4 repeat observations.
The red dotted lines mark the guiding cadence of 1, 4, 10, 40, 100, and 1000 days, the black dashed line multiples of 365 days.

Repeats



$$\Delta Q_i = Q_i^k - \bar{Q}^k$$

Table 1. Contents of RAVE DR6

in DR6	N. of spectra	N. of unique stars
Observed targets	518,392	451,788
with 2MASS cross match	518,305	451,711
with MADERA stellar Parameters	517,826	451,363
with Gaia DR2 cross match	517,100	450,646
with BDASP stellar parameters	494,699	431,064
with IRFM temperature	502,913	438,082
with at least 2 GAUGUIN abundances	381,062	337,139

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Summary