The Gaia Red Clump: calibration and characterisation

Laura Ruiz-Dern, C. Babusiaux, F. Arenou

Observatoire de Paris-Meudon

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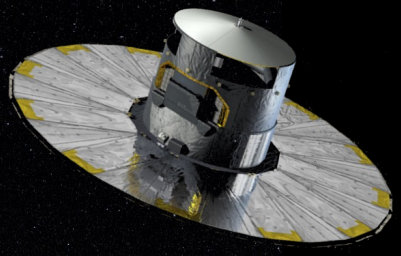
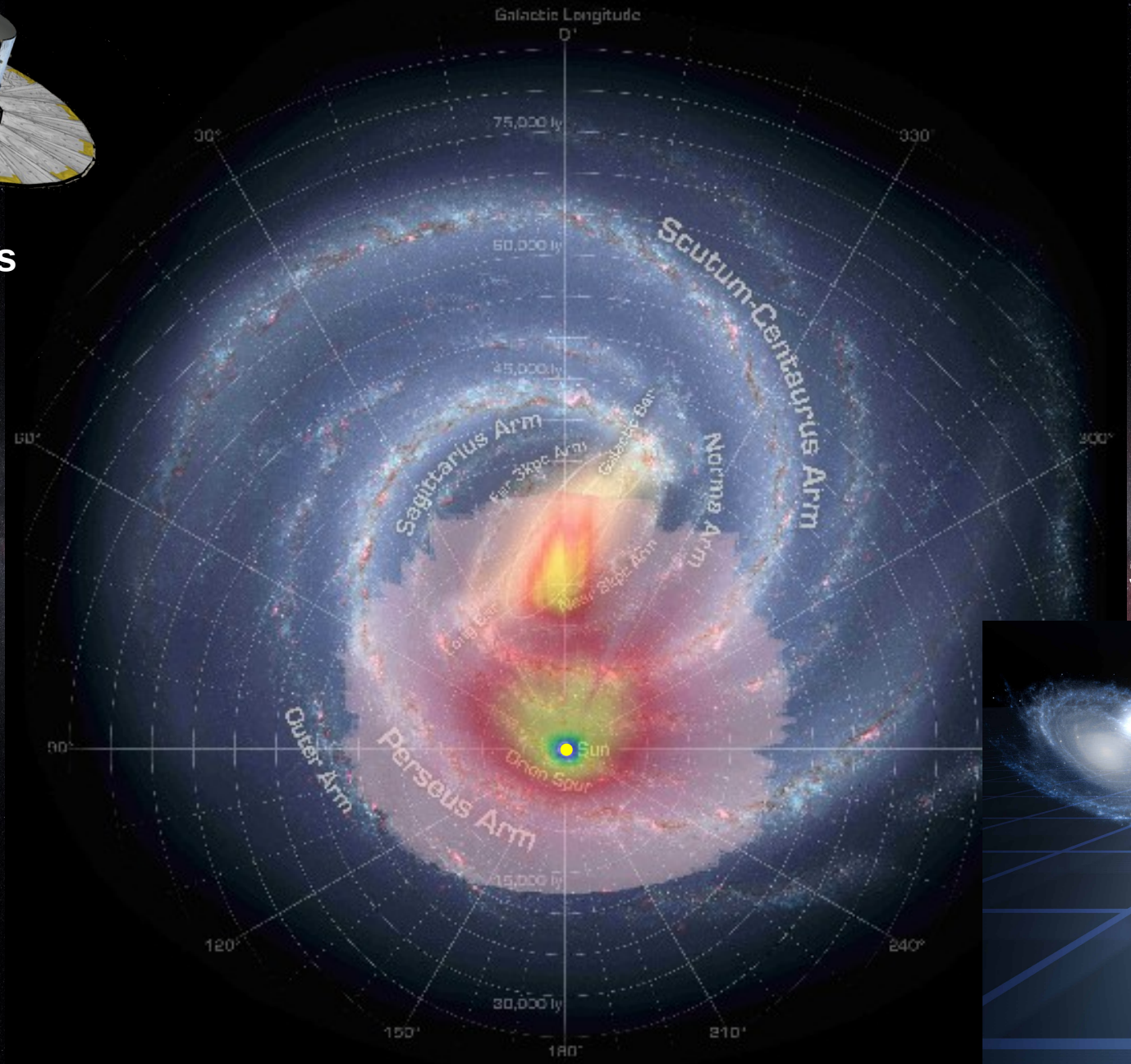
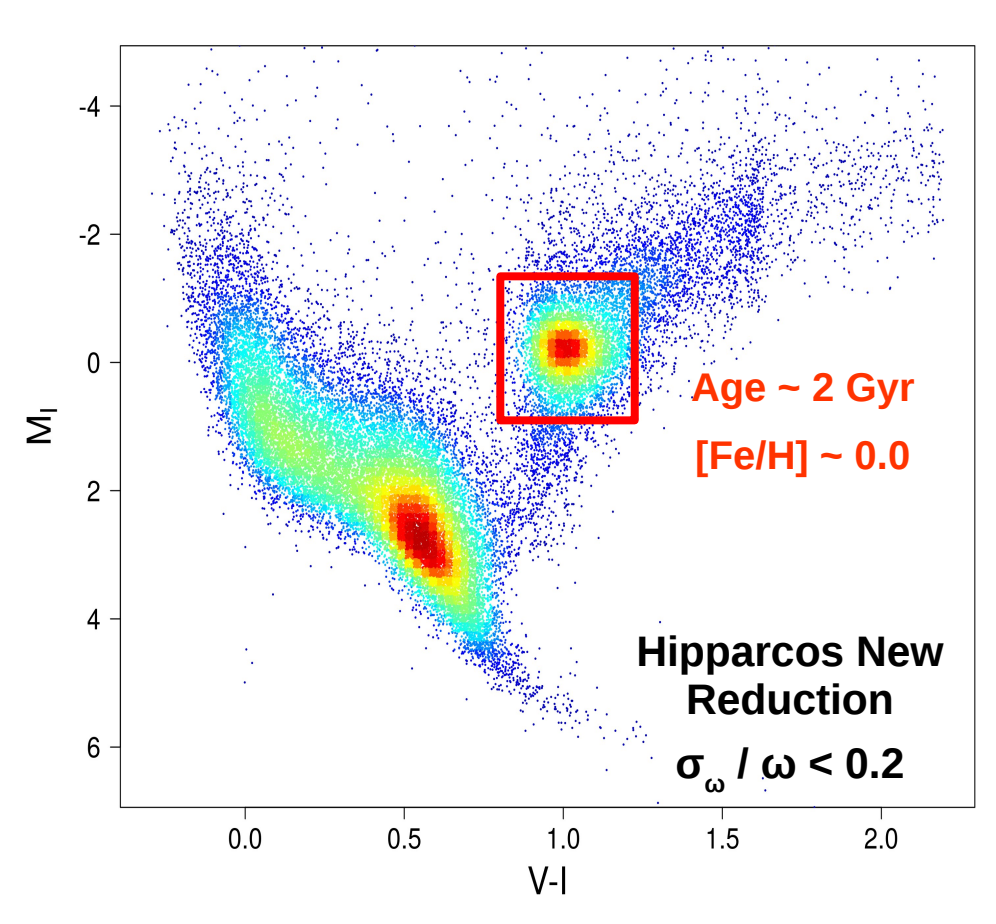


Parallaxes



Standard candles

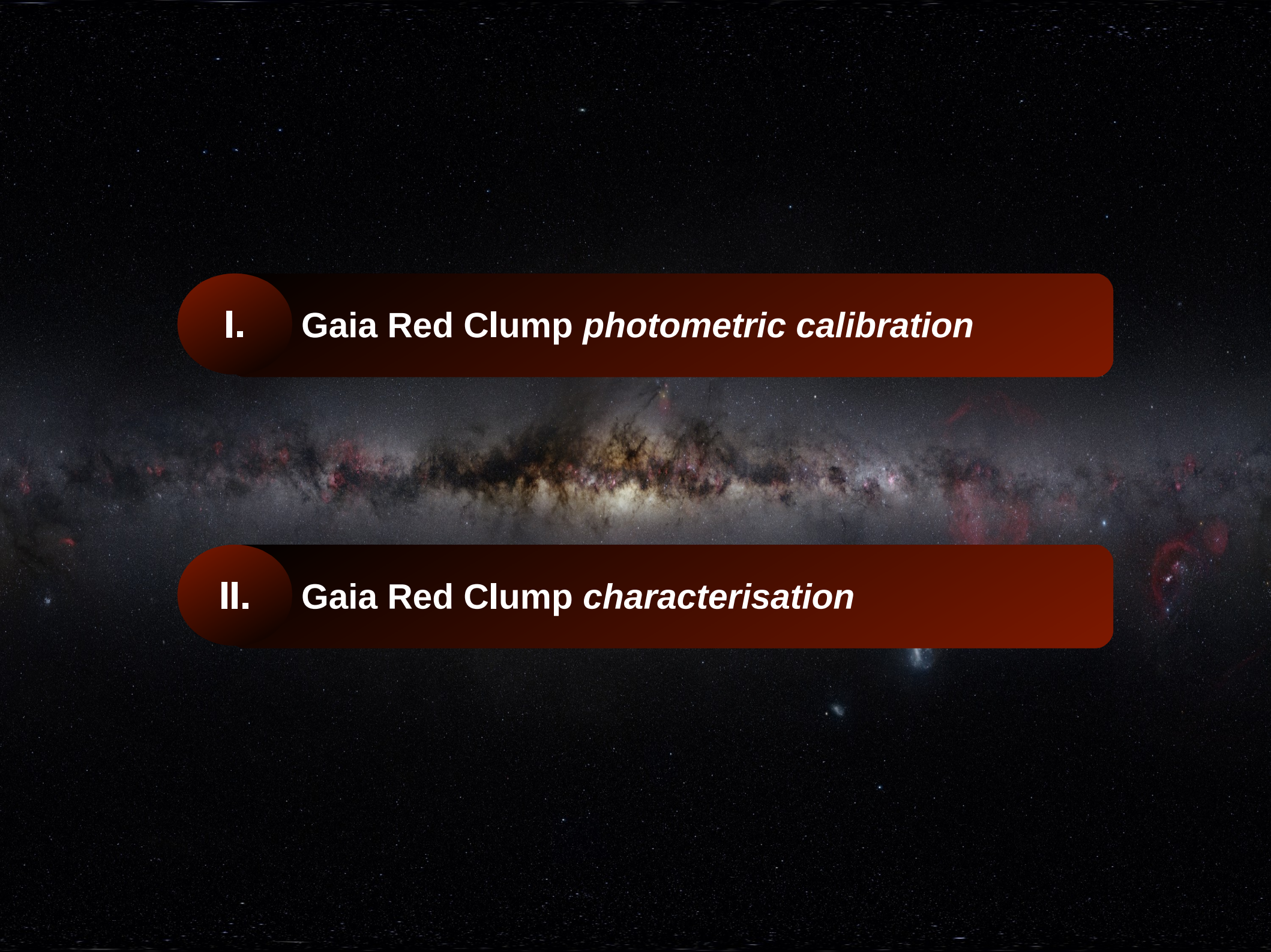
Standard candle → Good distance indicator



M_I weakly dependent on colour, age and chemical composition

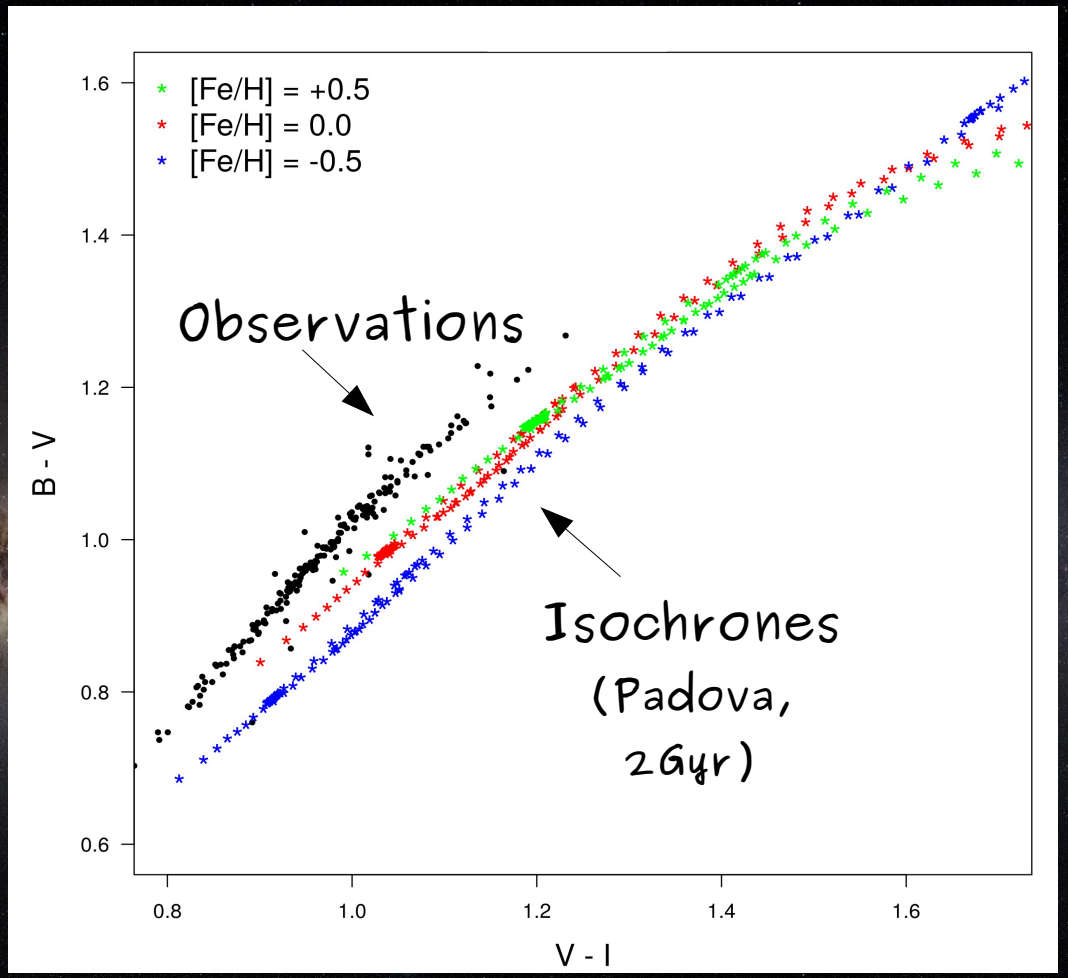
Many RC stars in solar neighbourhood

Colours → **Extinction** → **Absolute Magnitude** → **Distances**


I. Gaia Red Clump *photometric calibration*
II. Gaia Red Clump *characterisation*

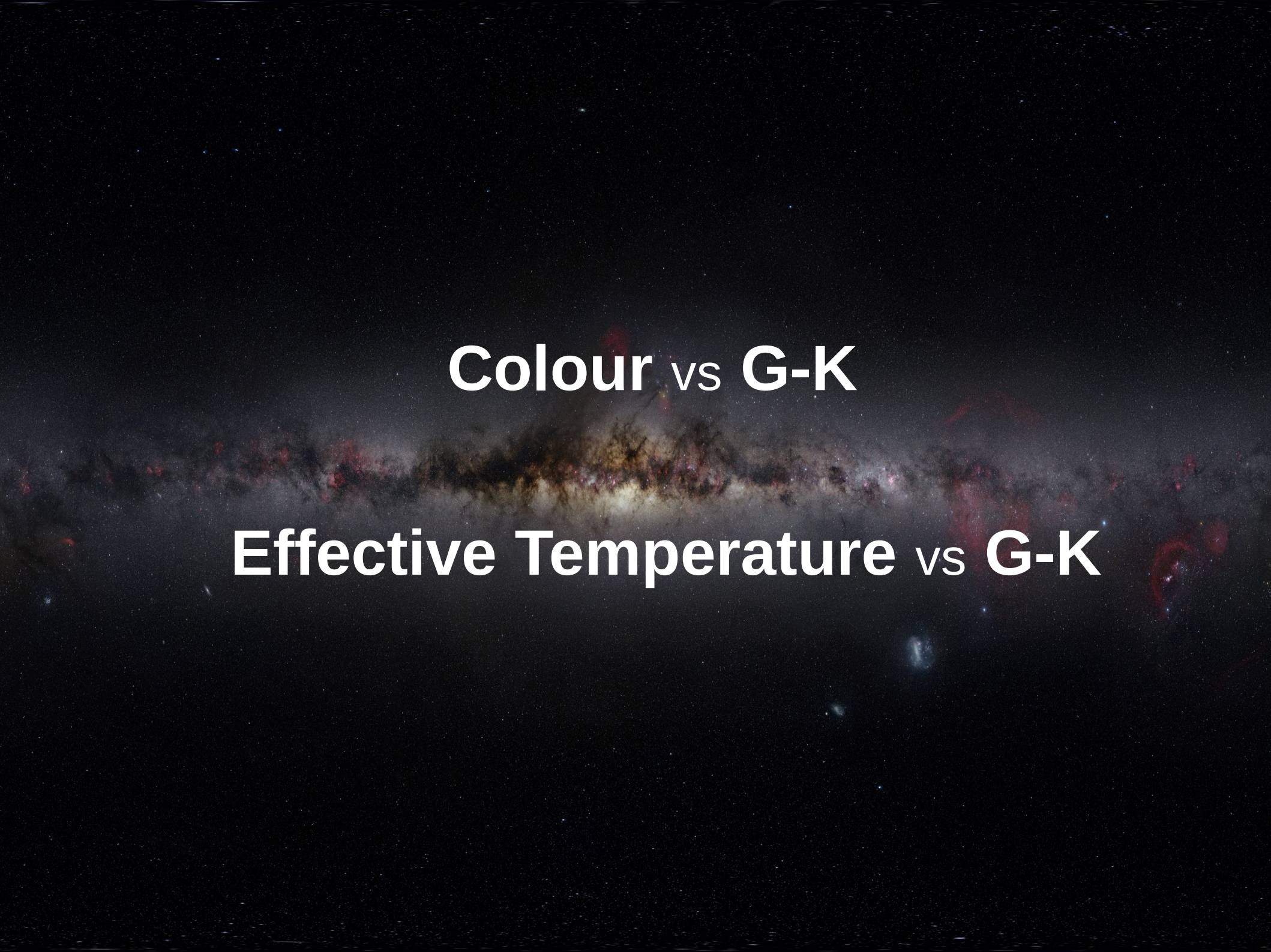
✗ **Models do not fit observations**

✗ **Unavailable Gaia calibrated filter model for the DR1**



Ruiz-Dern et al., 2017 (in prep.)

Empirical Calibration


Colour vs G-K
Effective Temperature vs G-K

Sample selection

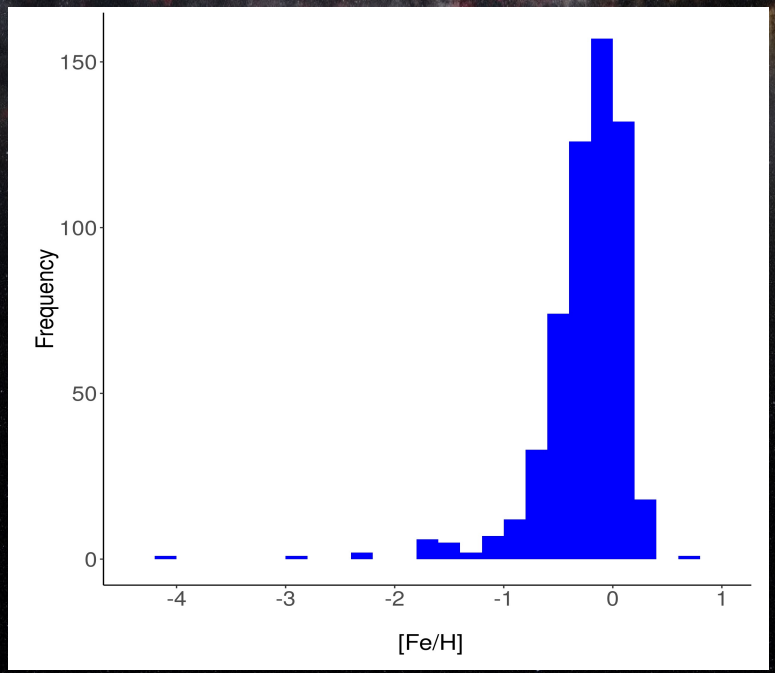
High Photometric quality

- G / B H_p V I / B_T V_T / J K
- GDR1 / Hipparcos / Tycho2 / 2MASS + Laney et al. [2012]

Binarity and Multiplicity removal

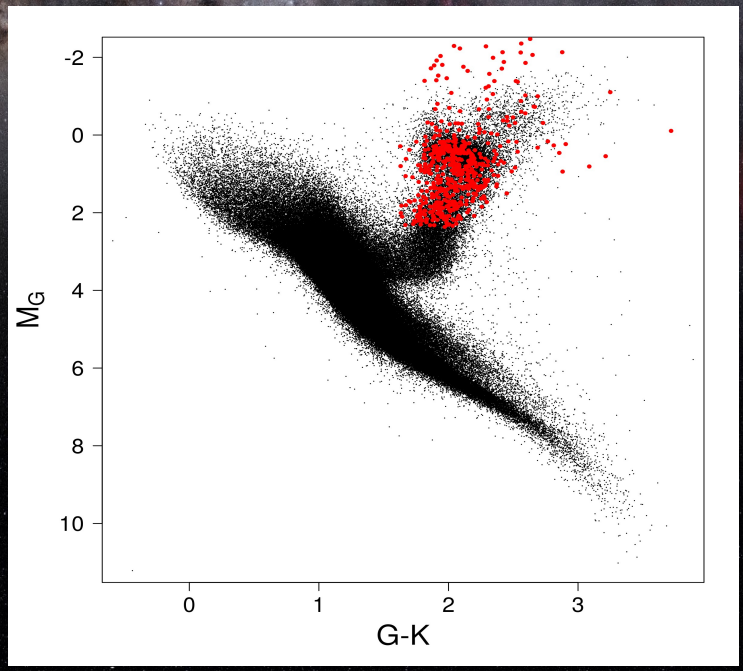
- Hipparcos Binary Flag
- Tycho Double System Catalogue
- SB9, Simbad

Spectroscopic Metallicity



- APOGEE, RAVE, LAMOST, PASTEL, GALAH,...

Giants selection

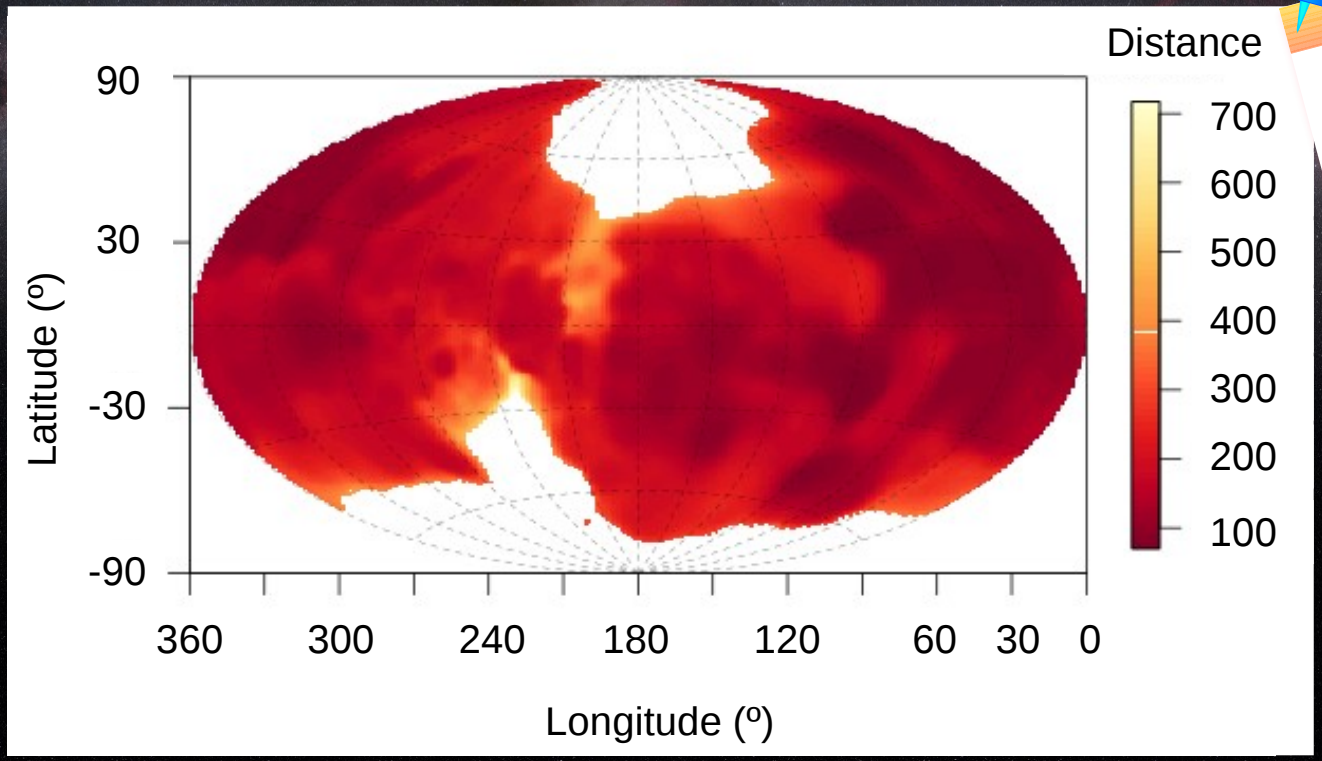


- Colour G – K > 1.6
- Parallax (ω): $m_G+5+5\log(\omega+2.3\sigma_\omega)<2.5$

Interstellar extinction handling

1329 stars

- $A_0 < 0.03$
- Based on :
  - **3D extinction map TGAS data** (Capitanio et al. 2017, in prep.)
  - **2D extinction map** (Schlegel et al. 1998)



Poster C19

Model selection method

$$Colour = a_0 + a_1(G-K) + a_2(G-K)^2 + a_3[Fe/H] + a_4[Fe/H]^2 + a_5(G-K)[Fe/H]$$

B
V
H_p
B_T
V_T
G
I
J
K

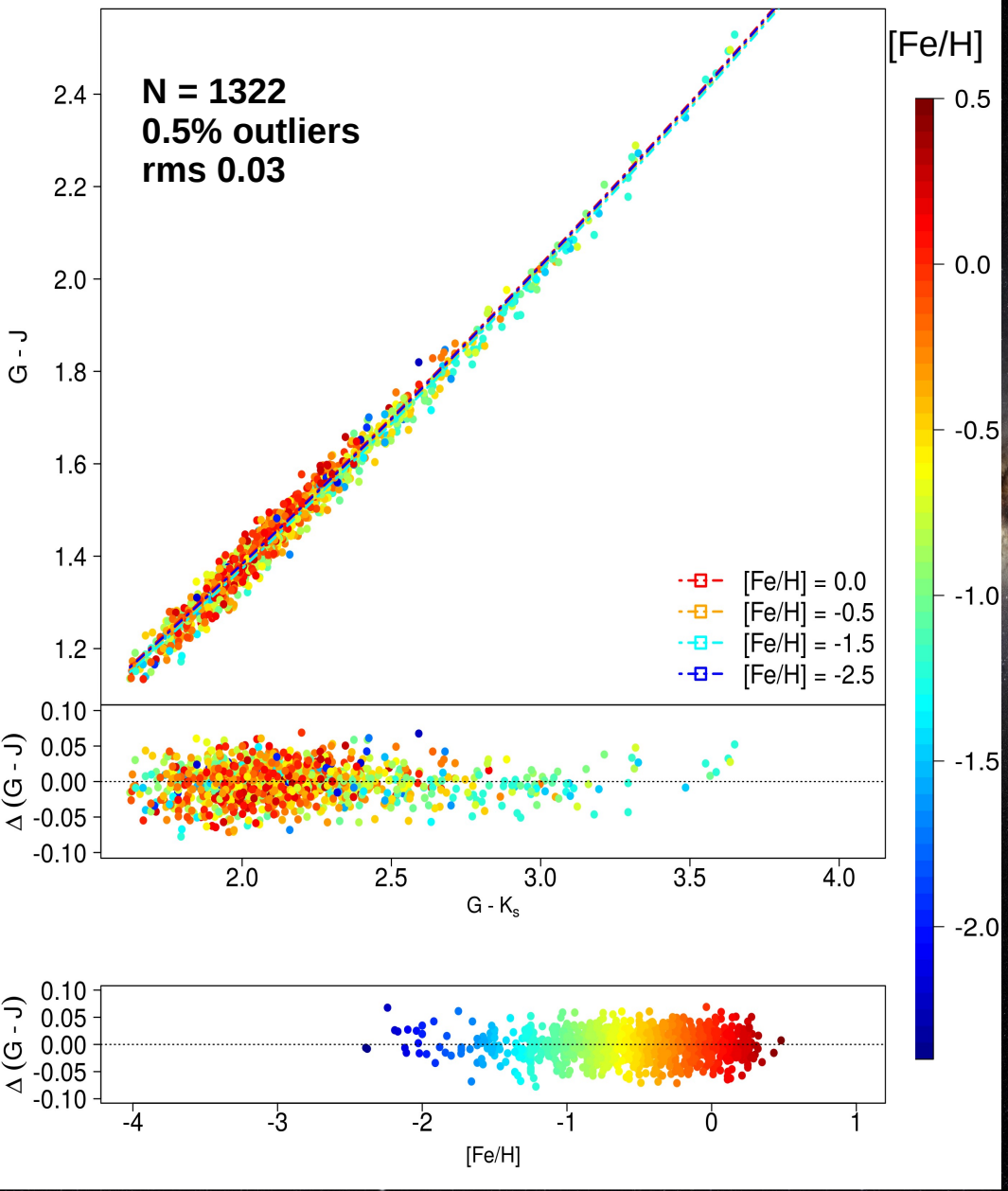
Monte Carlo Markov Chain (MCMC)
account for all variables uncertainties

Deviance Information Criterion (DIC)
Model selection: penalization by the complex terms

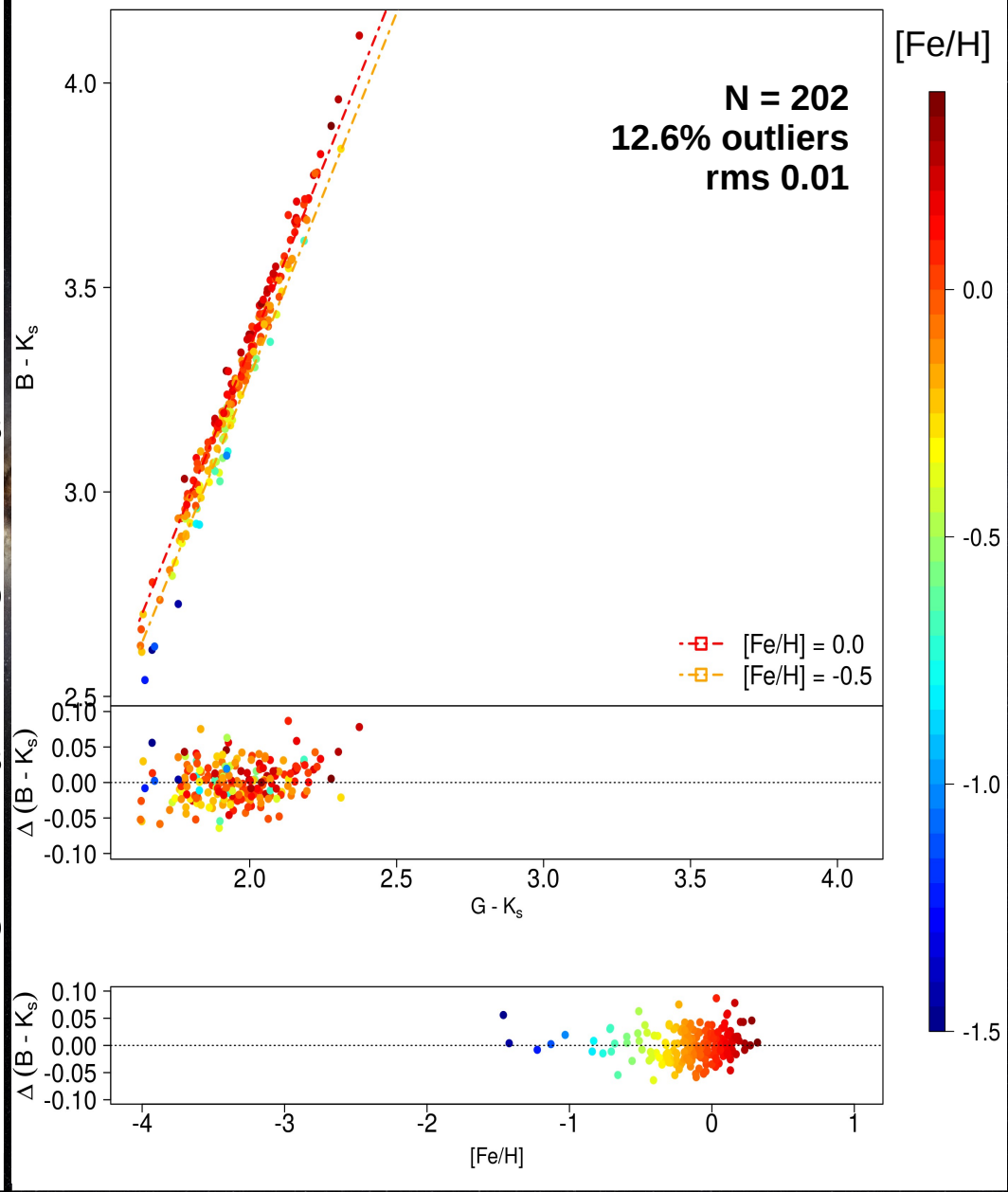
Outliers at 3σ from fit
Checked one by one

Colour vs $G-K_s$

G-J vs $G-K_s$



$B-K_s$ vs $G-K_s$



Ruiz-Dern et al., 2017 (in prep.)

T_{eff} calibrations

Giants selection

High Photometric quality

Spectroscopic Metallicity

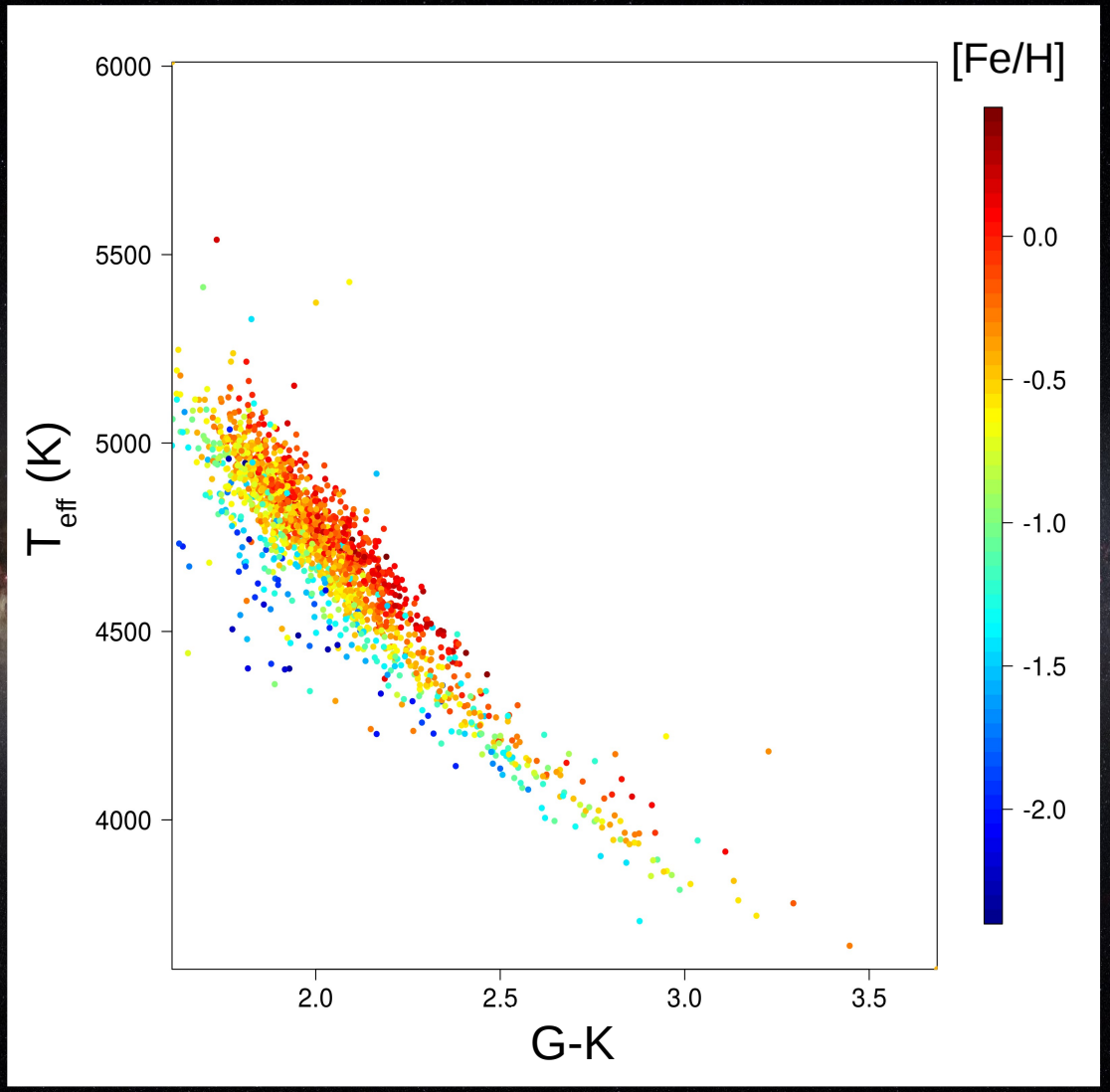
Interstellar extinction handling

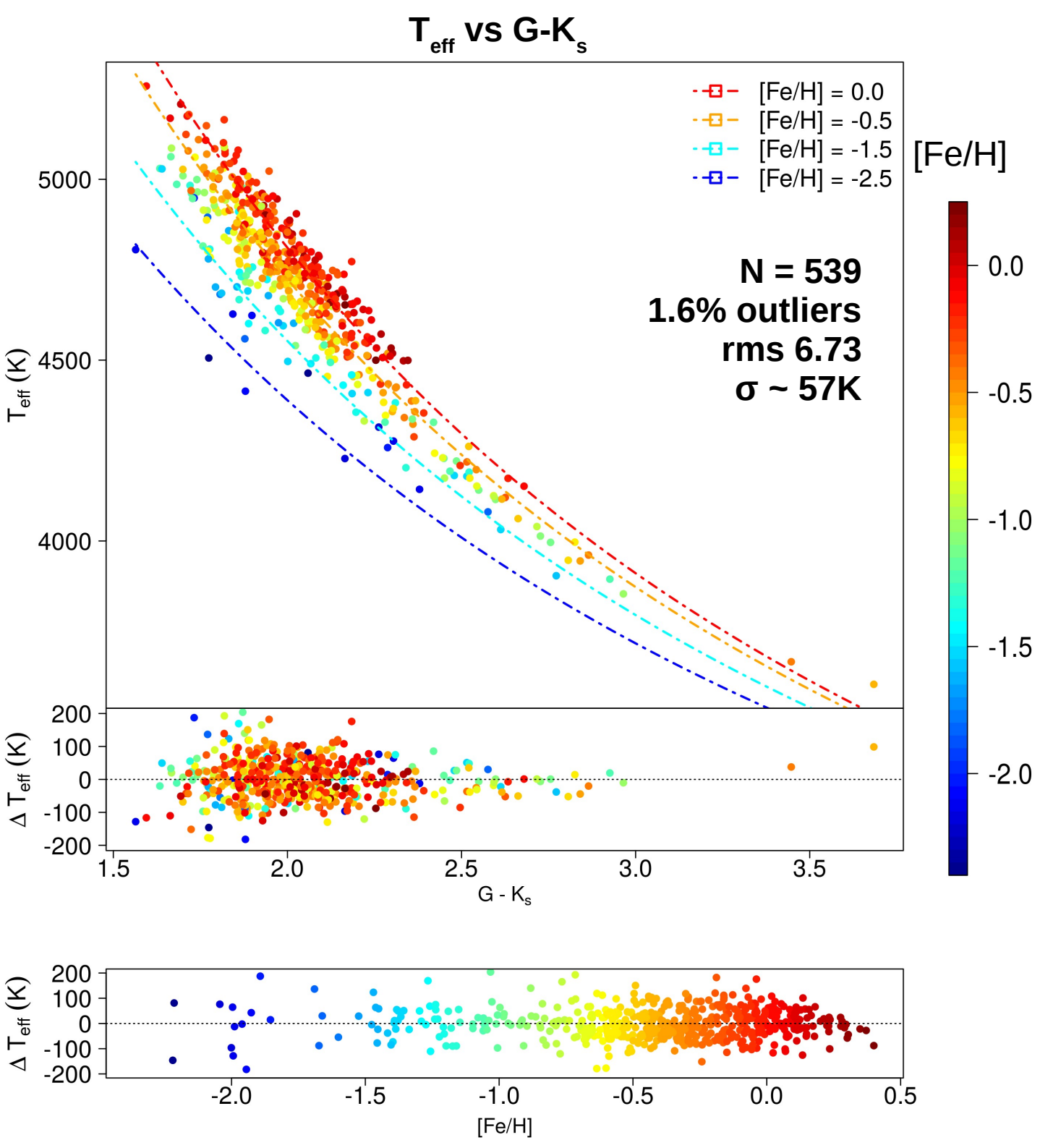
+

Homogeneous Effective Temperature

APOGEE (DR13)

548 stars





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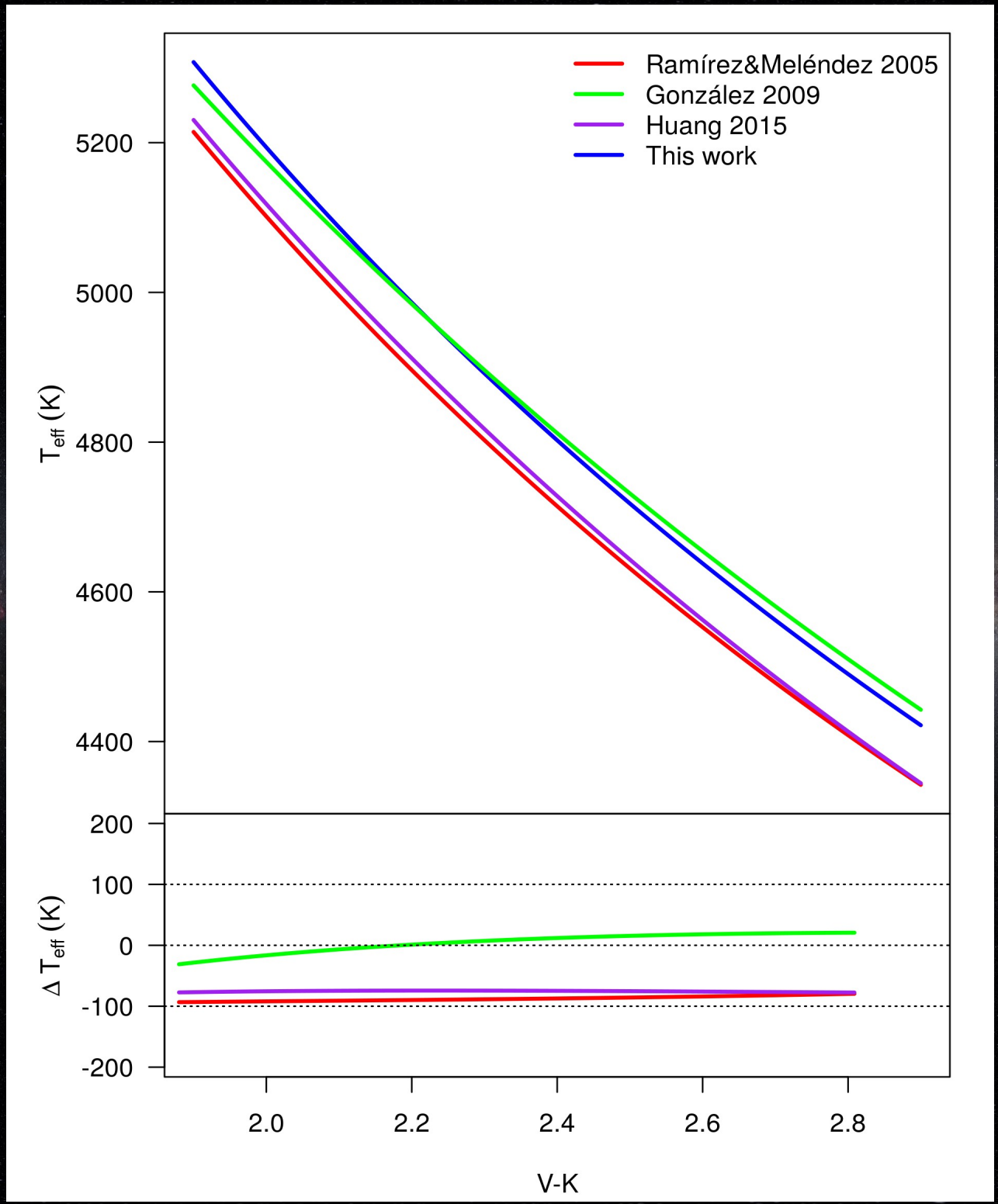


– IRFM giants
– IRFM giants
– Interferometry
– Photometry

Other authors:

T_{eff} vs $V\text{-}K_s$

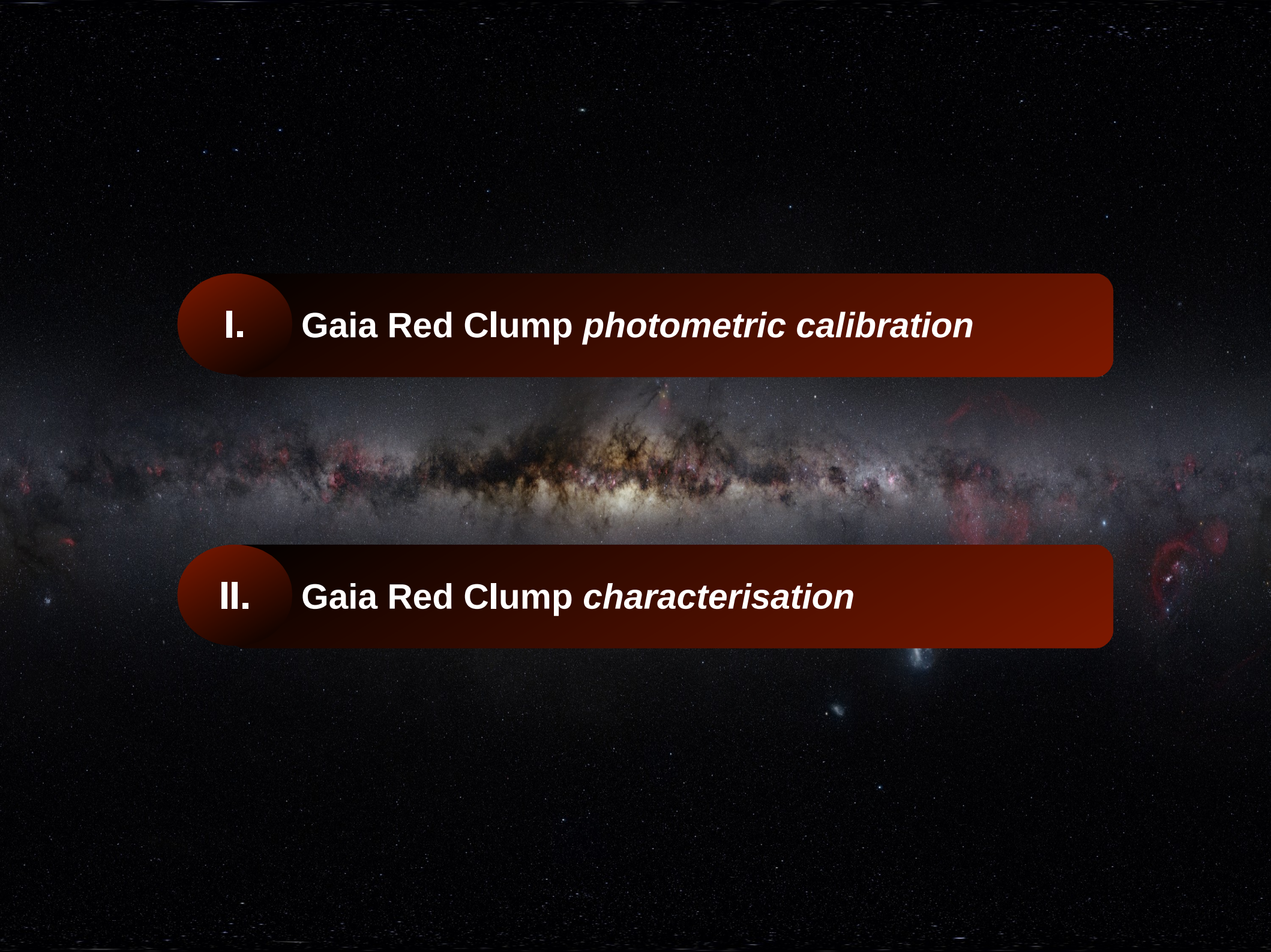
This work:

T_{eff} vs $G\text{-}K_s$

+

$V\text{-}K_s$ vs $G\text{-}K_s$

Ruiz-Dern et al., 2017 (in prep.)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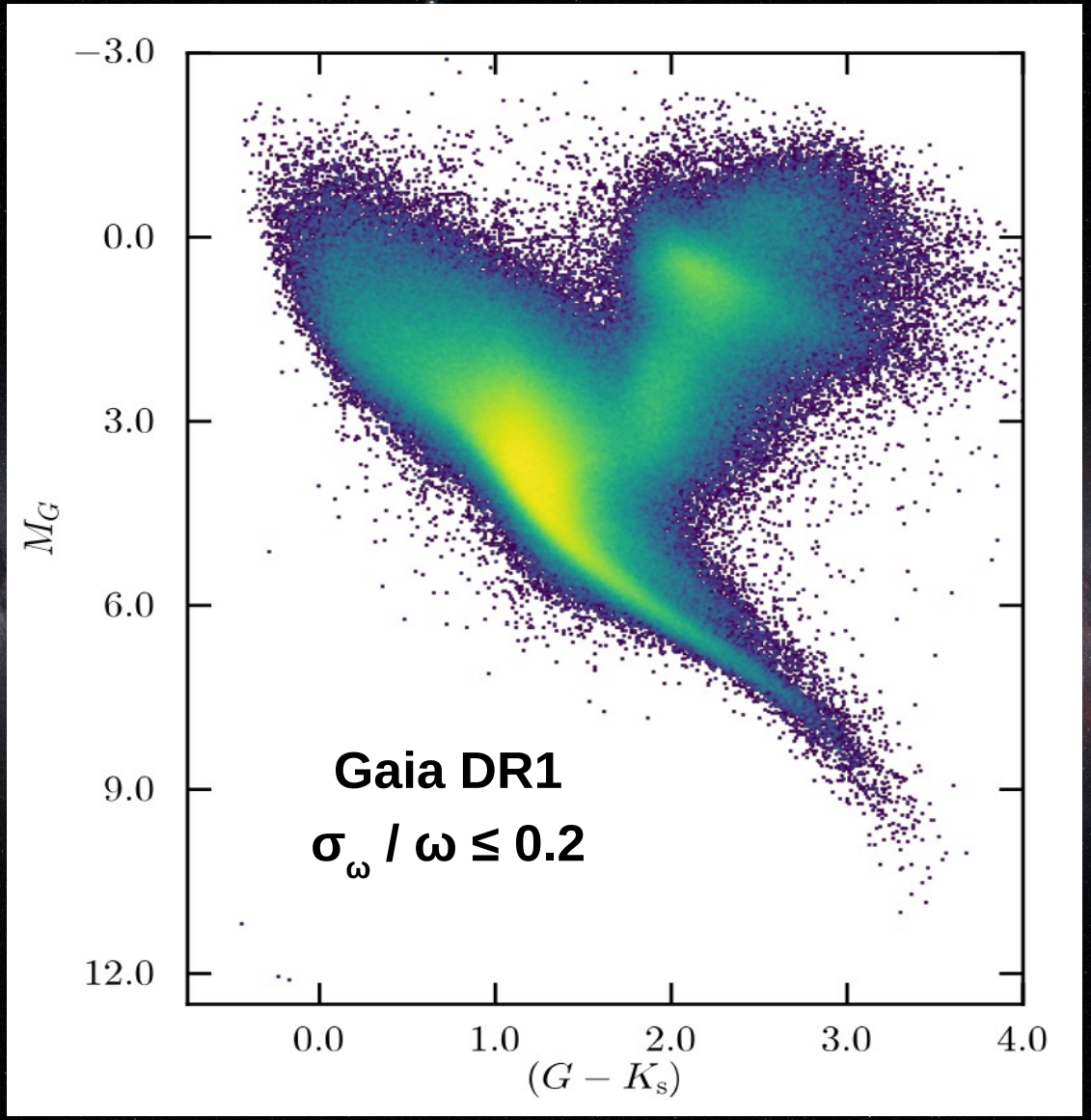


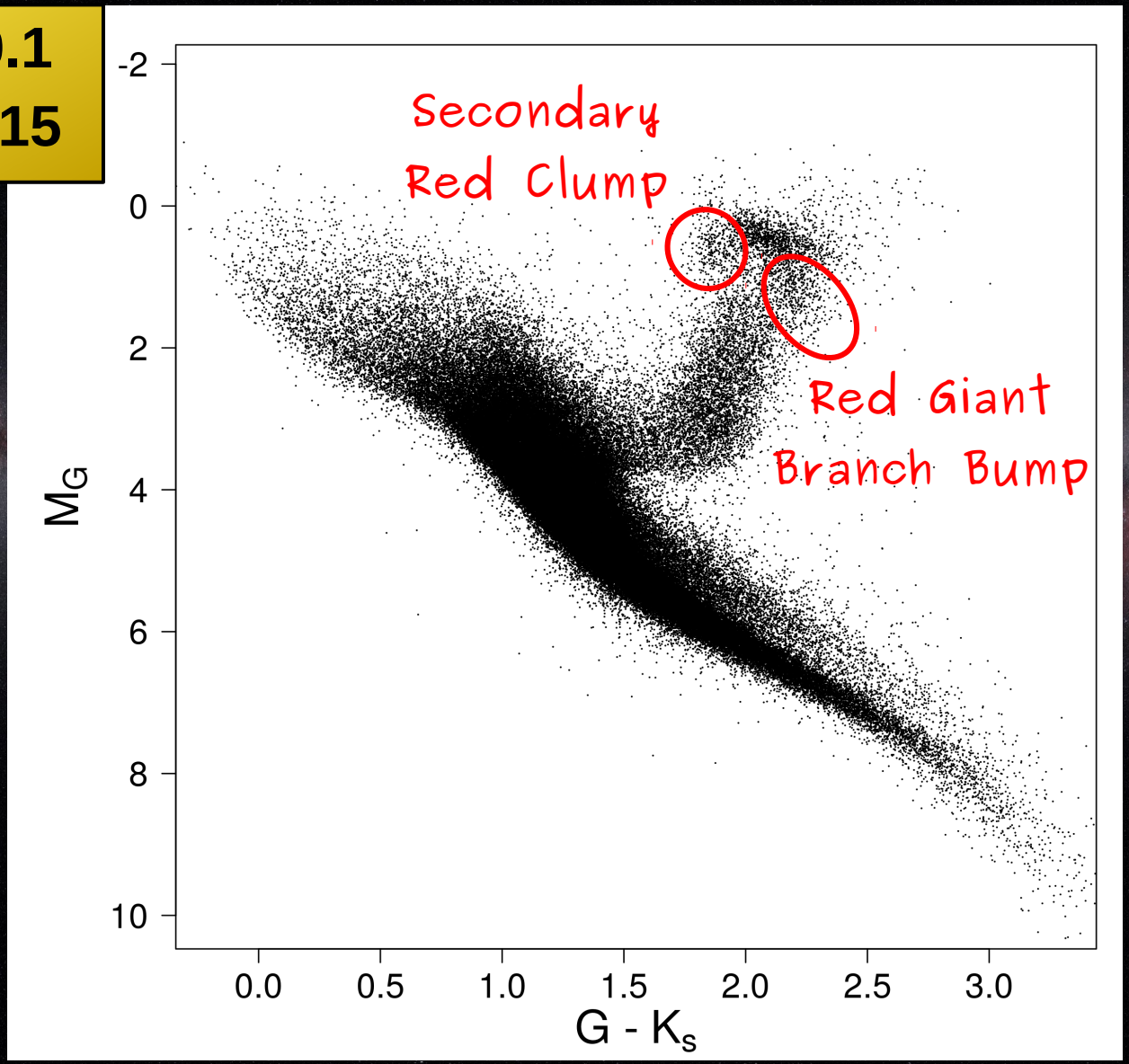
Gaia Collaboration, 2016, A&A

Need to account for extinction to use Gaia G magnitude

TGAS HR diagram

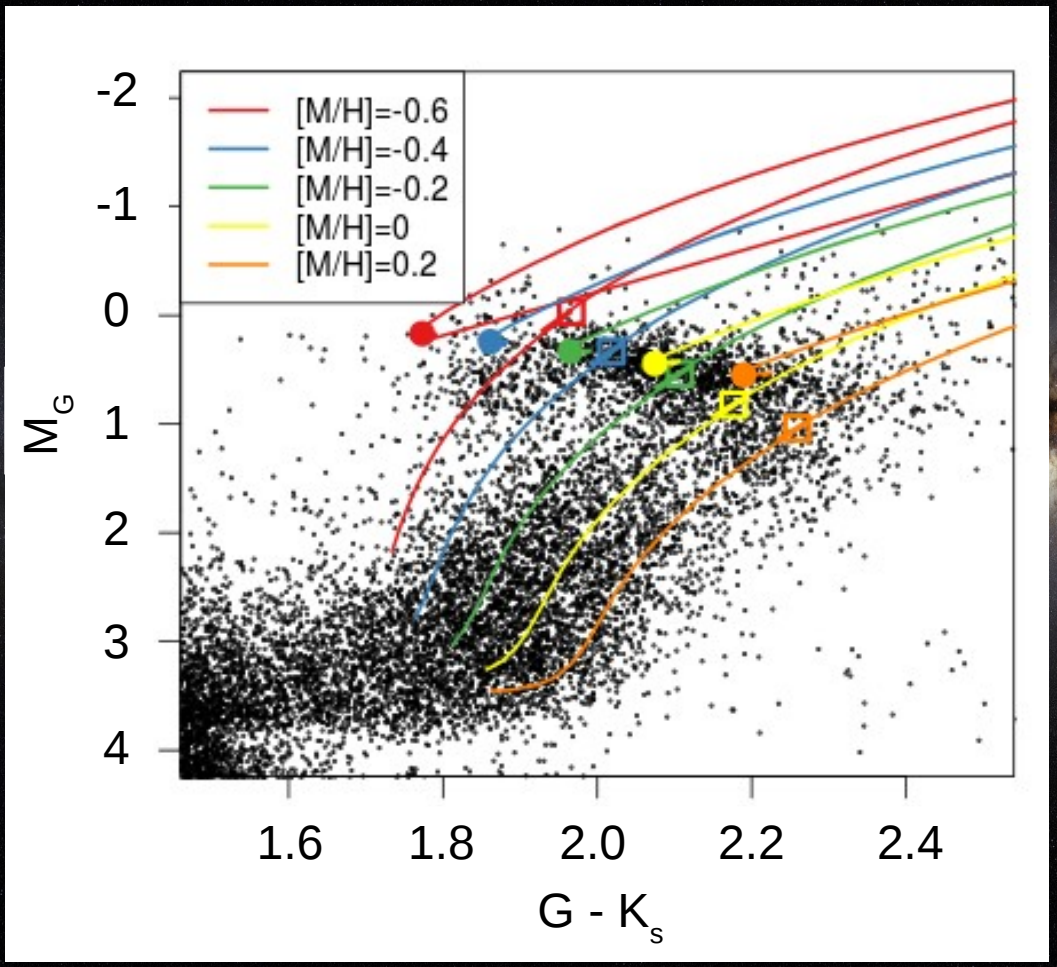
$\sigma_\omega / \omega < 0.1$

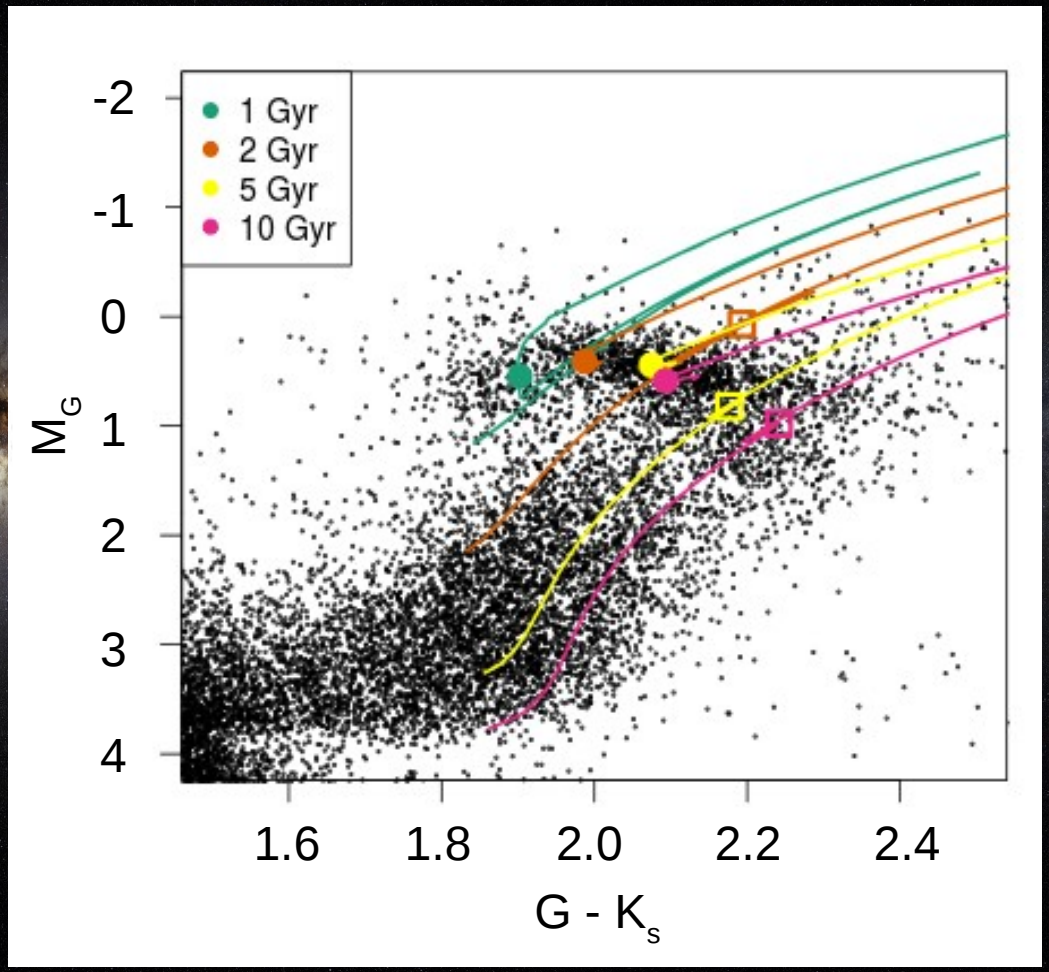
$E_{(B-V)} < 0.015$



Ruiz-Dern et al., 2017 (in prep.)

Padova Isochrones





T_{eff} from Padova Isochrones
G – K_s obtained using T_{eff} calibration

Ruiz-Dern et al., 2017 (in prep.)

RC Parameters

Colour – G-K_s calibrations

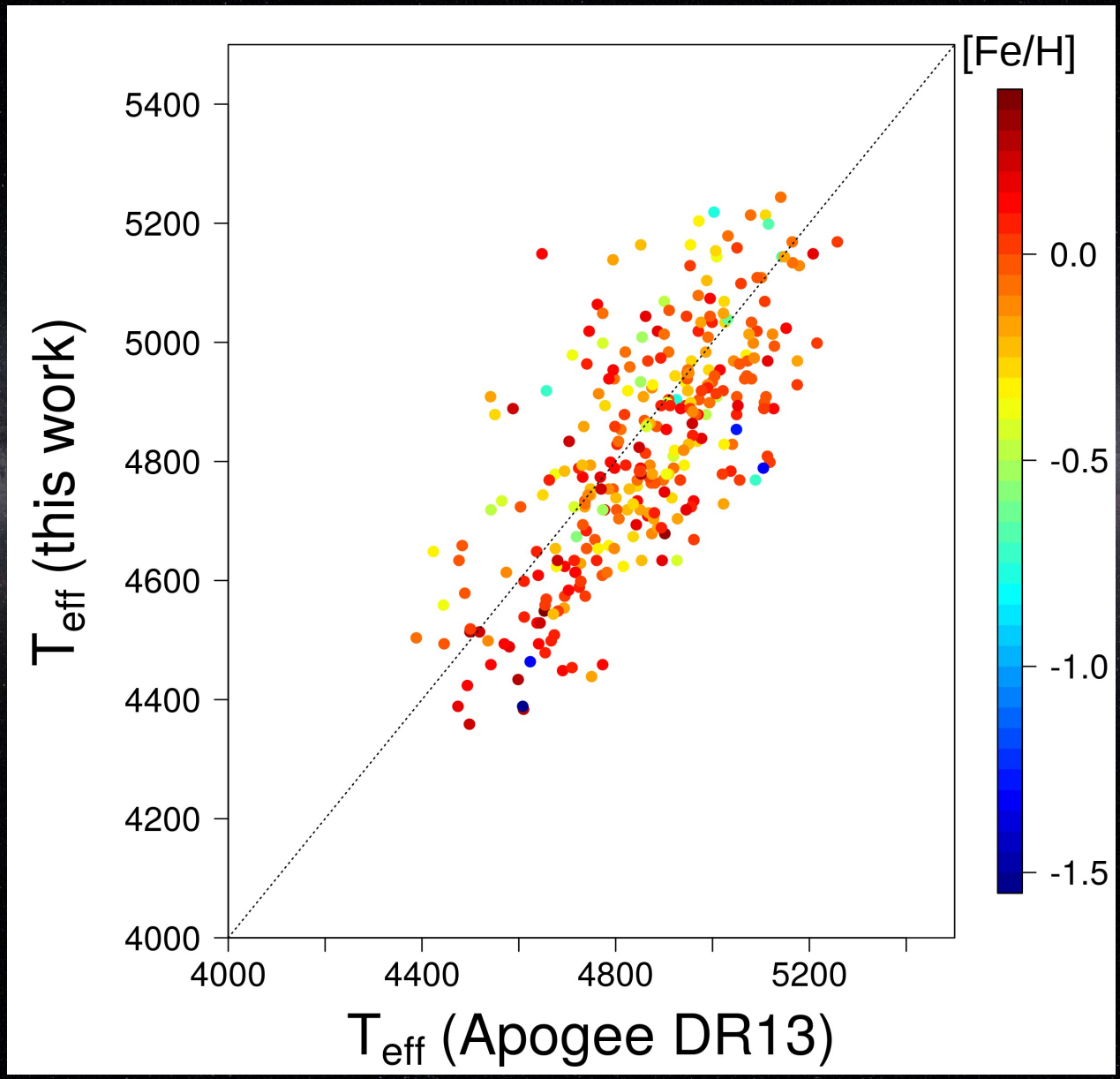
G-K_s – T_{eff} calibration

Extinction coefficients model
(C. Babusiaux)

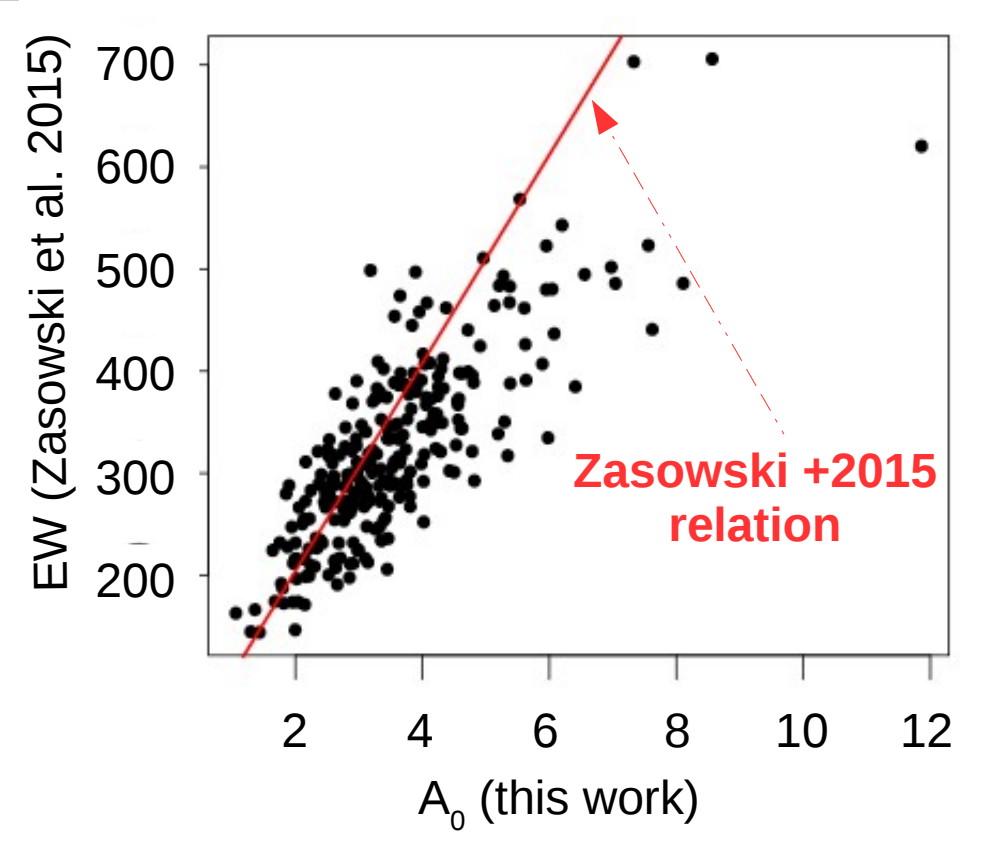
- $k_\lambda = f(A_0, T_{eff})$ and $k_\lambda = f(A_0,$ **colour**$)$
  - Fitzpatrick and Massa (2007)
  - RC Spectral Energy Distribution
- k_G **empirical**
  - Using calibrations of this work (Danielski et al. 2017, in prep.)

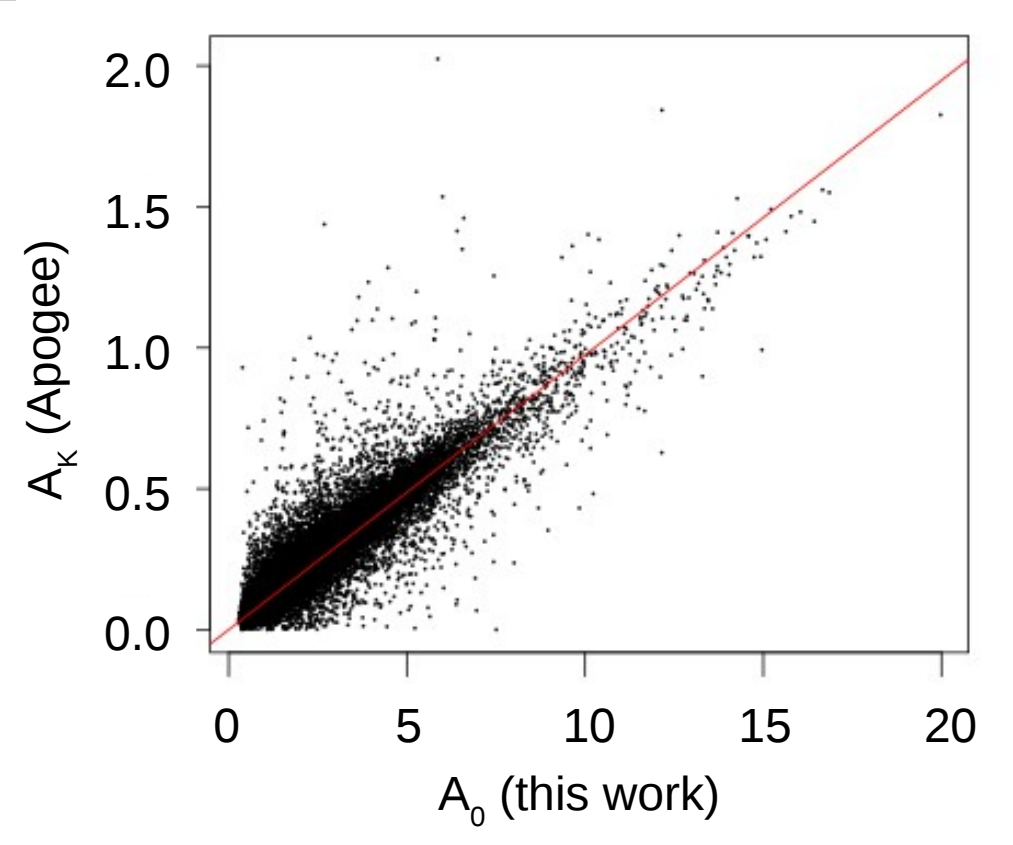
* A_0 absorption at λ = 550 nm (Gaia reference value)

✔ Effective Temperatures



✔ Interstellar extinctions





Gaia Data Validation

✔ **Zero-point of parallaxes and their precision**

DISTANT ENOUGH → **Estimated distance uncertainty better than Gaia ω precision [TGAS: $\sigma_{\omega(EXT)} < 0.1$ mas]**

DR1

APOKASC → Apogee + Kepler

- Distance modulus calculated by Rodrigues et al. (2014) using Padova isochrones relations
- 984 Tycho sources with σ < 0.1 mas (APOKASC median σ ~ 0.02 mas)
- Arenou et al. 2017

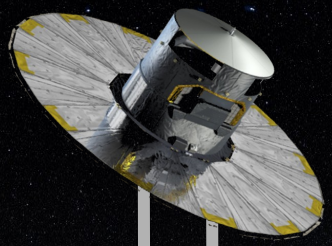
DR2

Larger RC sample

Distance modulus derived from:

Calibrations of this work + Asteroseismic constraints

Conclusions



DR1 Parallaxes

Gaia RC photometric calibration (Ruiz-Dern+ 2017, in prep.)

- **Other Spectral Types** (C. Danielski)
- **k_G extinction coefficients** (Danielski+ 2017, in prep.)

Gaia RC characterisation

- **Padova Isochrones**
- **RC Parameters**
- **New 3D extinction map** (Capitanio+ 2017, in prep.)
- **$M_G \rightarrow$ distances**
- **HR simulations** (C. Hottier)

Gaia DR2: Use of calibrations for astrometric and photometric validation