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Fundamental parameters for M dwarfs

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plato

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Outline

- M dwarfs, a reminder
- Observational difficulties
- Benchmark M dwarfs for PLATO
- Fundamental parameters of M dwarfs
- Conclusion

M dwarfs a reminder

- 70 % of stars in local galaxy
- T_{eff}: 2700-4000 K
- Mass: 0.08-0.6 M_{sun}
- Important in search for exoplanets
  - 2.5 planets with a radius of 1-4 R_E per M dwarf
    Dressing & Charbonneau (2015)
- Many are magnetically active
- Fully convective

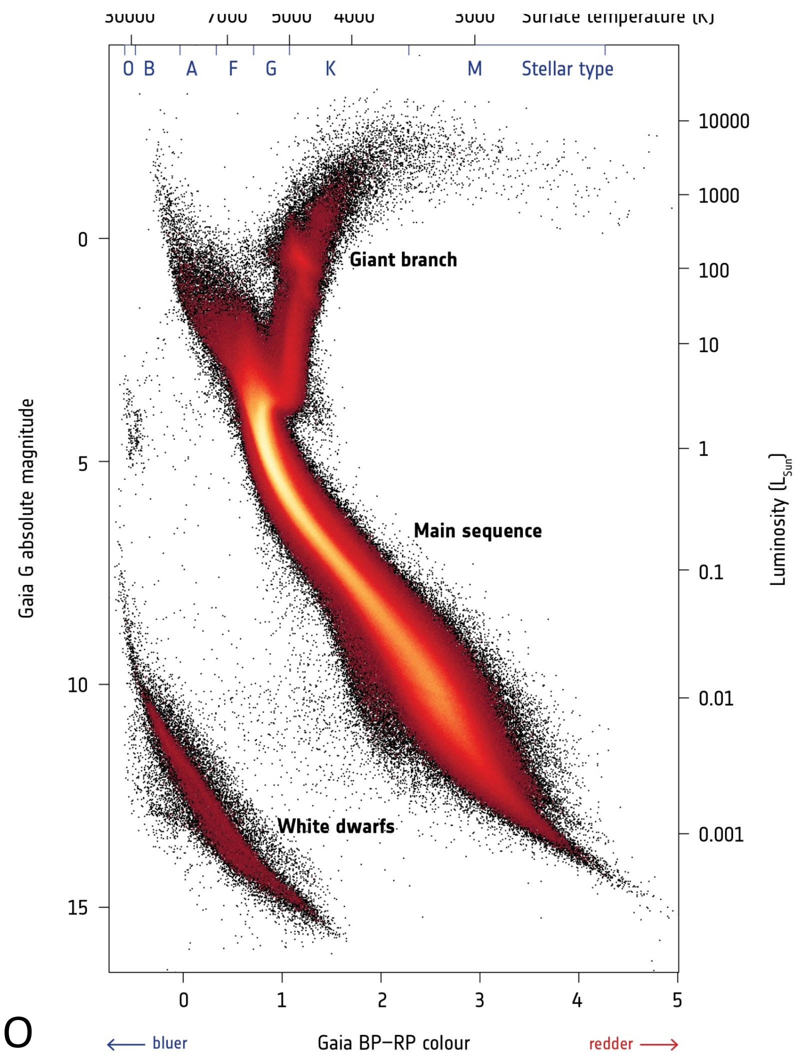


Figure: ESA/Gaia/DPAC, CC BY-SA 3.0 IGO

M dwarfs in PLATO

- Sample 4
  - V < 16
  - $M_G > 3$
  - $(G_{BP}-G_{RP})_0 > 1.84$
  - > 5000 stars

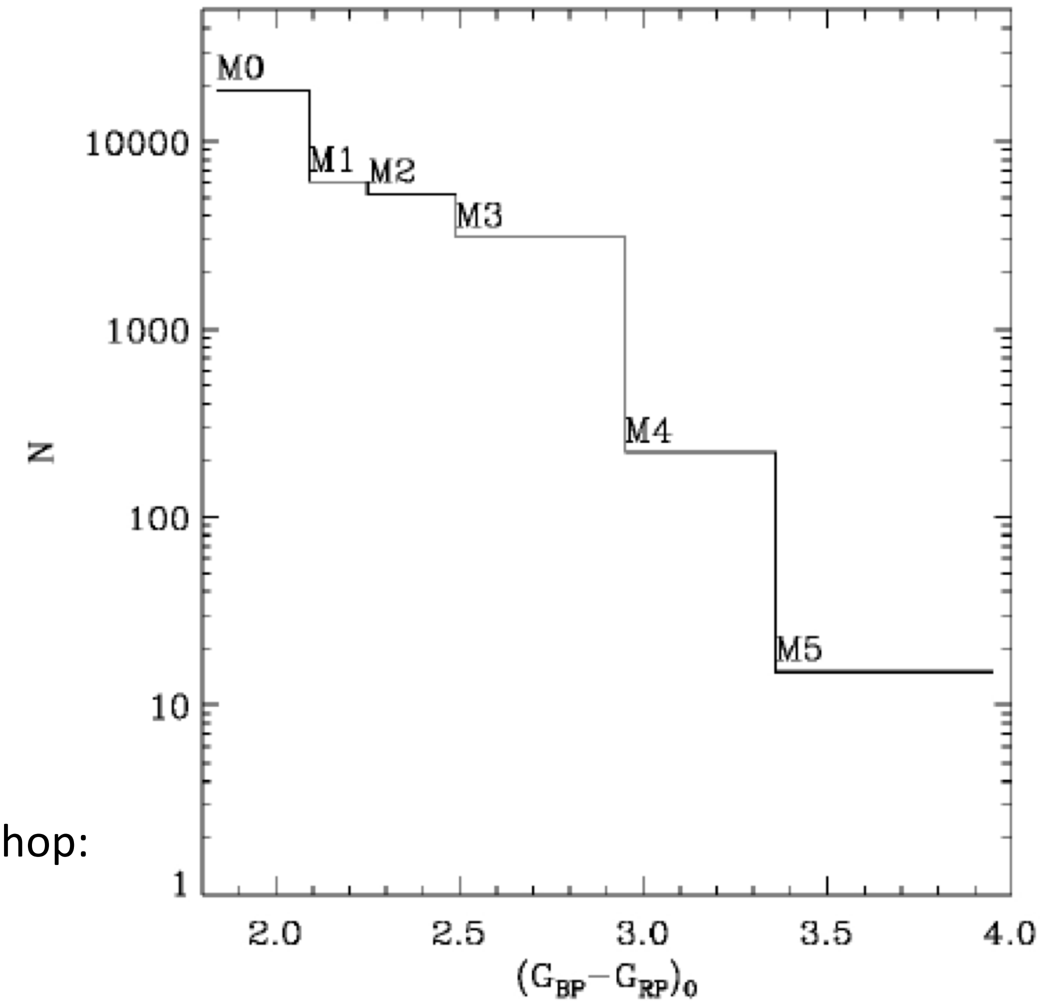
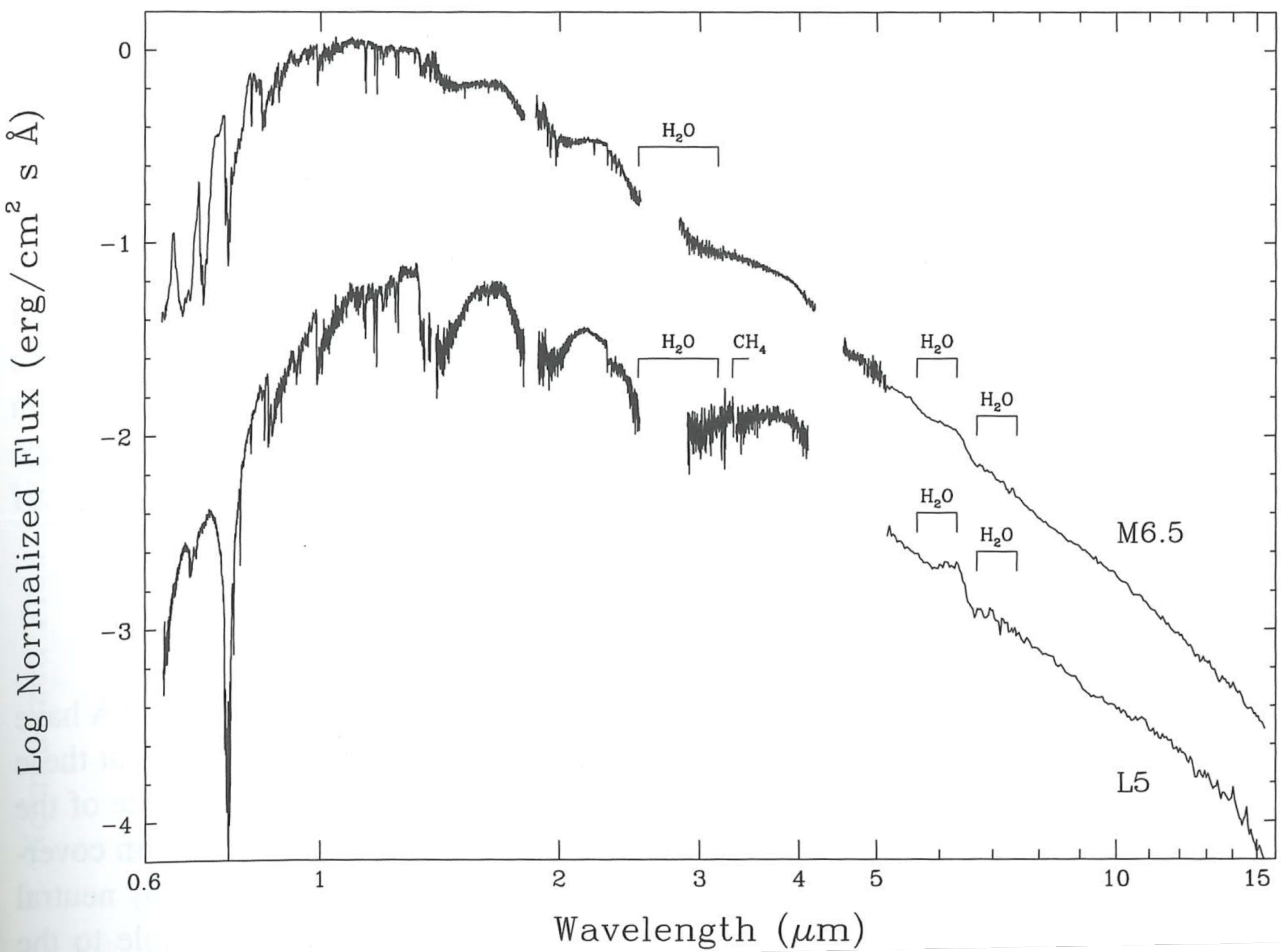


Figure: PLATO Input catalogue workshop:
Cool late-type dwarfs sample 4

Observational difficulties



Whole spectra
M6.6 dwarfs
and L5 dwarf

Figure: Stellar Spectral Classification, by Gray and Corbally 2009

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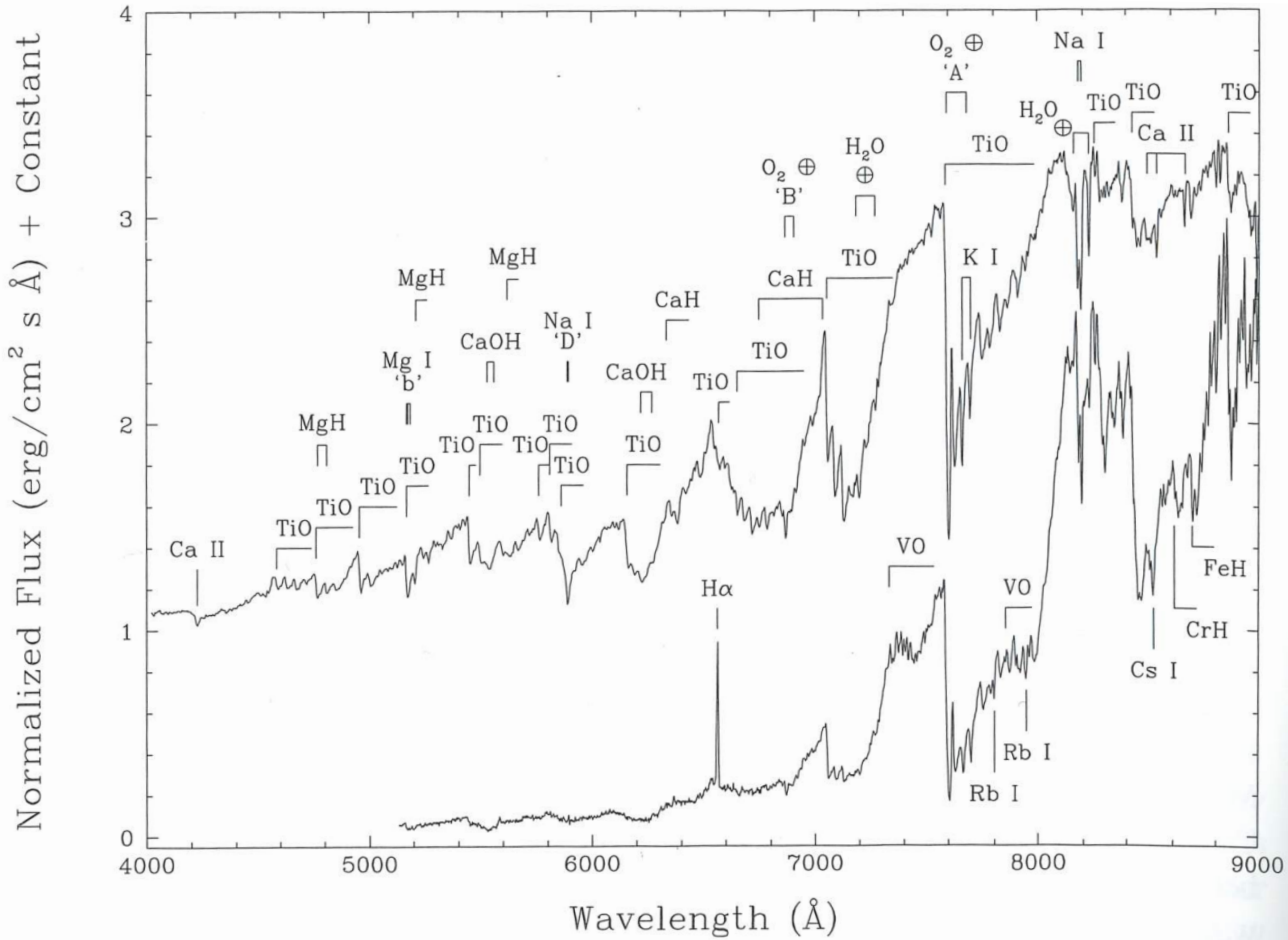
Observational difficulties



Optical wavelengths
M4.5 dwarf and
M9 dwarfs

Figure: Stellar Spectral Classification, by Gray and Corbally 2009

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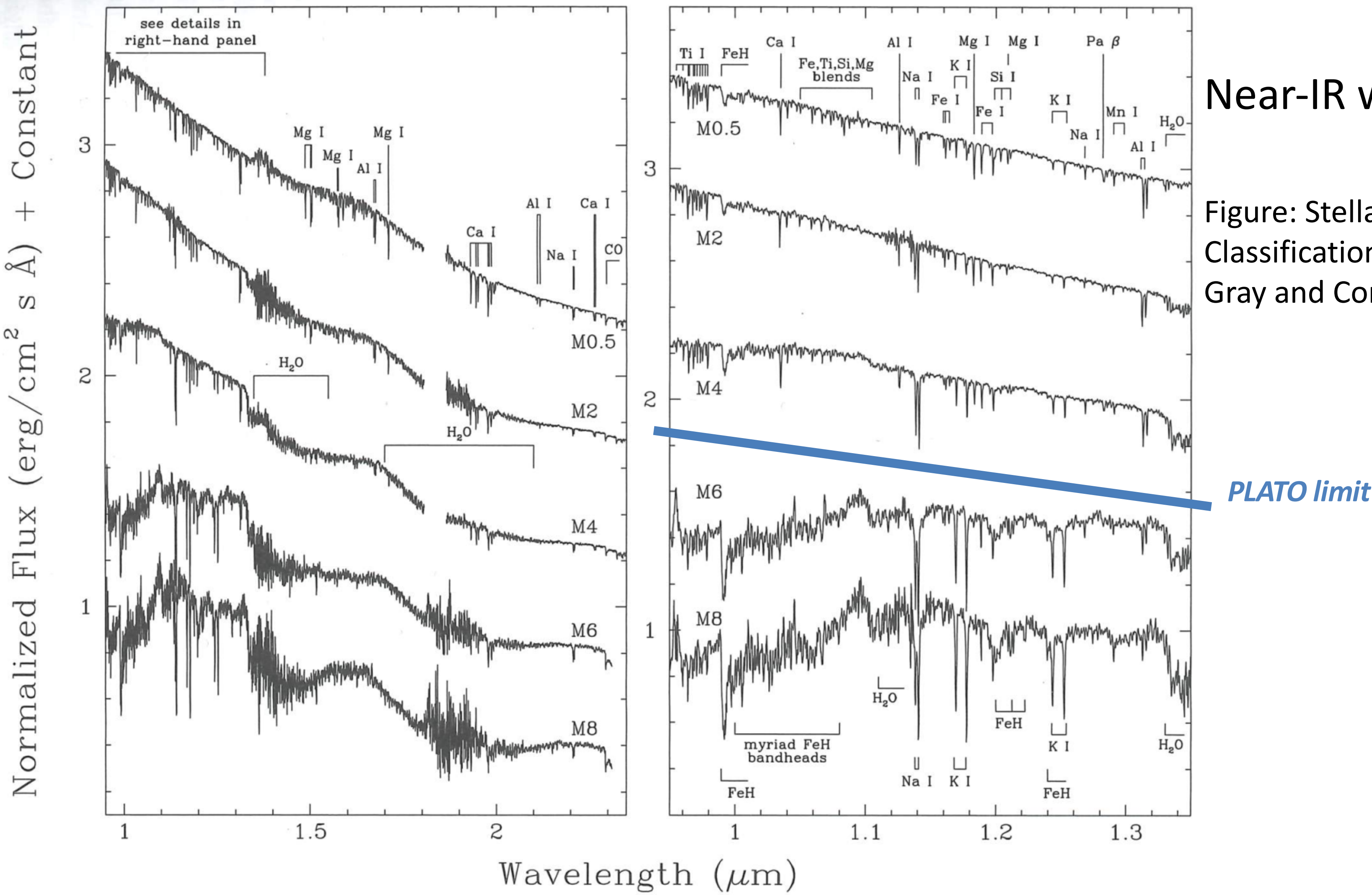
Observational difficulties



Near-IR wavelengths

Figure: Stellar Spectral Classification, by Gray and Corbally 2009

Benchmark stars

- Parameters derived by spectroscopy or photometry

- Constrained by
  - Angular diameter and bolometric flux (T_{eff} and radius)
  - Binarity (mass)
  - Asteroseismology (mass, radii, and ages)
    - Not possible with M dwarfs

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Benchmark M dwarfs for PLATO

- 7 suggested in Gaia-ESO Paper (Pancino et al 2017)
- Need more → need accurate parameters
- Up to M4, in PLATO input catalogue now

Benchmark M dwarfs in Pancino et al. 2017

GJ 205	GJ 581*
GJ 436*	GJ 699
GJ 526	GJ 880*
GJ 551	*Part of comparison sample on later slides

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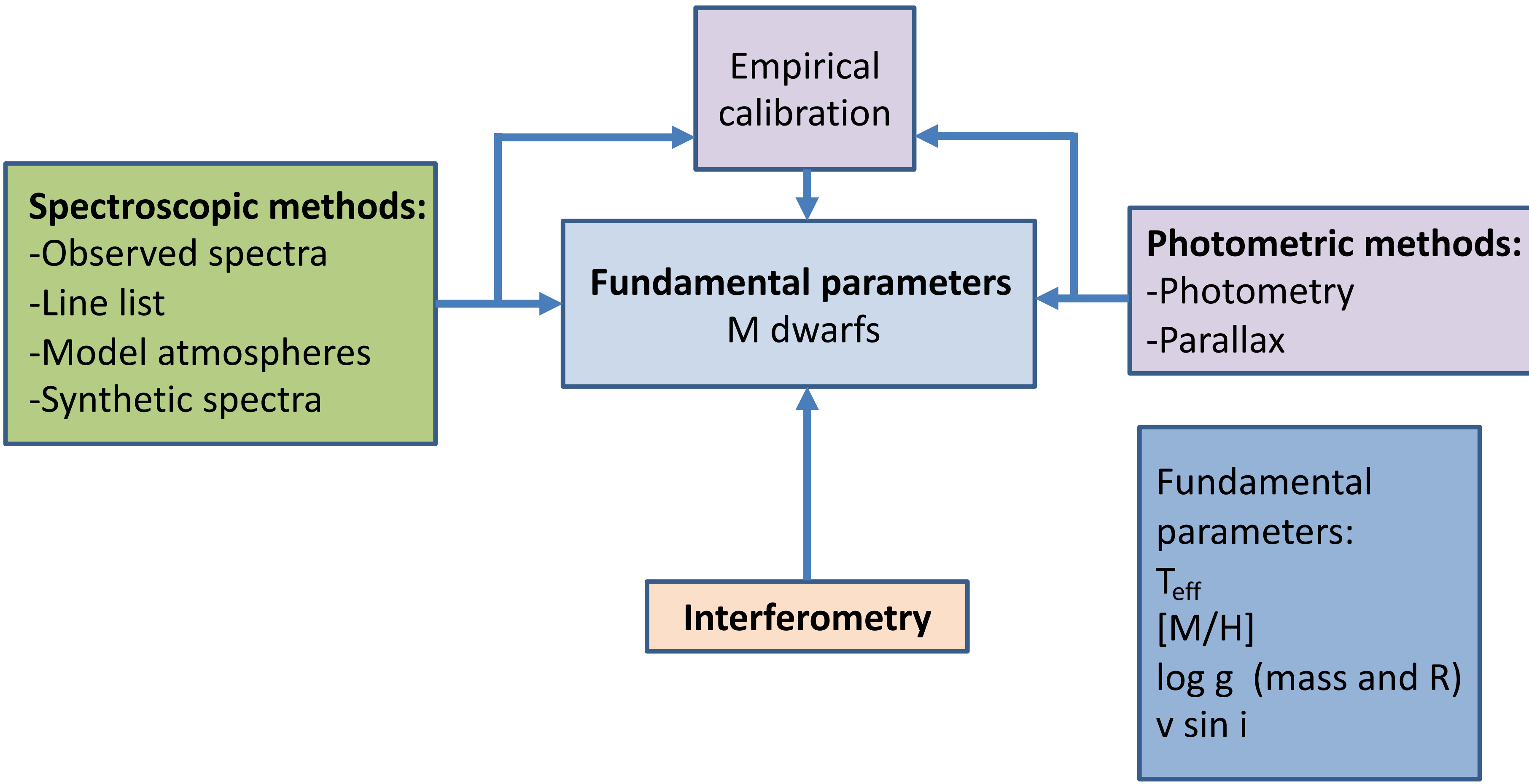
Fundamental parameters of M dwarfs



Spectroscopic methods

Lindgren et al. 2016 & 2017

- 28 stars
- CRIRES at VLT
  - 1.10-1.40 μm
  - R~50 000
- SME with MARCS

Passegger et al. 2018 & 2019

- 300 stars
- CARMENES, and more
  - 0.52-0.96 μm and 0.96-1.71 μm
  - R~94 600 and 80 500
  - 2 wavelength ranges
- PHOENIX-ACES

11 stars overlap

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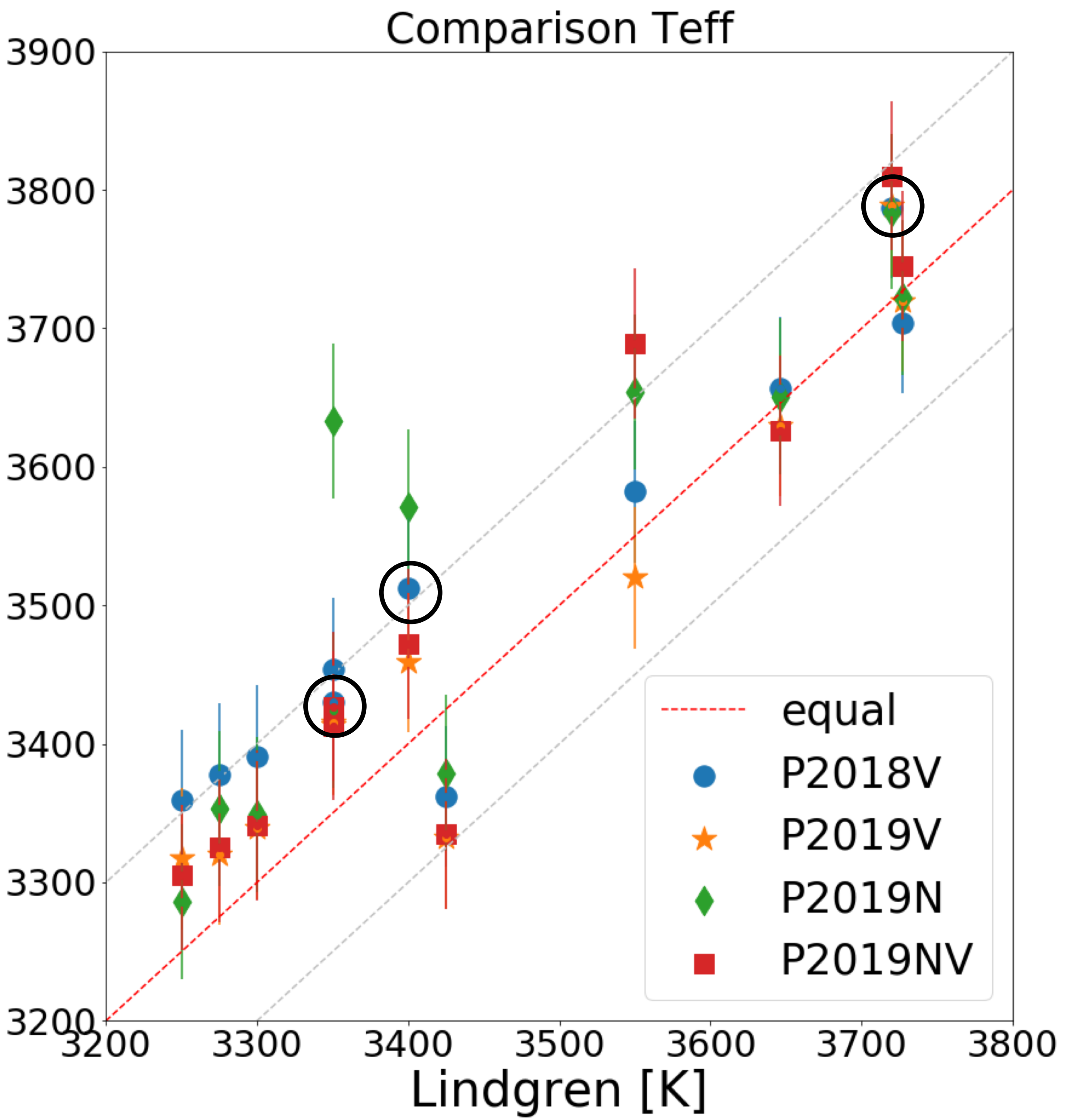
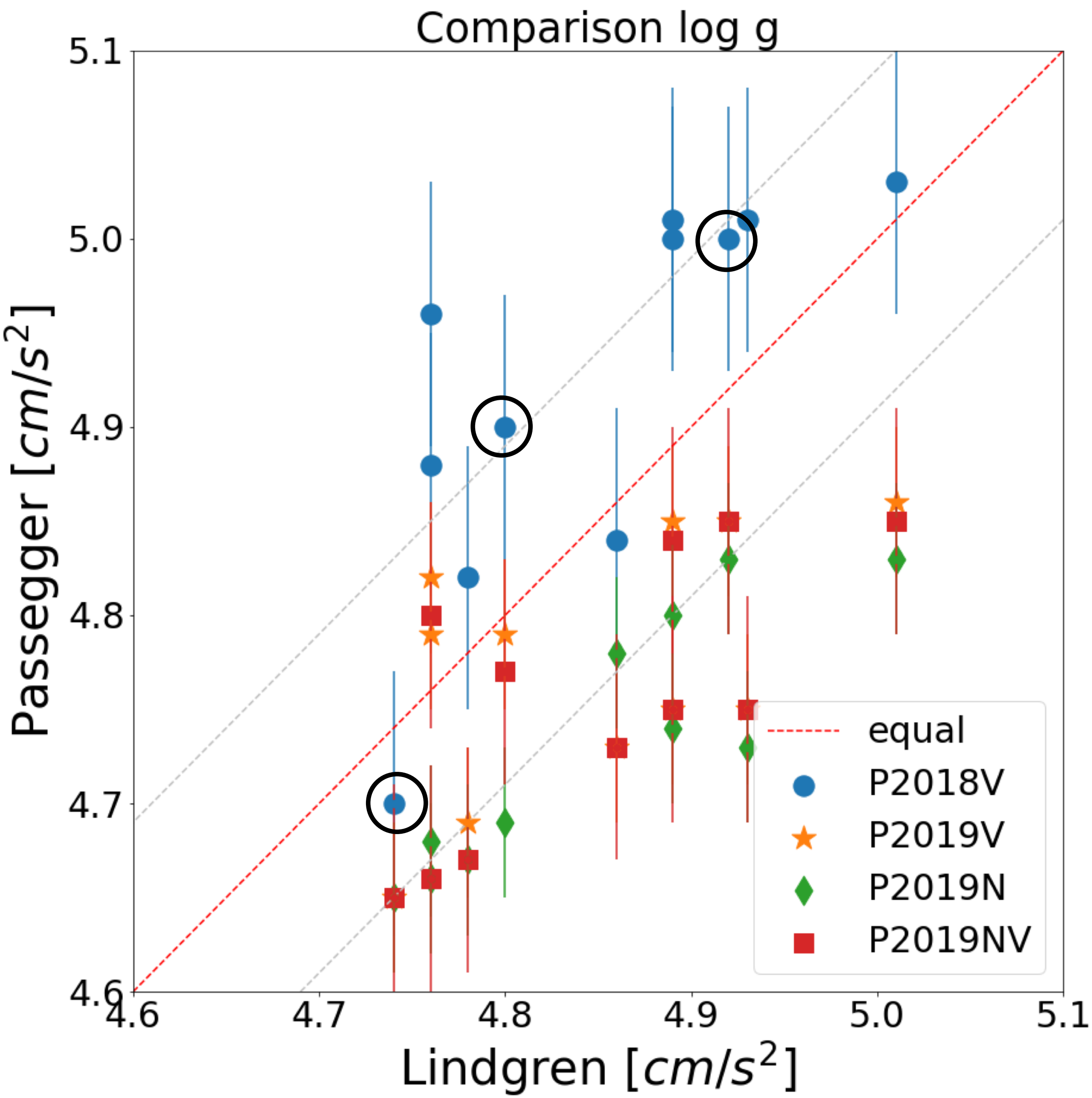
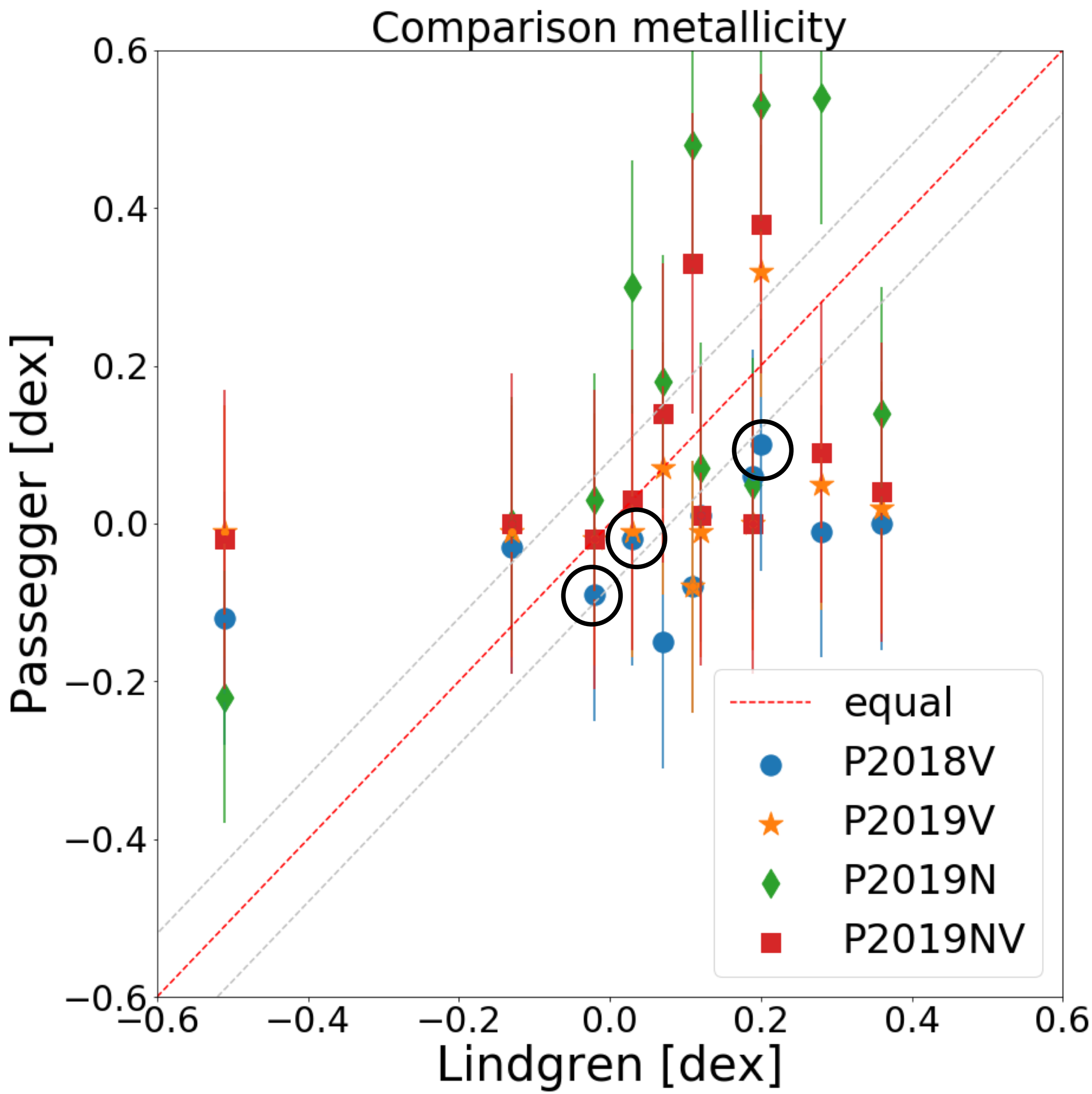
Stellar Parameters



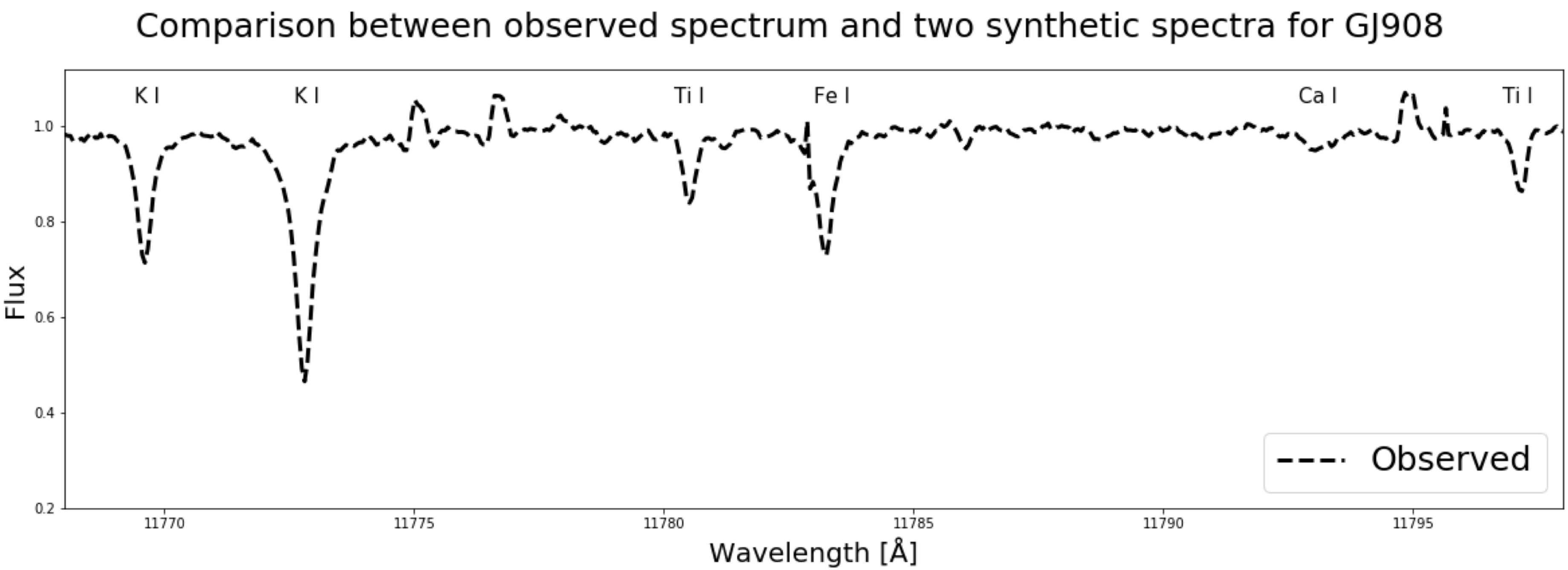
Stellar Parameters



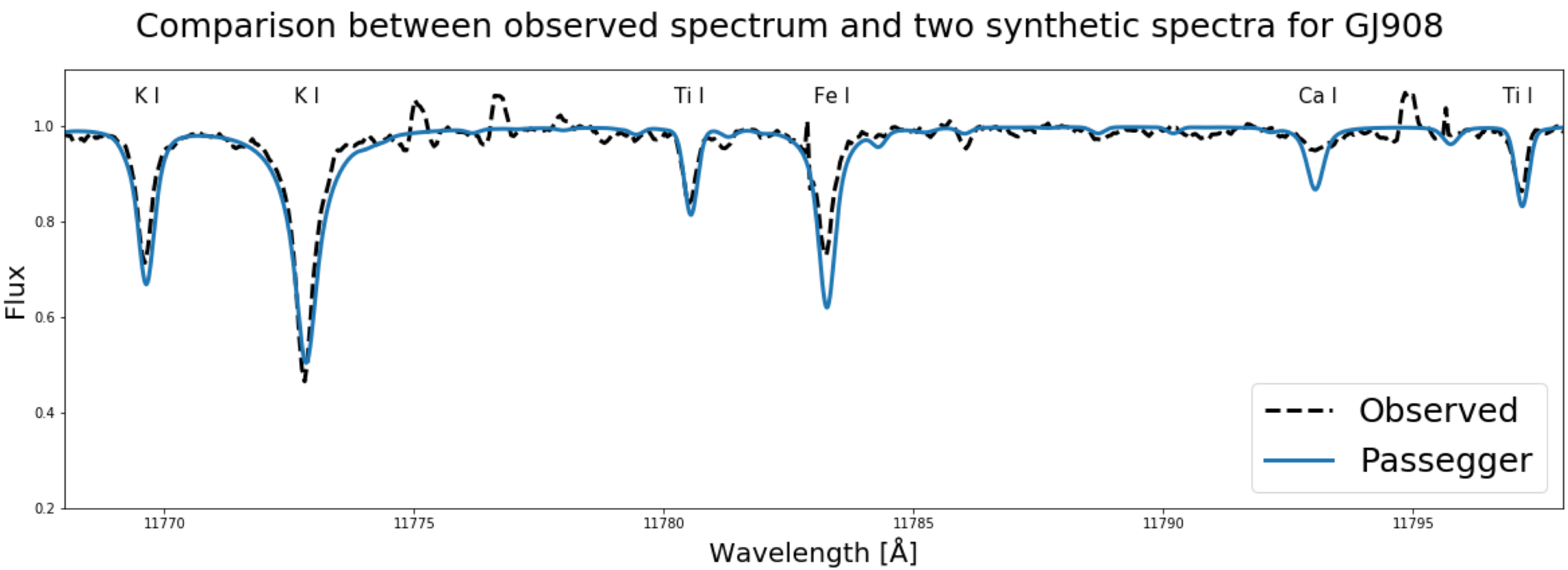
Stellar Parameters



CRIRES spectra of the outlier GJ908

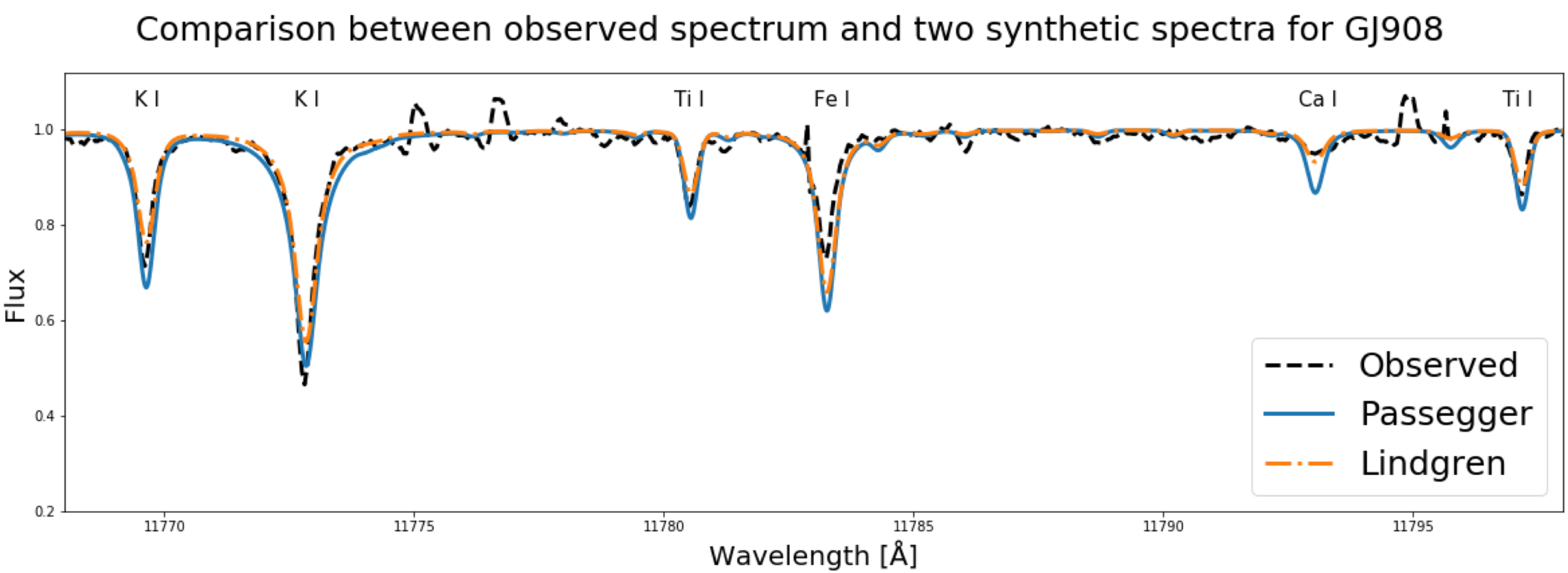


CRIRES spectra and synthetic of GJ908



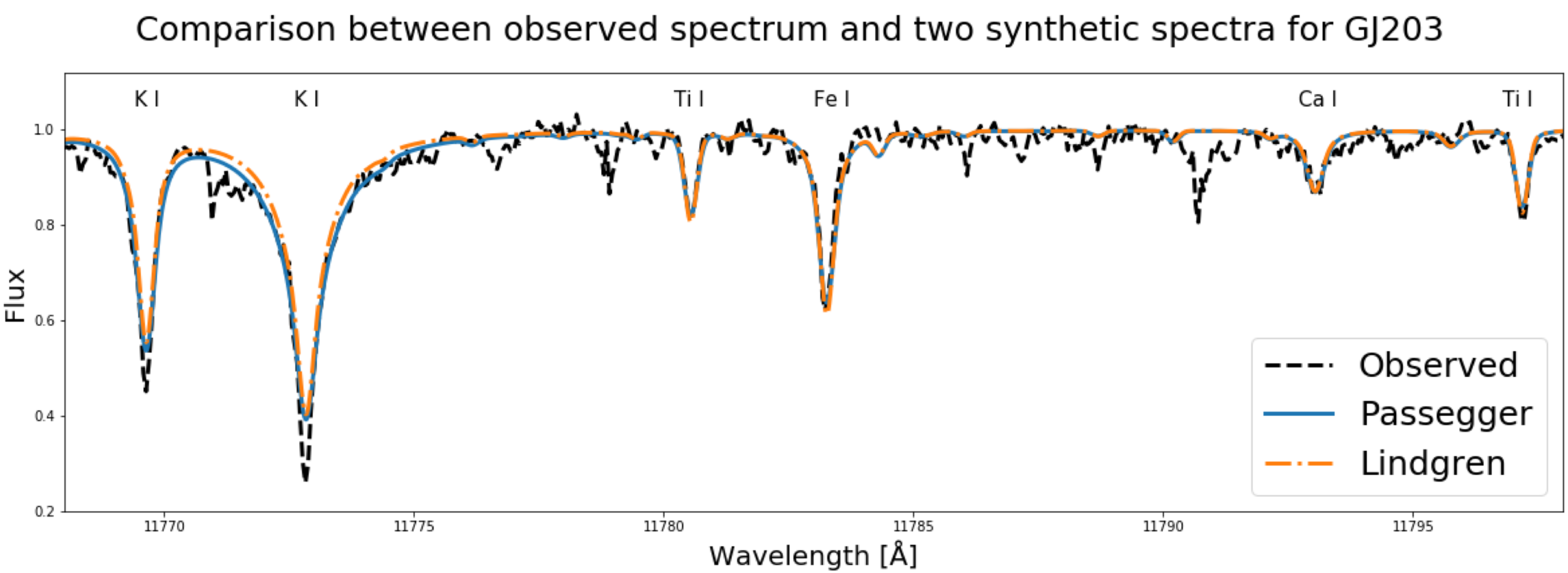
Passegger 2018 Parameters Teff: 3657 K, log g: 4.84 dex, M/H: -0.12

CRIRES spectra and synthetic of GJ908



Passegger 2018 Parameters Teff: 3657 K, log g: 4.84 dex, M/H: -0.12
Lindgren Parameters Teff: 3646 K, log g: 4.86 dex, M/H:-0.51

CRIRES spectra and synthetic of GJ203



Passegger 2018 Parameters Teff: 3362 K, log g: 5.03 dex, M/H: -0.03
Lindgren Parameters Teff: 3425 K, log g: 5.01 dex, M/H: -0.13

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Result

- Compared line core and line wings
  - Very rough first result

    Lindgren et al. 2016 and 2017 better fit in line core

    Passegger et al. 2018 better fit in line wings

- Compared parameters
  - Stars with “smallest” difference → candidate benchmark

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Conclusion and outlook

- Currently, no exhaustive list of benchmark M dwarfs
- Different methods give different parameters.
- Apply improved method on GIANO spectra (30 stars).

- New candidate Benchmark M dwarfs
  - GJ203^
  - GJ514^*
  - (GJ876^*)

^ In Gaia data release 2

* In Mann et al. 2015 and Cruzalèbes et al. 2019

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Thank you!

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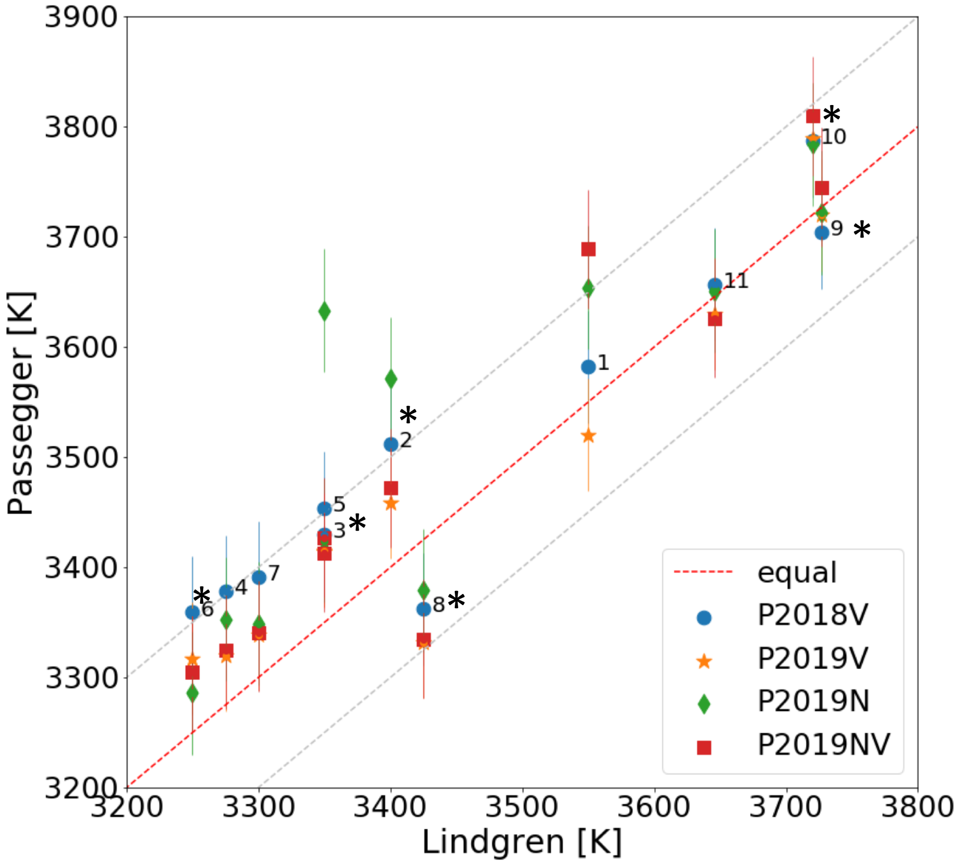
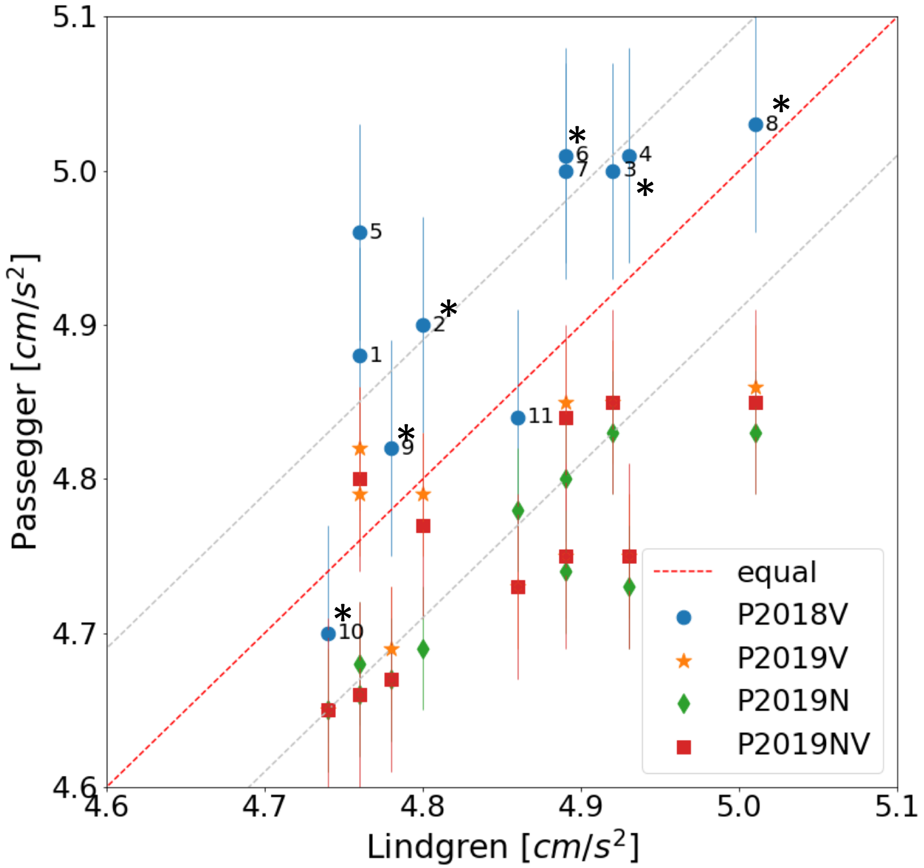
Stellar Parameters

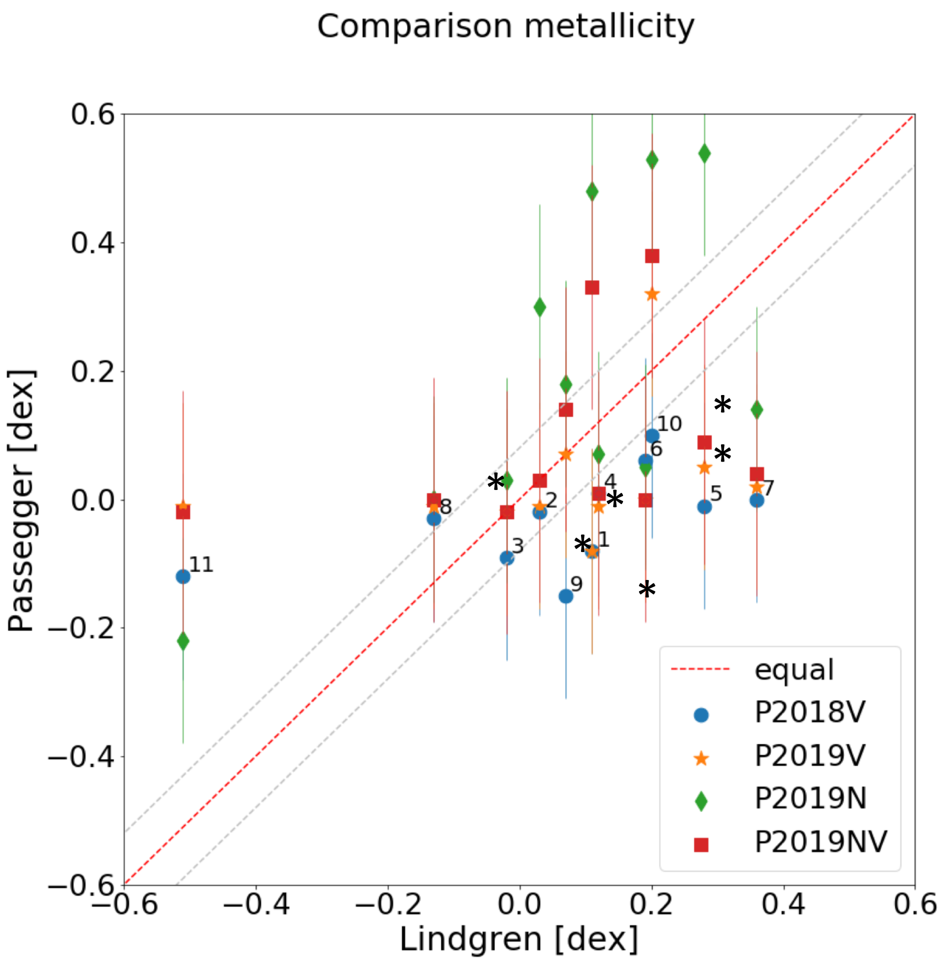
Comparison Teff



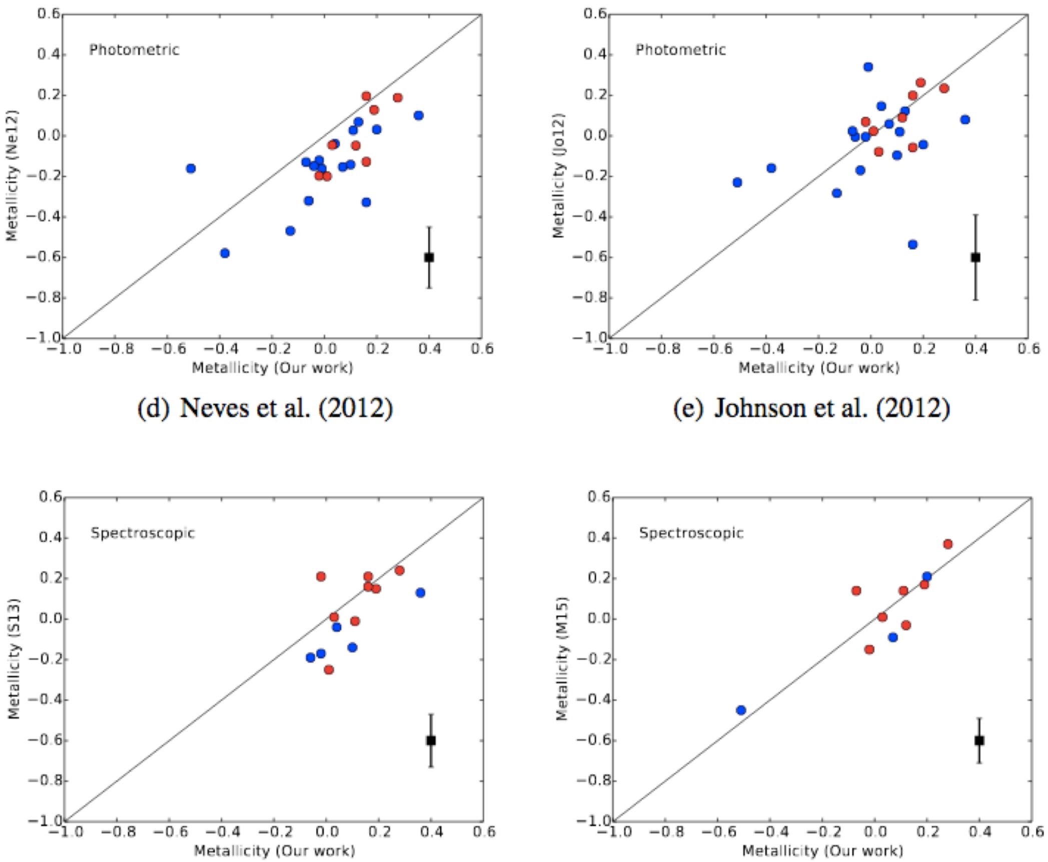
Comparison log g



Stellar Parameters



Spectroscopic compared to photometric



(d) Neves et al. (2012)

(e) Johnson et al. (2012)

(f) Rojas-Ayala et al. (2012)

(g) Santos et al. (2013)

(h) Mann et al. (2015)

Figure: Lindgren et al 2017