

Detailed Chemical Analysis of M dwarfs

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With

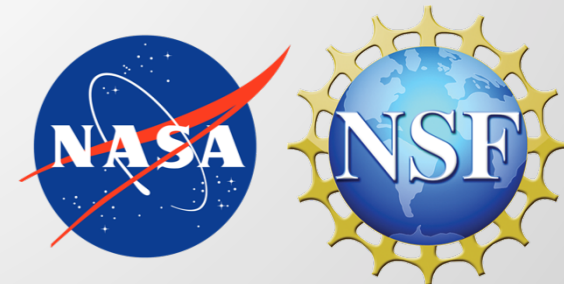
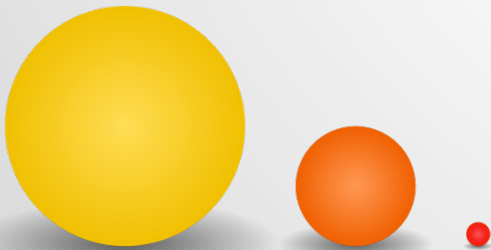
Philip Muirhead (Boston Univ)

Andrew Mann (Columbia)

John Brewer (Yale)

France Allard (Univ Lyon)

and Derek Homeier (Univ Heidelberg)

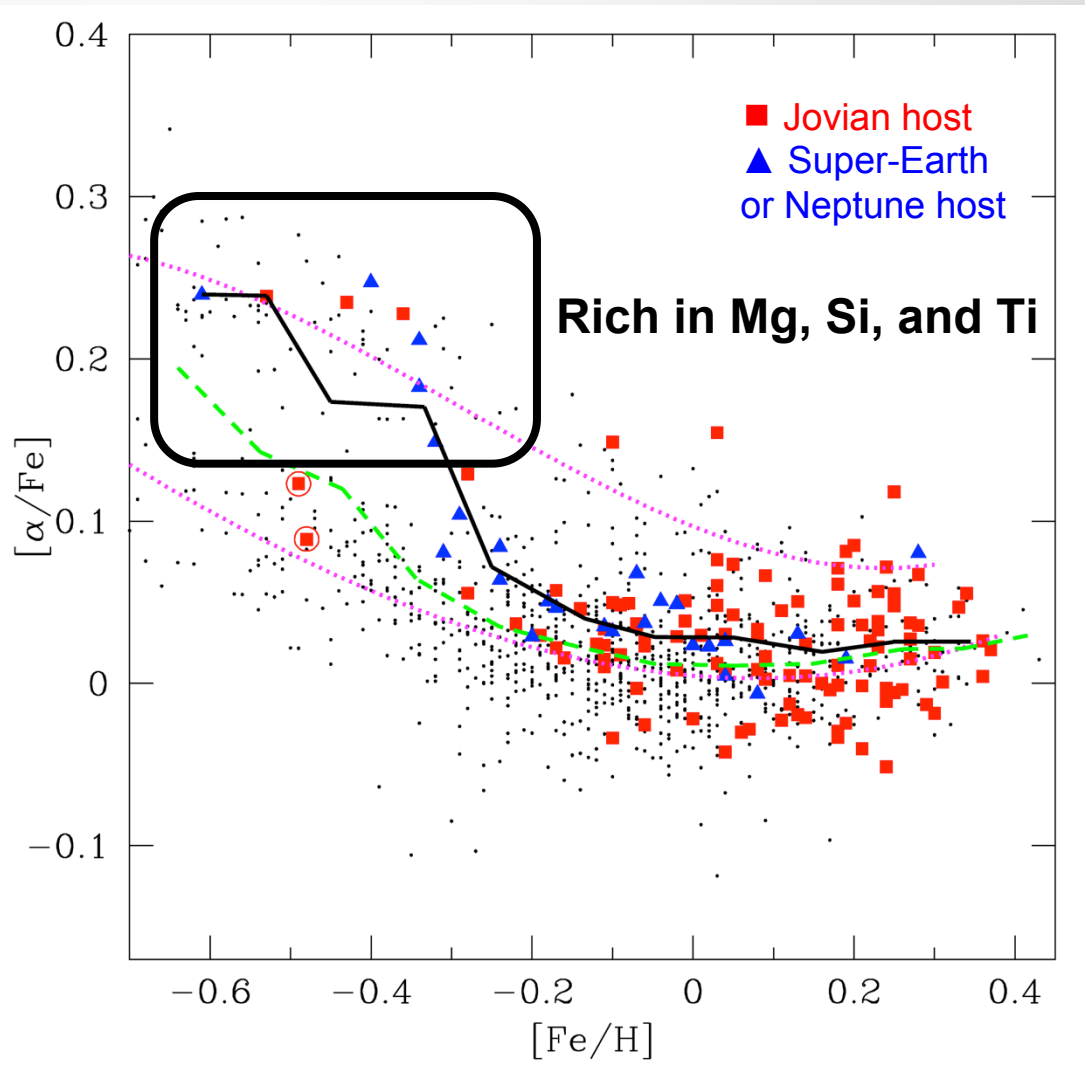


Host star composition holds clues for planet formation

Stellar abundances play an important role in constraining planet formation theories.

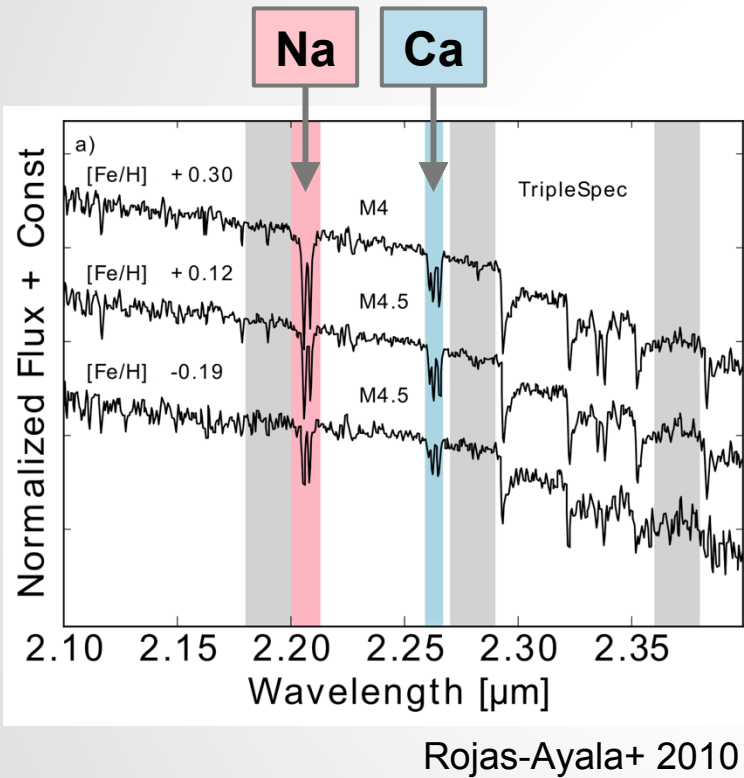
So far, the focus has largely been on Sun-like FGK stars.

Can we use current M dwarf stellar atmosphere models to directly measure abundances?

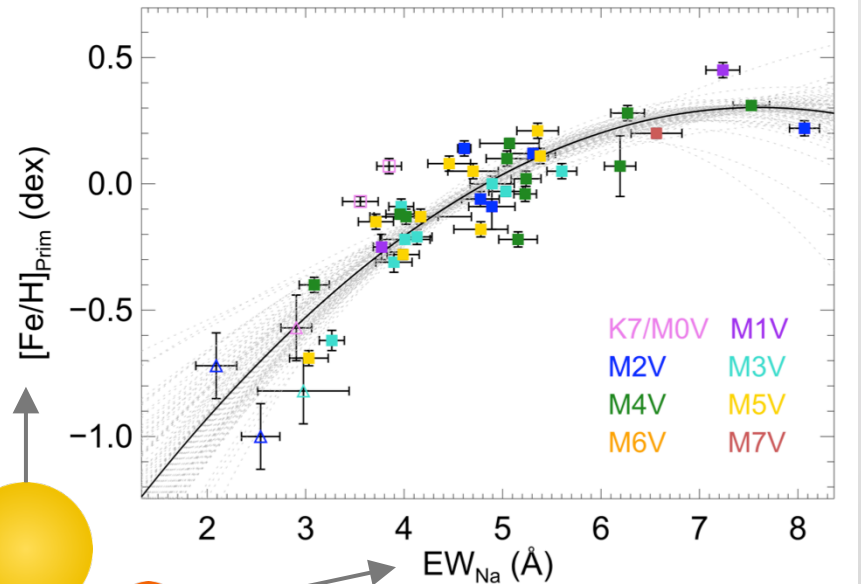


Adibekyan+ 2012

Empirically-calibrated M dwarf metallicities



FGK+M systems can be used to empirically calibrate methods to measure M dwarf metallicity.



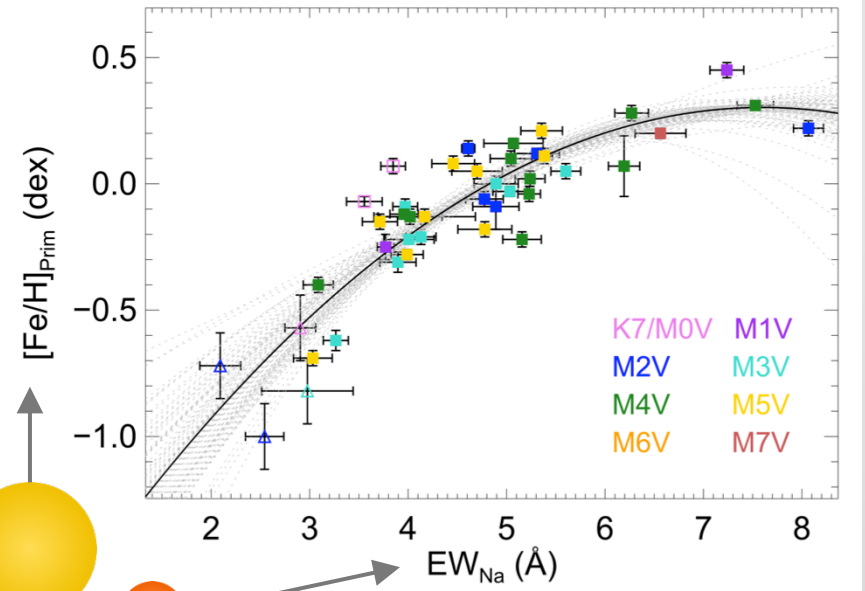
Empirically-calibrated M dwarf metallicities

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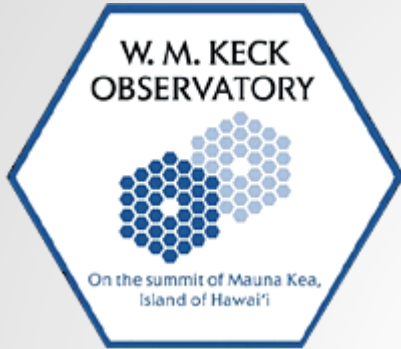
Two improvements:

Measure Fe abundance directly from Fe lines.

Use BT-Settl models to go from equivalent widths to abundances



A high-resolution, NIR calibration sample



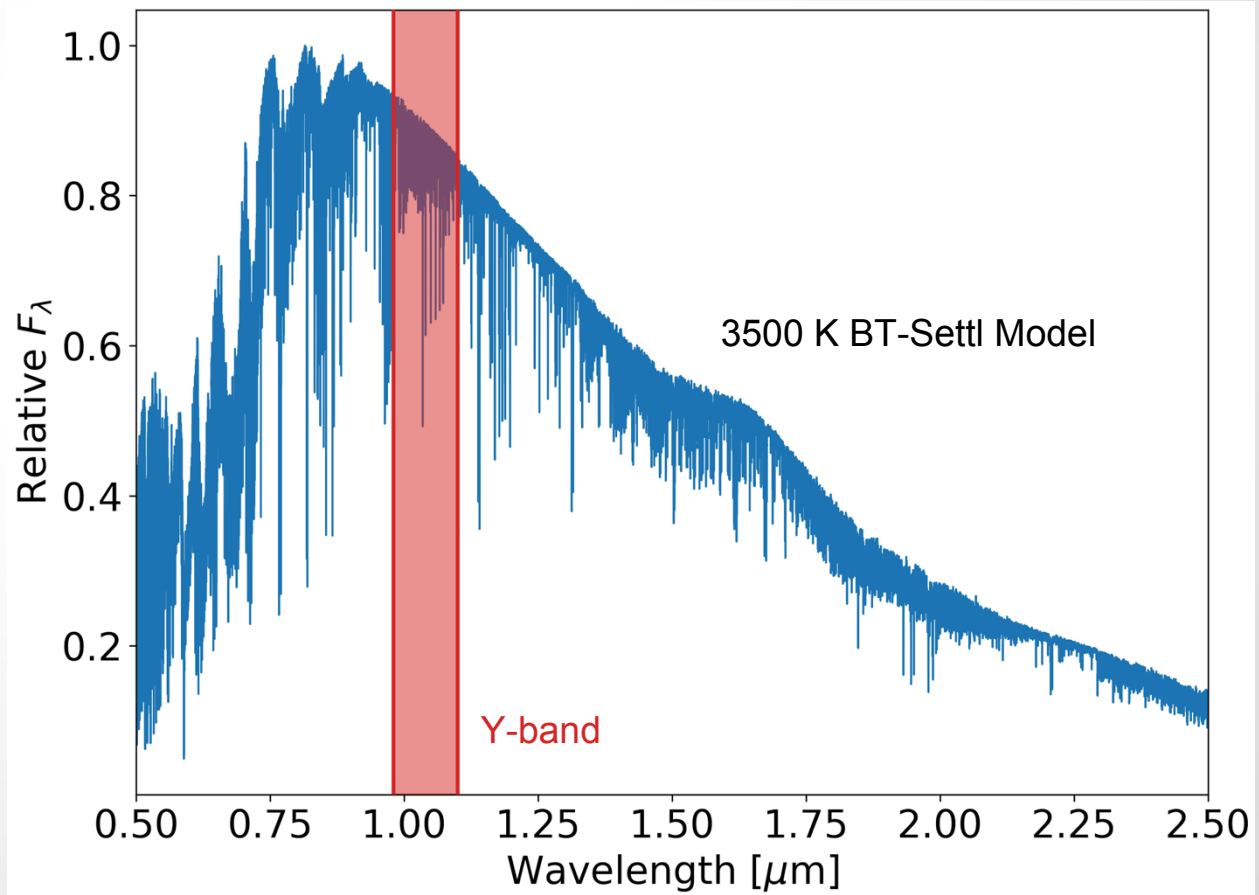
NIRSPEC on Keck allows us to measure high-S/N, high-resolution, Y-band spectra

We obtained Y-band spectra for 29 M dwarfs in wide FGK+M systems

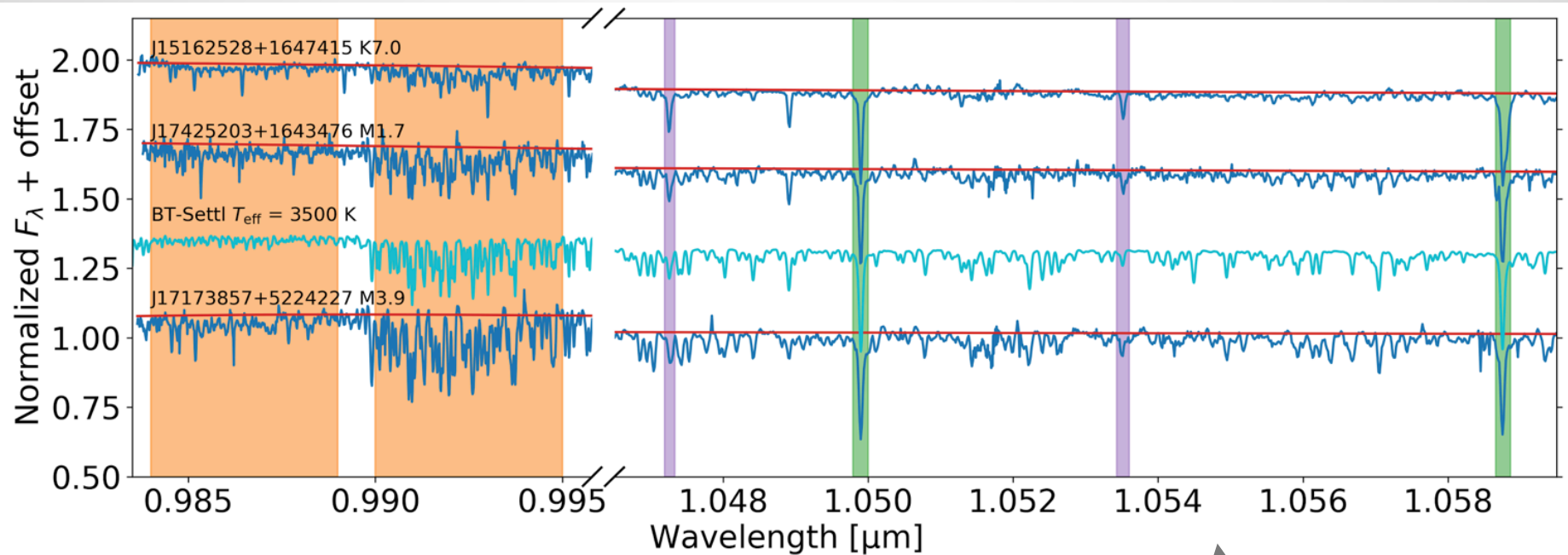
Sample spans K7 to M4

Abundances from John Brewer's analysis of FGK primaries.

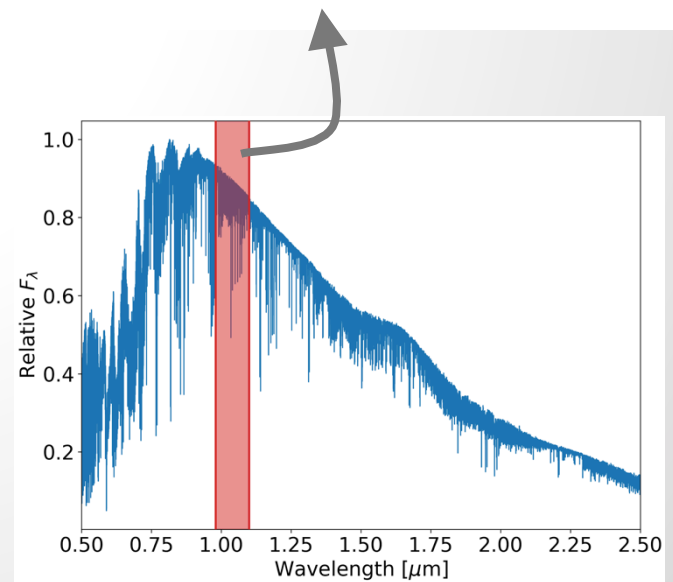
M dwarf temperatures from Mann+ 2015.



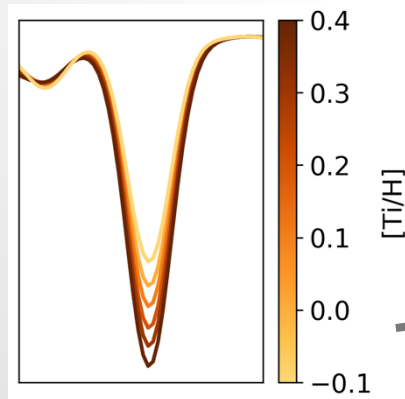
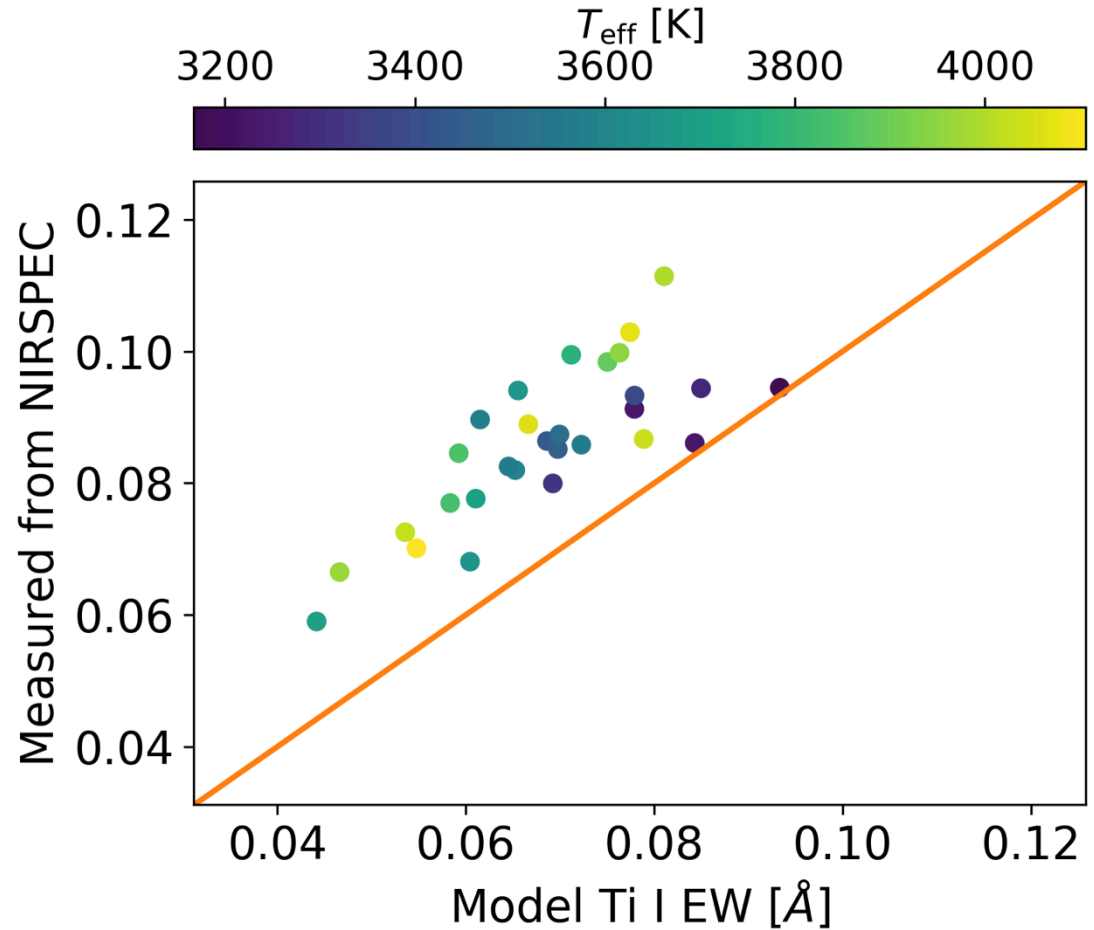
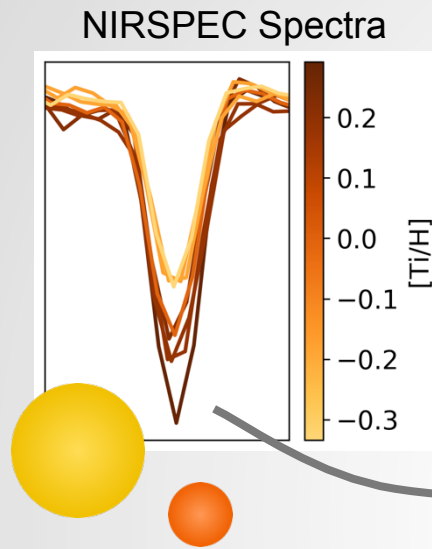
Y-band contains many strong Fe and Ti lines.



- 1x **FeH Band**
- 7x **Fe I Line**
- 10x **Ti I Line**



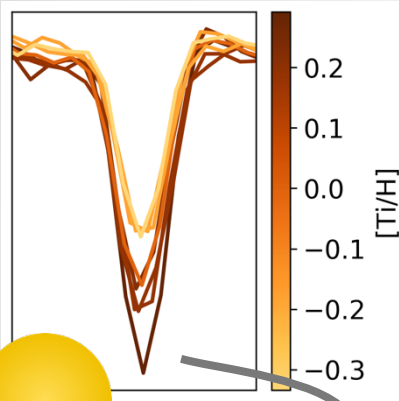
Models do not predict the right line strengths out of the box



PHOENIX BT-Settl Models

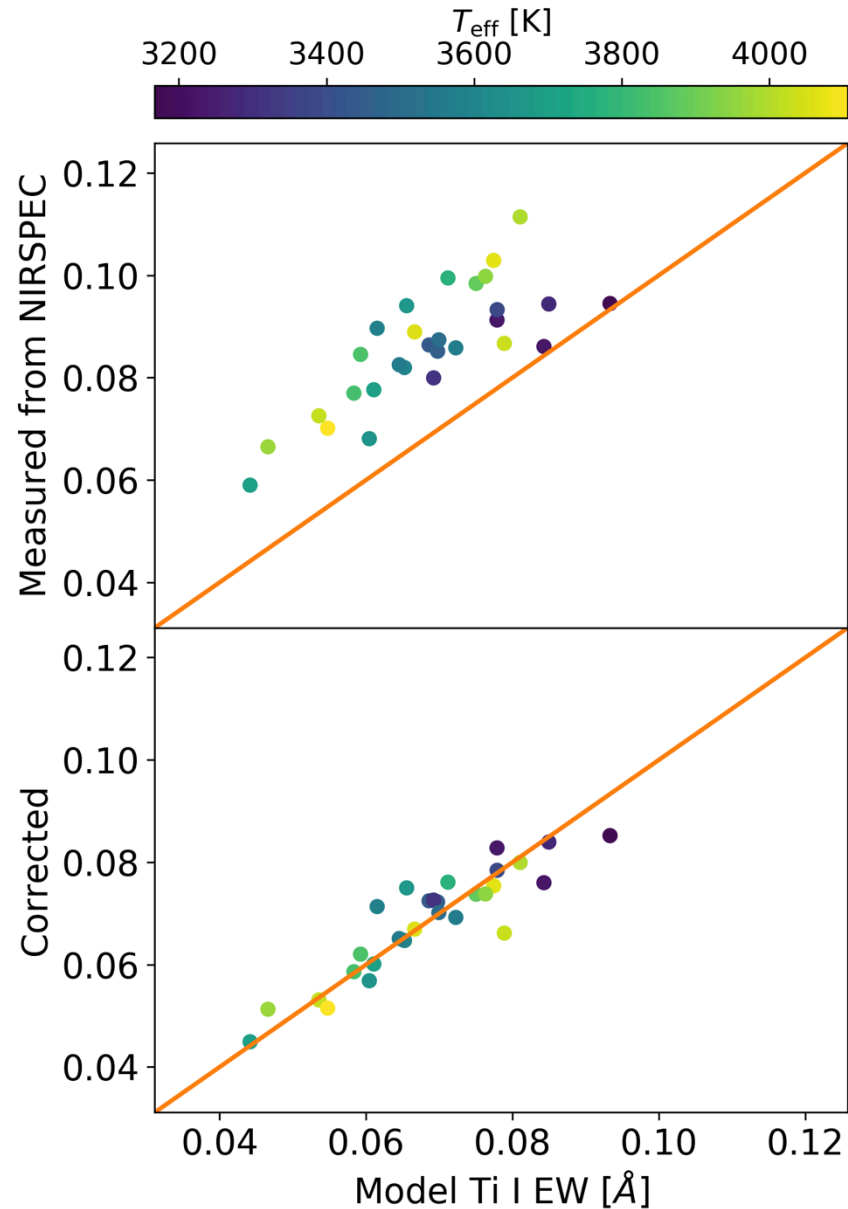
But we can calibrate them the FGK+M systems

NIRSPEC Spectra

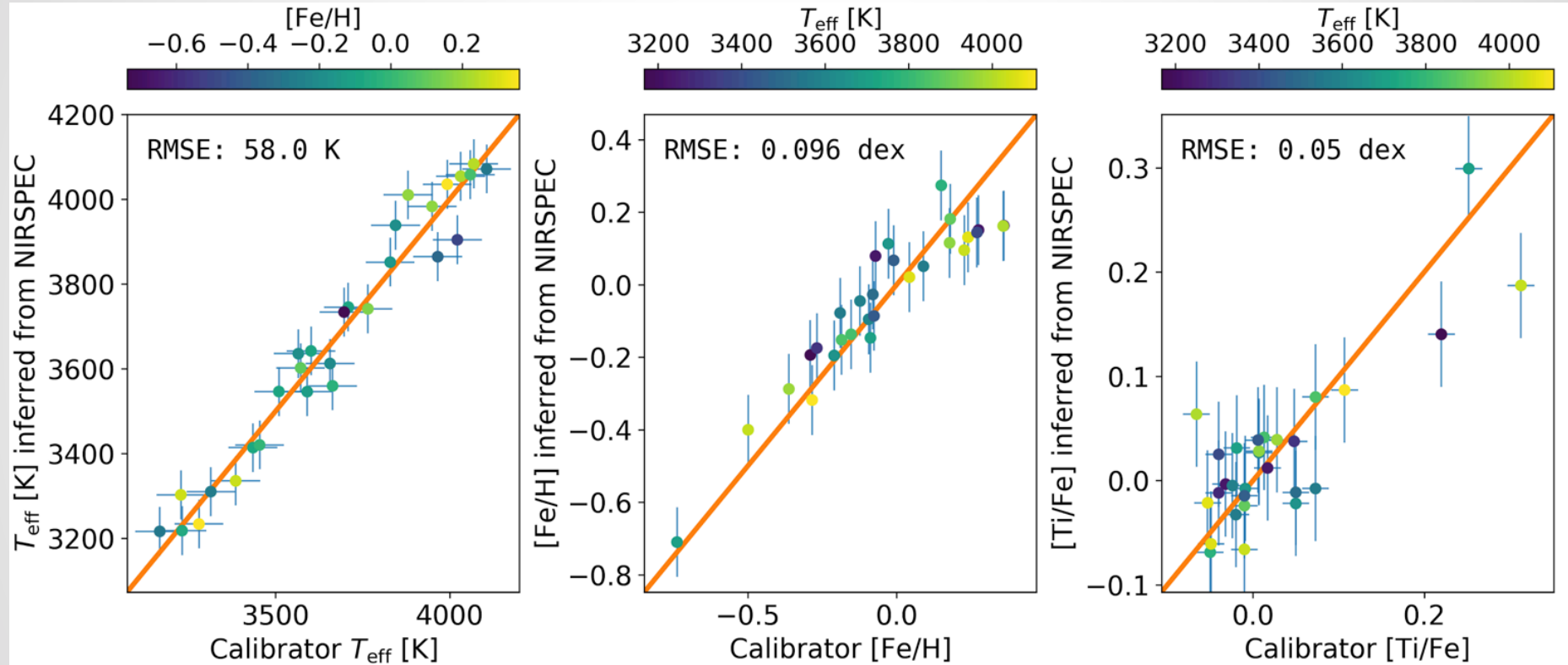


$$EW'_{Ti} = c_1 + c_2 EW_{Ti} + c_3 I_{FeH}$$

Simple corrections are enough to bring observations and models into agreement



We can directly measure abundances of individual elements



Takeaway

Can we use current M dwarf stellar atmosphere models to perform detailed chemical analysis?

Yes...

But only after calibrating them with benchmark FGK+M systems.



Looking to the future:



**The Habitable Zone
Planet Finder**

**High-resolution NIR RV surveys will
test if these abundance trends hold
for planet-hosting M dwarfs**

