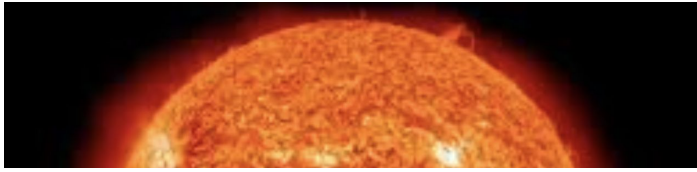


Solar-stellar connection



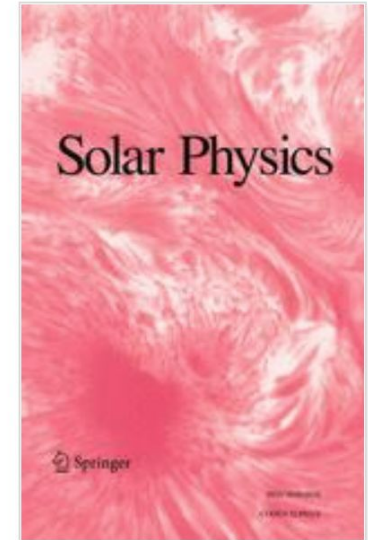
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Irradiance Variations of the Sun and Sun-like Stars

ISSN: 0038-0938 (Print) 1573-093X (Online)

In this topical collection (12 articles)



Editor's Choice

Non-Equilibrium Spectrum Formation Affecting Solar Irradiance

Robert J. Rutten

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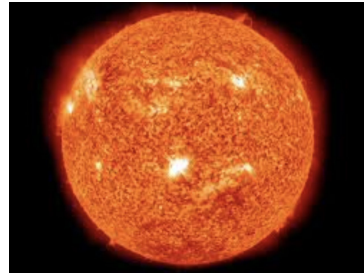
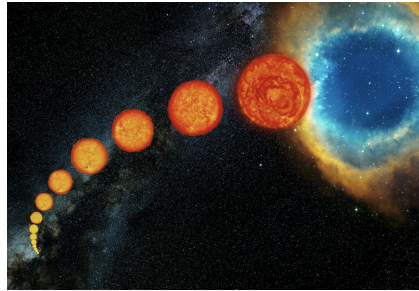
Article:165

OriginalPaper

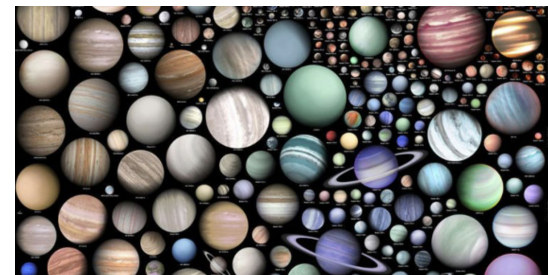
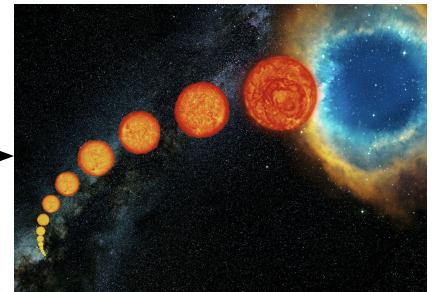
Neural Network for Solar Irradiance Modeling (NN-SIM)



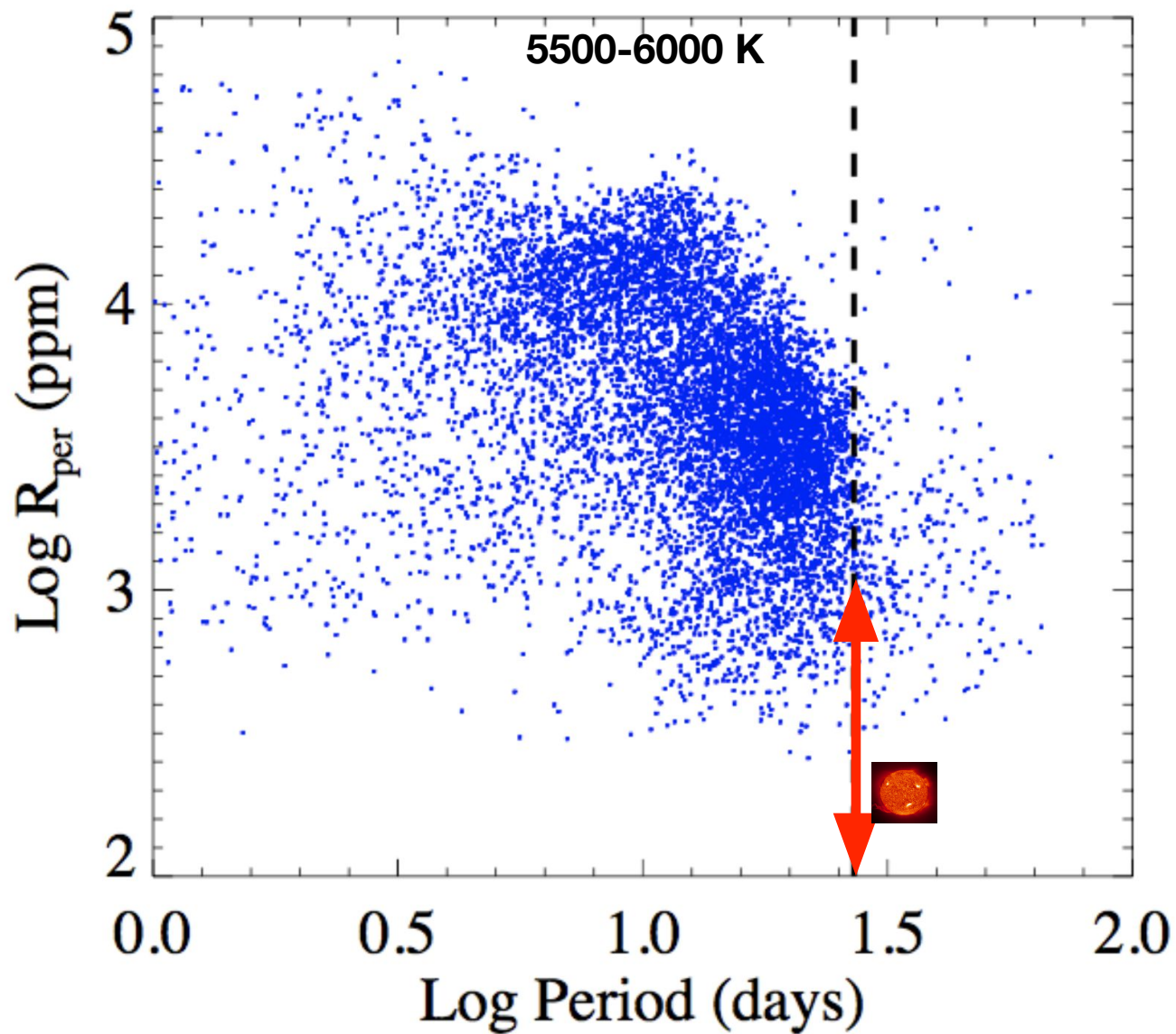
I.



II.



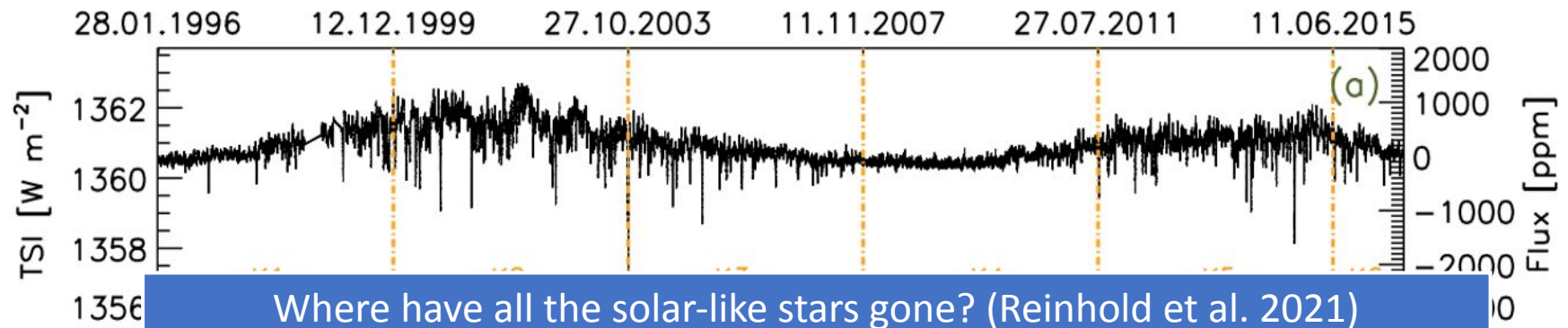
Is the Sun unusually quiet?!



$R_{\text{stars}} = 0.36\%$

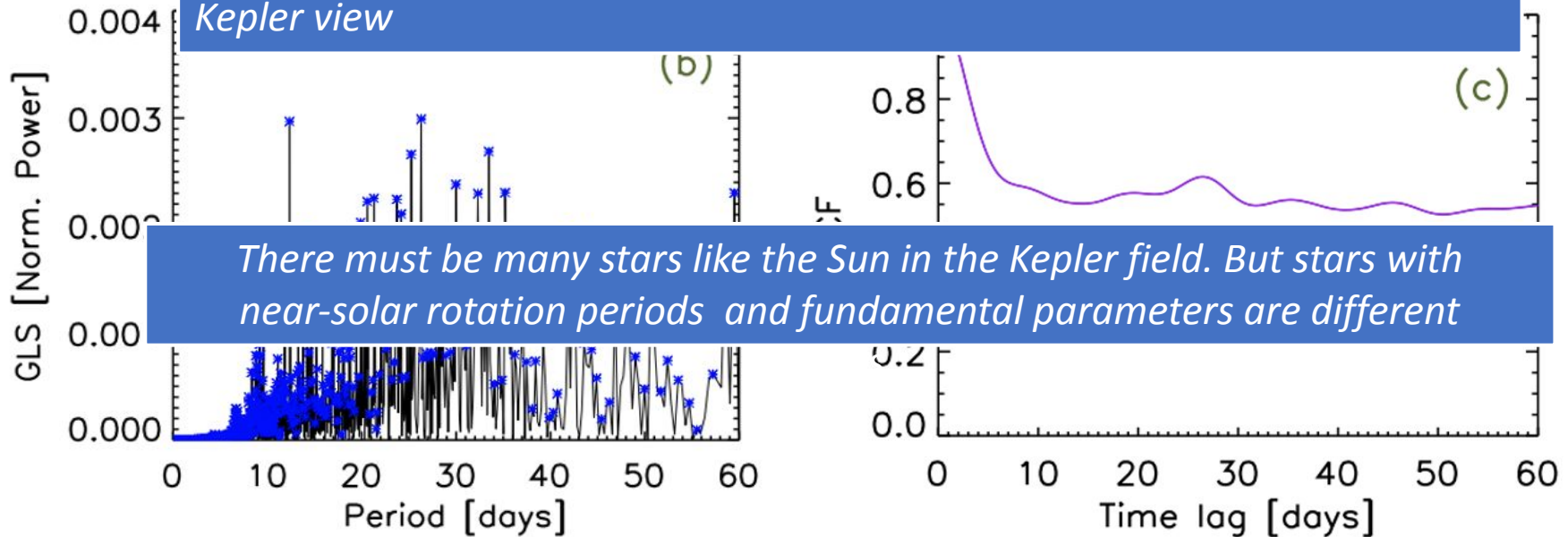
$R_{\text{Sun}} = 0.07\%$

Suns in the Kepler field



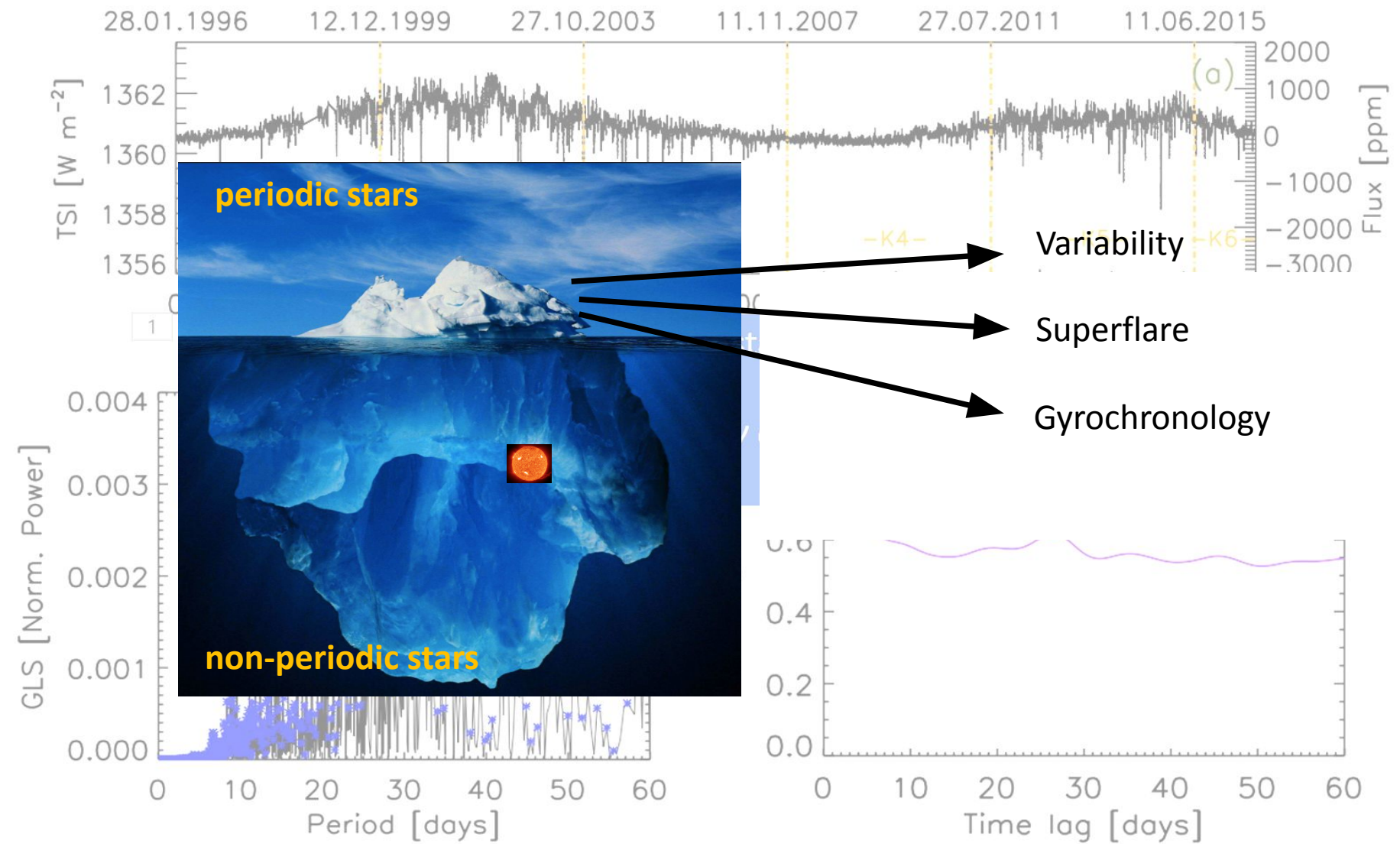
Where have all the solar-like stars gone? (Reinhold et al. 2021)

*The rotation periods can be correctly detected for only **3%** Suns in the Kepler view*



There must be many stars like the Sun in the Kepler field. But stars with near-solar rotation periods and fundamental parameters are different

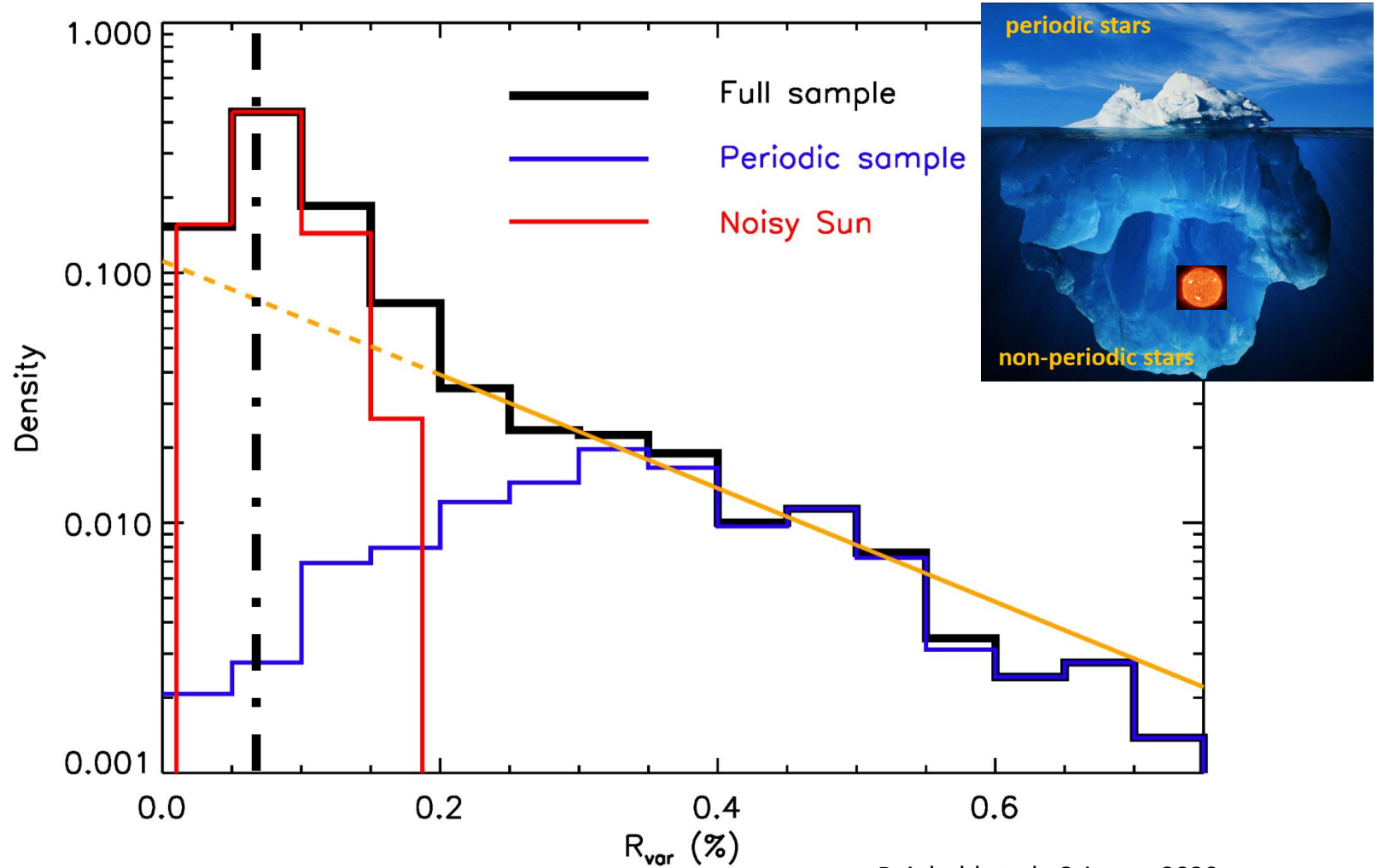
Suns in the Kepler field



Distribution of stellar variabilities

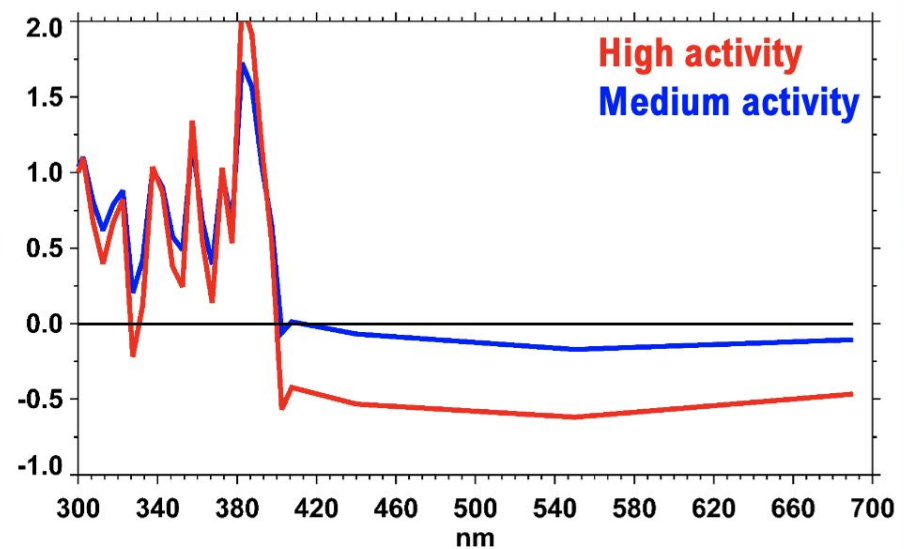
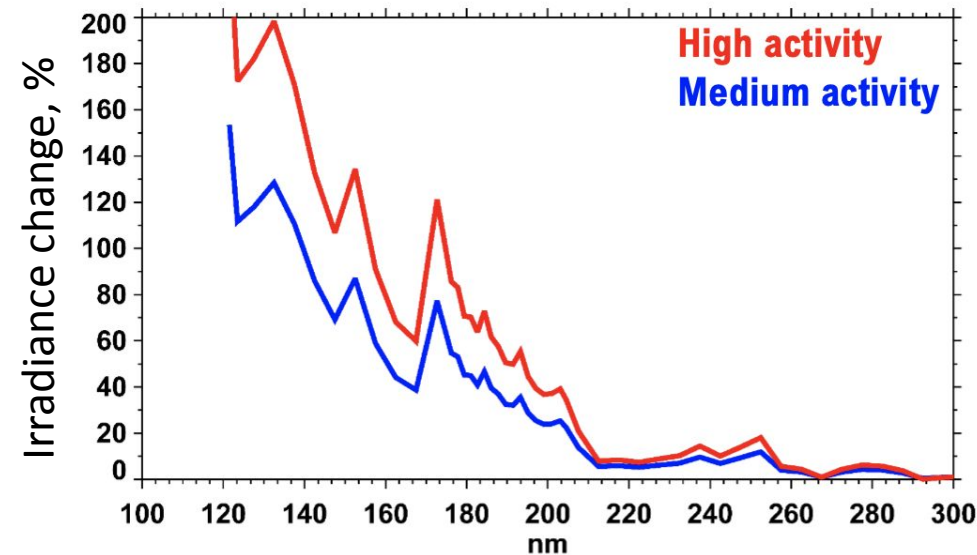
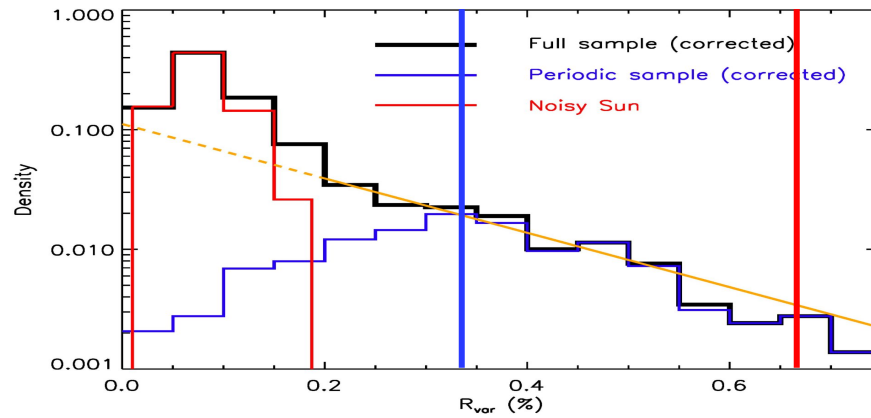
2529 stars with unknown rotation periods

369 stars with $20 \text{ d} < P_{\text{rot}} < 30 \text{ d}$



Reinhold et al., Science, 2020

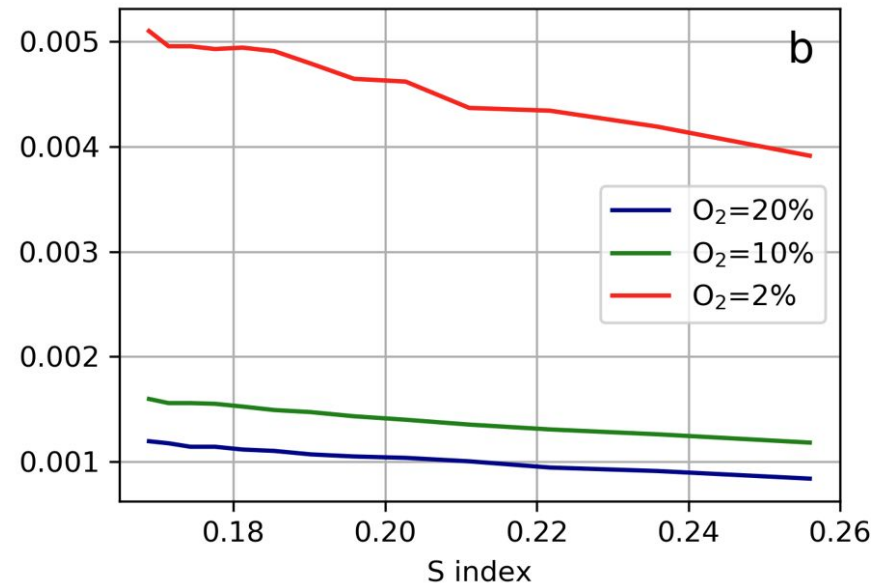
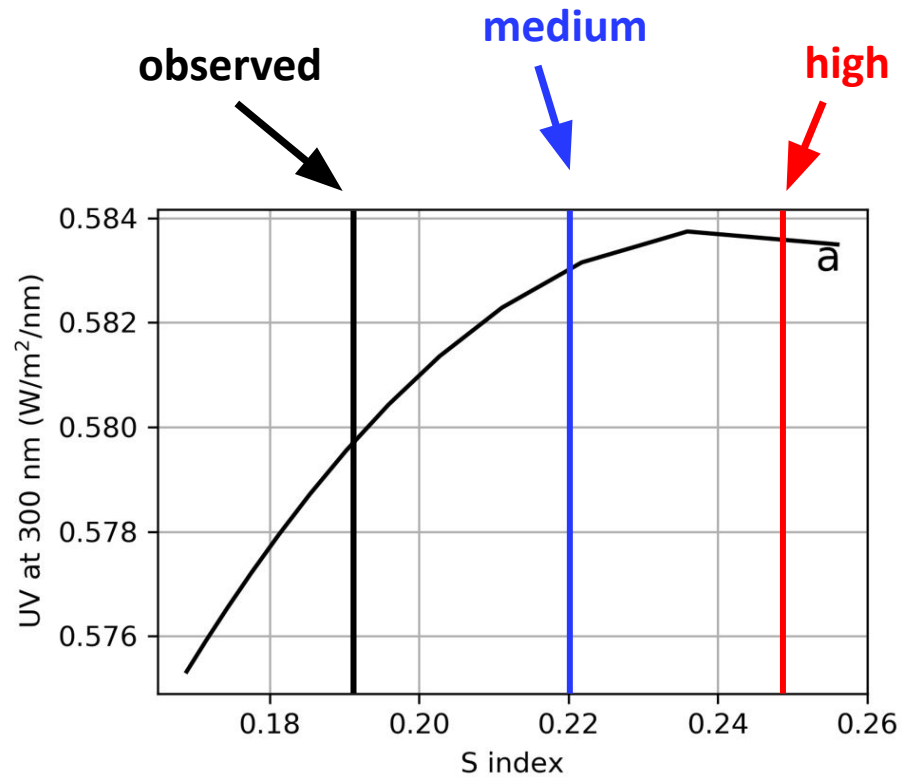
How would irradiance from a very active Sun look?



TSI=-0.3 W/m² (0.02%)

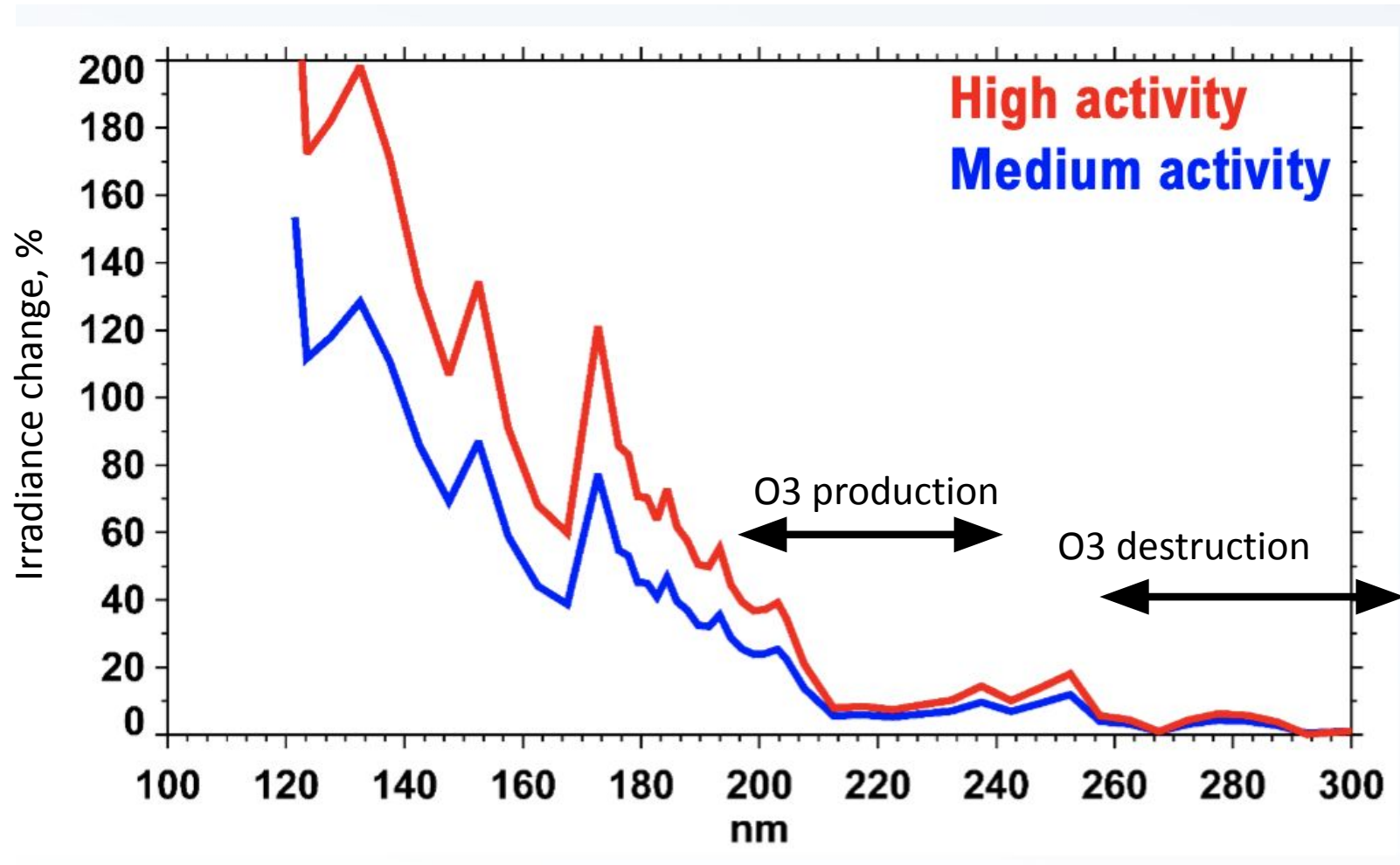
TSI=-4.4 W/m² (0.3%)

Anticorrelation of the space and ground UV

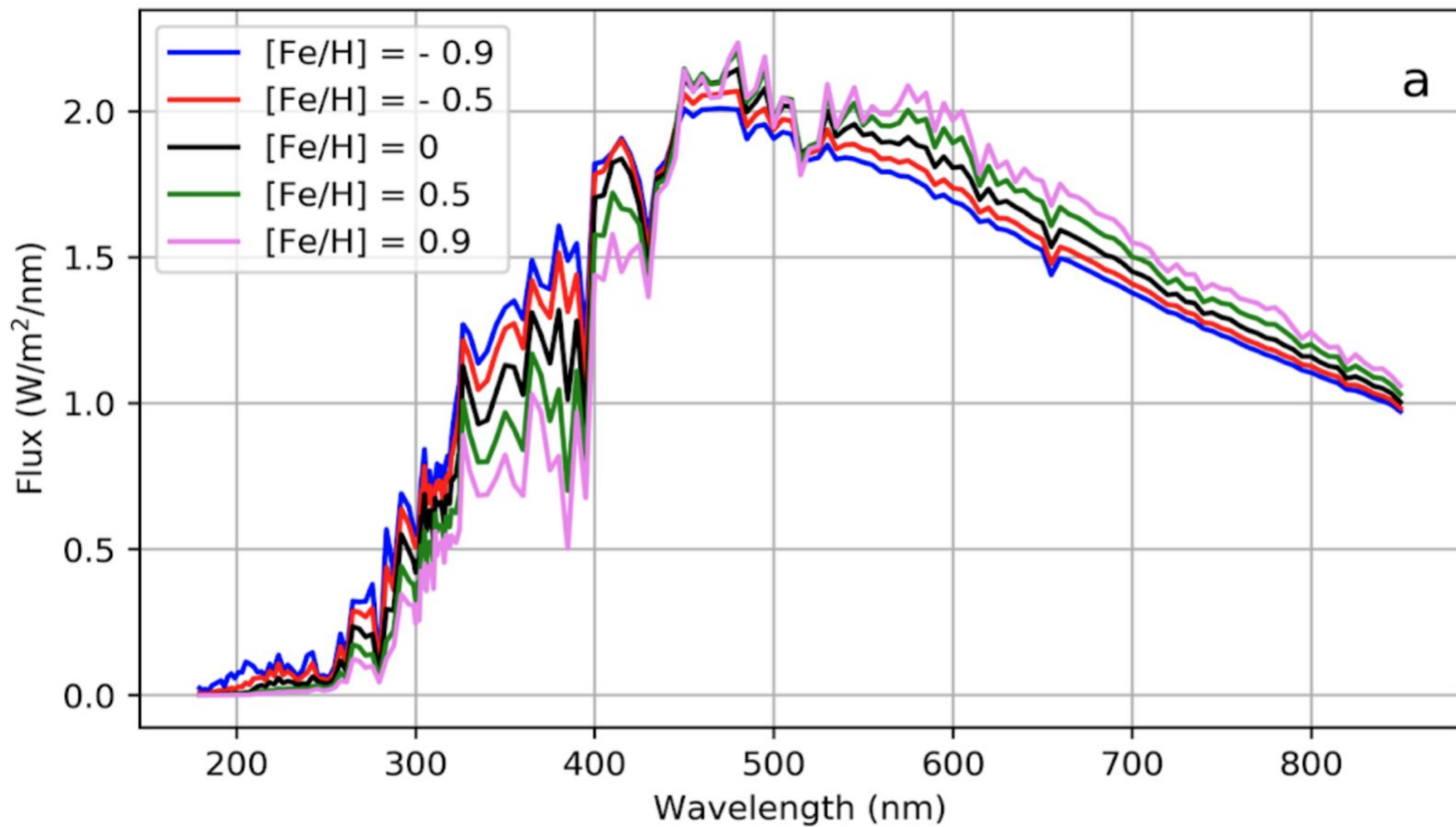


The rise of the space UV is accompanied by the drop of the ground UV

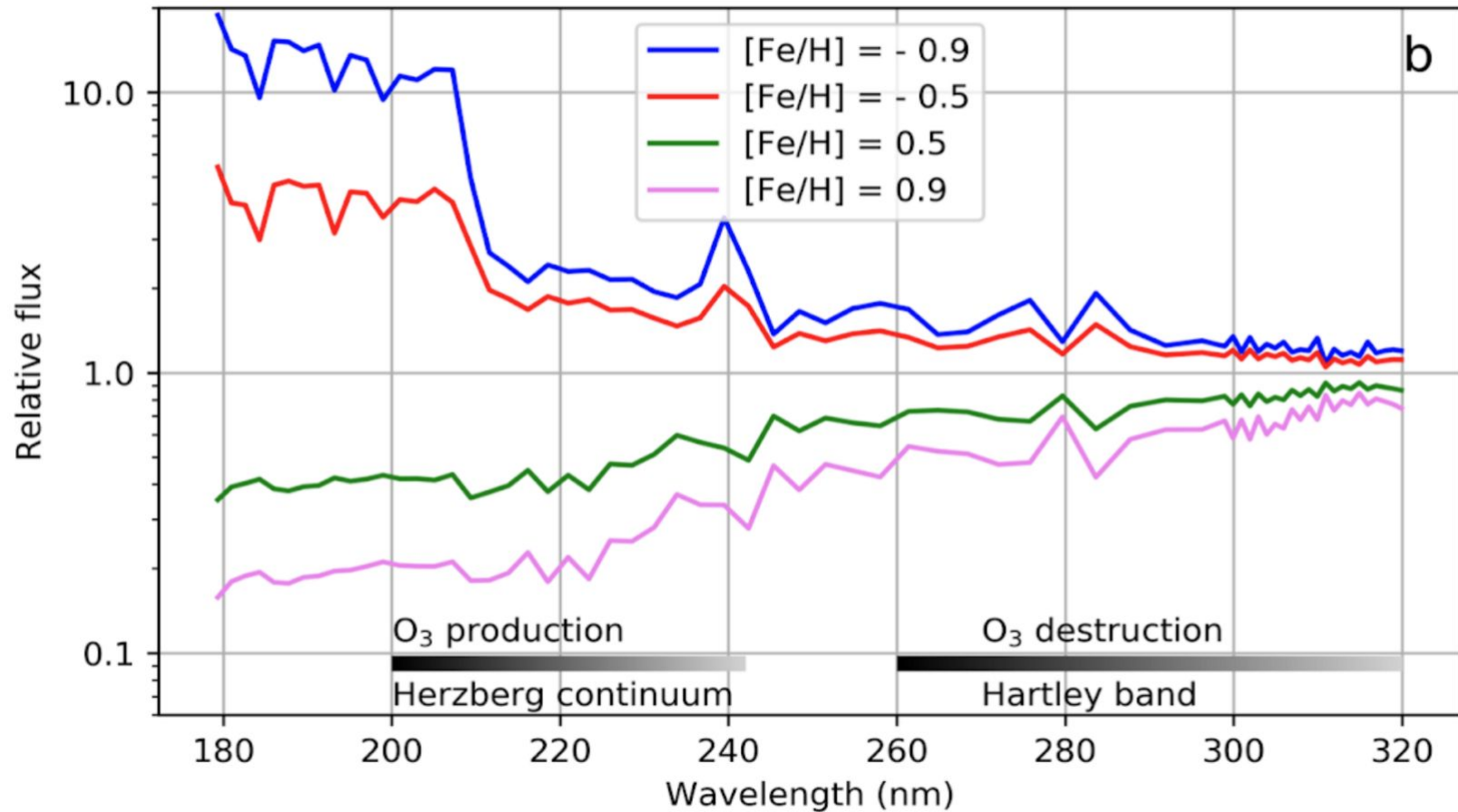
Anticorrelation of the space and ground UV. Explanation



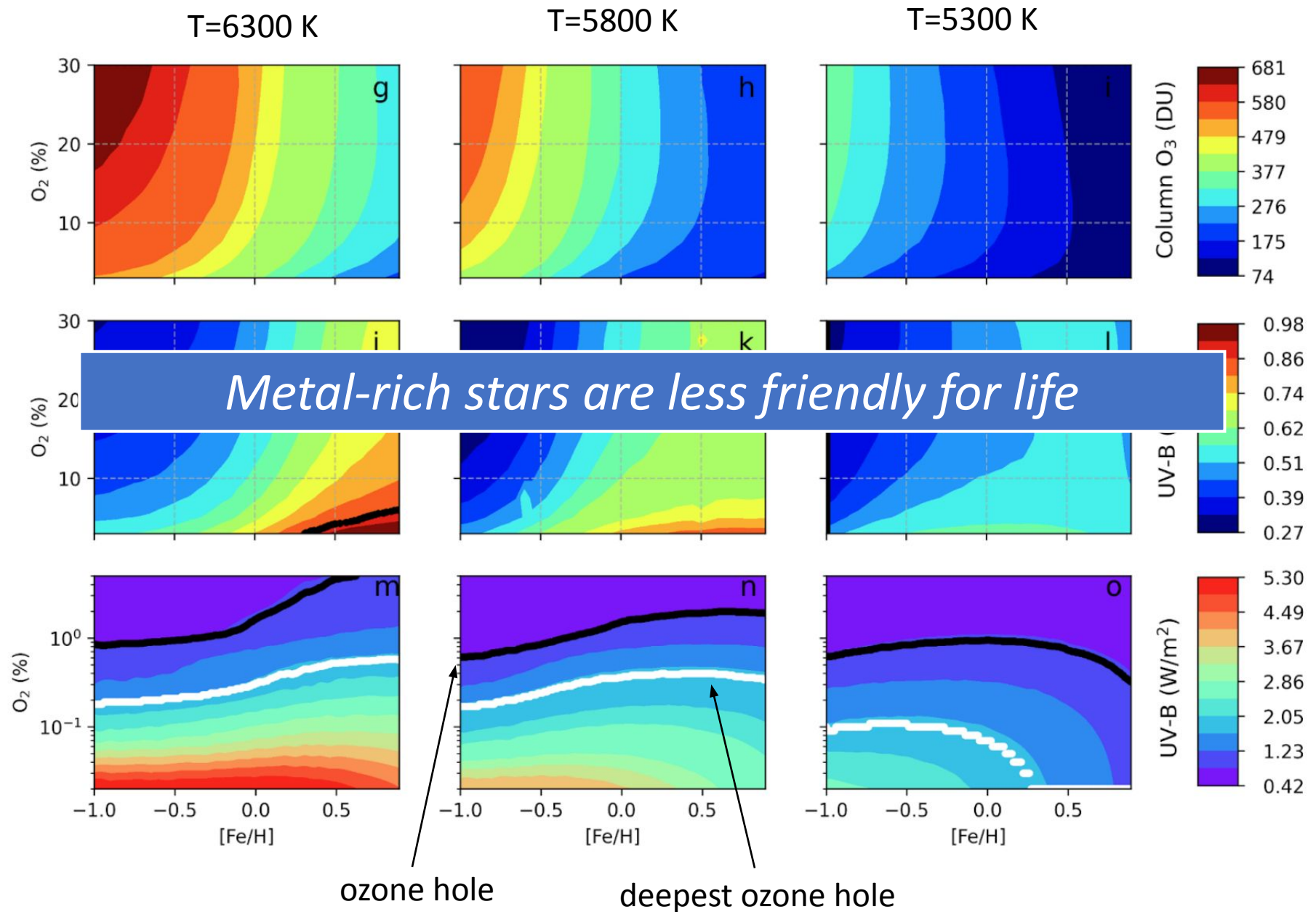
G-dwarfs with different values of metallicity



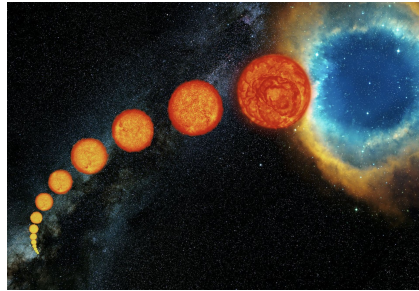
G-dwarfs with different values of metallicity



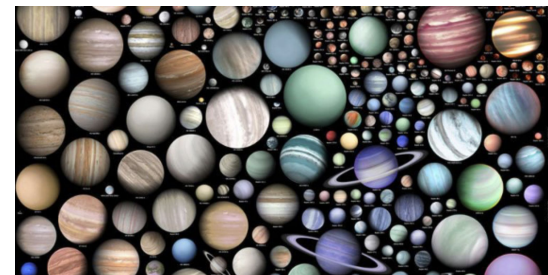
Column ozone and UV-B as a function of host star Fe/H



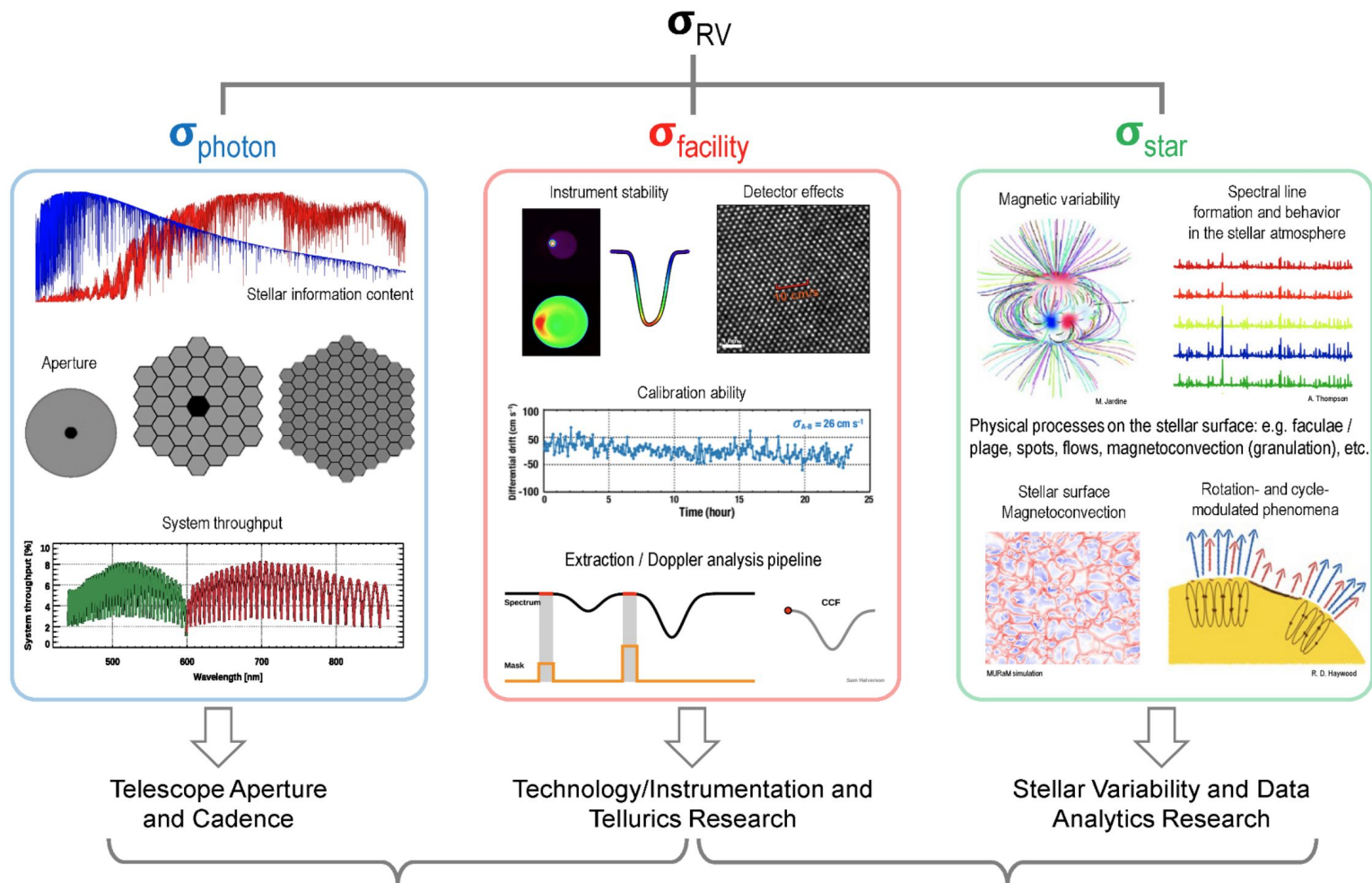
I.



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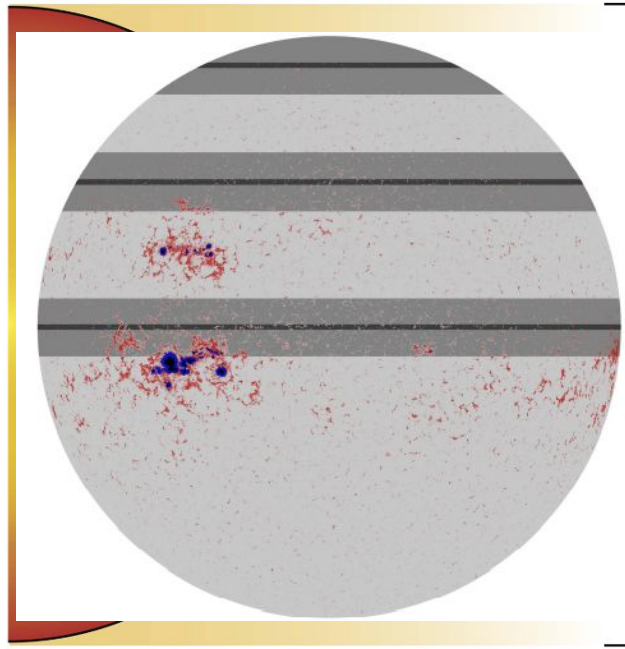
The problem. RV



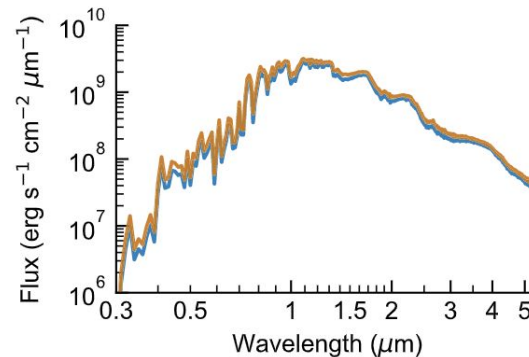
Intrinsic stellar variability currently precludes the confirmation and characterization of Earth-analogs

Understanding and modeling intrinsic stellar variability is critical to achieving Extreme Precision Radial Velocity

The Transit Light Source Effect

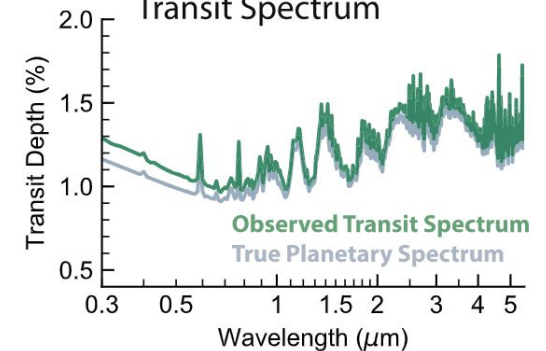


Pre-transit Stellar Disk is the
Assumed Light Source



Actual Light Source is the Chord
Defined by the Planet's Projection

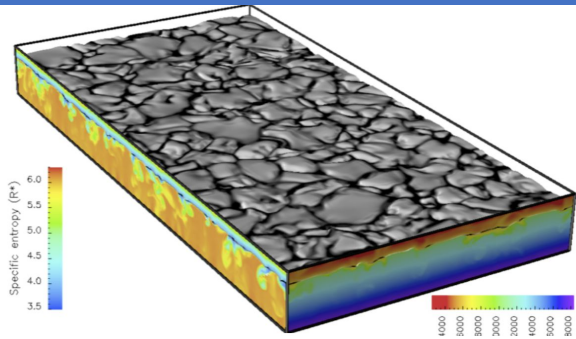
Spectral Difference due to
Different Spot/Faculae
Contributions Contaminates
Transit Spectrum



Rackham et al. 2018

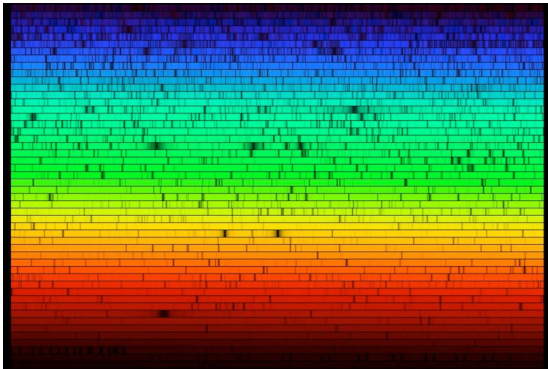
To make the most of transit studies from current NASA facilities like HST and JWST and future facilities like a 2040s Large Infrared/Optical/Ultraviolet Space Telescope, it is essential that we quantify the impact of stellar contamination on transmission spectroscopy and develop methods to mitigate for it.

The modelling approach



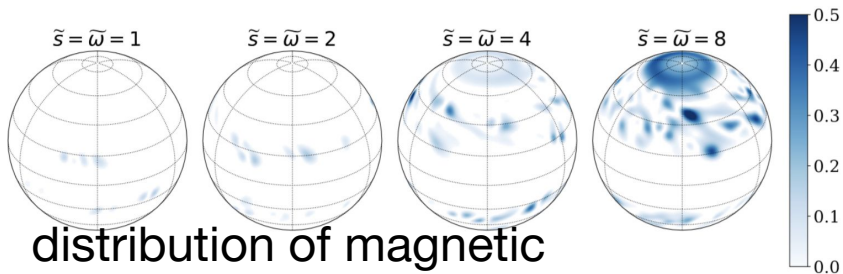
Radiative-MHD code MURaM

atmospheric structures



Radiative transfer code MPS-ATLAS

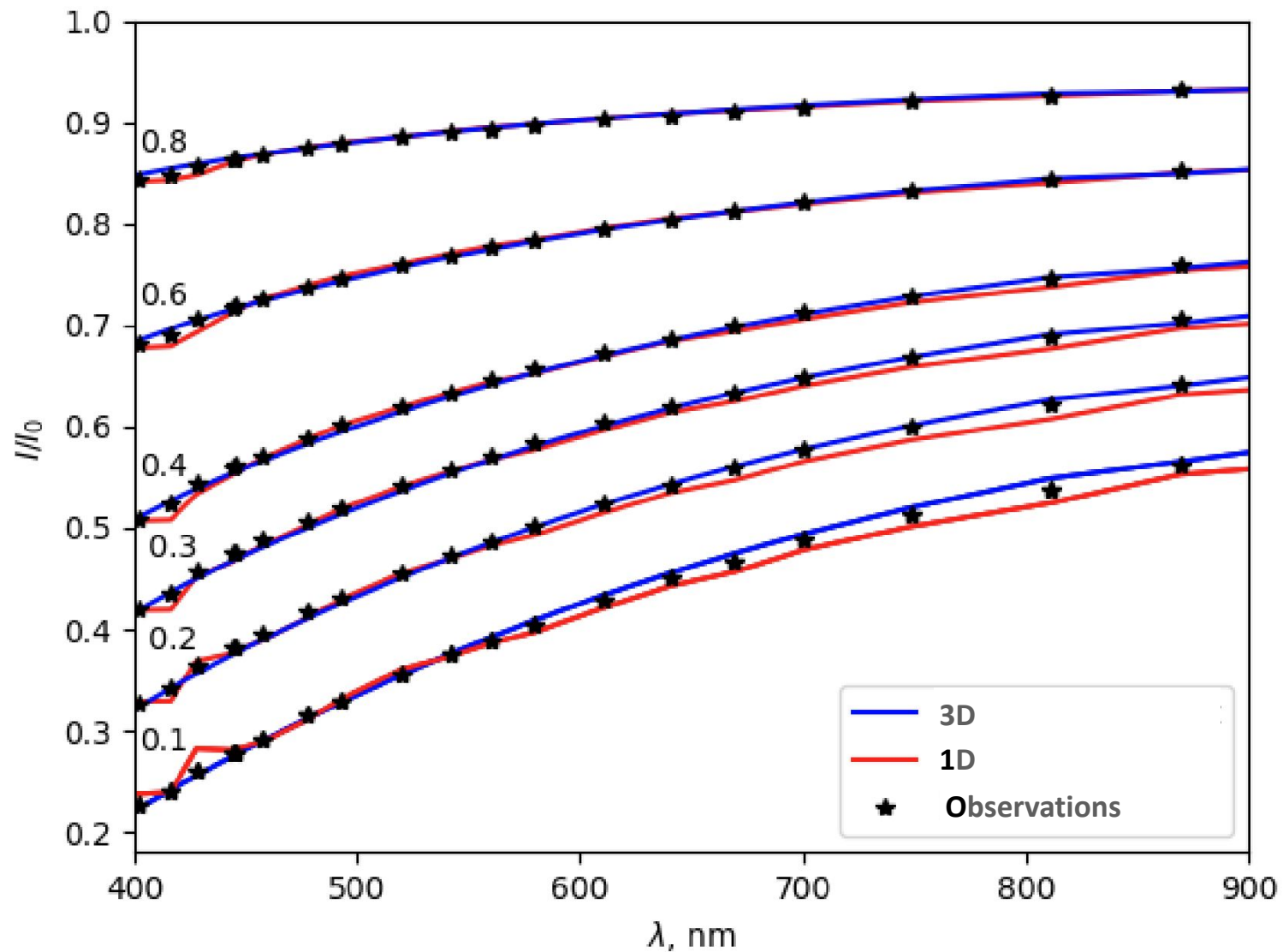
spectra



distribution of magnetic features

Flux emergence and transfer model (FEAT)

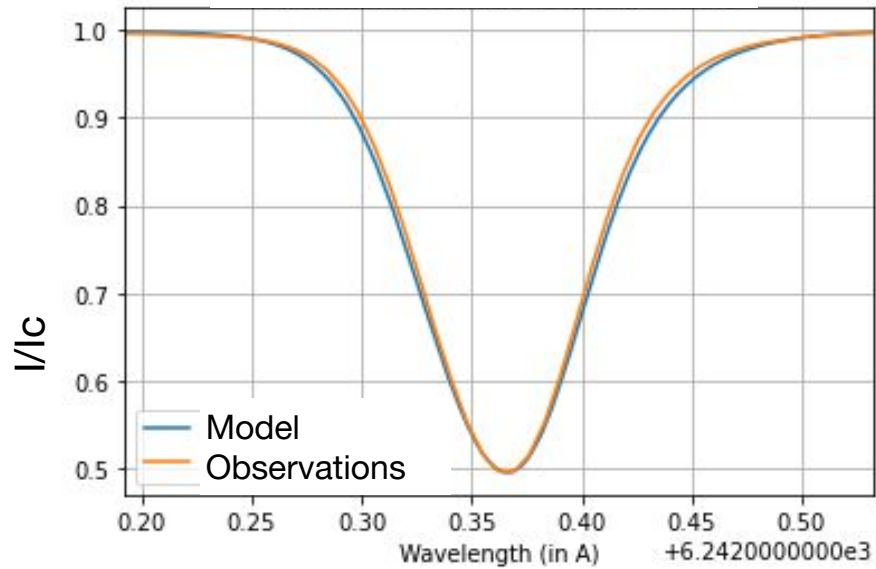
Solar example. Limb darkening



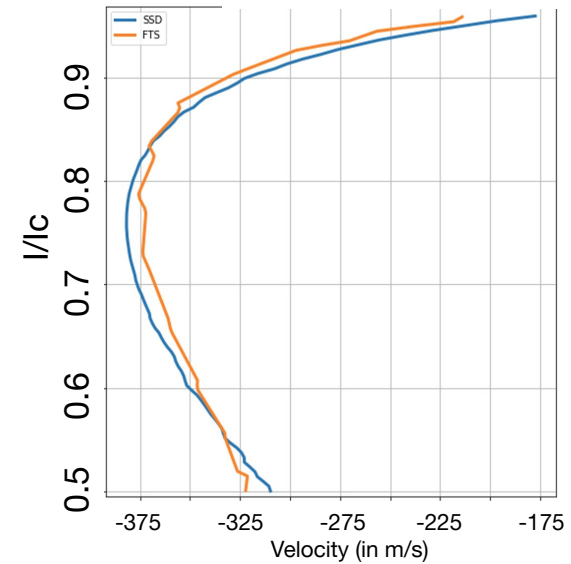
Kostogryz et al. (in press) + Shapiro et al. (in prep)

Solar example. Line profiles and bisectors

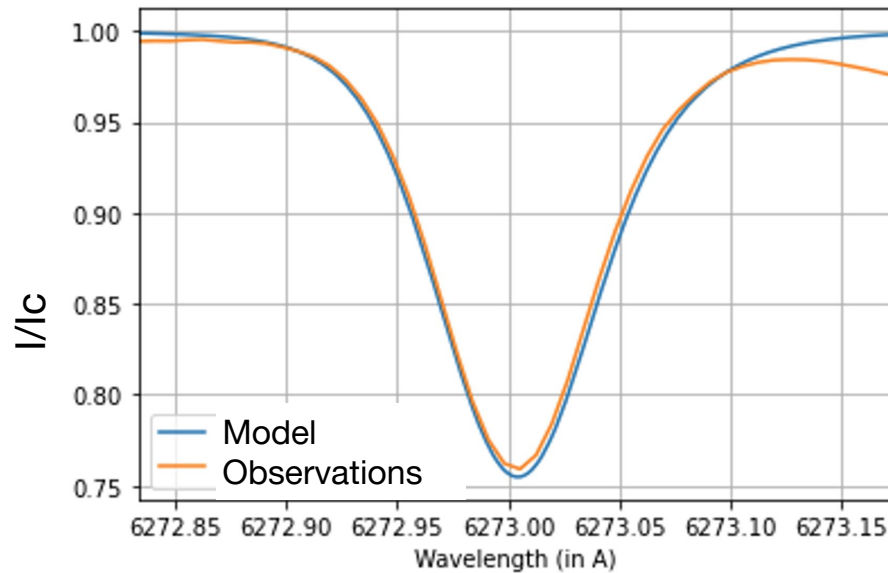
Fe I 6242



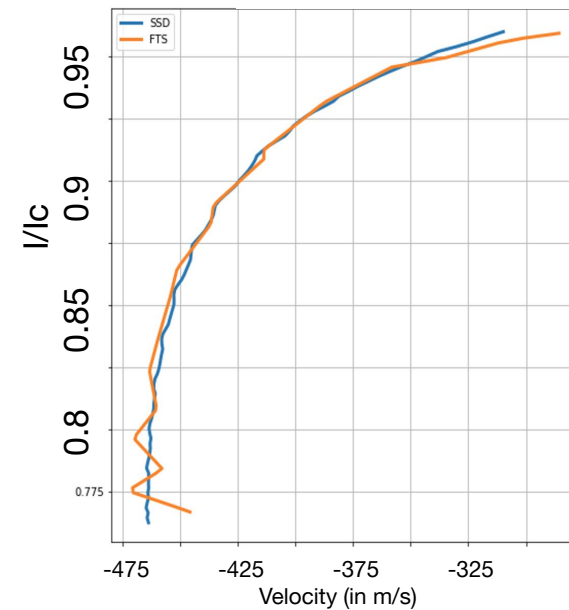
Fe I 6242



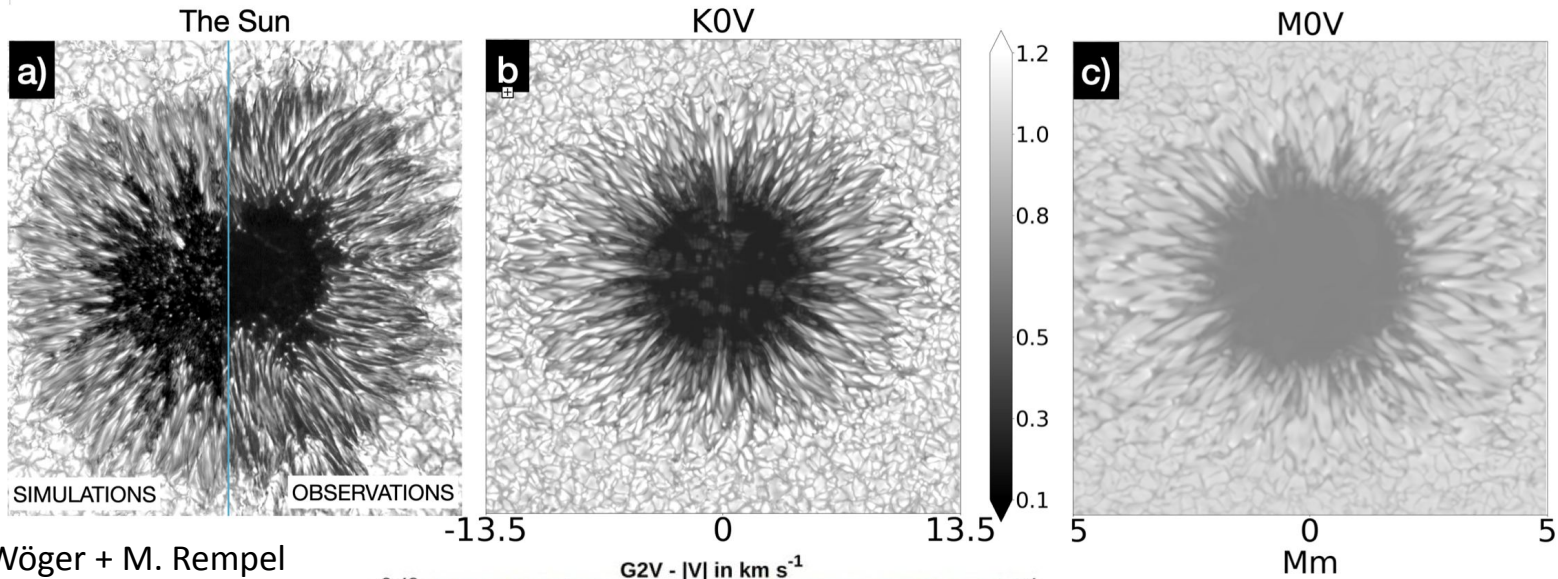
Fe I 6273



Fe I 6273

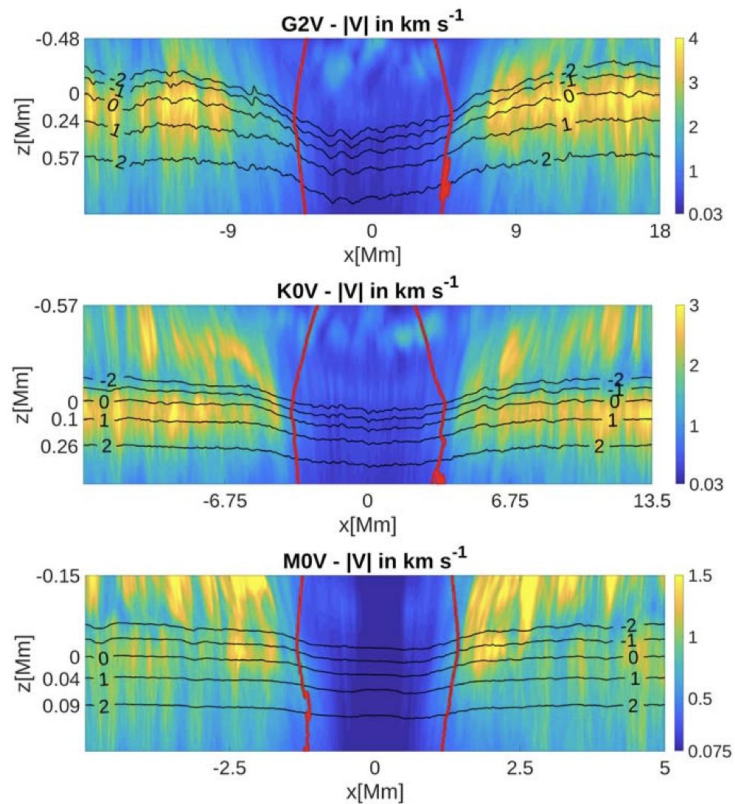


Spots on stars cooler than the Sun



F. Wöger + M. Rempel

Panja et al. (2021)



Panja et al. (2020)

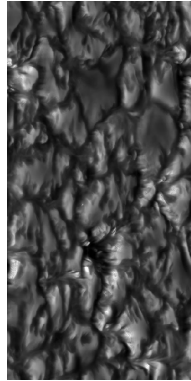
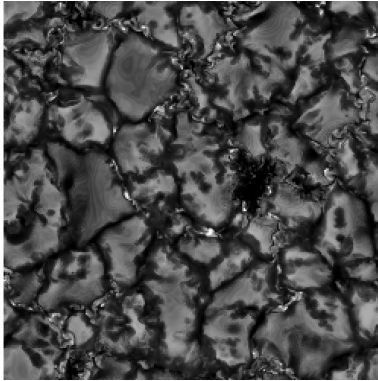
Small-scale (facular) features on stars with different metallicities

388 nm

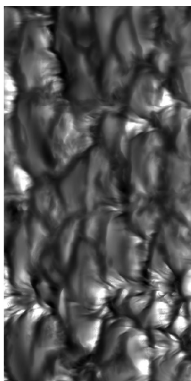
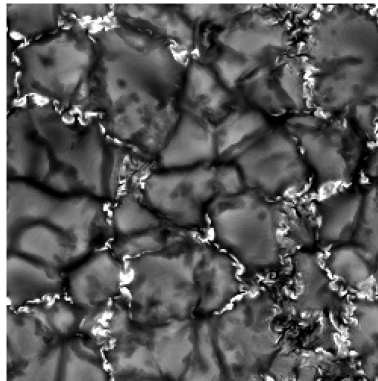
$\mu=1$

$\mu=0.5$

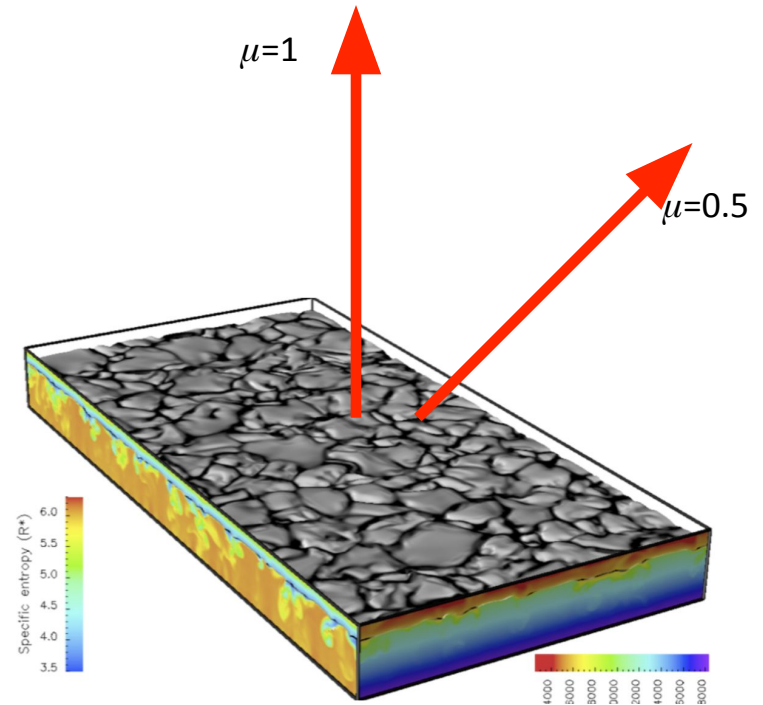
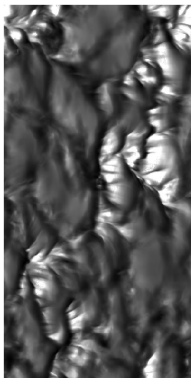
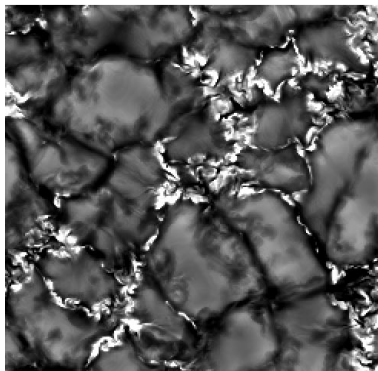
Fe/H=-1



Fe/H=0



Fe/H=0.5



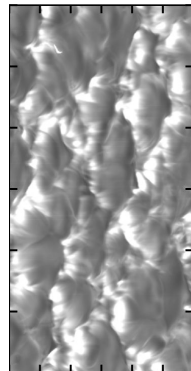
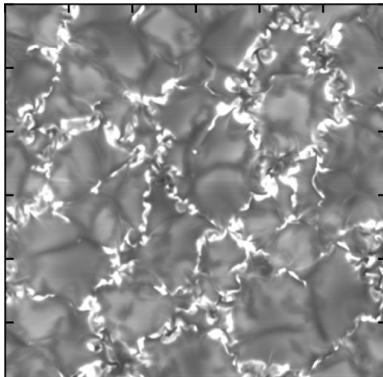
Small-scale (facular) features on stars cooler than the Sun

388 nm

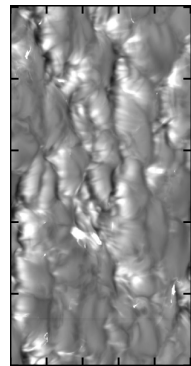
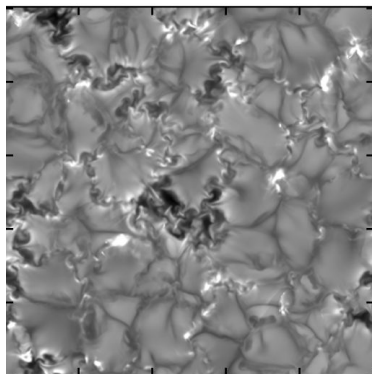
$\mu=1$

$\mu=0.5$

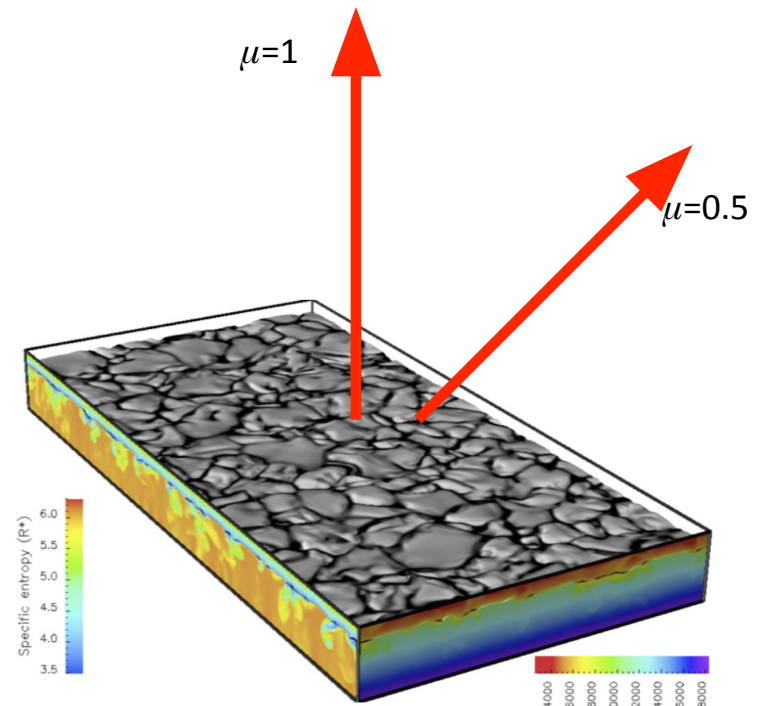
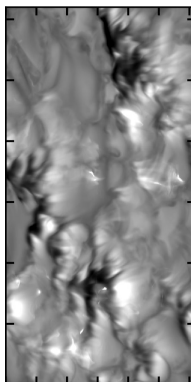
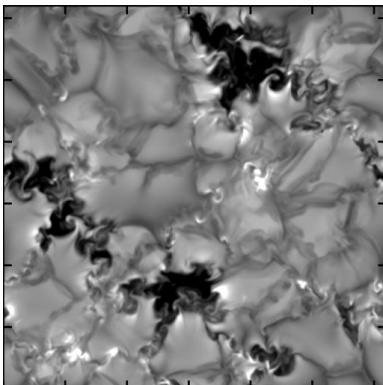
K0



M0



M2





Segmentation fault

THANK YOU!