Constraints on granulation from 3D models

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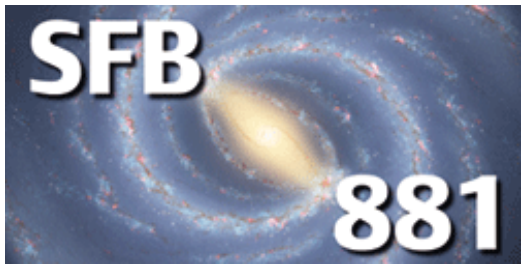
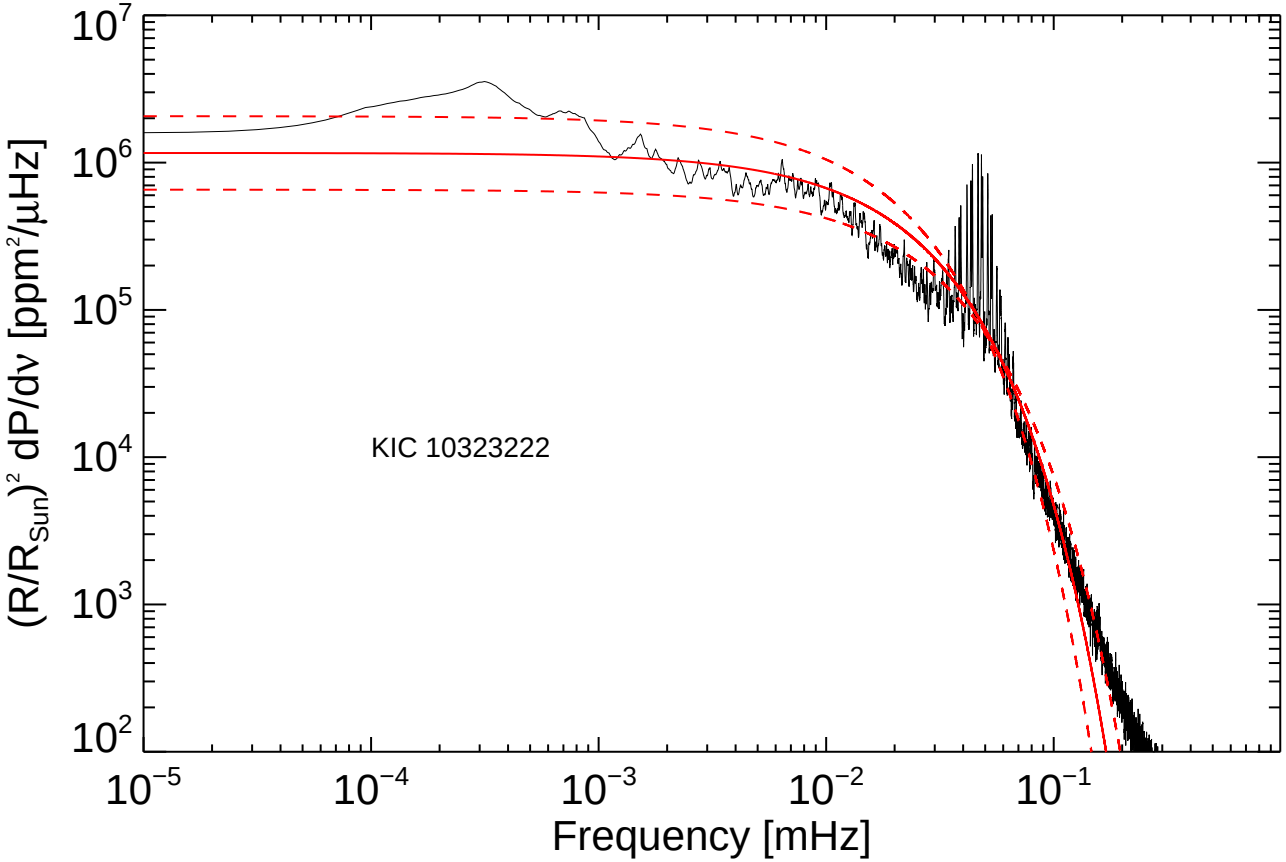
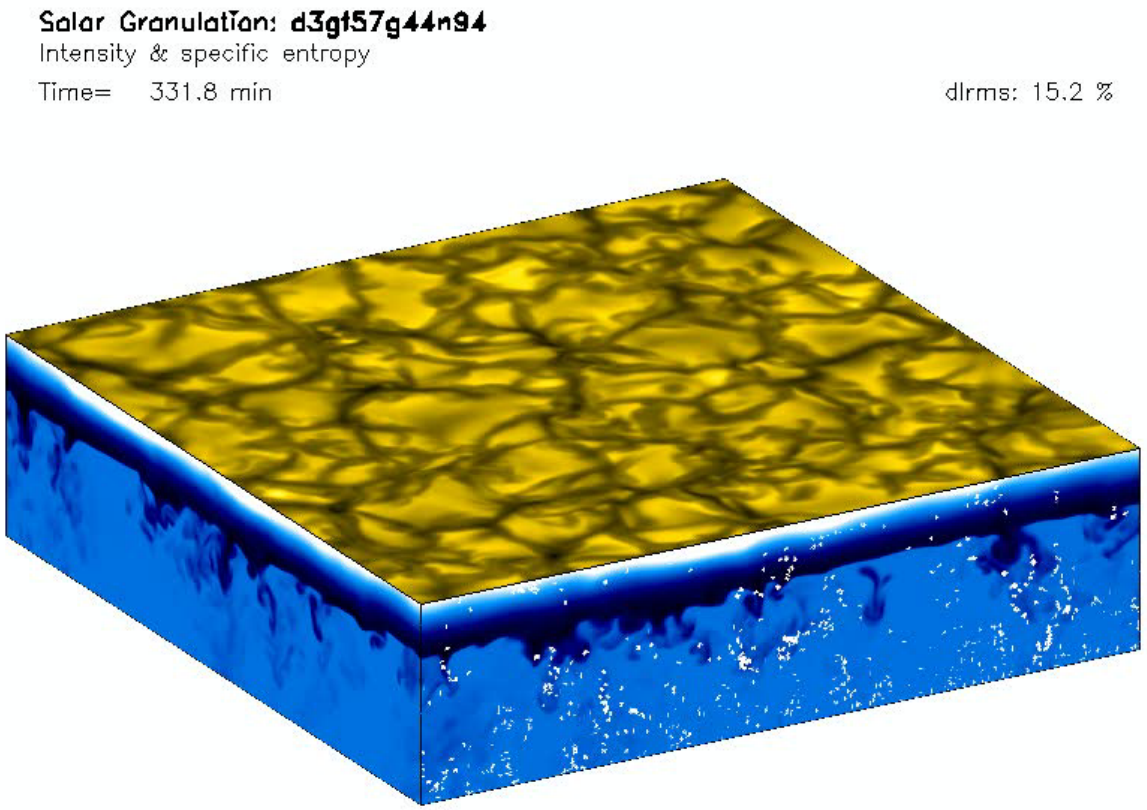


Granulation and PLATO: what does one want to know?



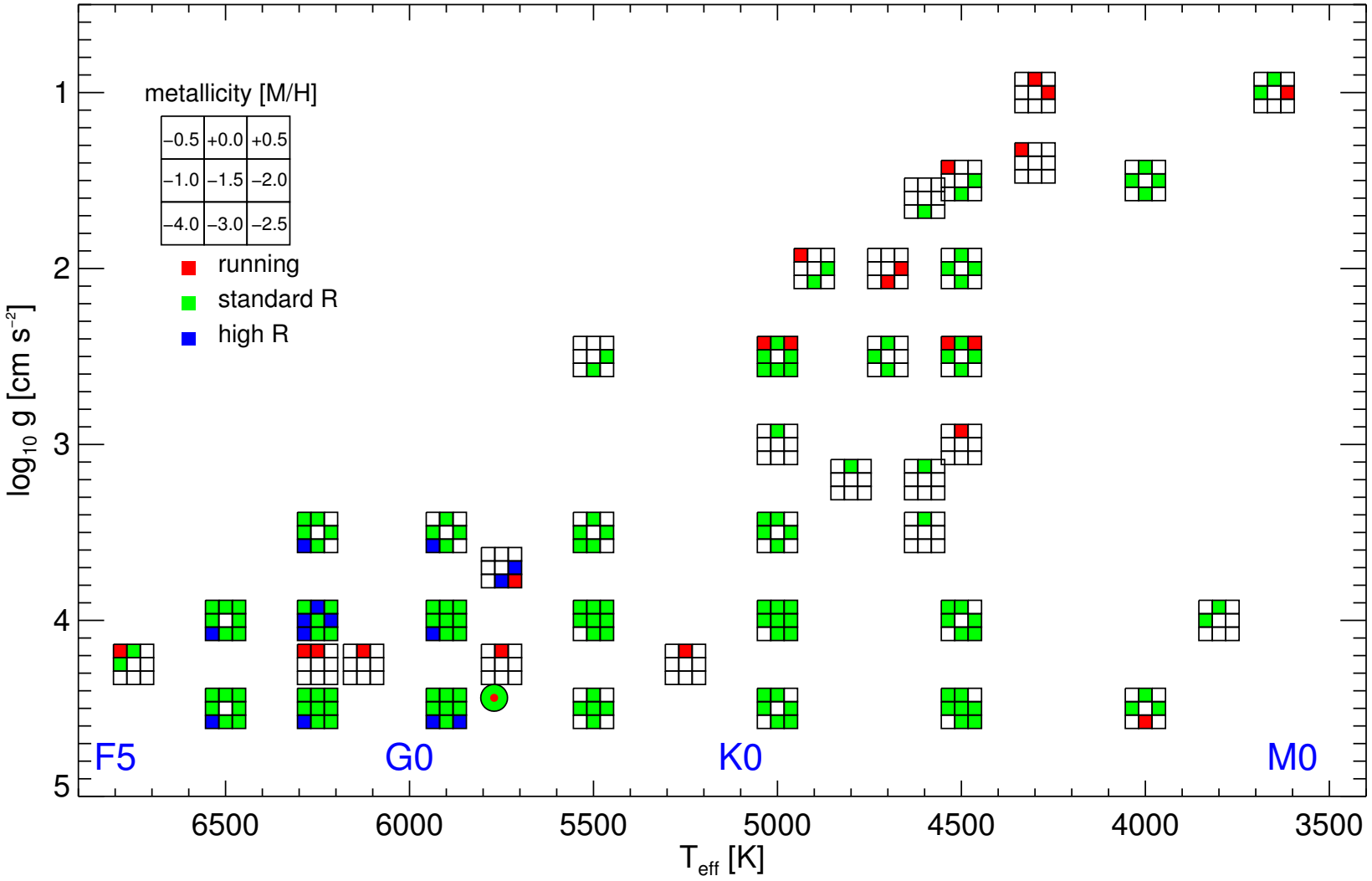
- Shape of continuous granulation background in power spectra influences ...
  - measured frequency of maximum oscillation power $\nu_{\rm max}\rightarrow$ scaling-relations
  - measured frequency and height of individual frequencies
- Data analysis: What does the shape of the granulation background look like?
- Physics: Why does it look as it looks, and what does it tell us?

"Local box" 3D model atmospheres of late-type stars



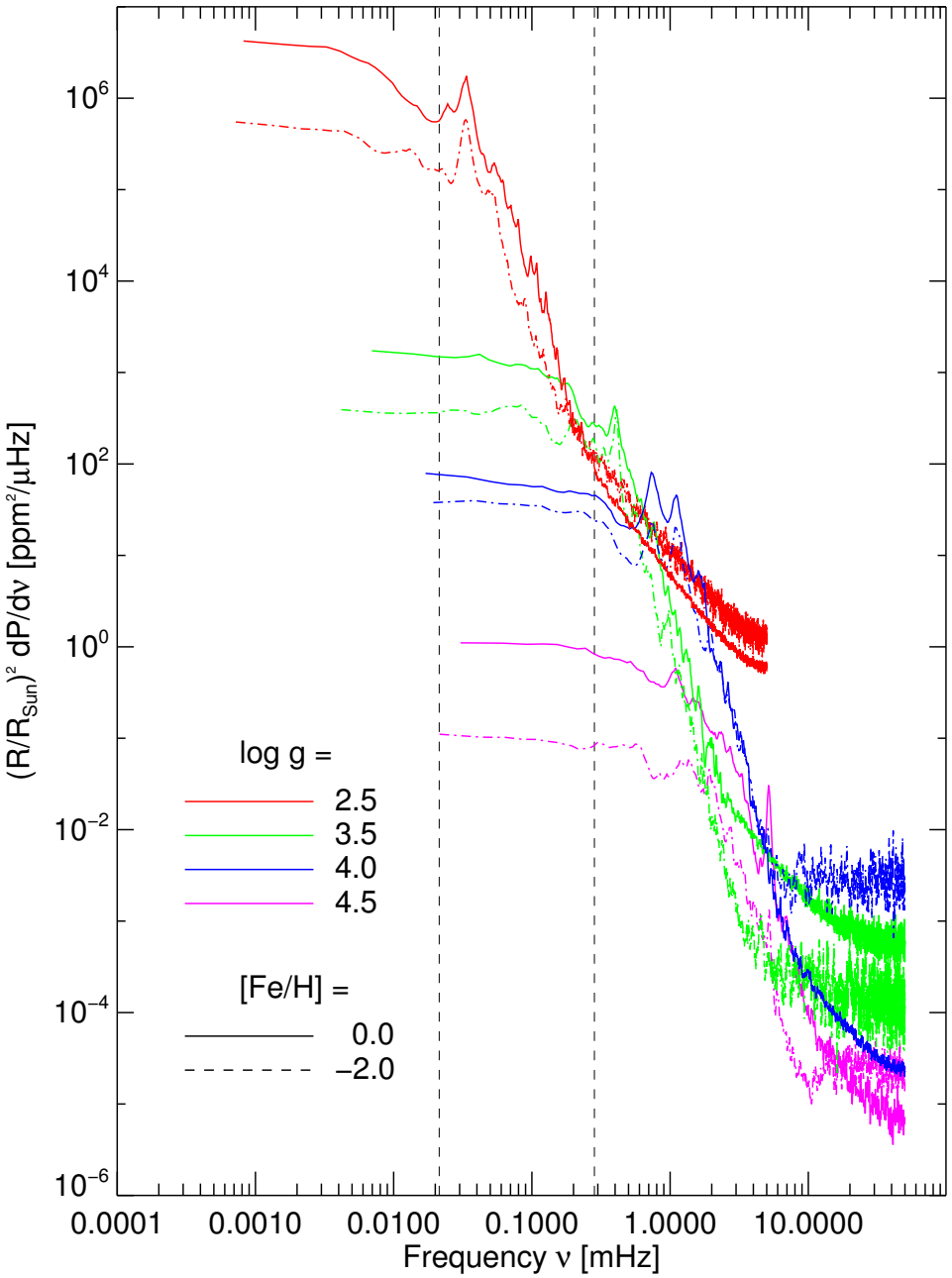
- Solution of (M)HD equations coupled to RT in representative small volume
- Spatially inhomogeneous (no assumed symmetry) and time-dependent
- Evolution of stochastic granulation pattern leads to fluctuations in radiative output can be scaled to full disk, but stellar radius needed

CIFIST **3D model atmosphere grid**



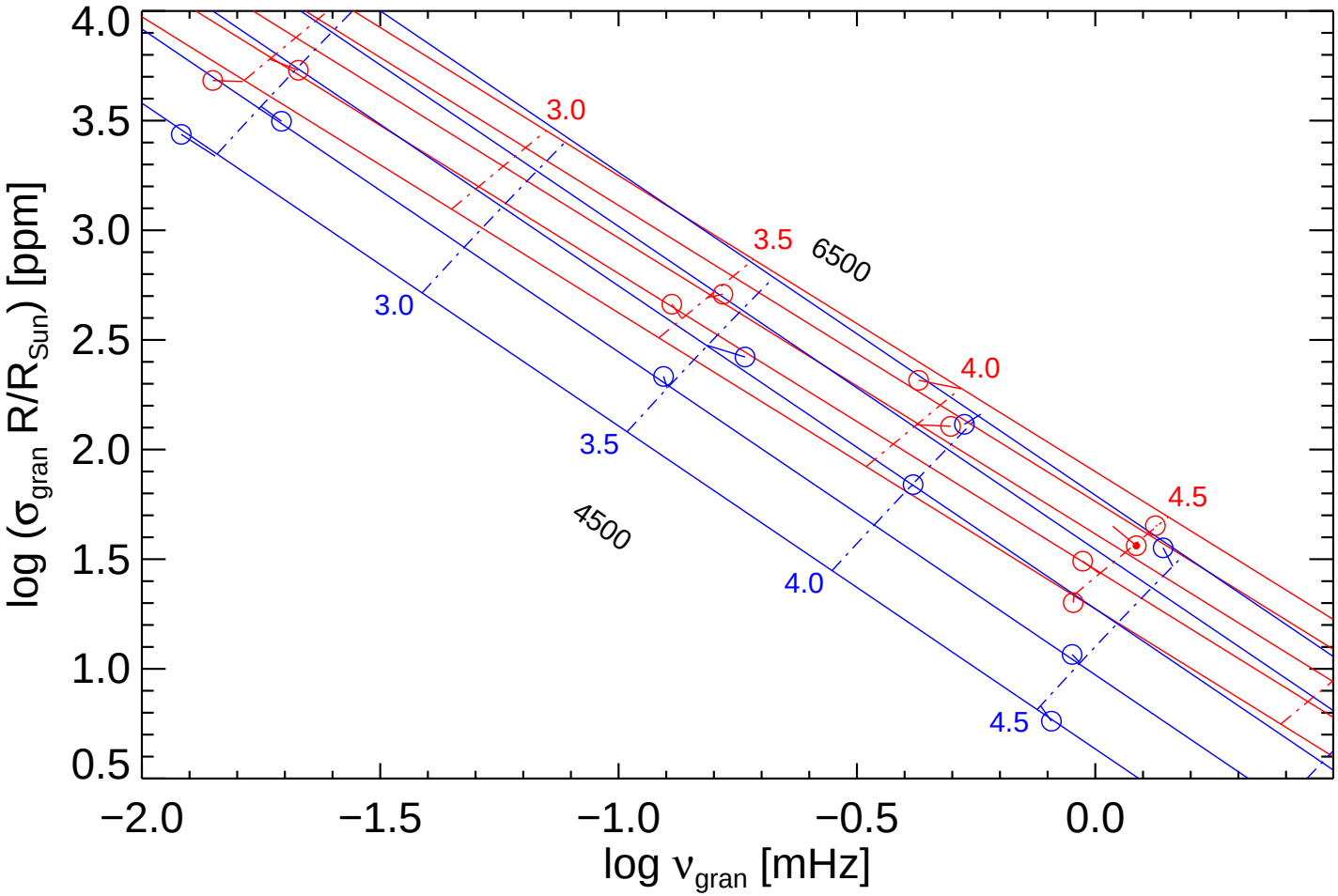
- Most stars with granulation can be modelled, incl. wide range in metallicity
- Also M-dwarfs, brown dwarfs, white dwarfs (not shown, interesting for PLATO?)

Simulated power spectra from dwarfs to giants



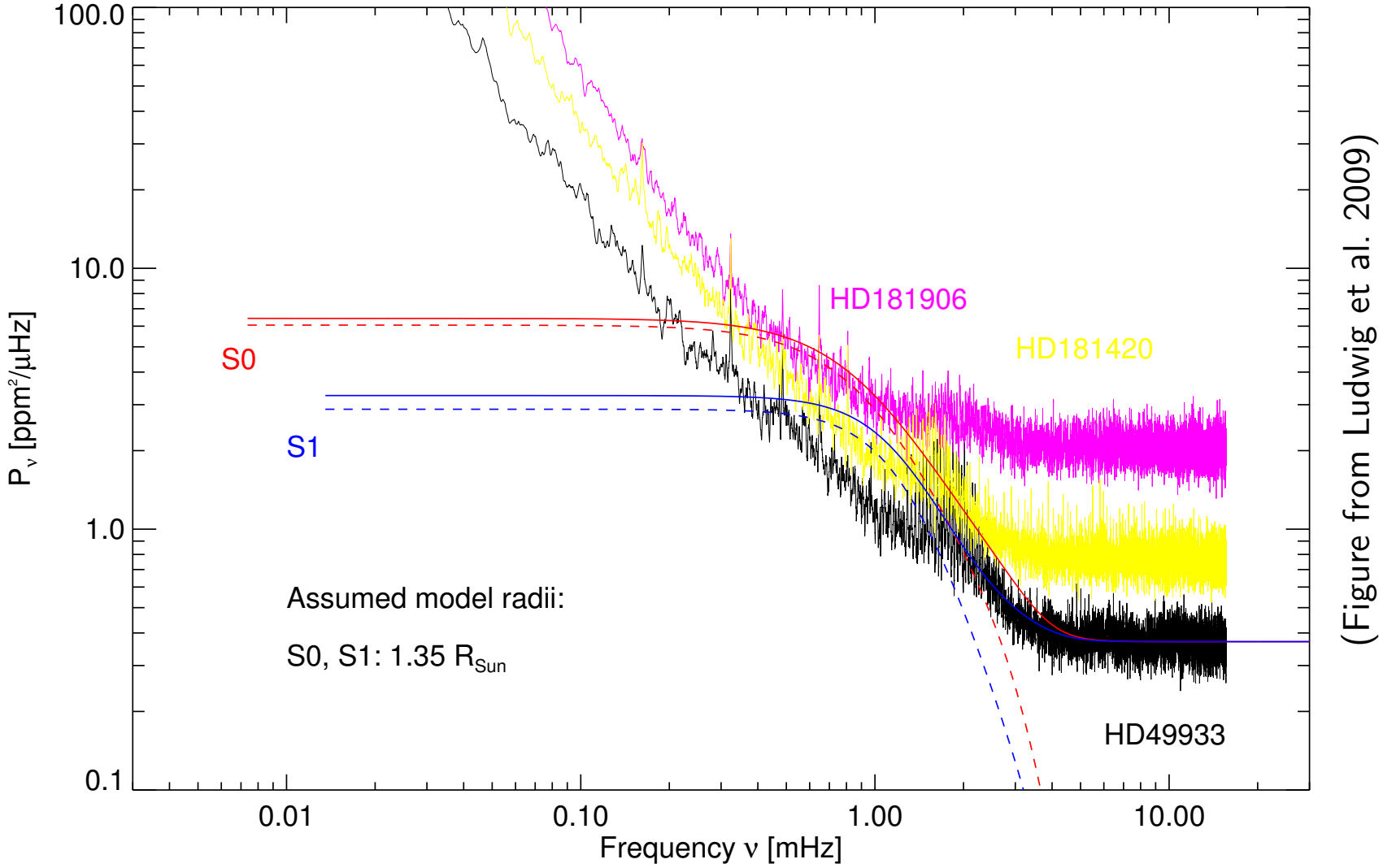
- Simulated power spectra of relative bolometric brightness fluctuations
- Scaled power: granules put on a star with $R = 1\,\mathrm{R}_\odot$
- Simulated power spectra are noisy
- Similar color also means similar T_{eff}: low-metallicity leads to ...
  - lower granulation background
  - lower oscillation amplitudes (theoretical prediction)

"Reverse" Hertzsprung-Russell diagram of convective properties



- 10 models solar metallicty (red), 9 models $[\mathrm{M/H}] = -2$ (blue)
- Exponential power model: $\frac{dP}{d\nu}(\nu) = \frac{\sigma^2_{\mathrm{gran}}}{\nu_{\mathrm{gran}}} \exp\left(-\nu/\nu_{\mathrm{gran}}\right)$ + sum of Lorentzians
- Lines of constant $\log(T_{\mathrm{eff}})$ and $\log g$ from bi-linear fits separately for each $[\mathrm{M/H}]$

F-stars: model failure due to activity?



- Shape and absolute power off
  typical situation (violet & yellow vs black), red: $[\mathrm{M/H}] = 0$, blue: $[\mathrm{M/H}] = -1$

Perspectives

- Local 3D models can provide information on granulation background

$$\frac{dP}{d\nu}(\nu) = \left(\frac{R_{\rm Sun}}{R}\right)^2 f(\nu|T_{\rm eff}, \log g, [{\rm M/H}])$$

- Access to detailed granulation properties in simulations holds promise to understand why shape-function f looks as it looks
  - $\rightarrow$ ongoing work
  - might provide better motivated analytical function(s) for background model
- Granulation background can be included to constrain stellar parameters
  - granular gravimeter: "8-hour flicker" of Bastien et al. (2013) and follow-up works
- Can magnetic fields be included in the prediction of the shape function?
- Data handling in simulations needs to be improved to improve S/N of simulated power spectra