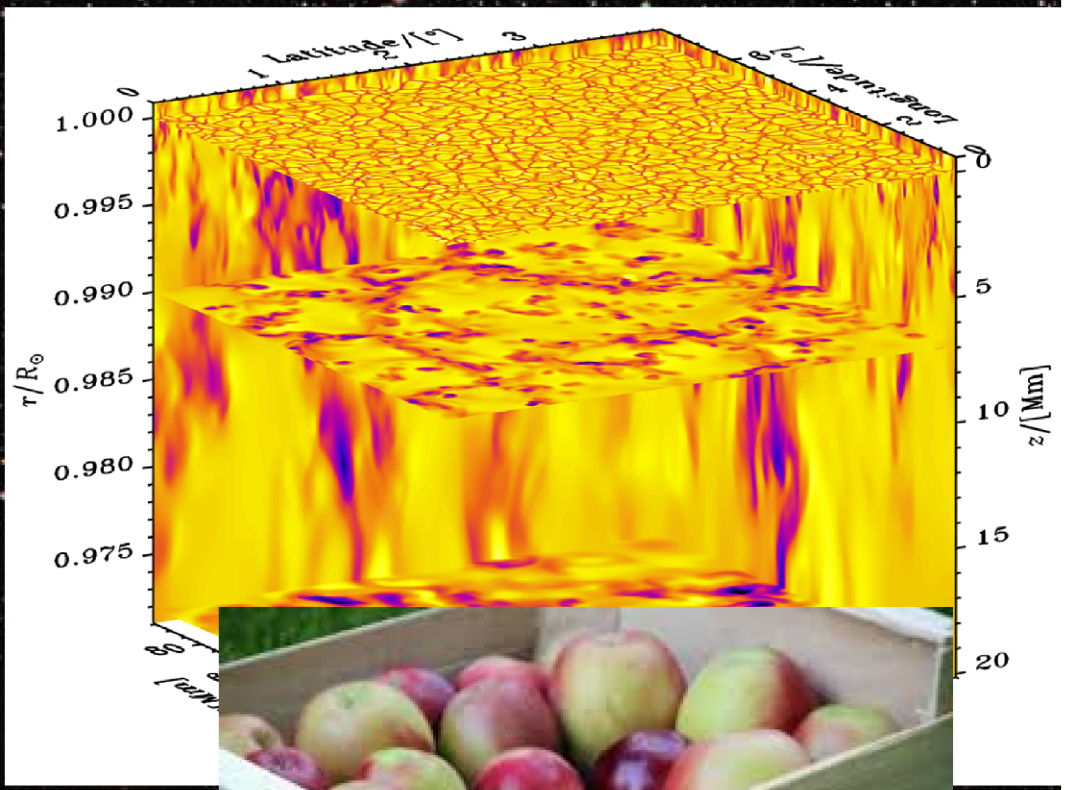
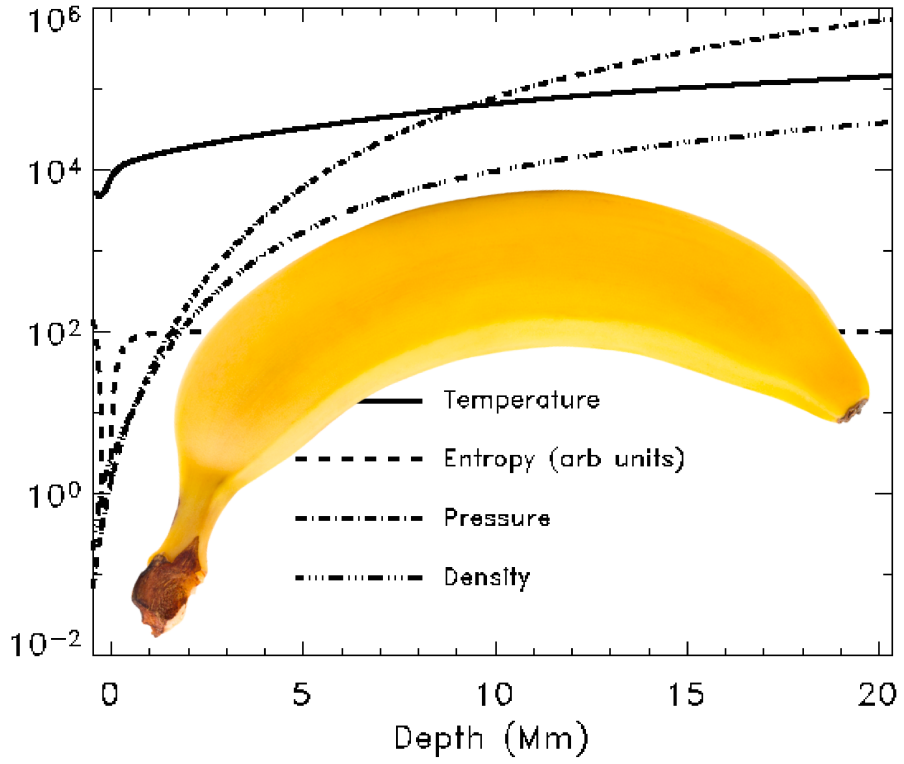
Comparing Apples and Bananas
- or how to arrive at a consistent surface effect





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A working definition of asteroseismic surface effect..?...

- Difference between 1D MLT and realistic 3D
- Keep everything else the same:
  - Abundances
  - Equation of state (EOS)
  - Opacities
  - Photospheric transition
  - Deep (nearly adiabatic) convection zone = mixing-length calibration
- α calibration is 1st step of 1D+3D patching

The surface effect – two parts

- ν-shift from patched – un-patched models
  = *structural* surface effect, only!
  - The part to include in stellar structure models
  - Due to convective expansion
- Also a *modal* part
  - Response by turbulent pressure and convective flux to modes
  - The part to include in oscillation codes

Patching calibrated 1D with averaged 3D

α calibration is 1st step:

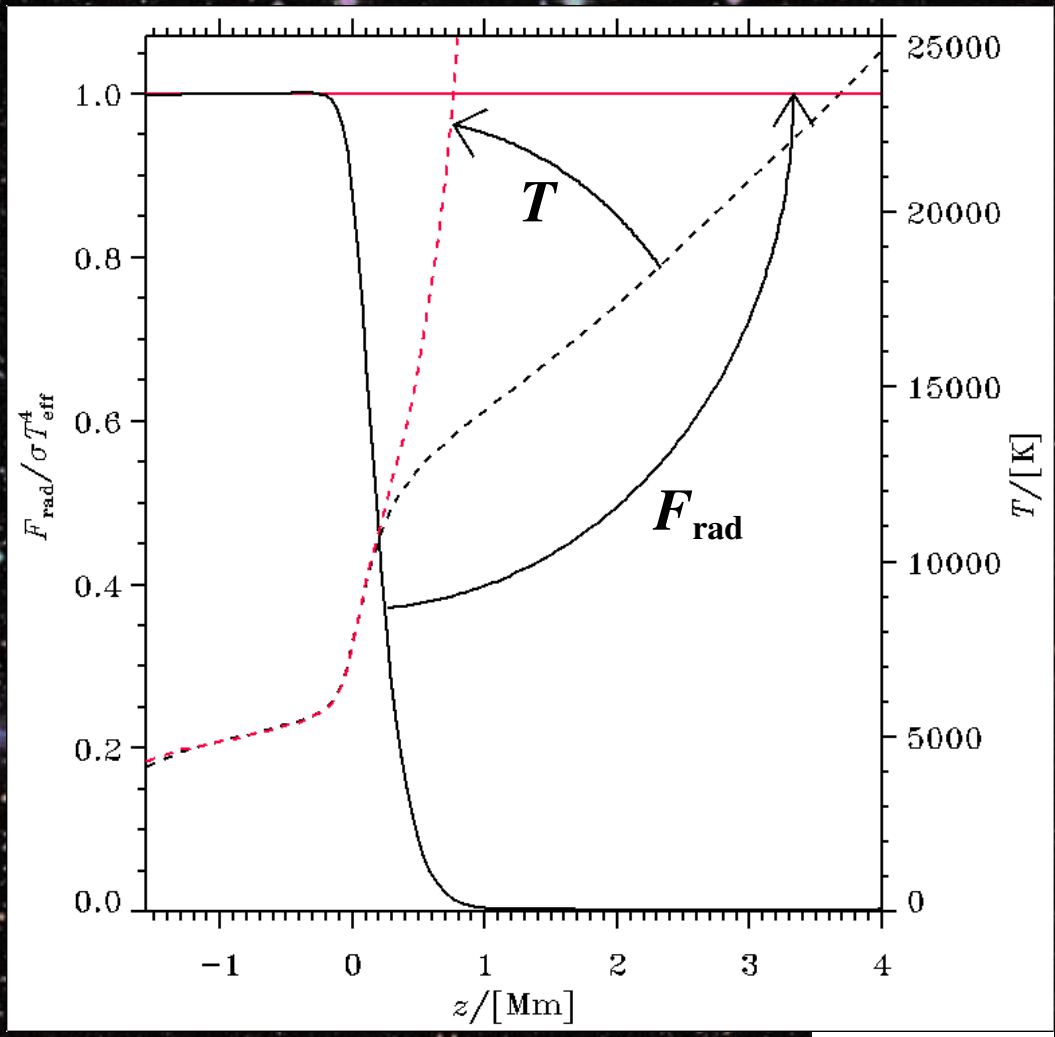
- Match 1D model to bottom of 3D sim (but avoid bottom bdry conditions)
  - Use same abundances, EOS and opacities (in atm.)
  - Use $T(\tau)$ extracted from simulations
  - Use $p_t = \beta \rho v_z^2$ calibr to 3D match-point and inward. If local MLT, suppress above, with minimal gradient.
  - Correct $\langle 3D \rangle$ for finite radius by integrating hydrostatic equilibrium for z, extrapolating $g_{1D}(r)$
- Use envelope models – much faster = better fit, and $\partial\alpha/\partial(M/M_\odot) \sim 0.001$!

$T(\tau)$ = Photospheric Transition

- Describes transition from optically deep to thin
- Takes monochromatic radiative transfer for 10^5 wavelengths to capture = atmosphere calculation
- $T(\tau)$ is a distillate of atmosphere calculation
- A cheap way of implementing atmospheres in 1D structure calculations.
- $T(\tau)$ can encompass any kinds of atmosphere physics: 3D, non-LTE, magnetic fields, dust, etc.
  - Without the 1D structure model needing to know about it

Radiative Equilibrium?!?!?

- Atm. and interior models have diff. convection
- Reduce atmospheric $T(\tau)$ to rad.equil.
- Implement in 1D interior model
- Add convection back-in, but from interior model



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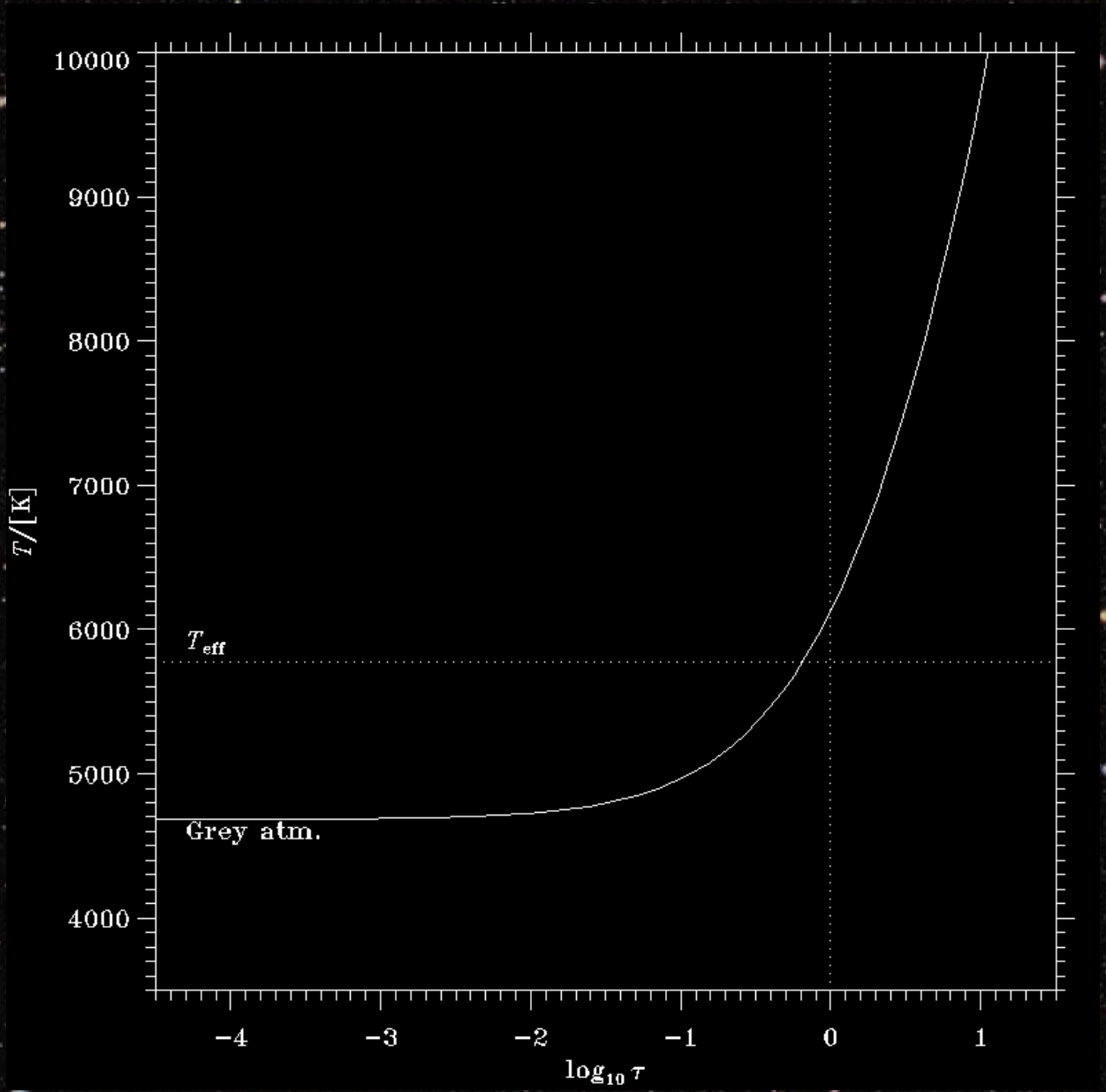
Isn't it just grey, anyway?
And isn't that just Eddington?



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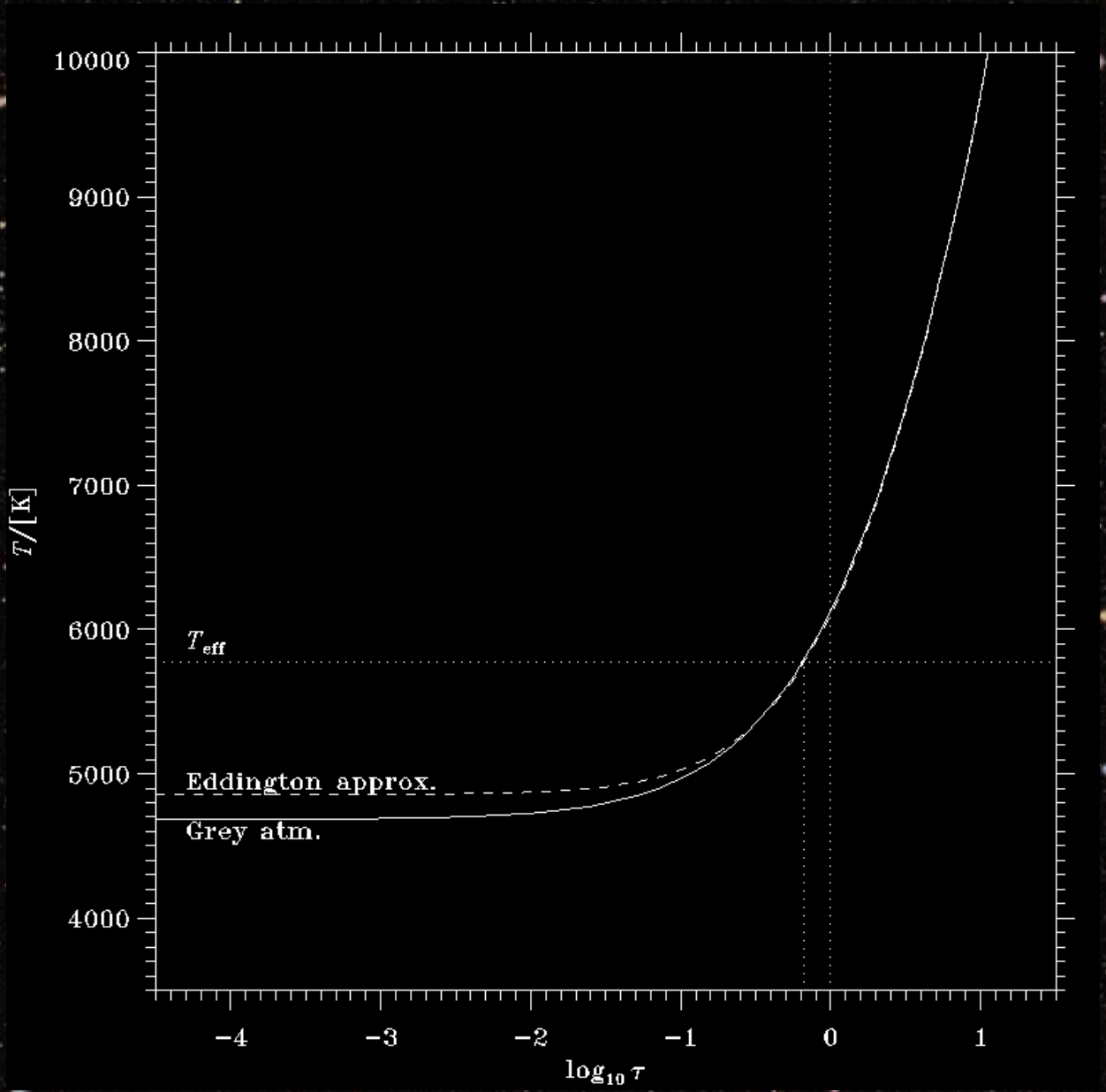

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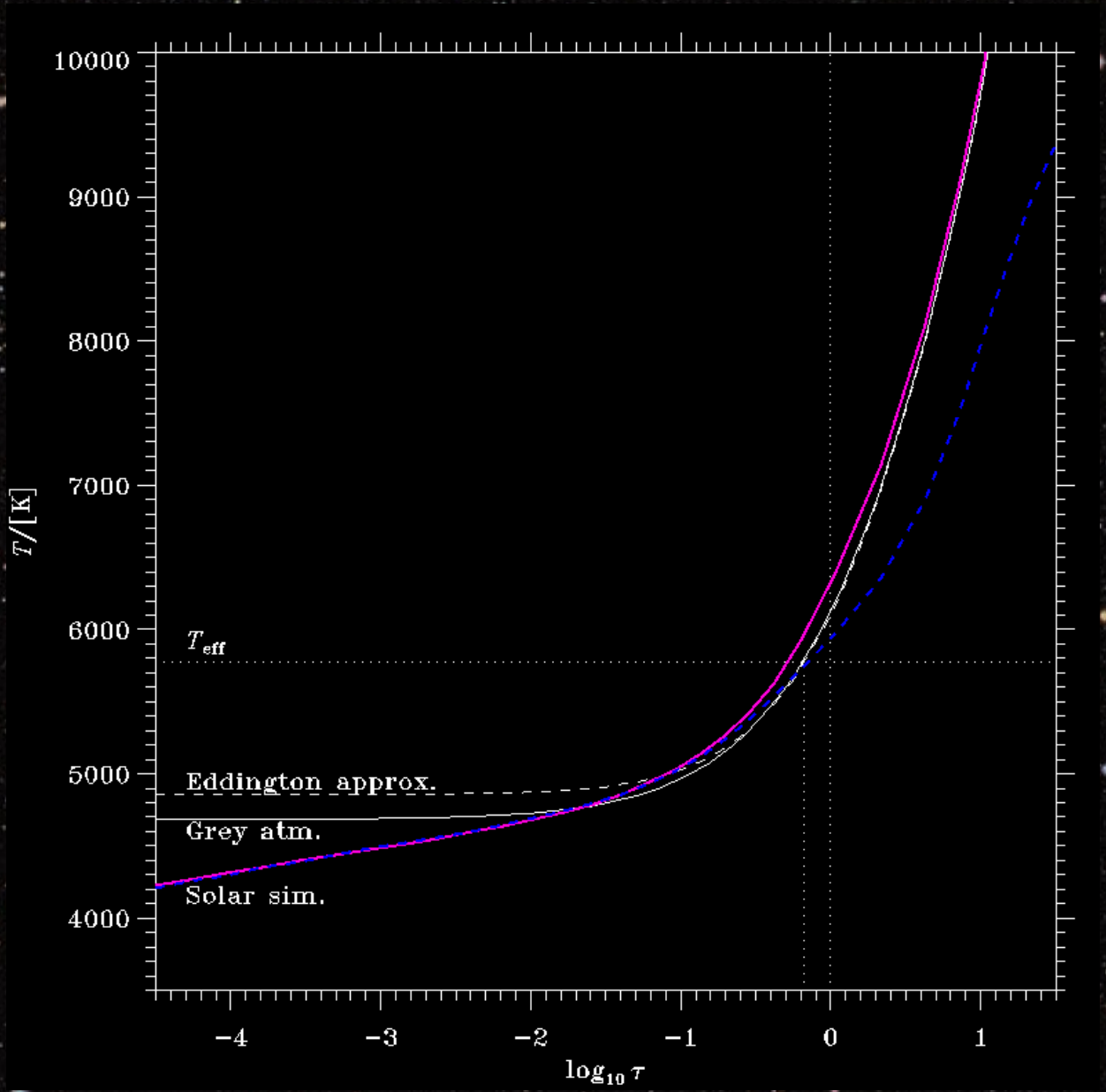

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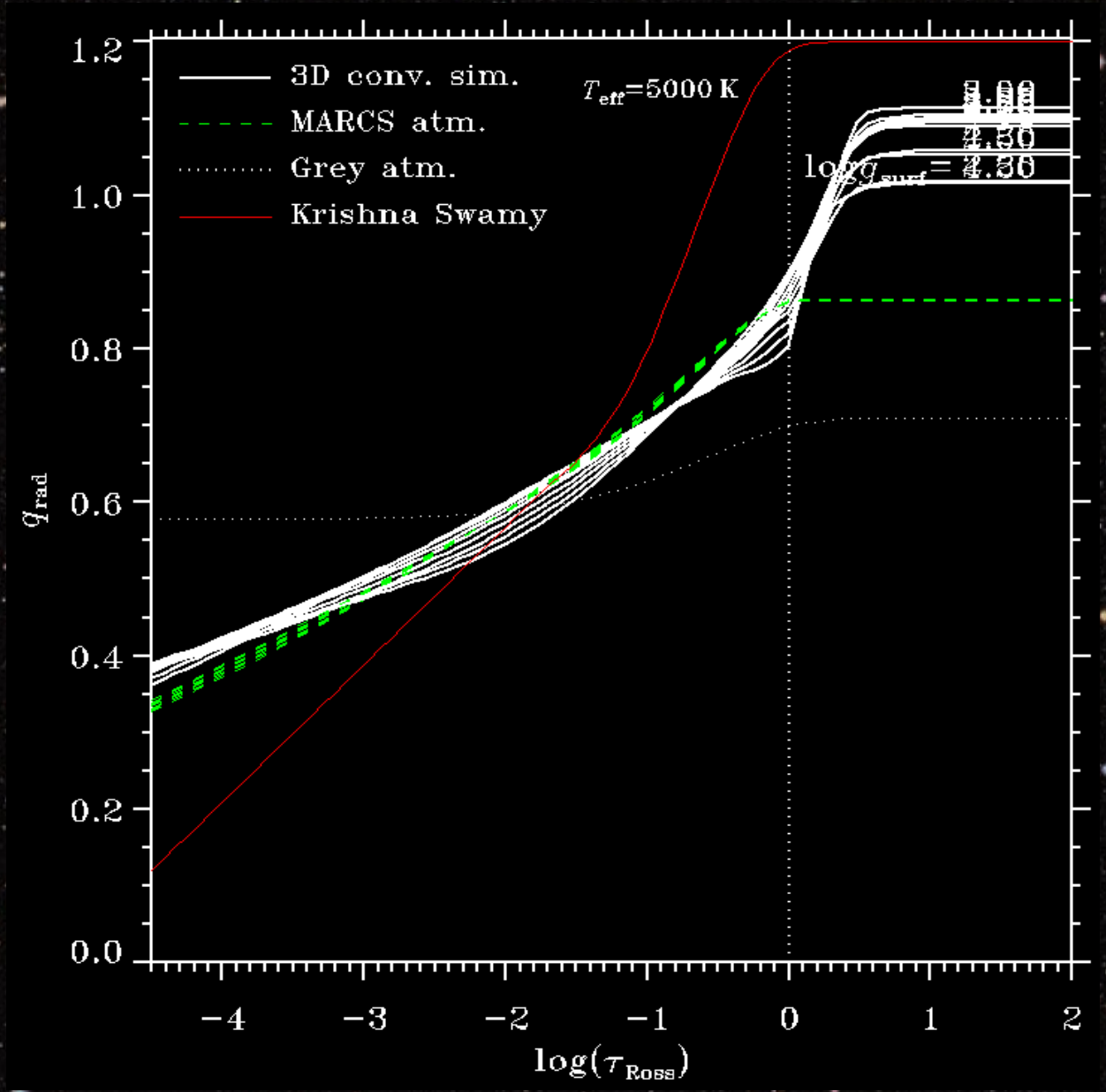

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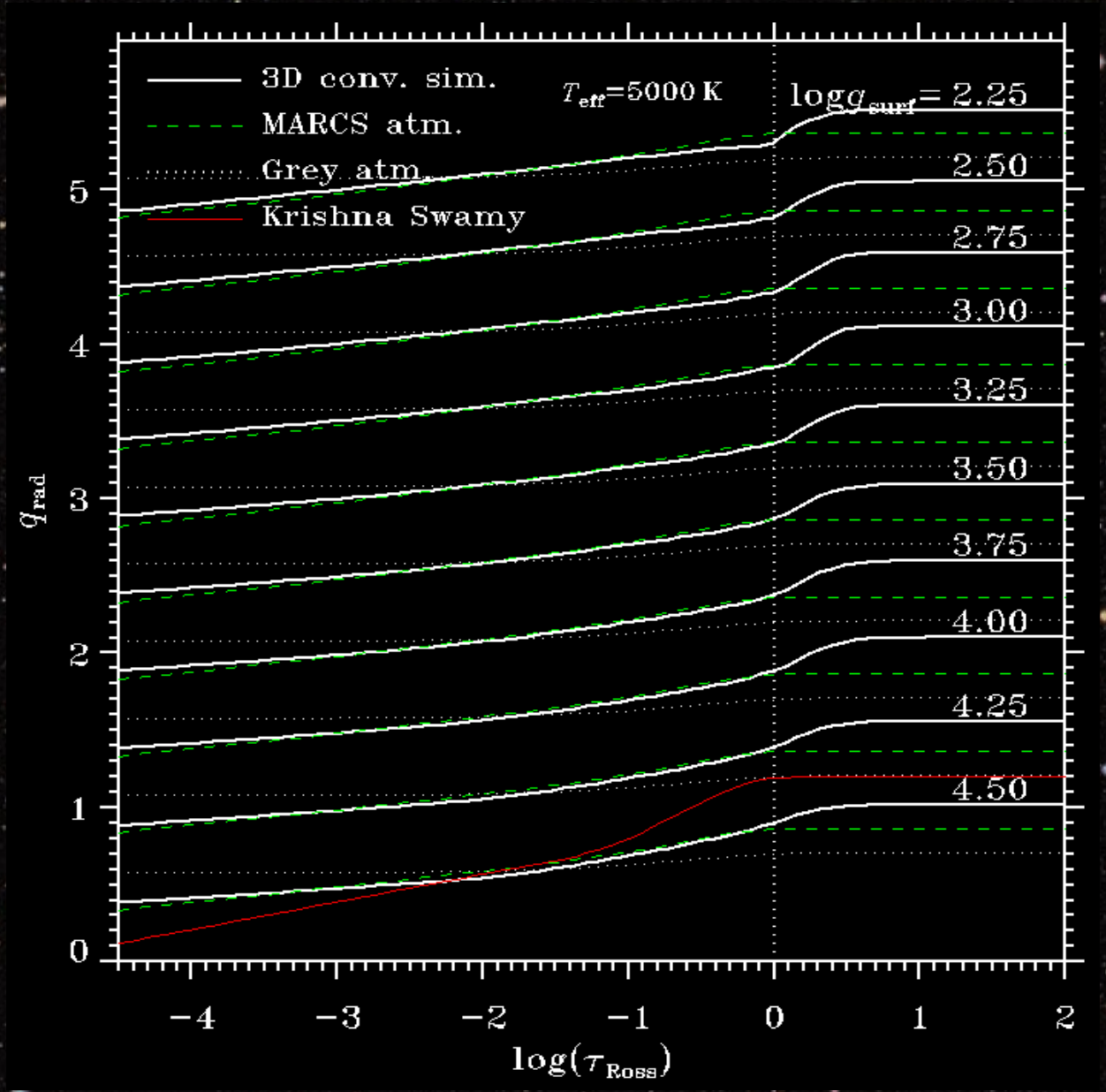

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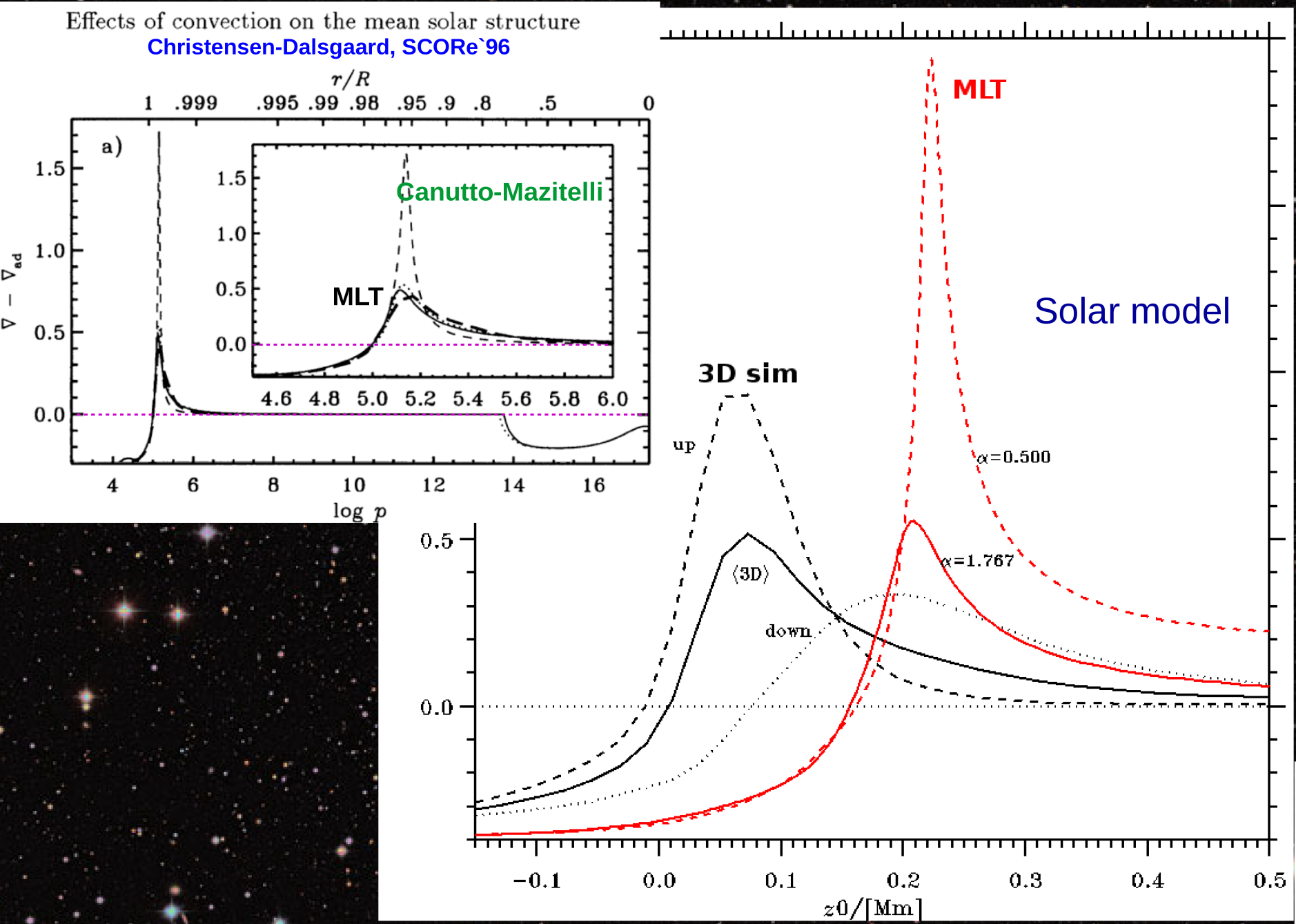
Super-adiabatic gradient



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Conclusions

- α calibration is 1st step in patching 3D on 1D
- Calibrating 1D models against 3D sims takes consistency
- $T(\tau)$ relations are one important step – also needed in general for stellar structure models
- ν-shift from patched – un-patched is only *structural* part of surface effect = atmospheric expansion by:
  - Turbulent pressure + convective backwarming
- Also has a *modal* part: the response of turbulent pressure and convective flux to modes.