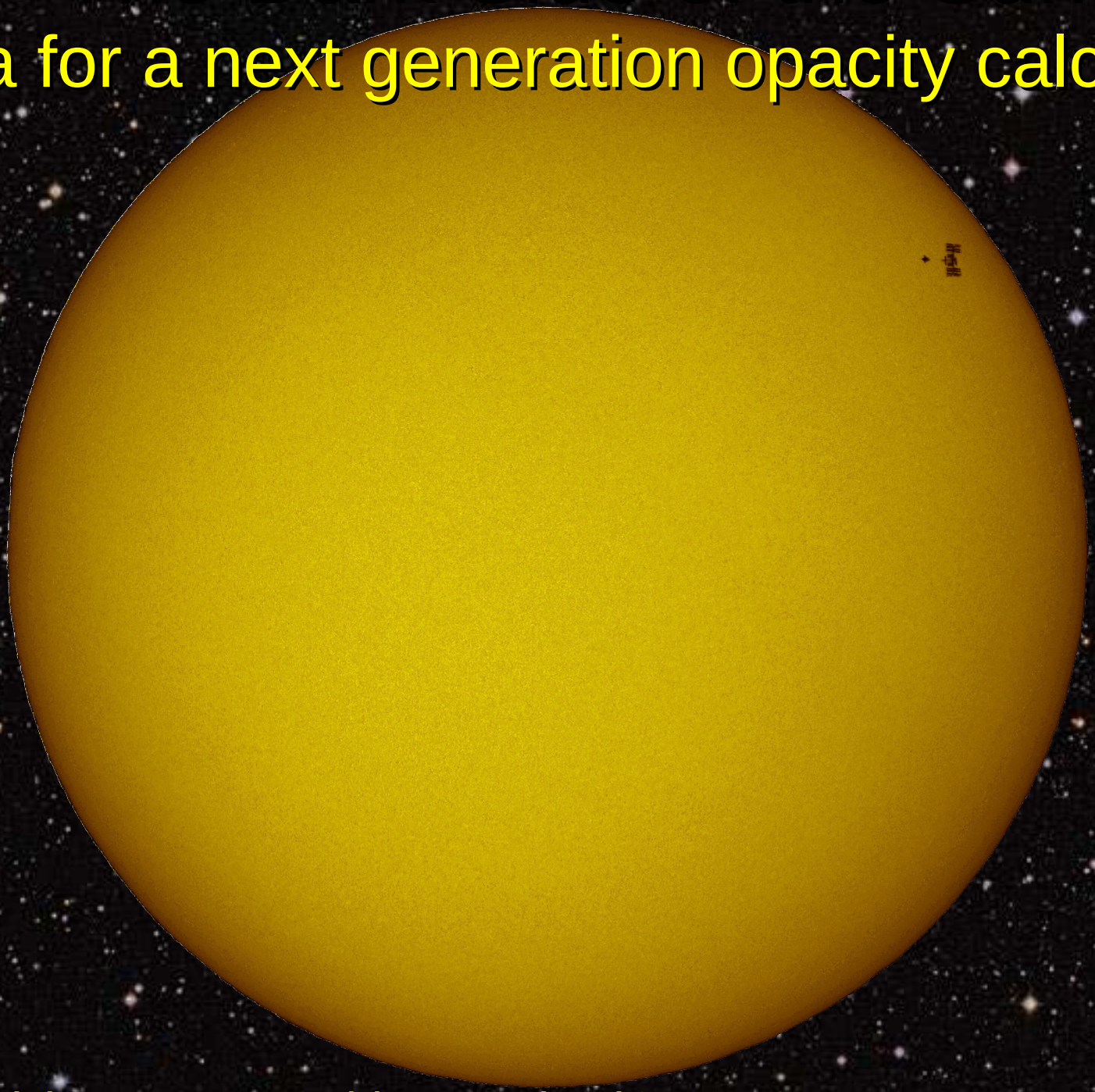
The Dark Side of the Sun

A plea for a next generation opacity calculation



Regner Trampedach

Workshop on Astrophysical Opacities, , Aug.1st, 2017

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The Dark Side of the Sun

A plea for a next generation opacity calculation

Regner Trampedach

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Heard about the "Solar Abundance Problem"?

- Asplund, Grevesse & Sauval (2005, AGS`05): Abundance analysis on 3D simulation of Solar atmosphere ⇒ ~2/3 of the 'old' CNO abunds.
- Wrecked havoc on solar models vs. seismology!
- Asplund, Grevesse, Sauval & Scott (2009, AGSS`09): New analysis, better simulation and atomic data ⇒ ~3/4 of 'old' CNO abunds.
- Caffau et al. (2011): 85-95% of 'old' abunds.
- Scott et al. (2015a,b), Grevesse et al. (2015): Minor changes from AGSS`09

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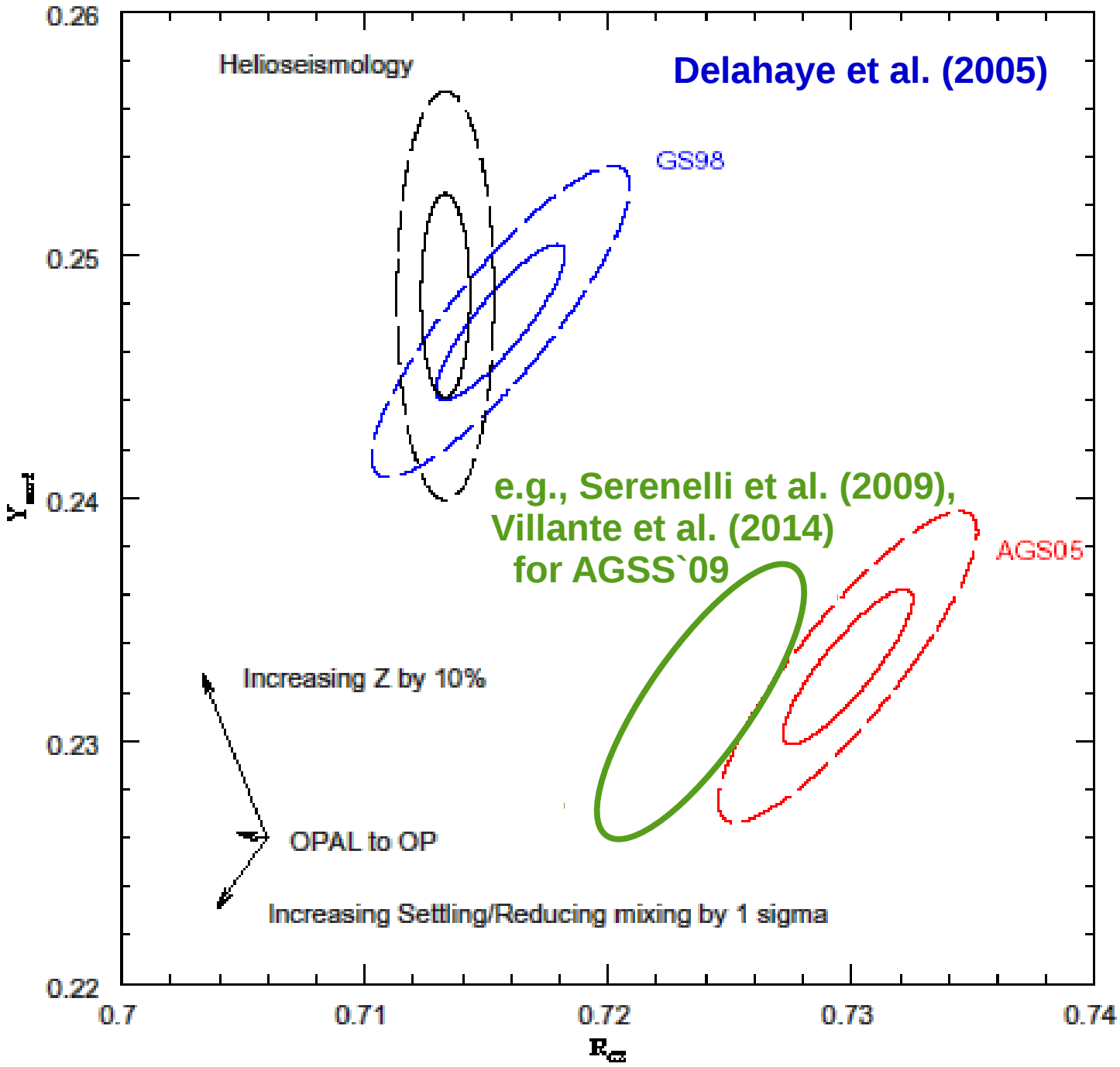

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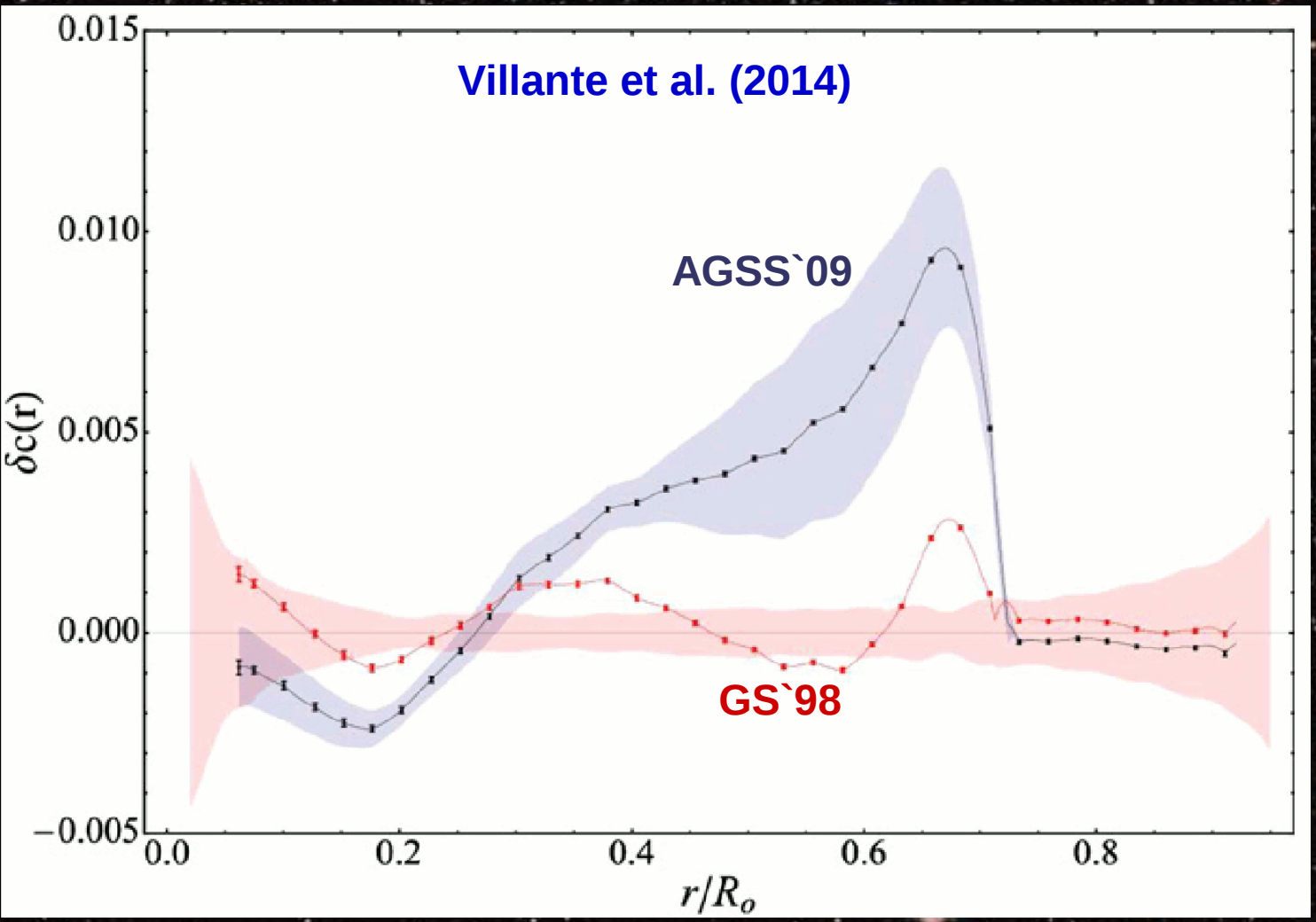

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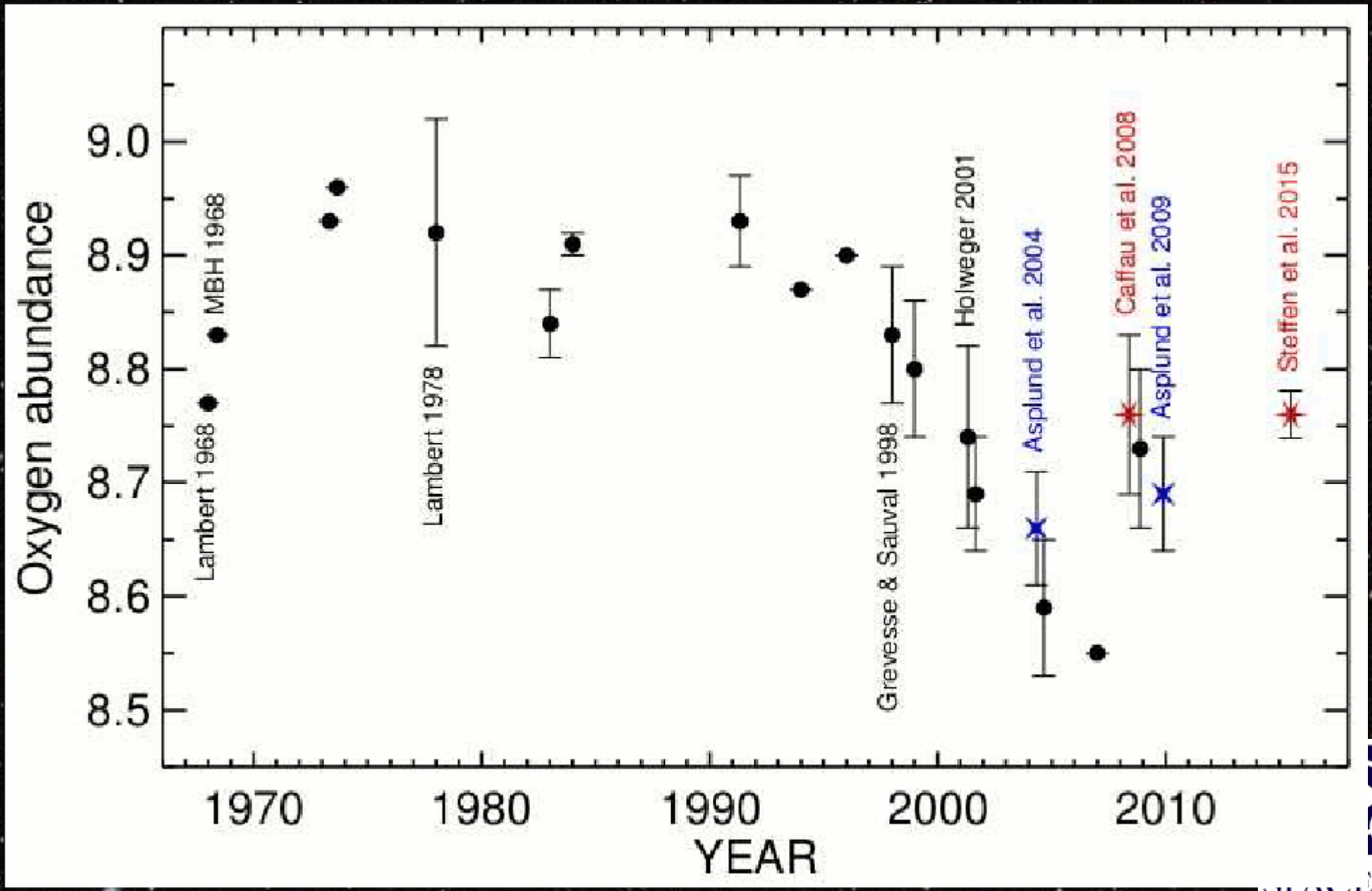
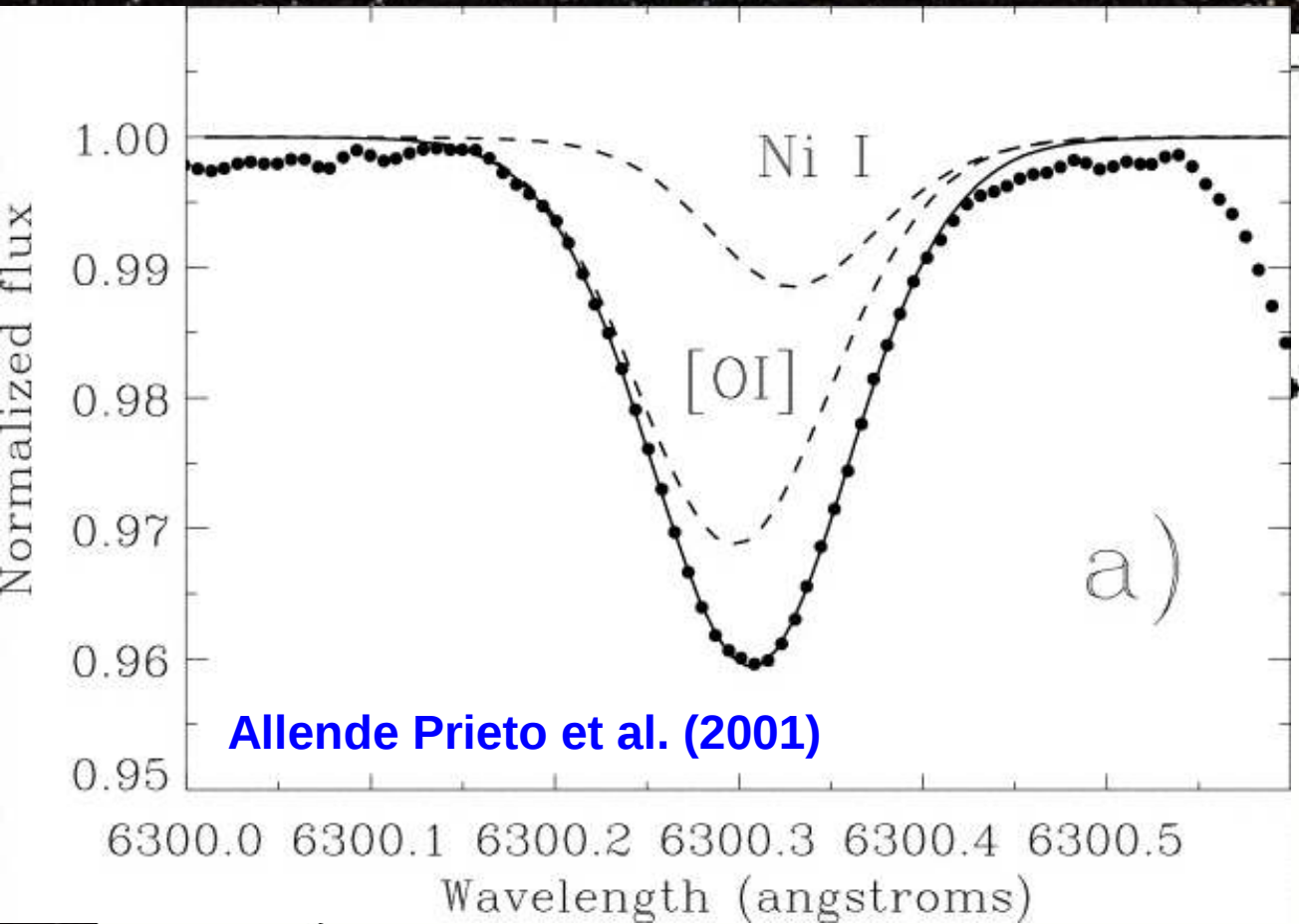
Oxygen!



Oxygen!



Allende Prieto et al. (2001)

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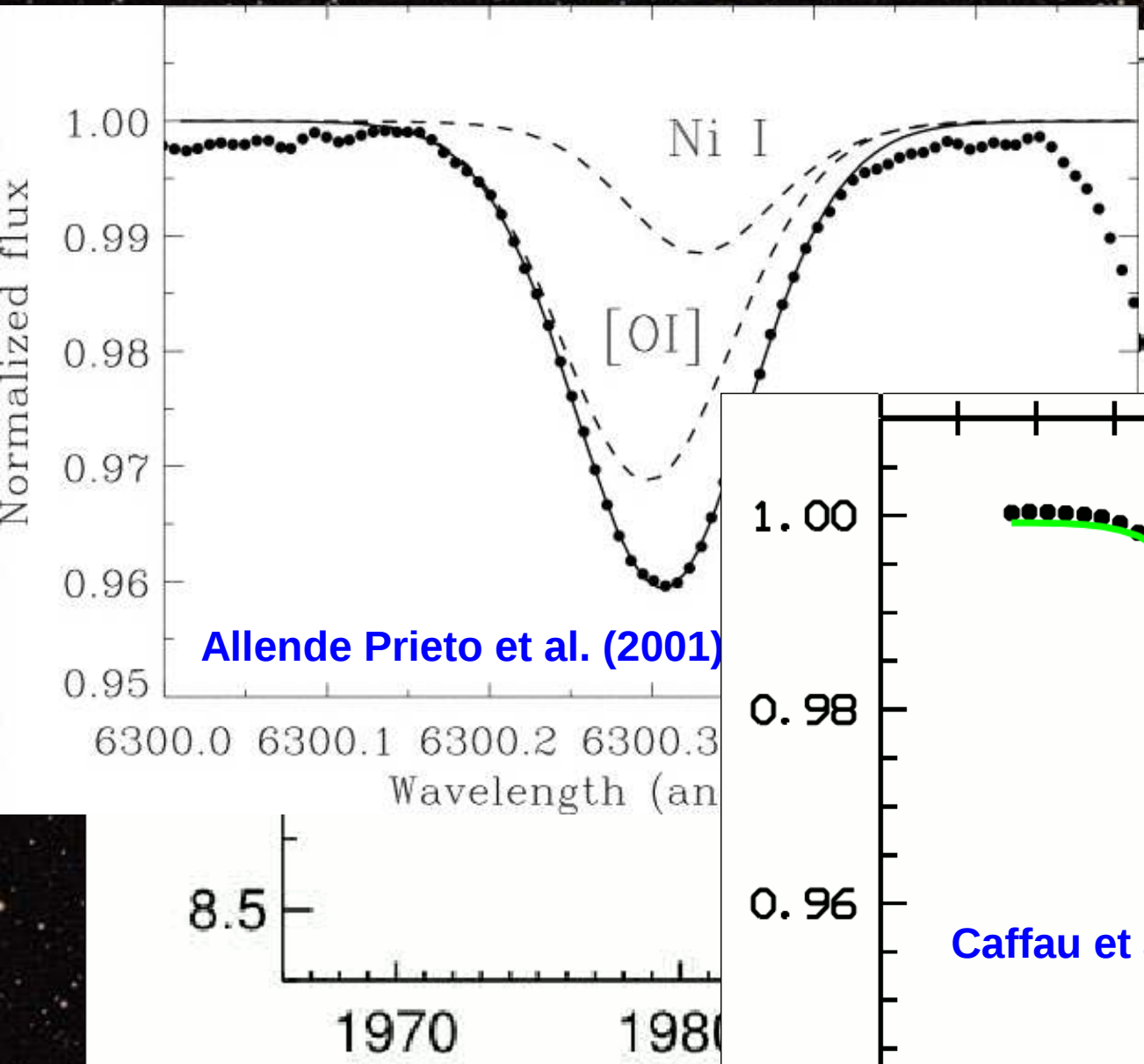
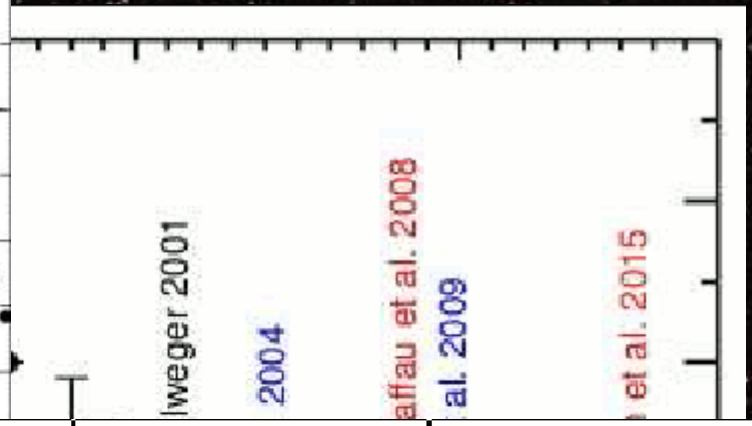
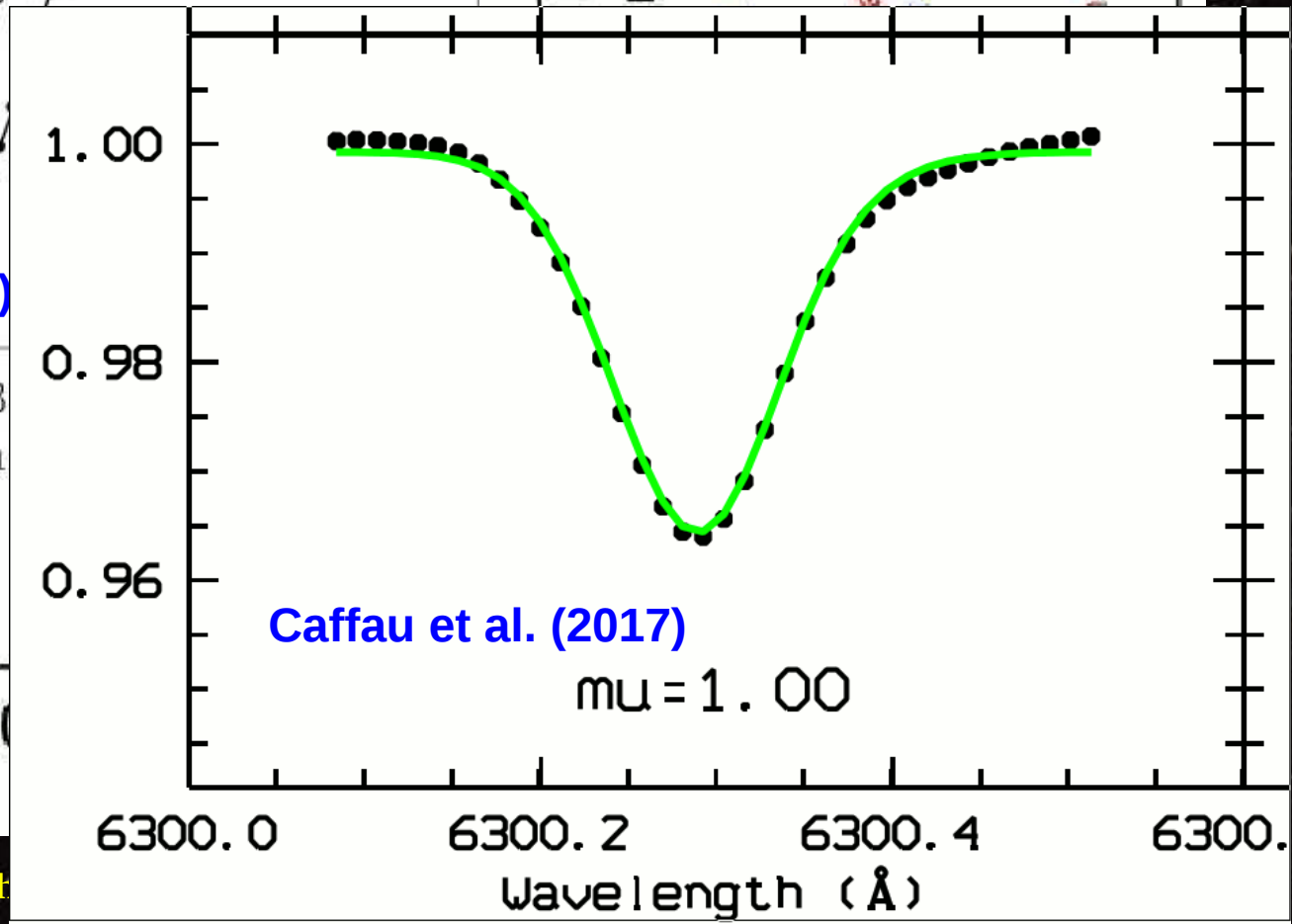
Oxygen!


Normalized flux
1.00
0.99
0.98
0.97
0.96
0.95
Ni I
[OI]
6300.0 6300.1 6300.2 6300.3
Wavelength (an
Allende Prieto et al. (2001)


weger 2001
2004
affau et al. 2008
al. 2009
et al. 2015


1.00
0.98
0.96
Caffau et al. (2017)
mu=1.00
6300.0
6300.2
6300.4
6300.
Wavelength (Å)

8.5
1970
198

Solution: Increase Z or Opacity

- Then Bailey et al. (2015) *measured* the opacity of Fe at conditions close to bottom of solar CZ.

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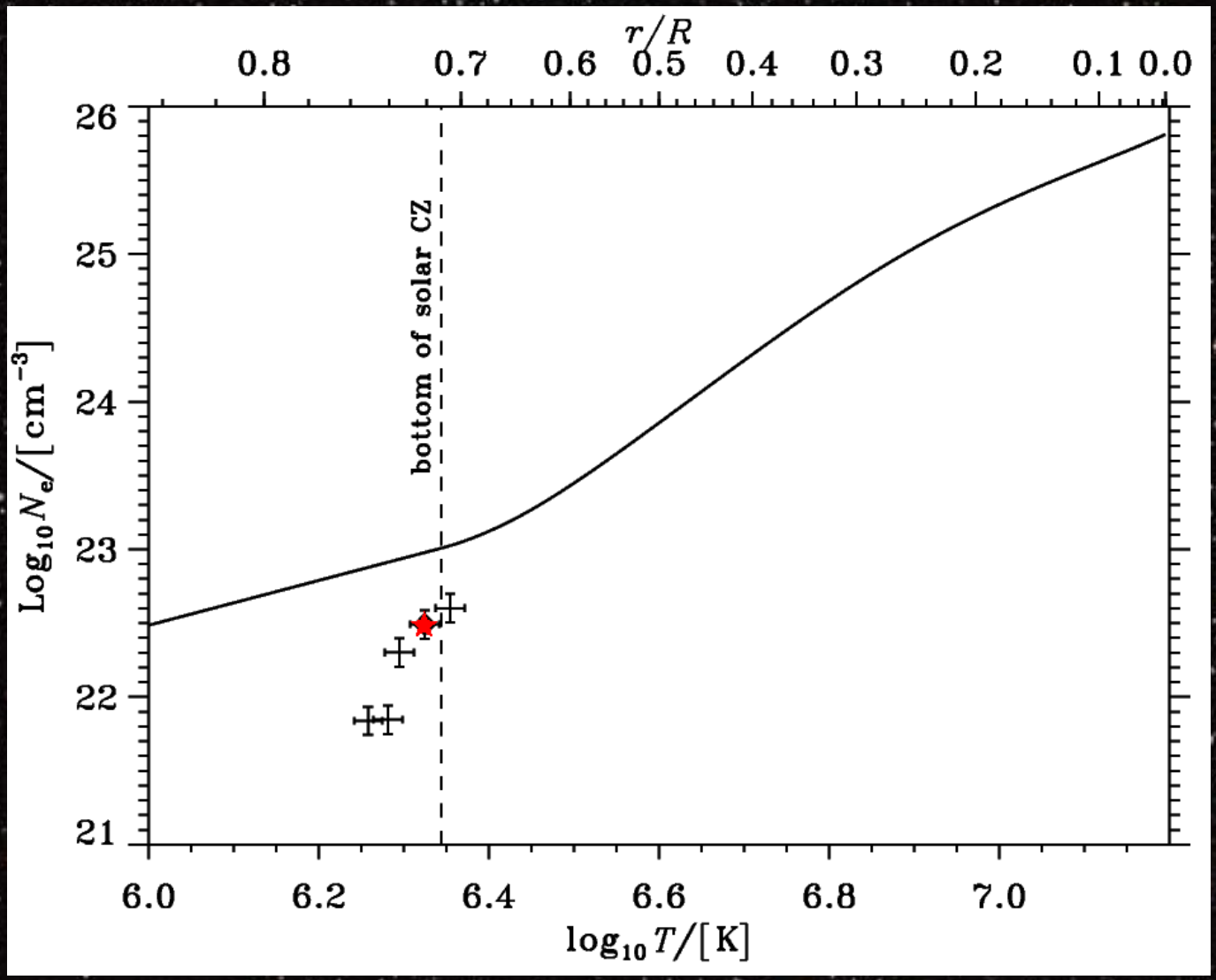
Solution: Increase Z or Opacity



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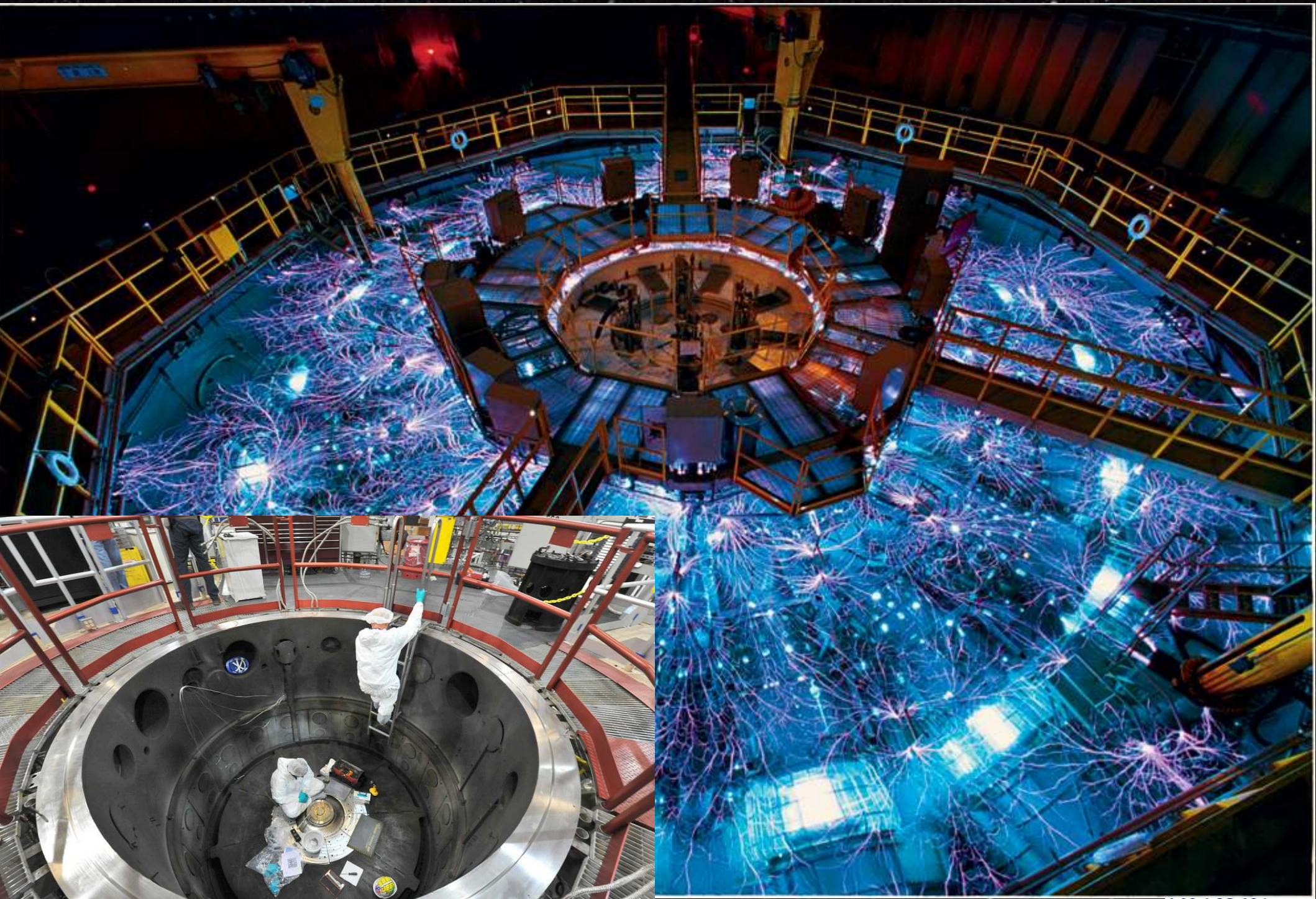
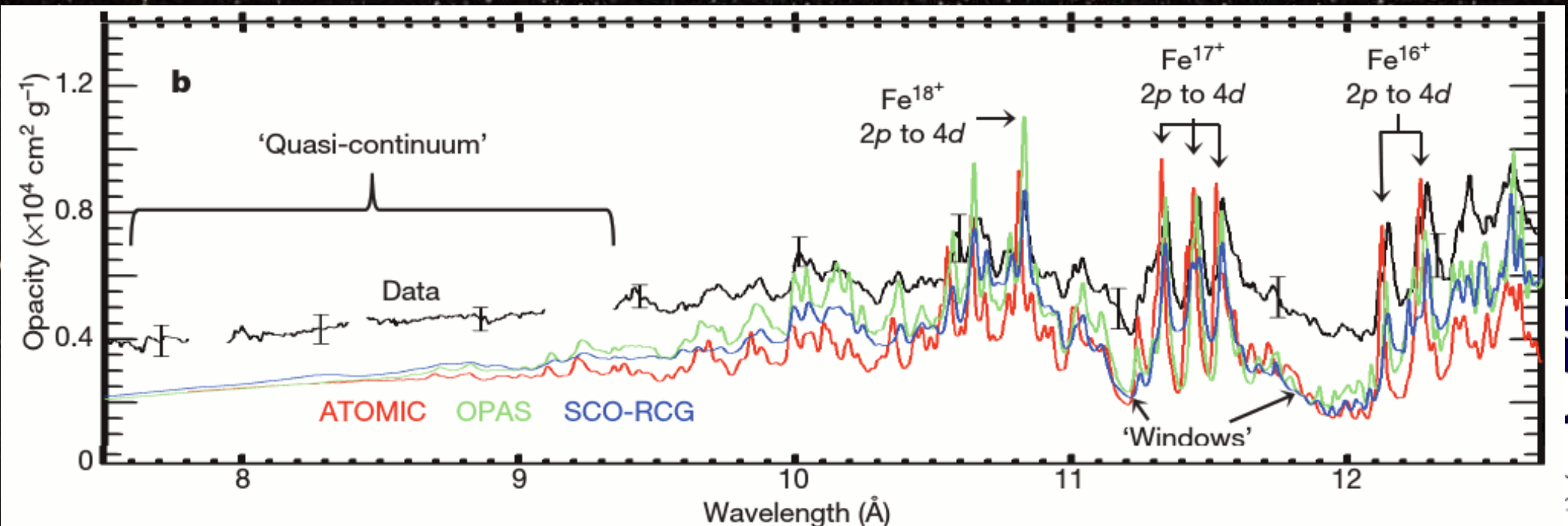
Solution: Increase Z or Opacity

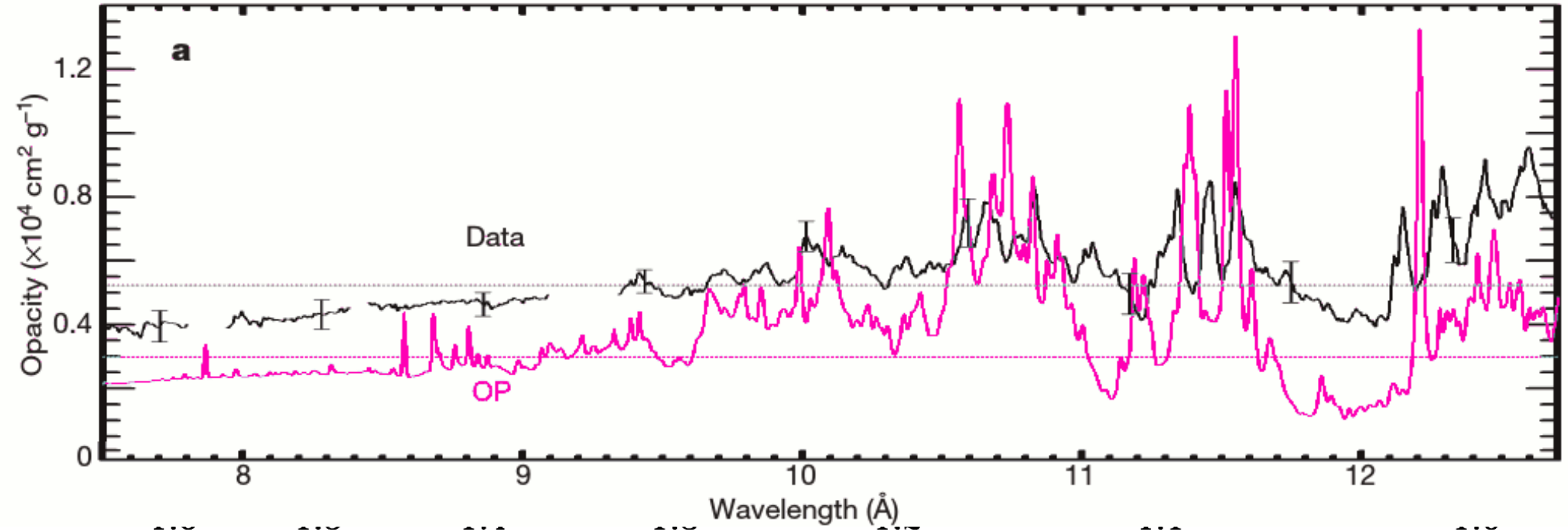
- Then Bailey et al. (2015) *measured* the opacity of Fe at conditions close to bottom of solar CZ.
- And found significantly higher opacity than any calculations to date!
- Switching out Opacity Project (OP`05) Fe-absorption for the measured $\Rightarrow$ +7% κ_{Ross}
- Let's try to mimick Fe measurement in OP`05 and see what happens!

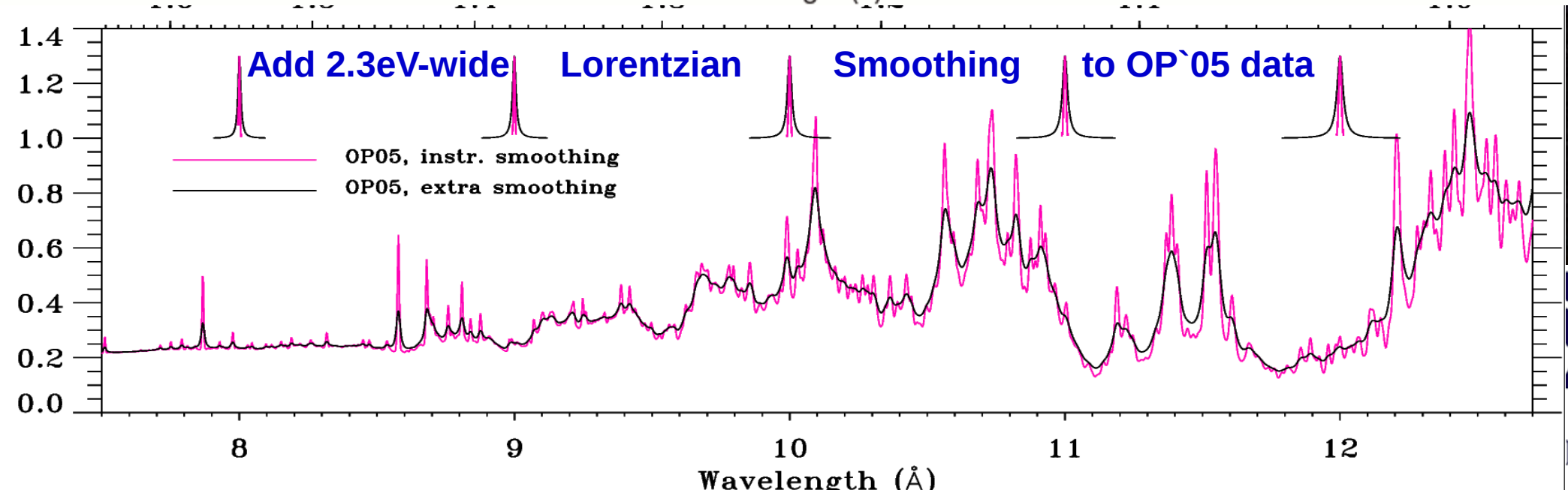


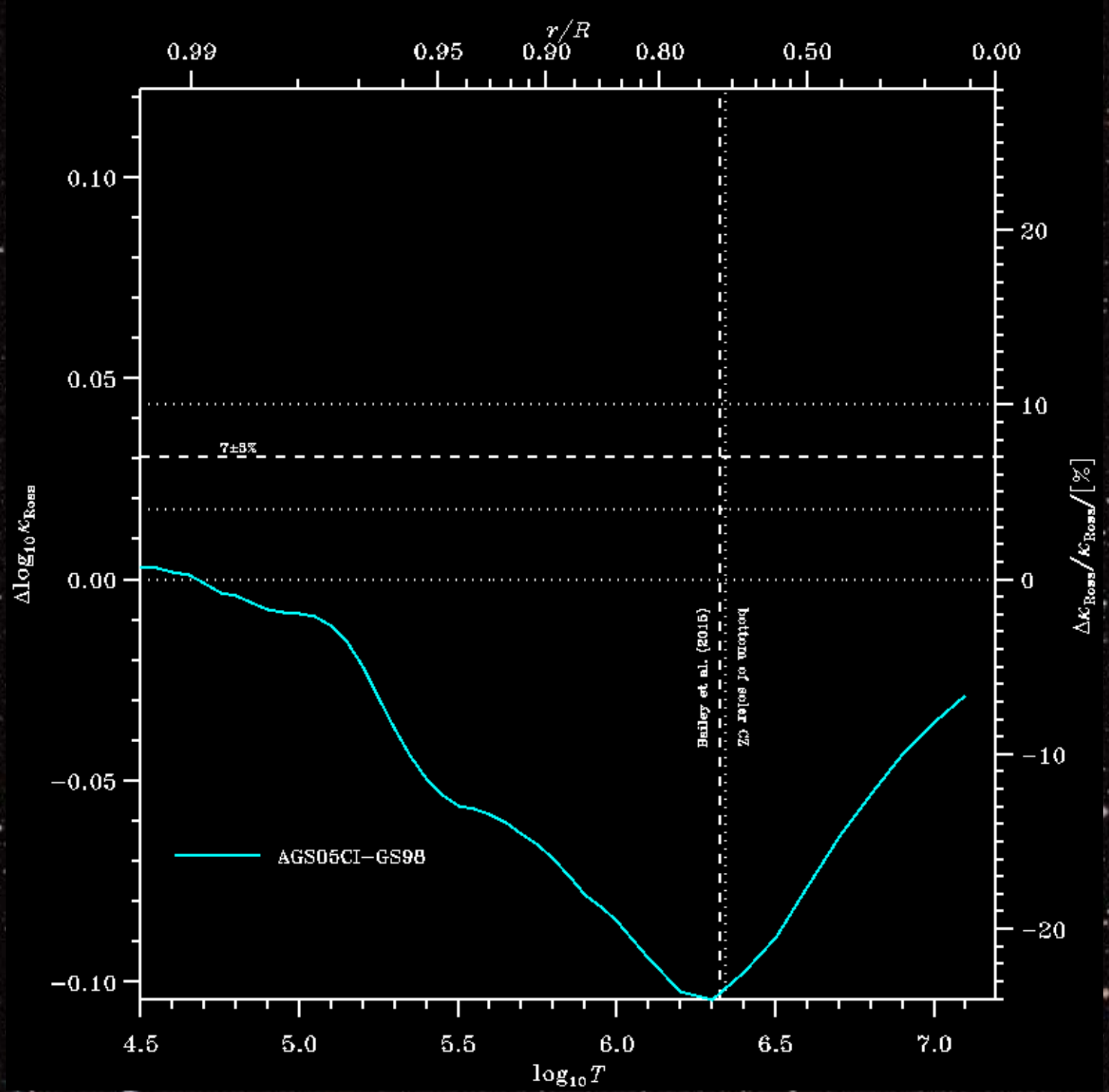
Solution: Increase Z or Opacity



Solution: Increase Z or Opacity







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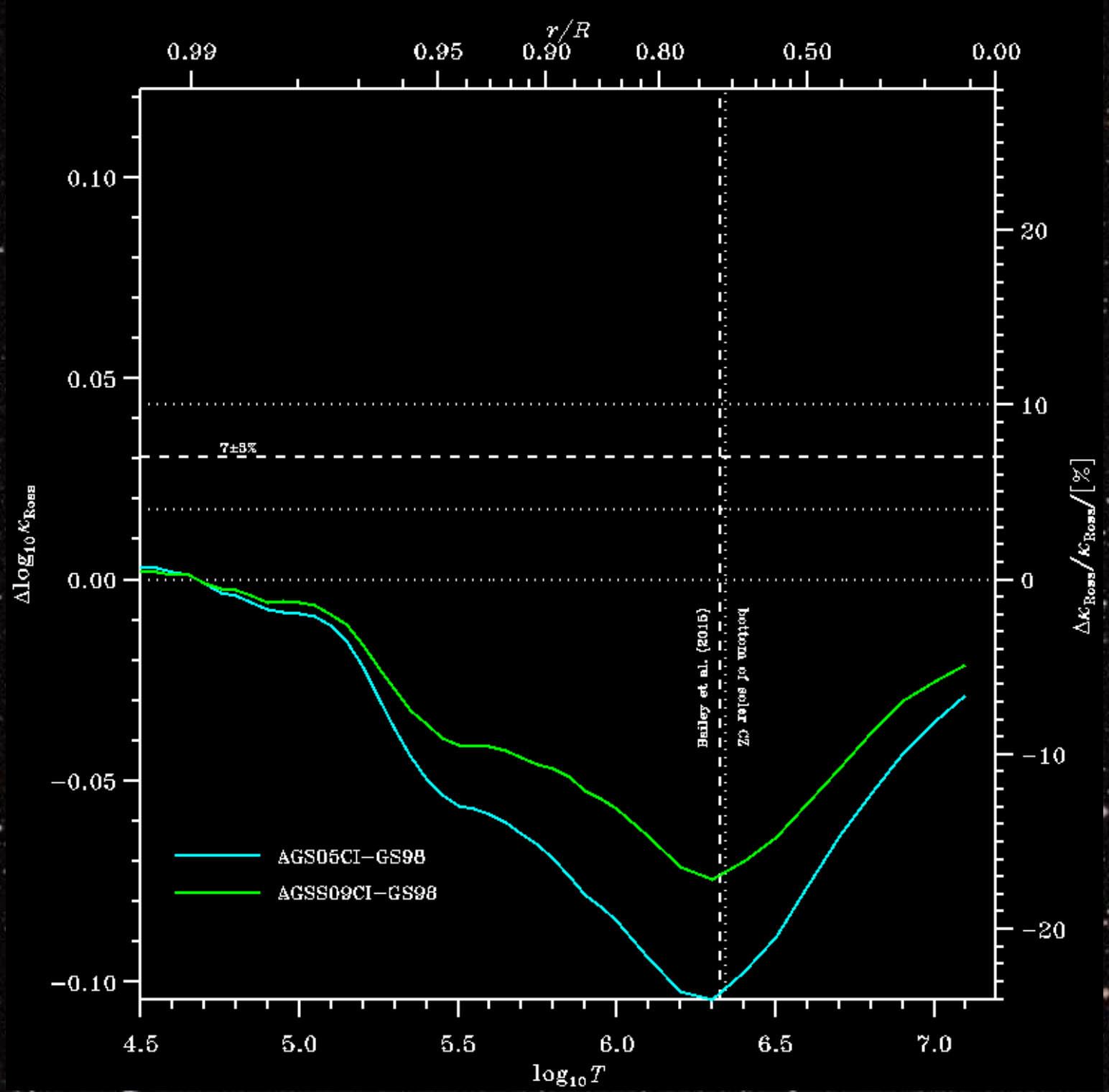

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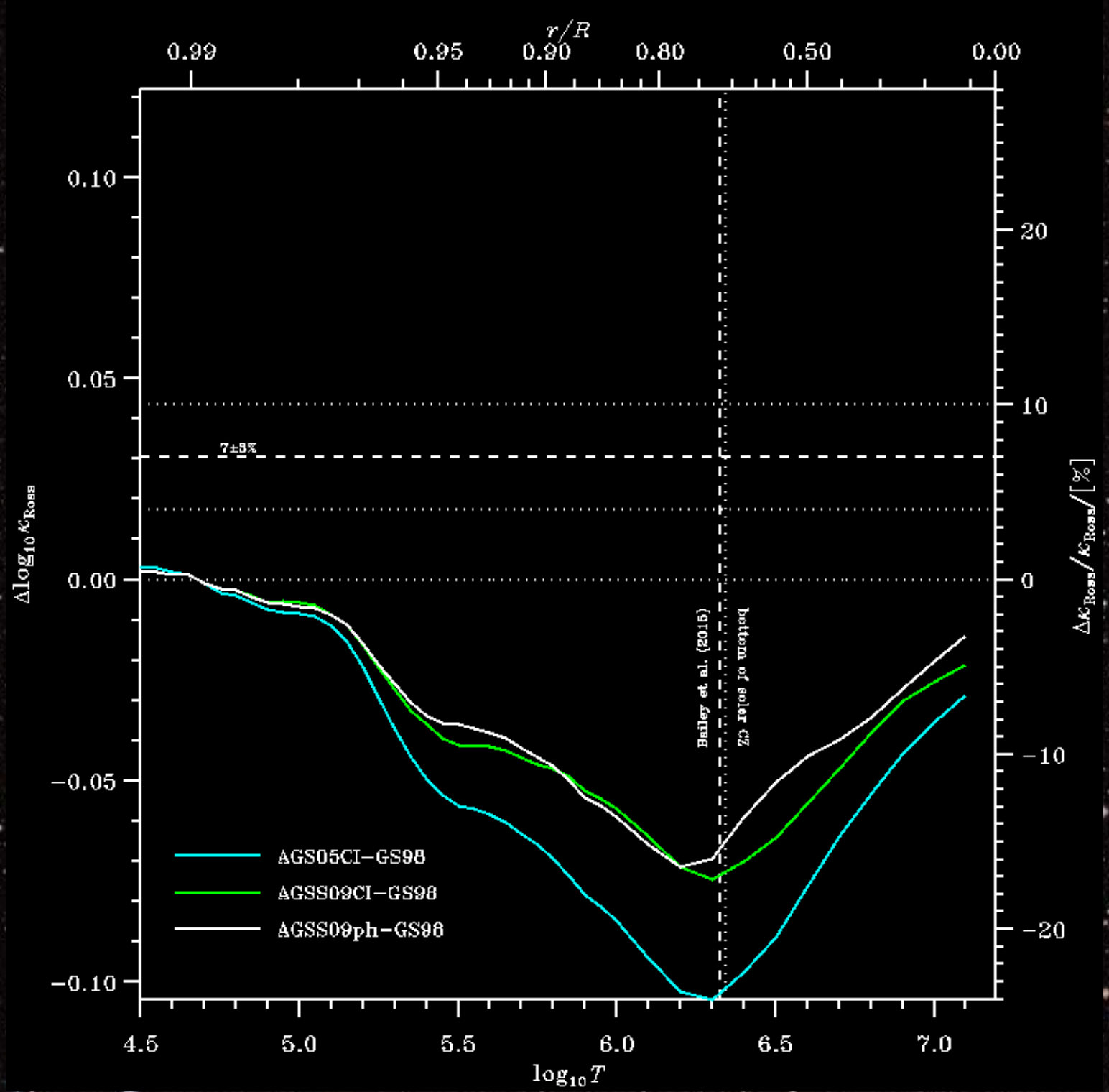

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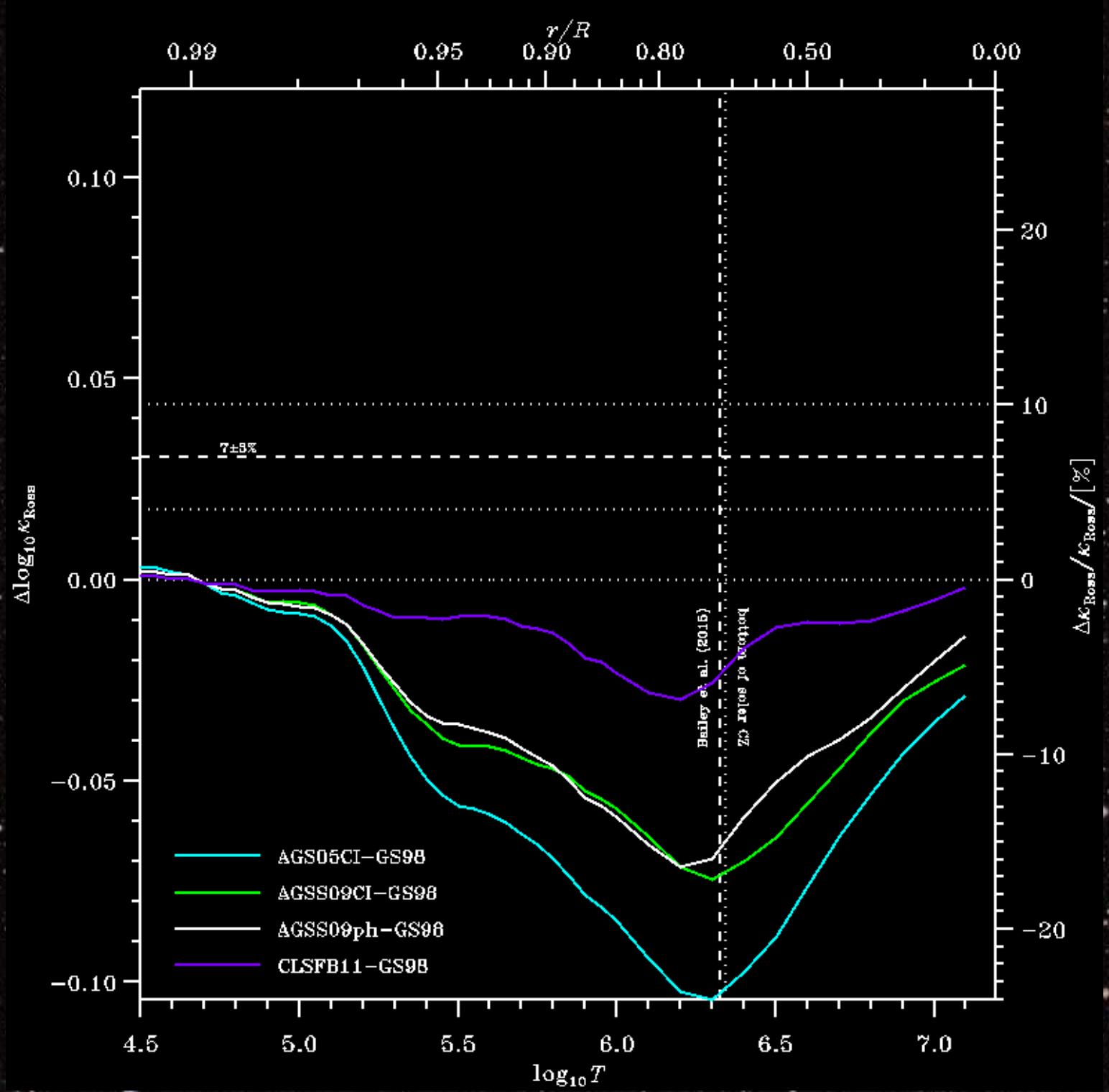

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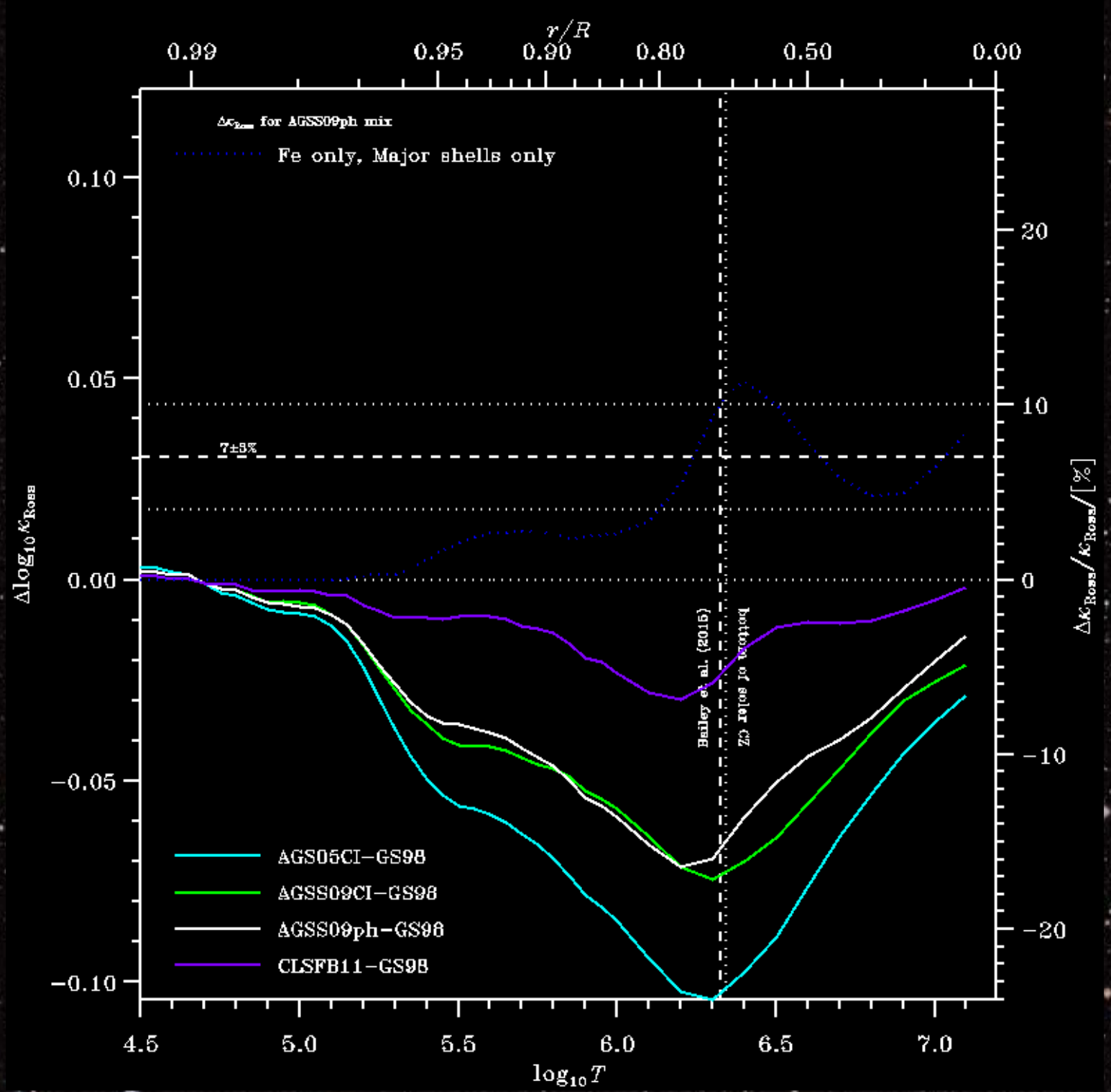

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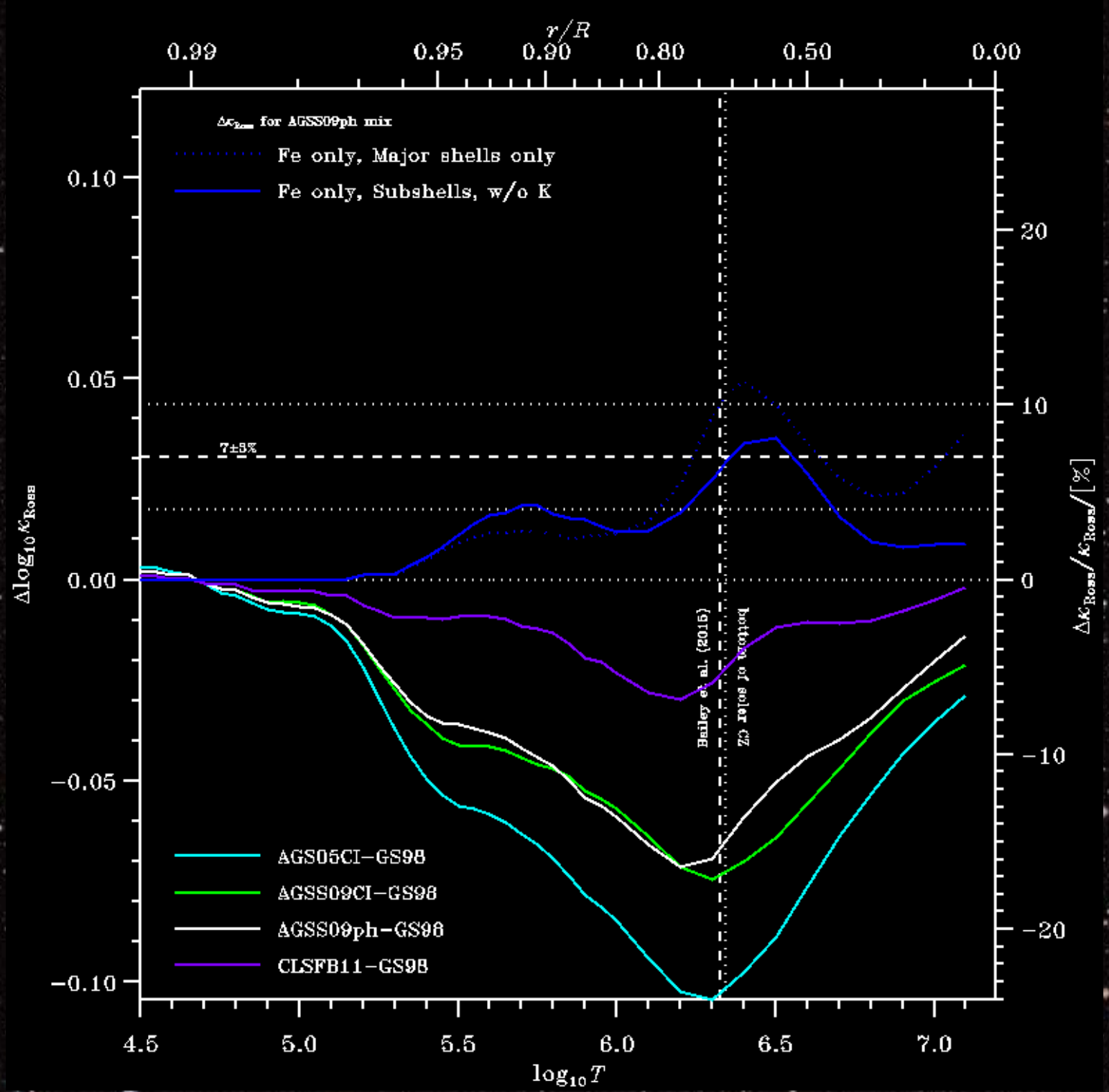

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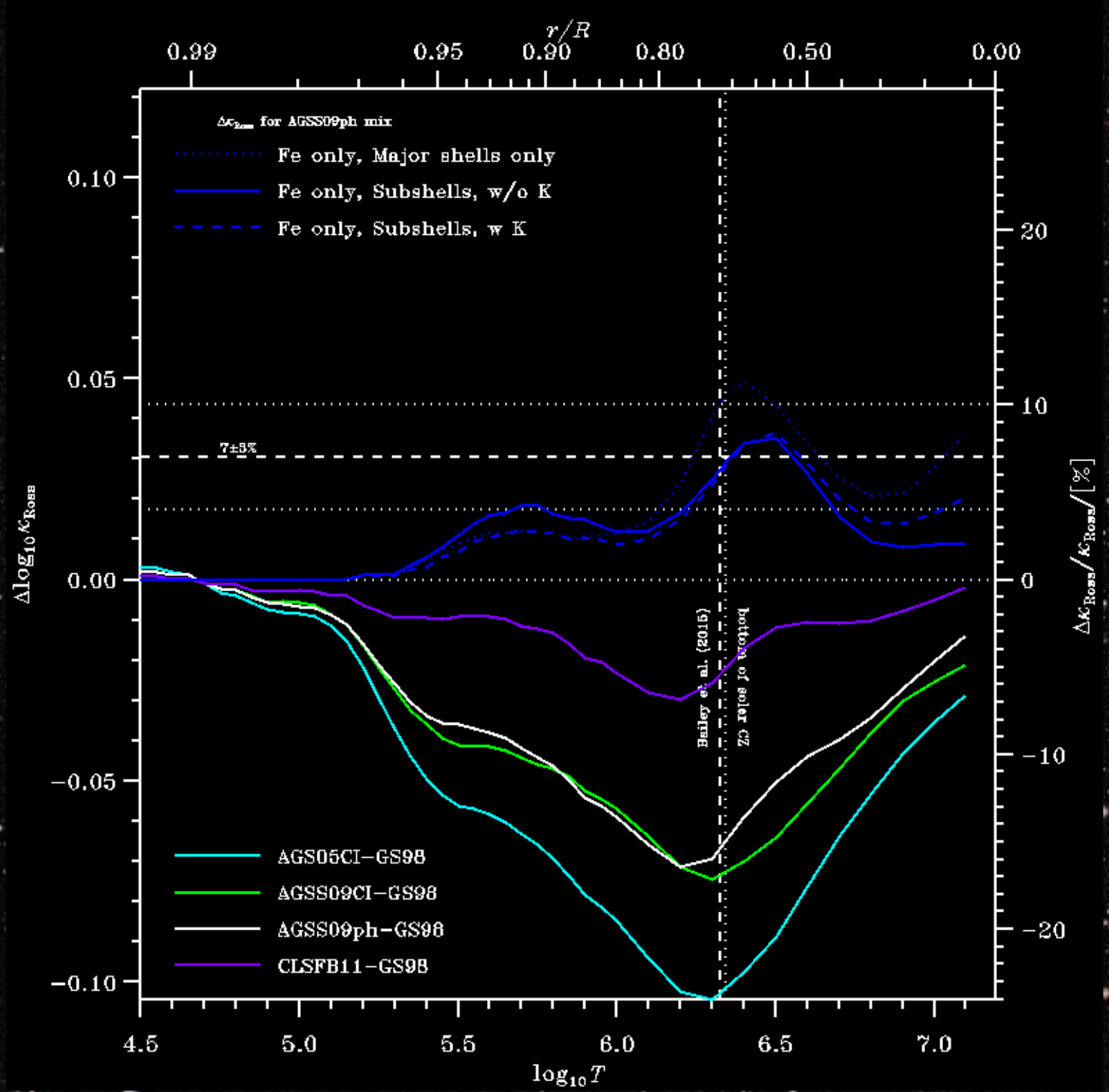

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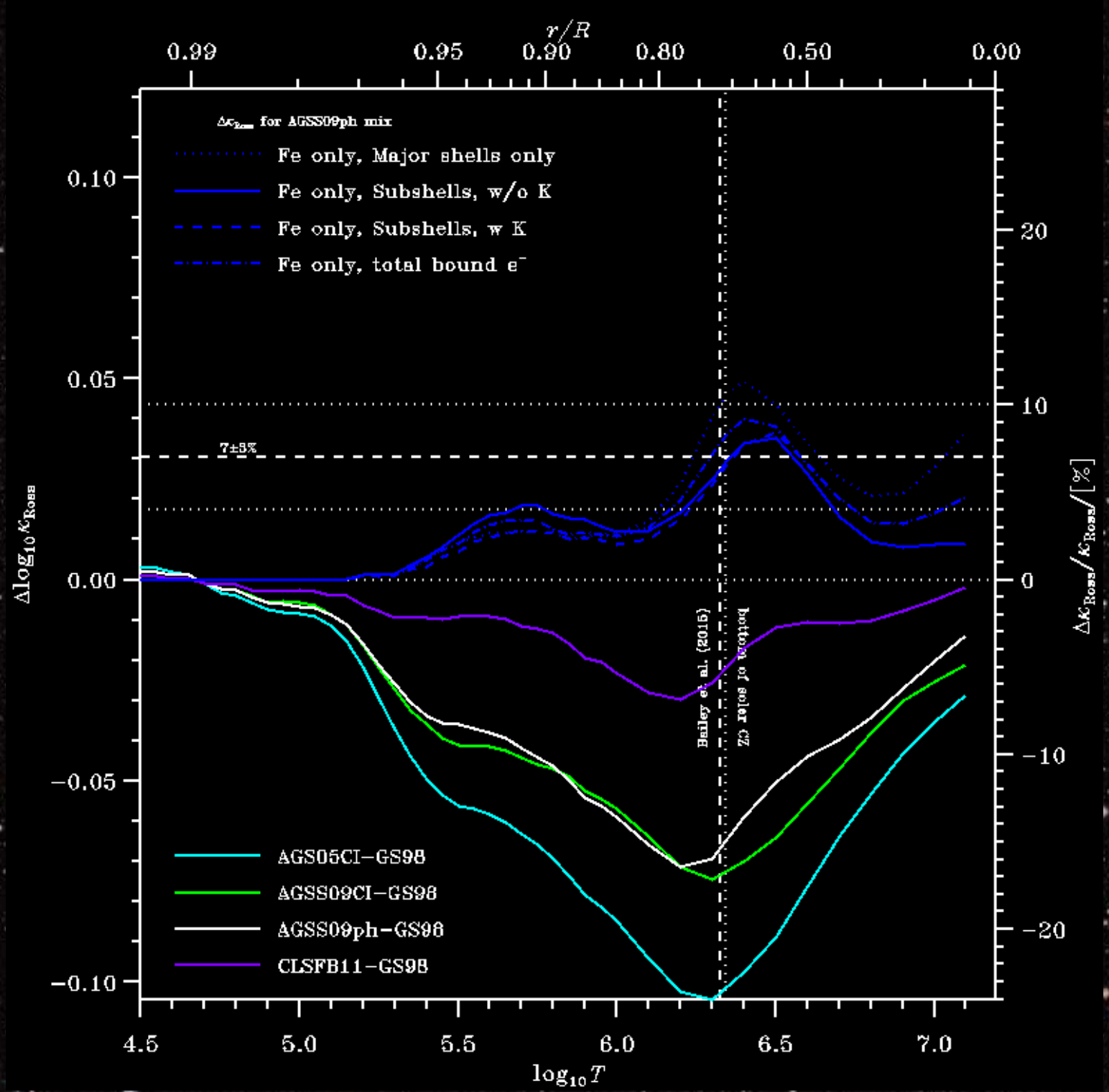

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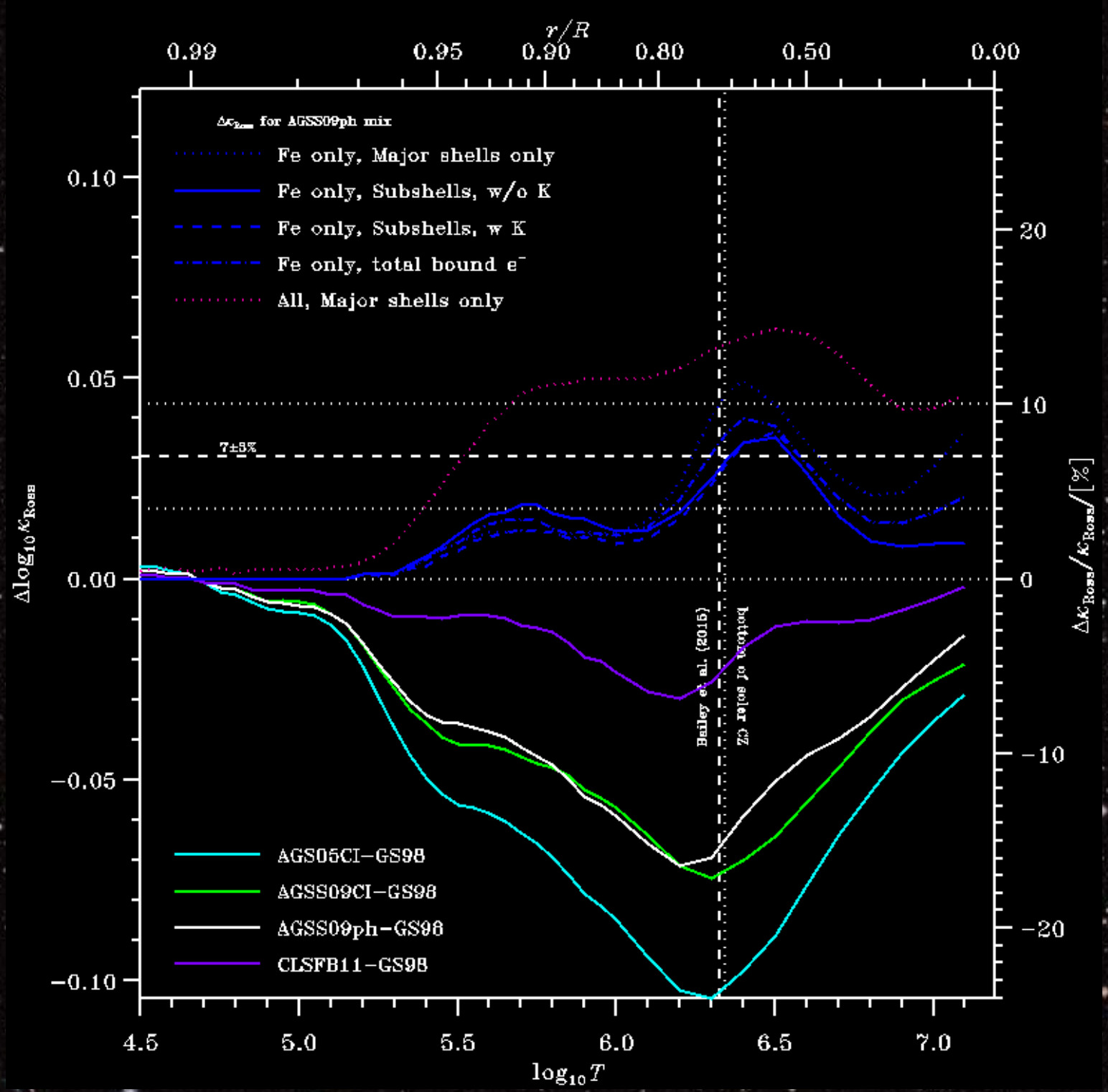

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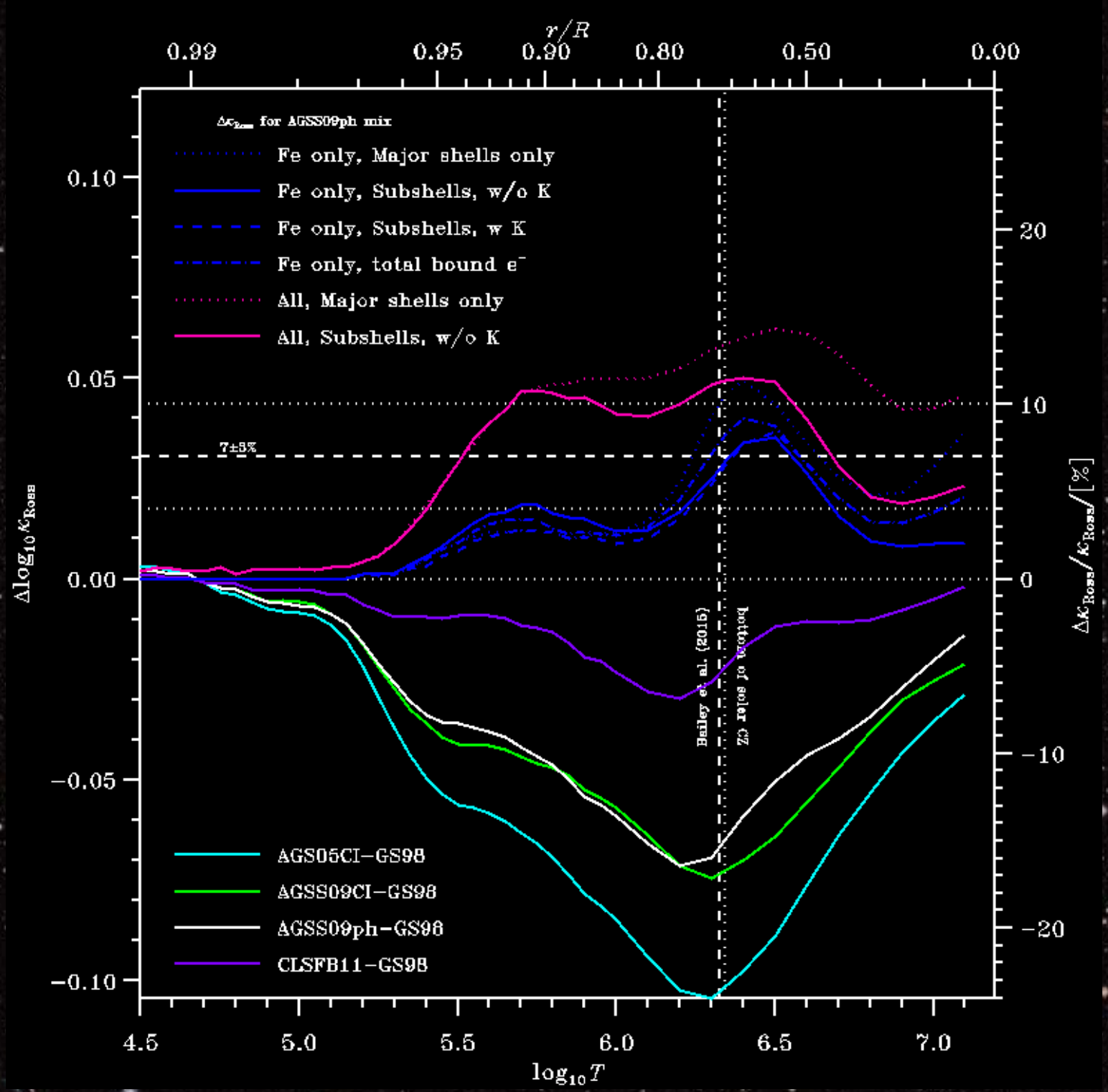

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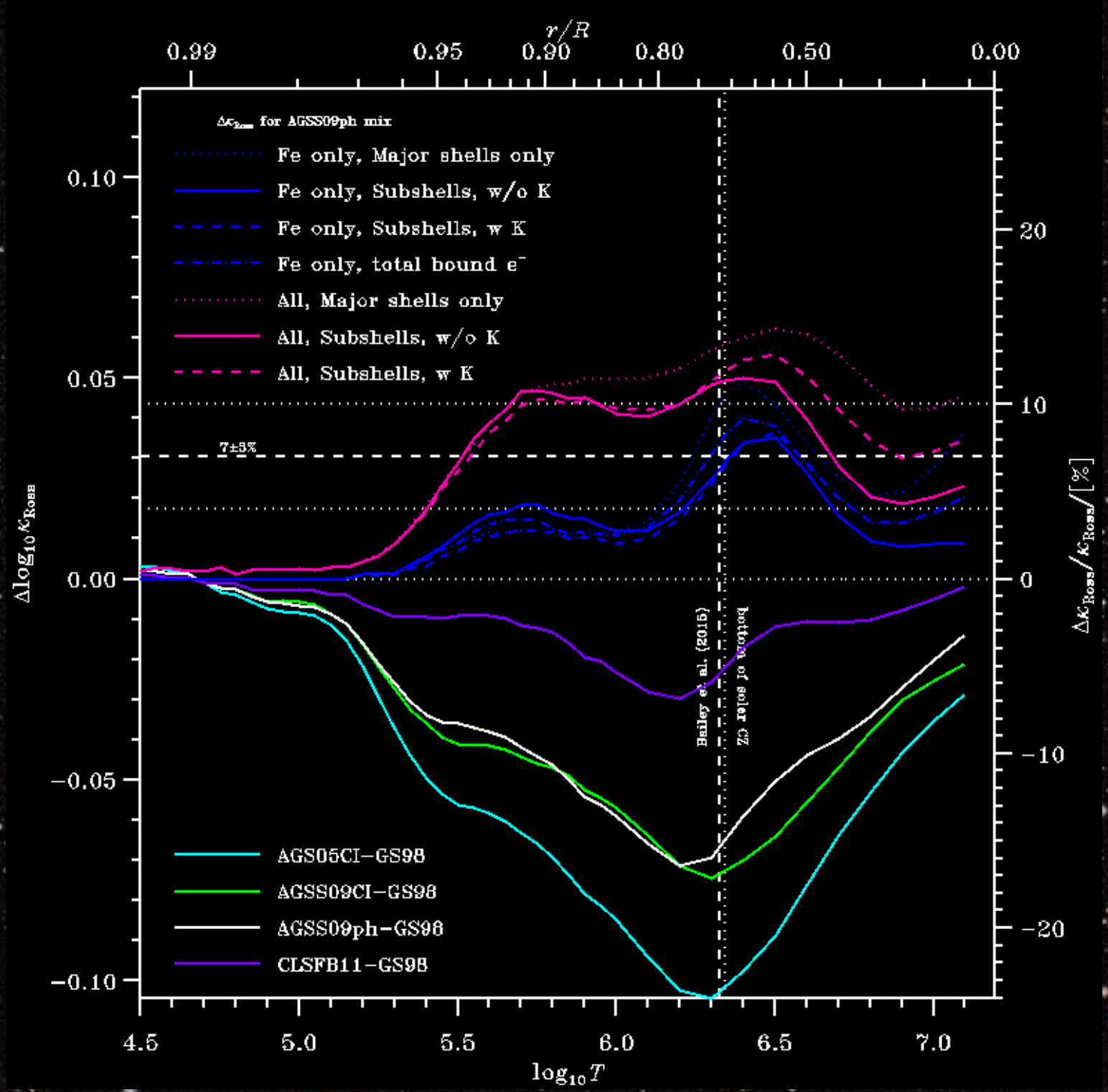

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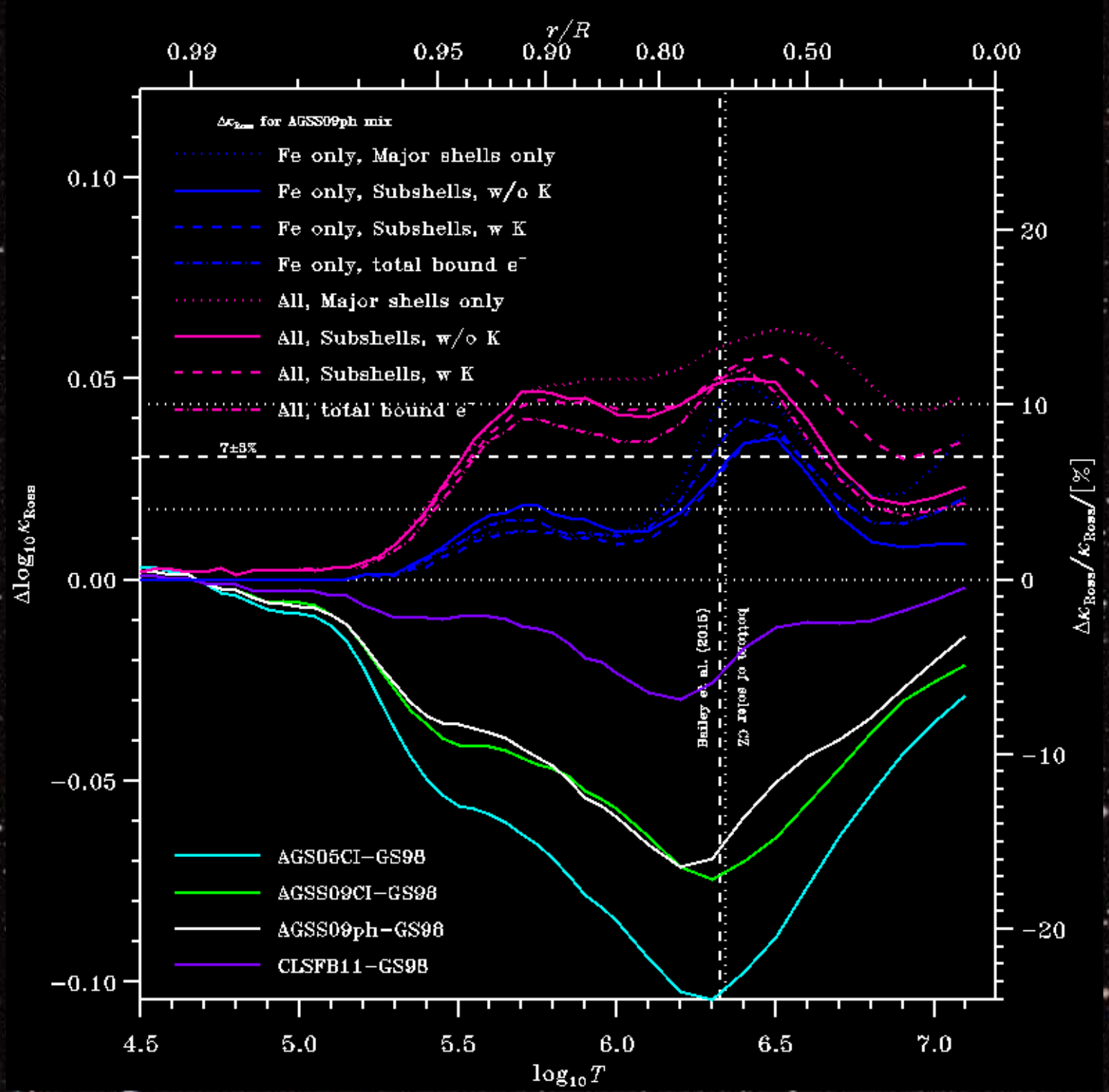

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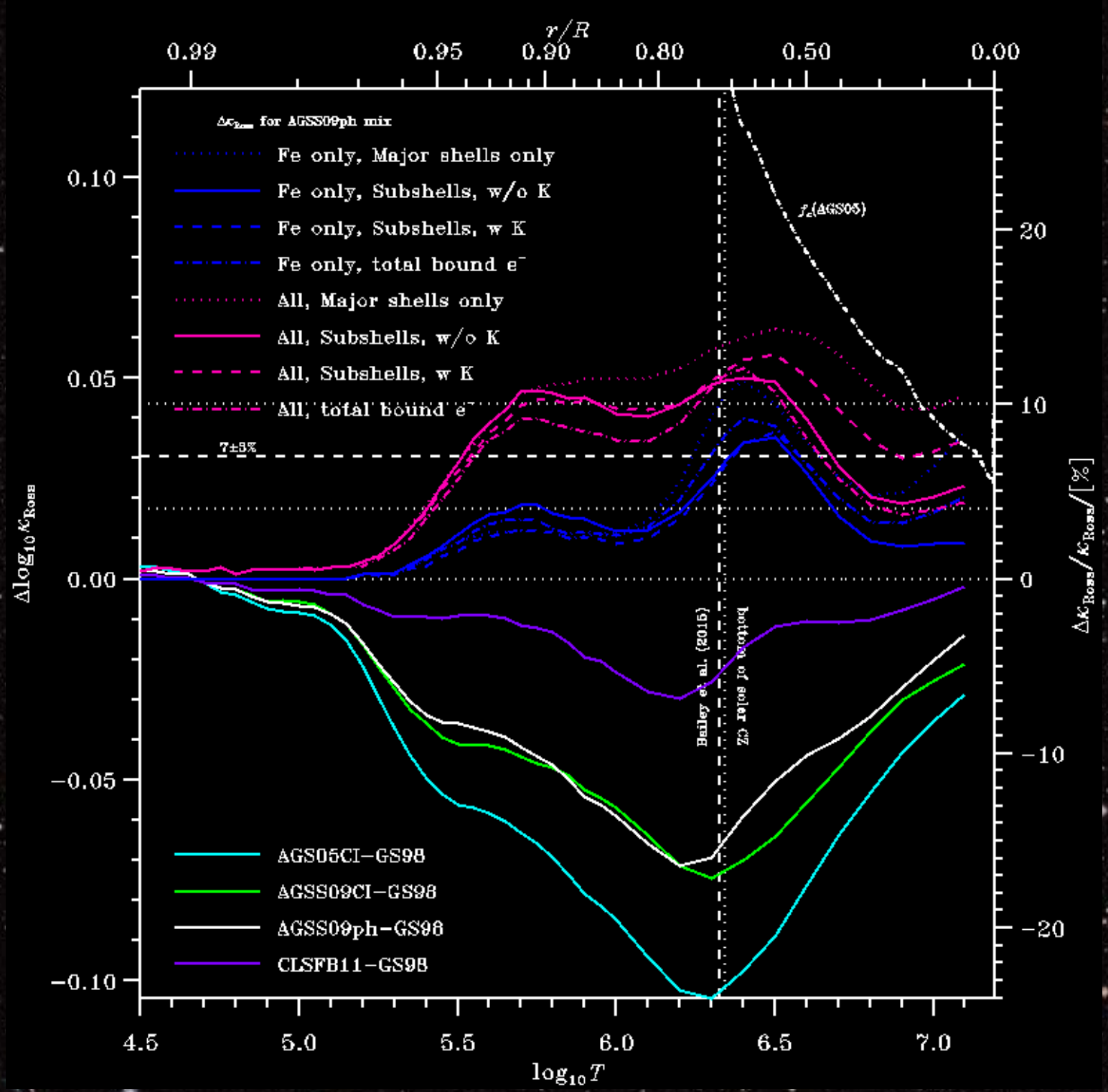

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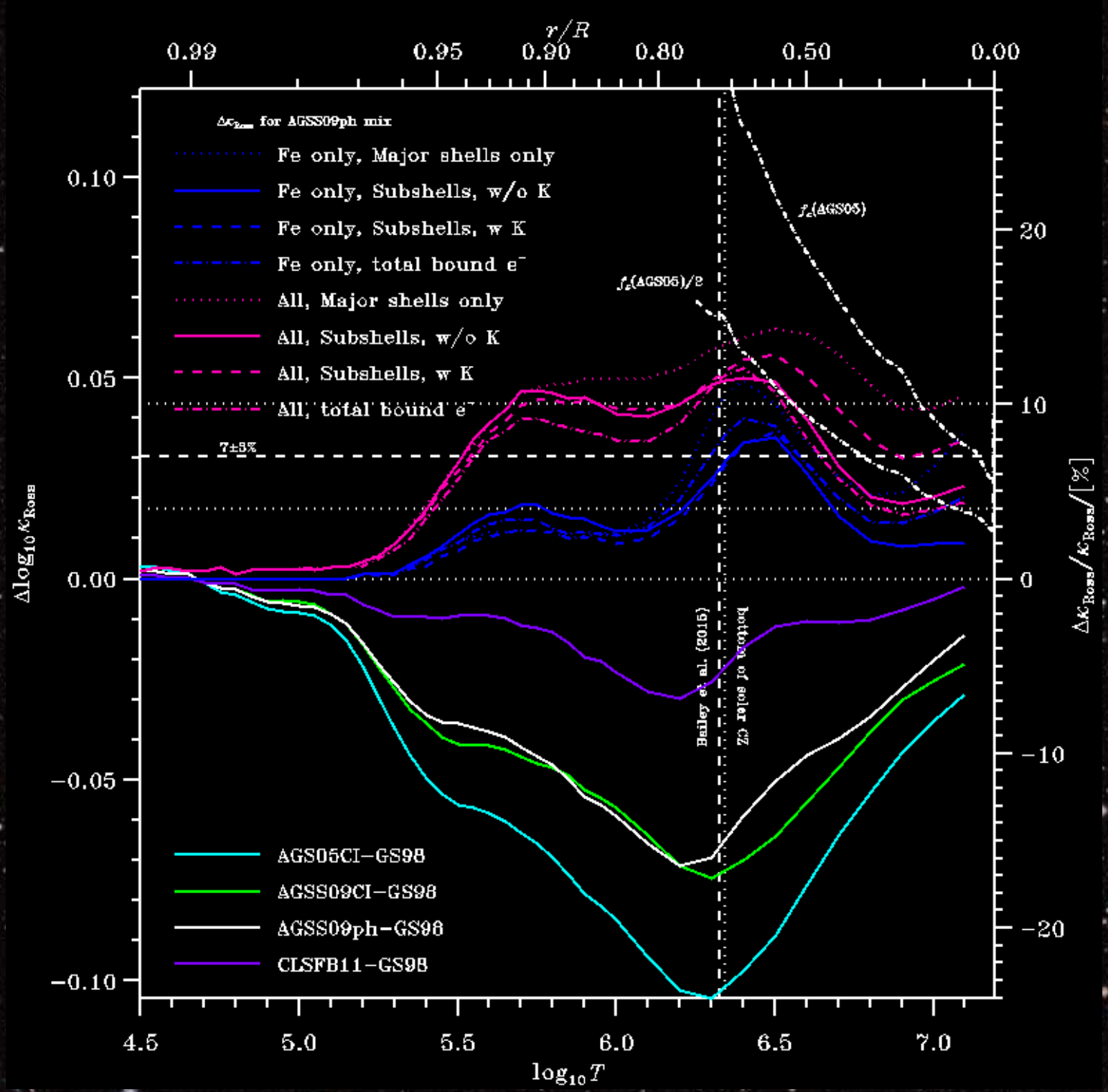

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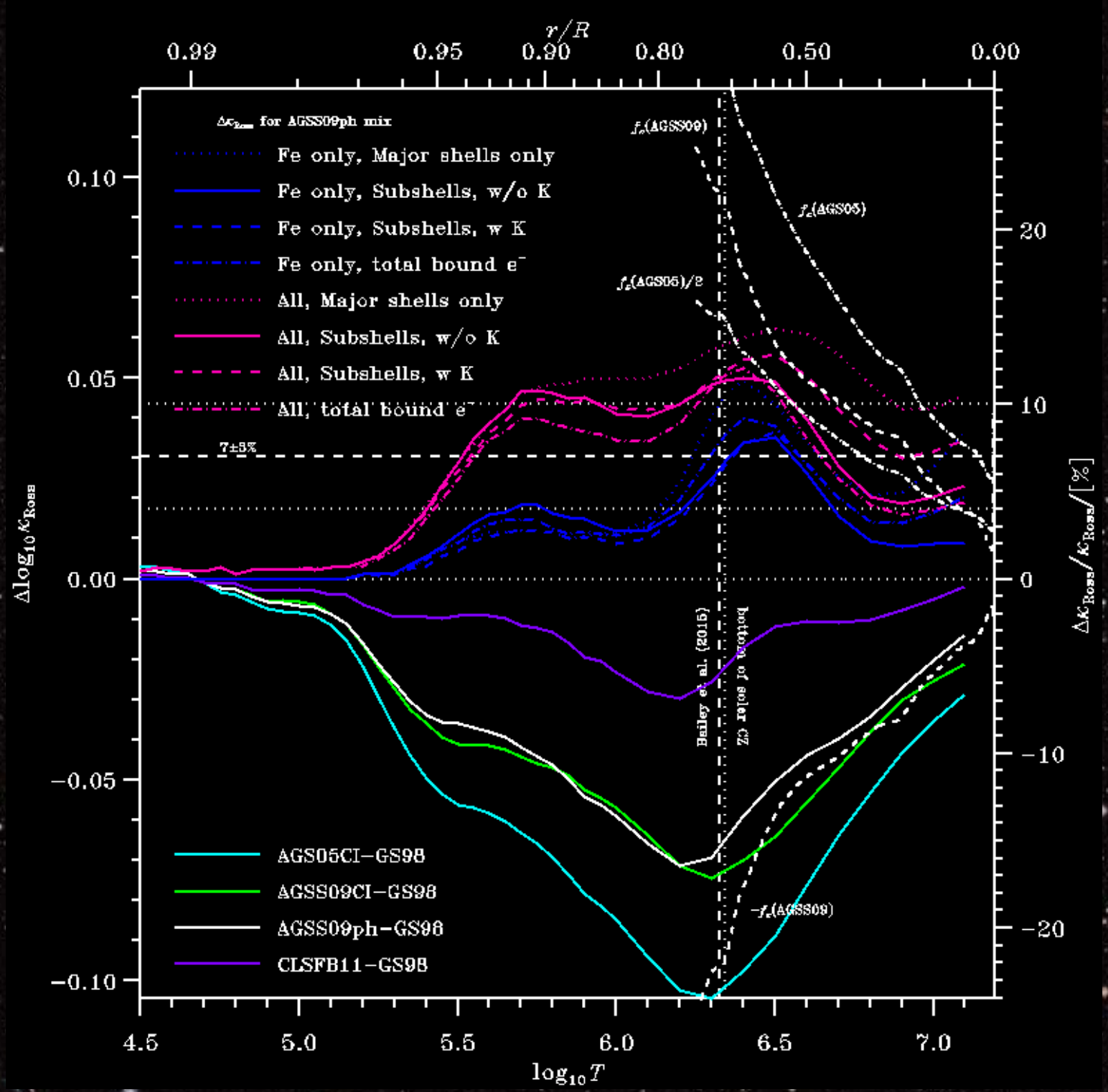

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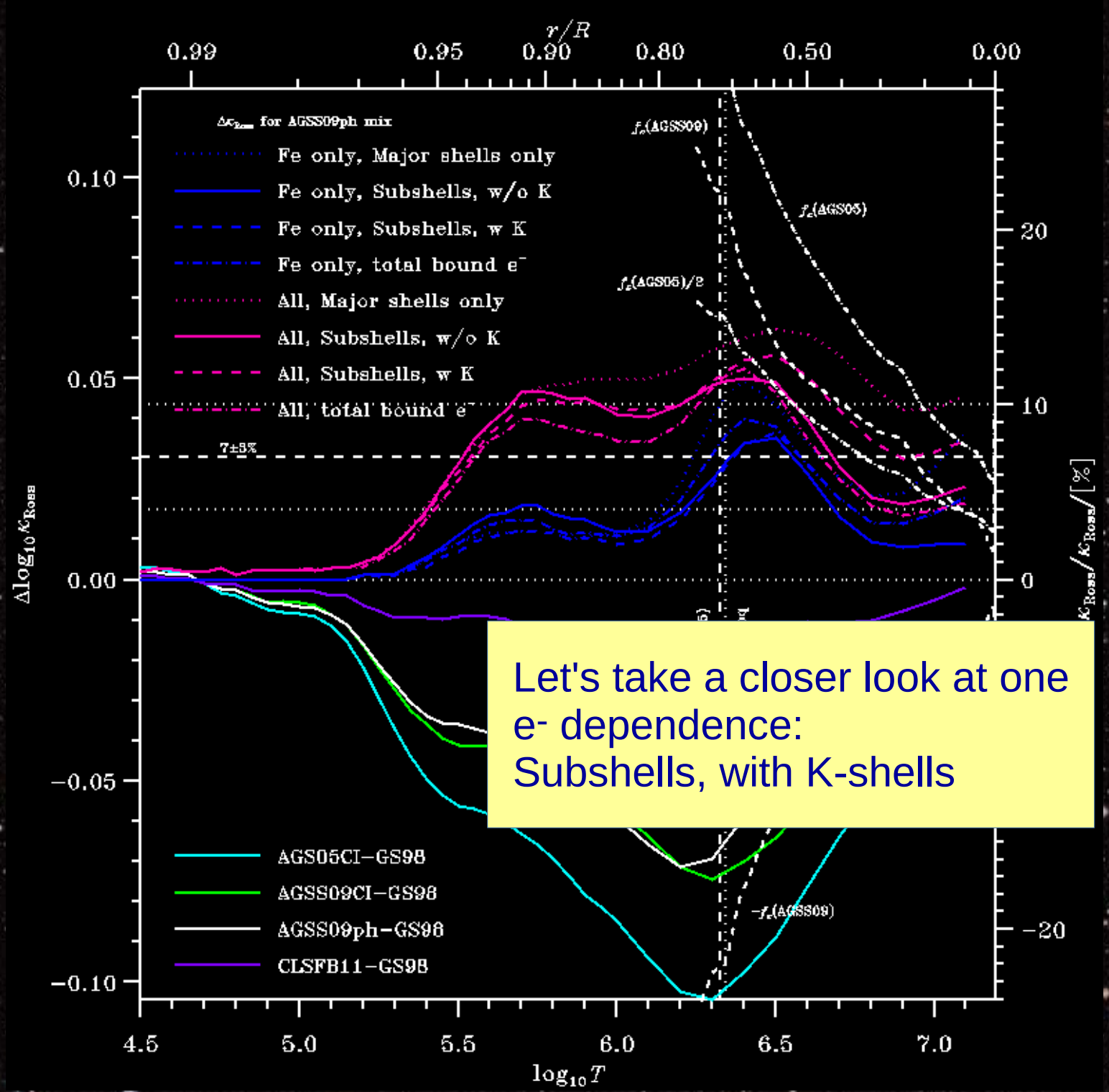

Let's take a closer look at one e⁻ dependence:
Subshells, with K-shells

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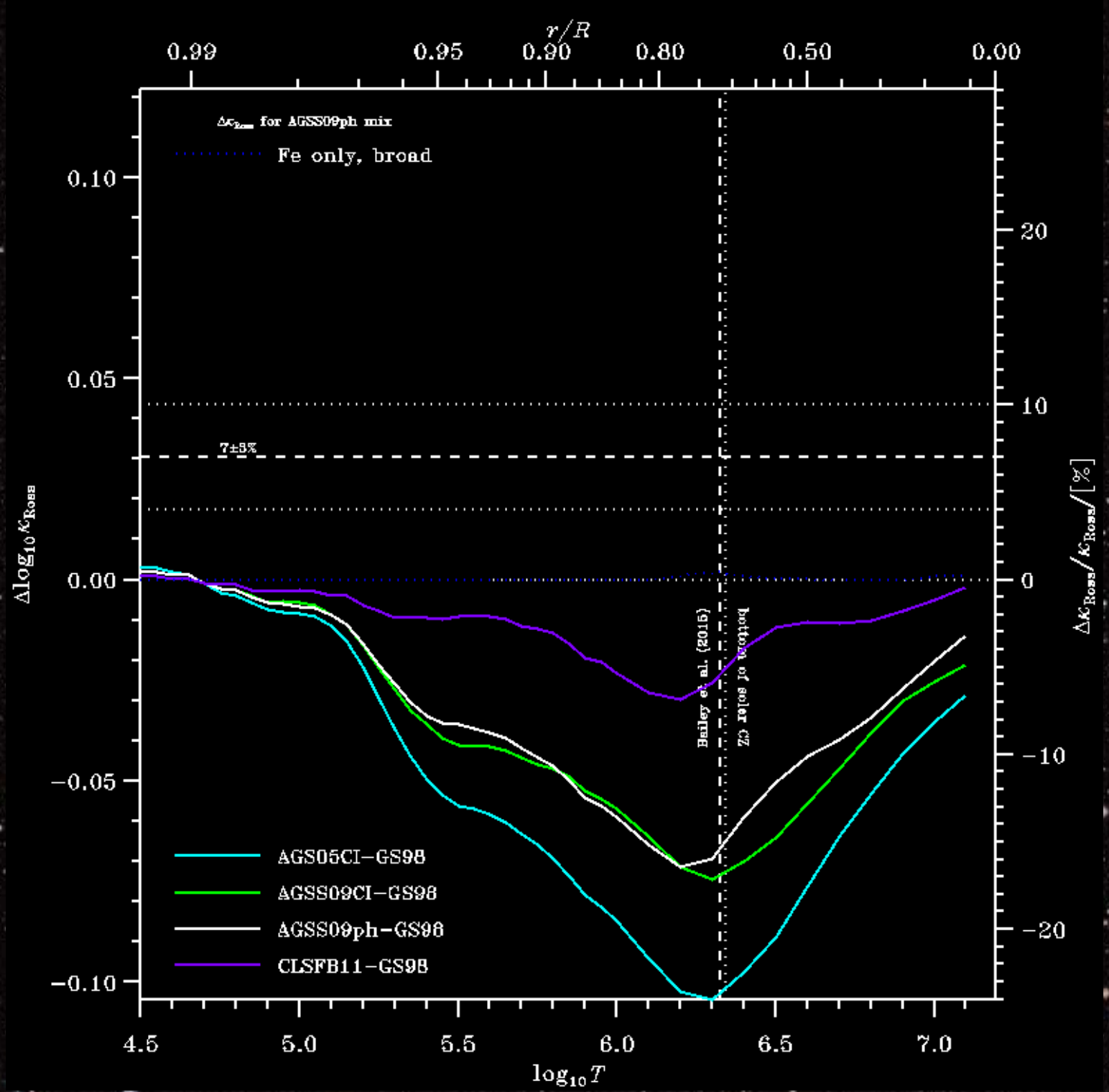

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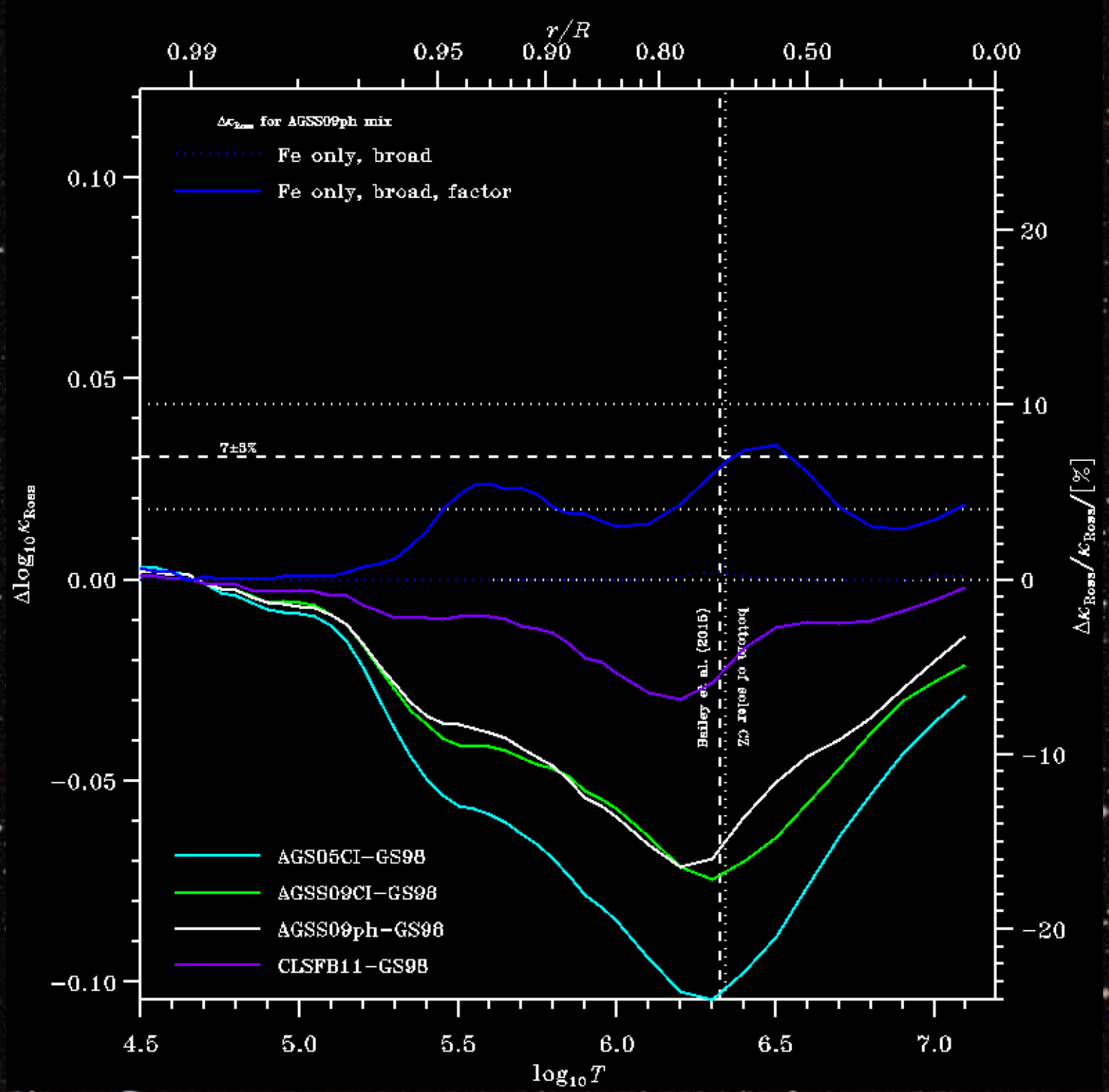

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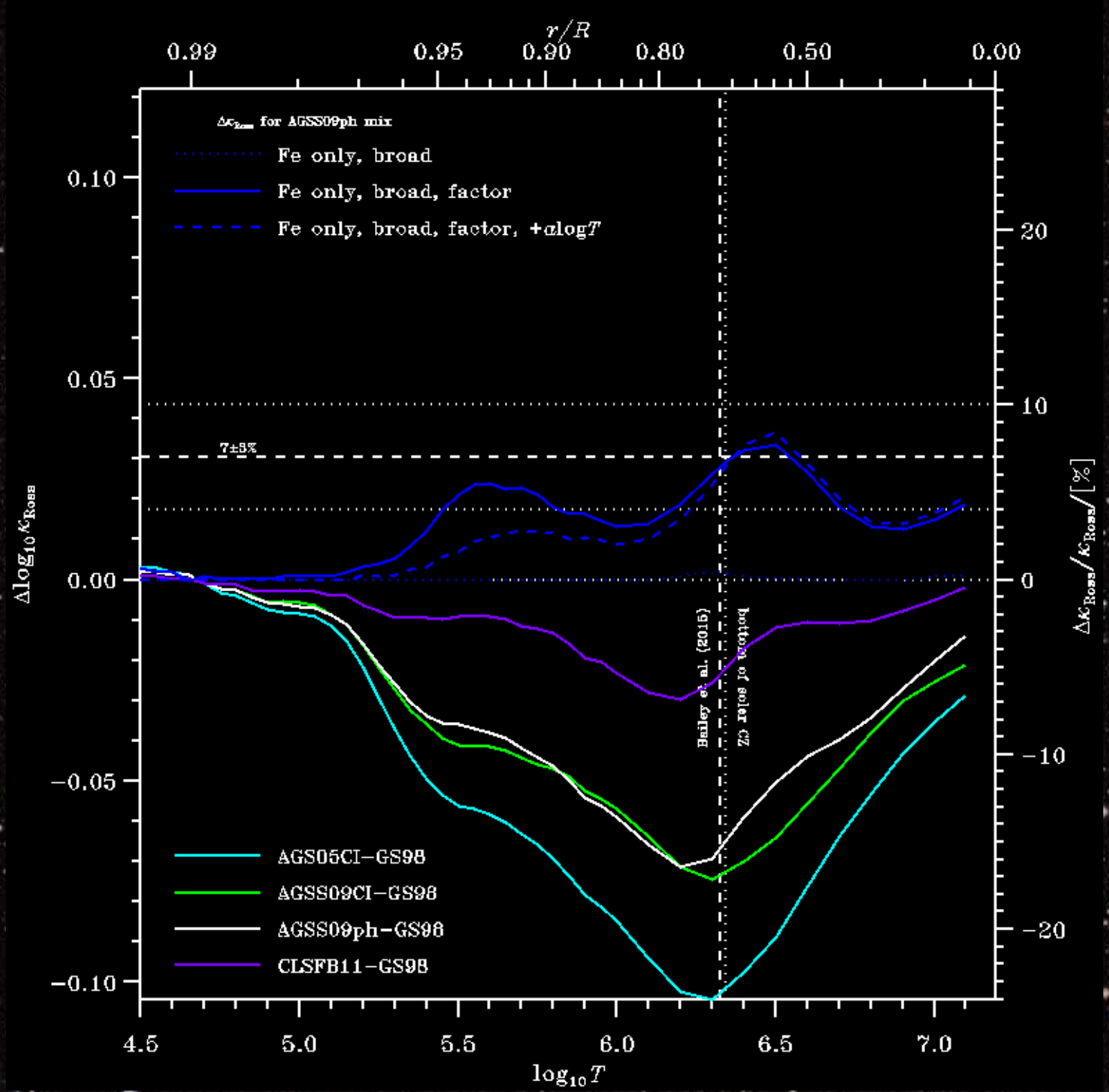

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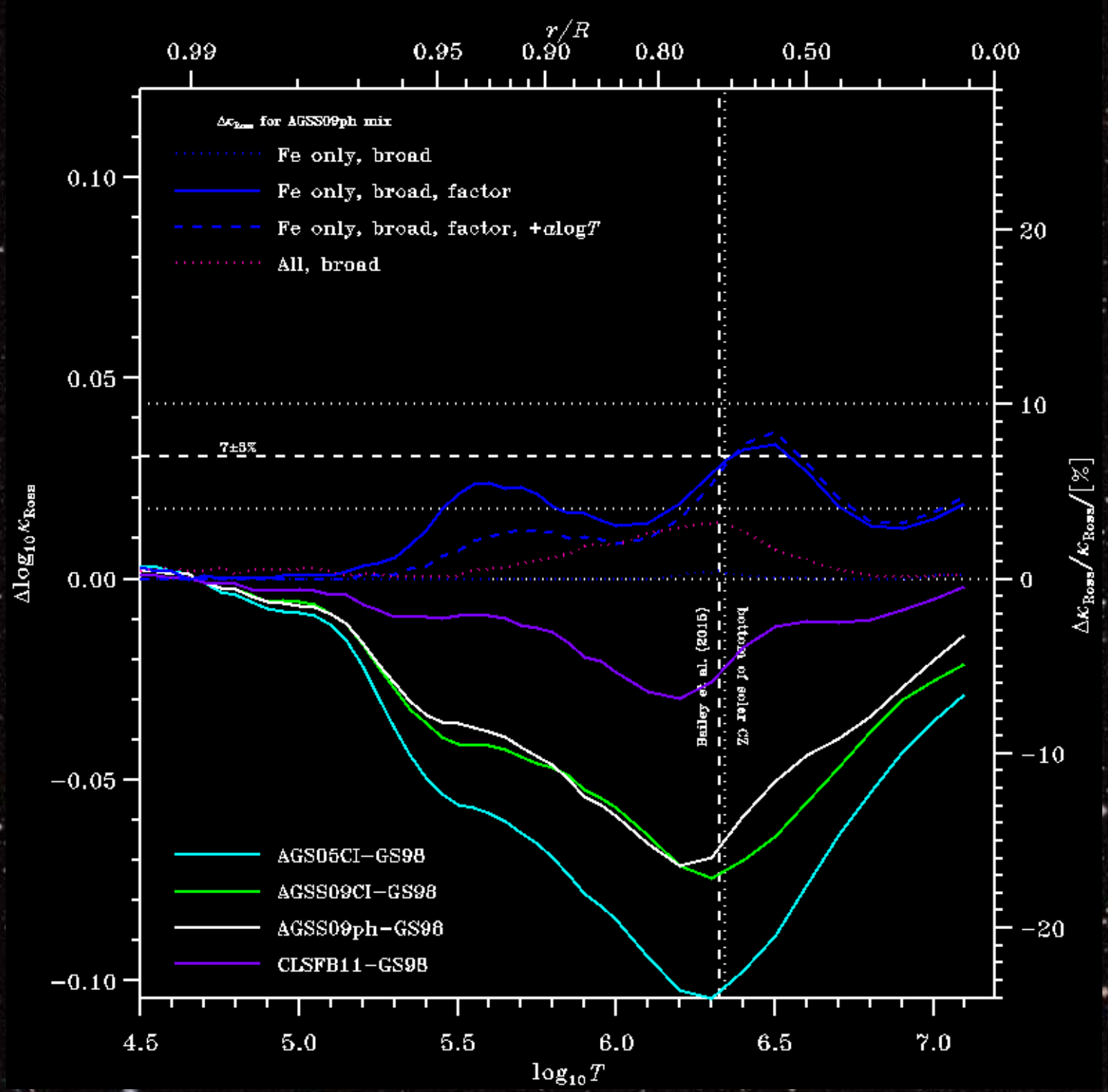

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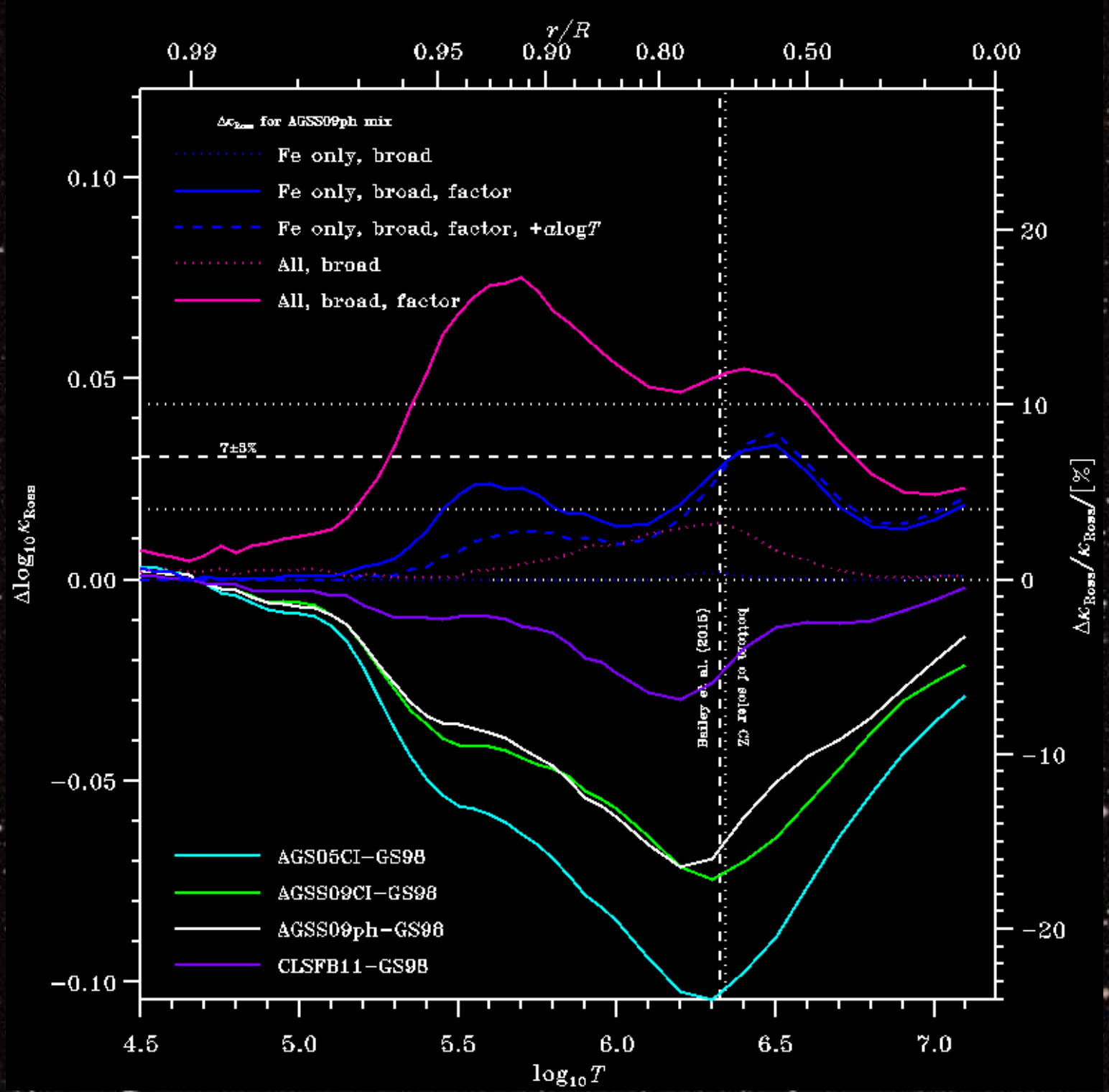

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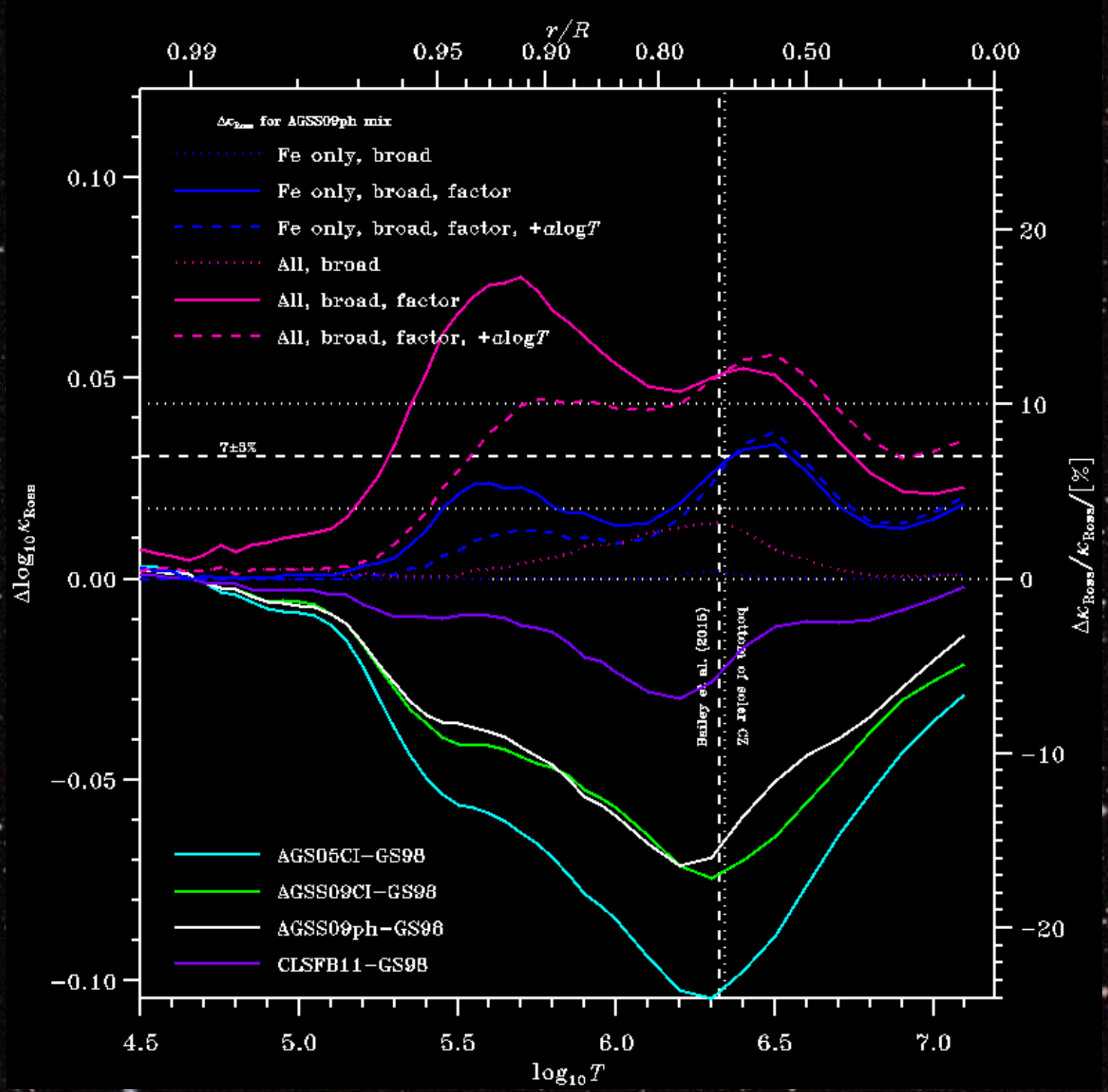

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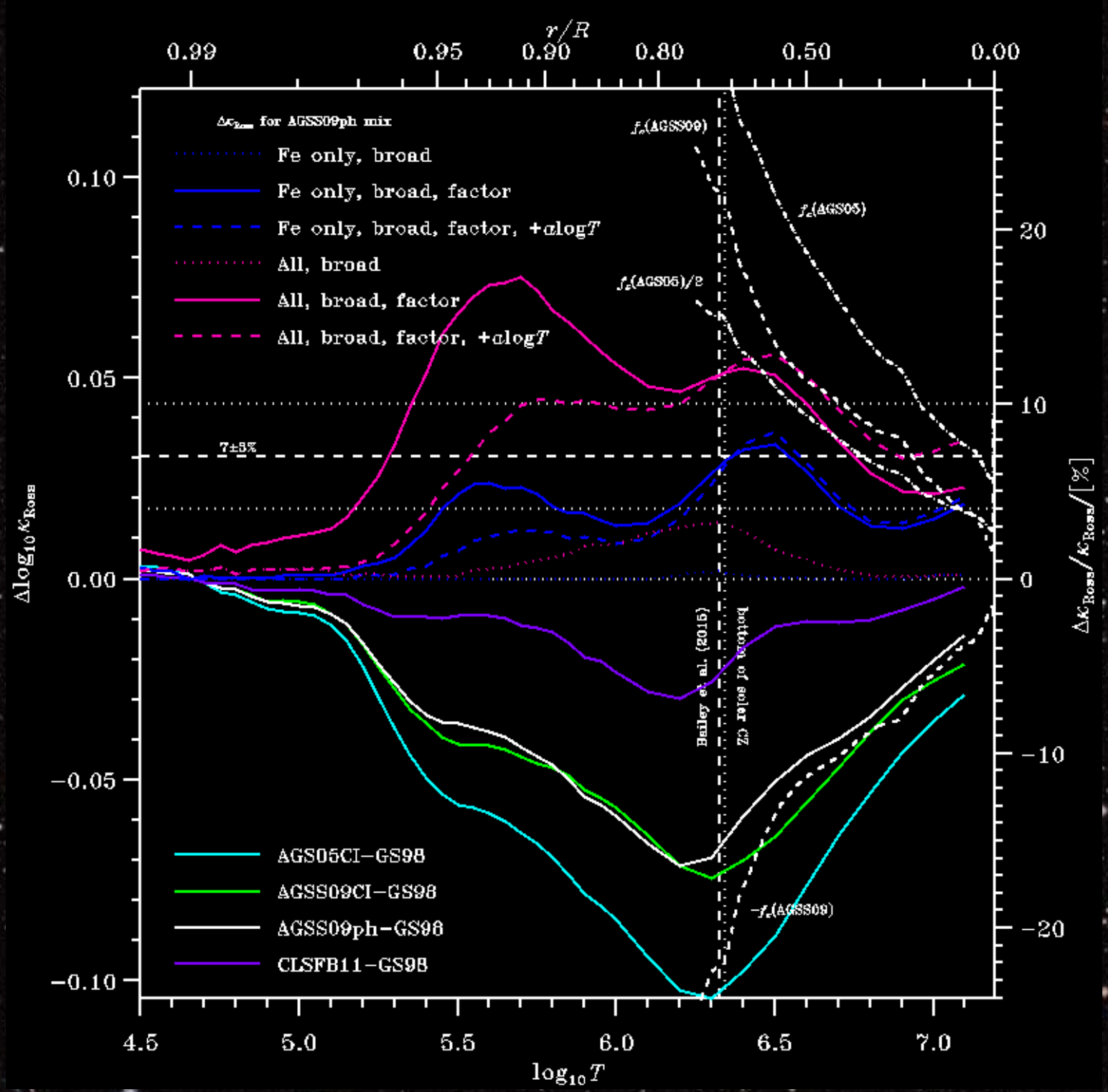

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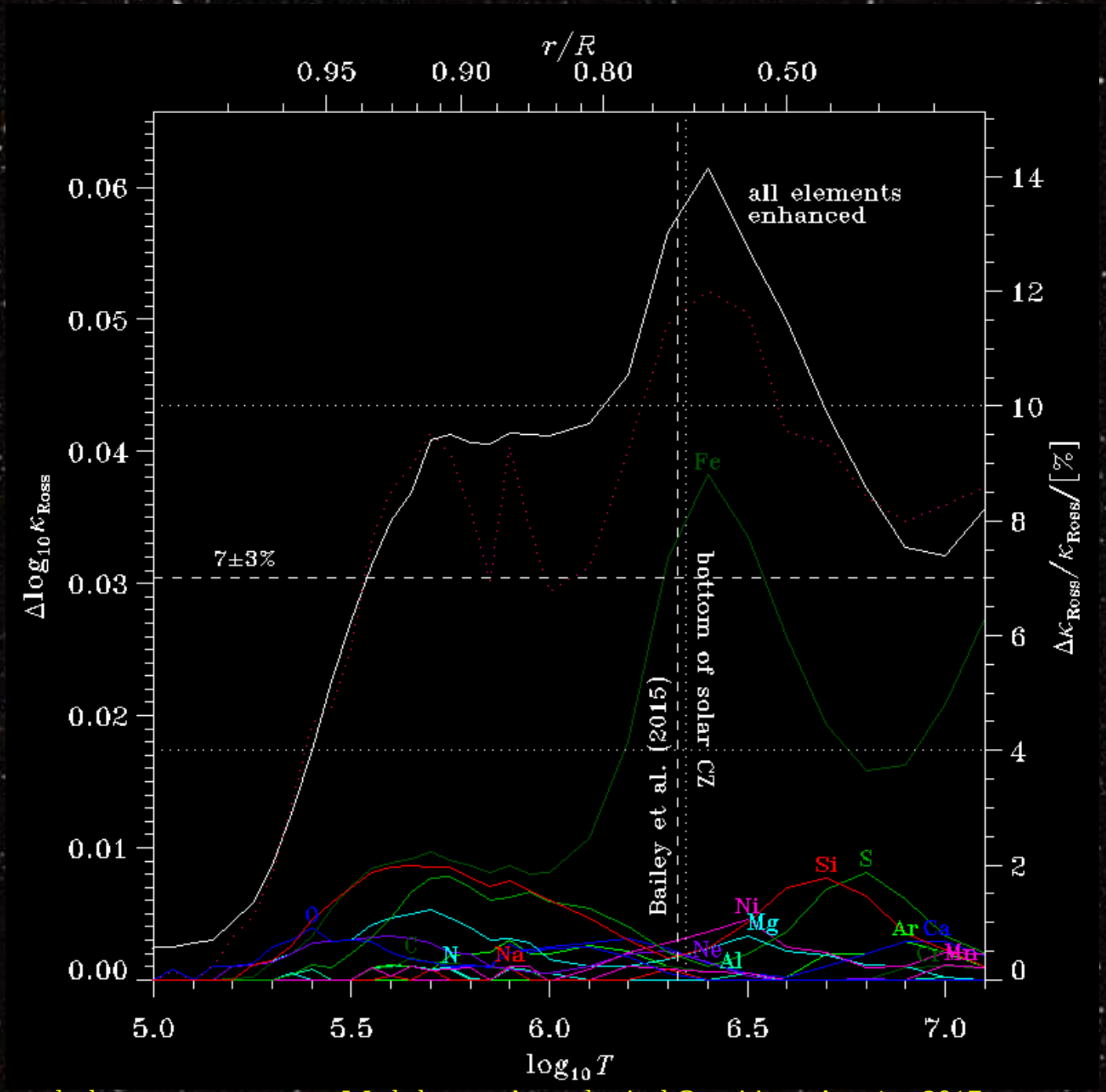
Which elements make that change?



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Conclusions

- AGSS`09 abundances give 15-20% too little κ_{Ross}
- Measured Fe absorption at conditions near those at bottom of the Solar conv. zone adds ~7% κ_{Ross}
- Increasing OP`05 by 23% per closed electron shell, and broadening by 2.3eV wide Lorentzian for Fe only, adds ~7% κ_{Ross}
- Doing it for all other elements possibly adds enough opacity to solve Solar abundance problem!
- Caffau`11 abunds. only permits change to Fe!

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