Hermean Atmospheres of Hot Rocky Exoplanets

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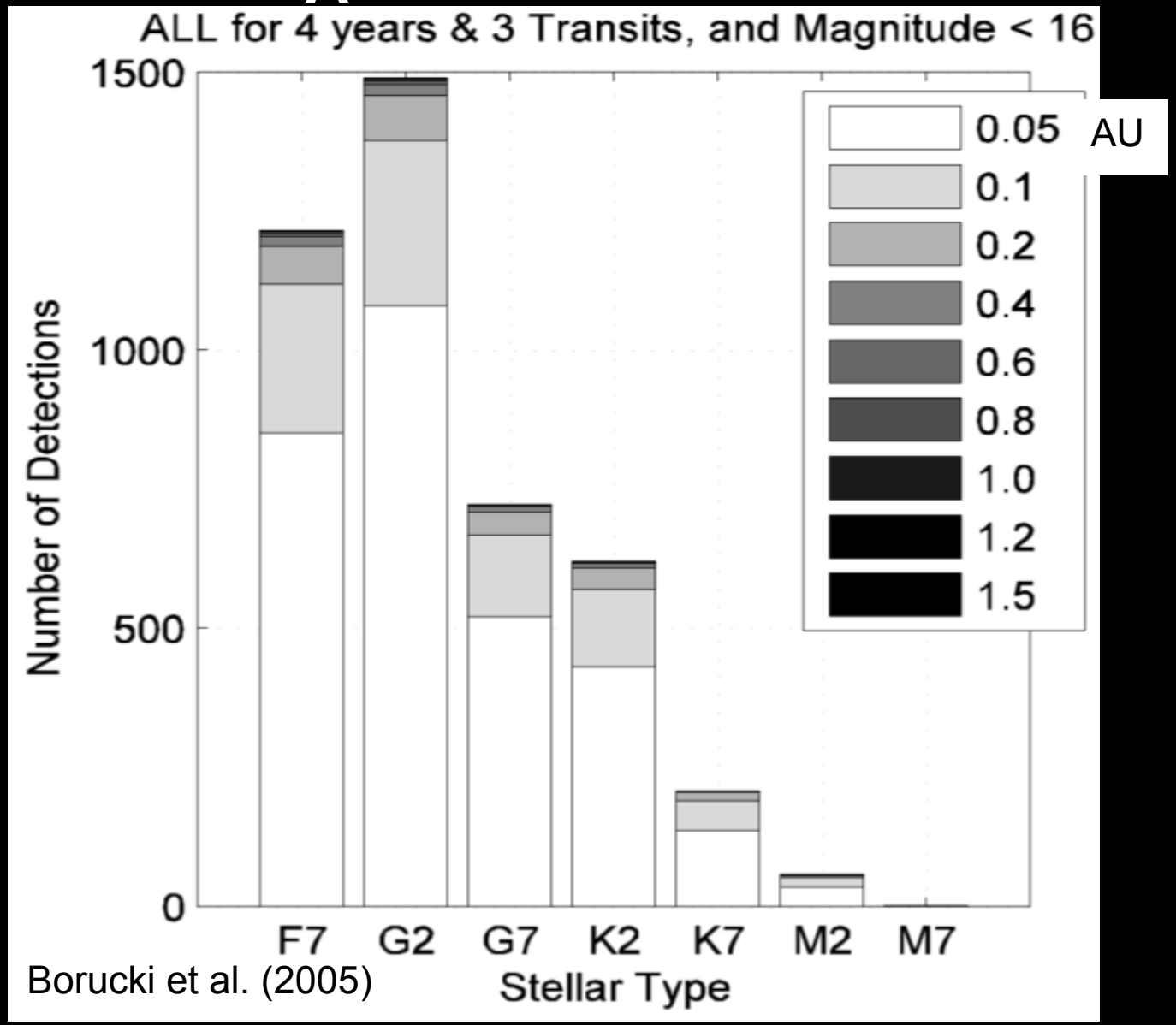
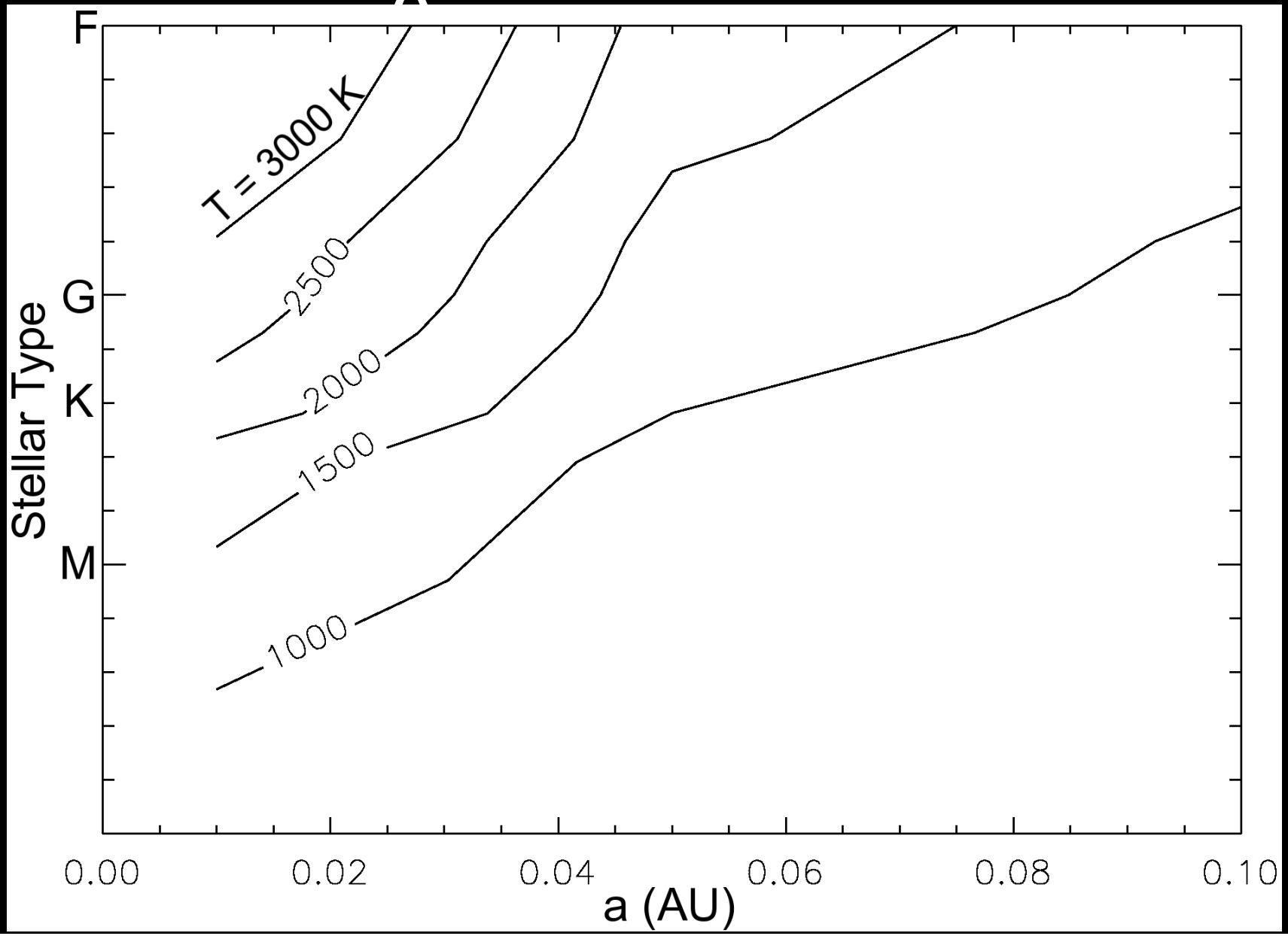
Hot Rocky Exoplanets

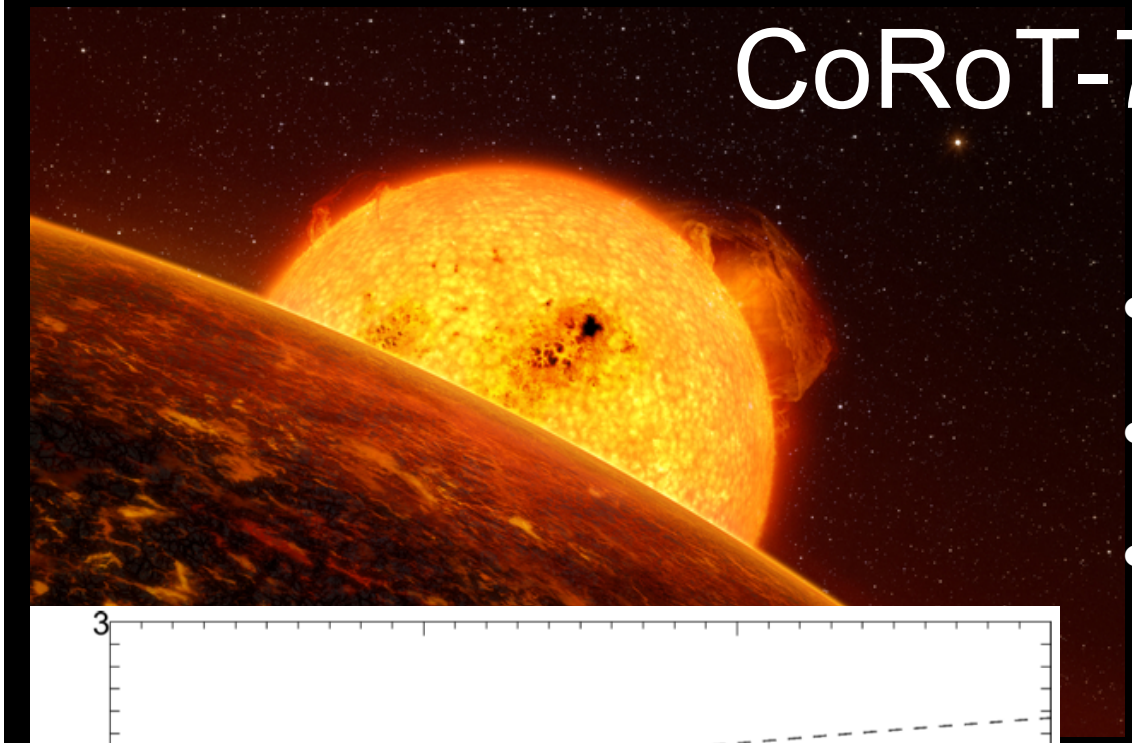


Borucki et al. (2005)

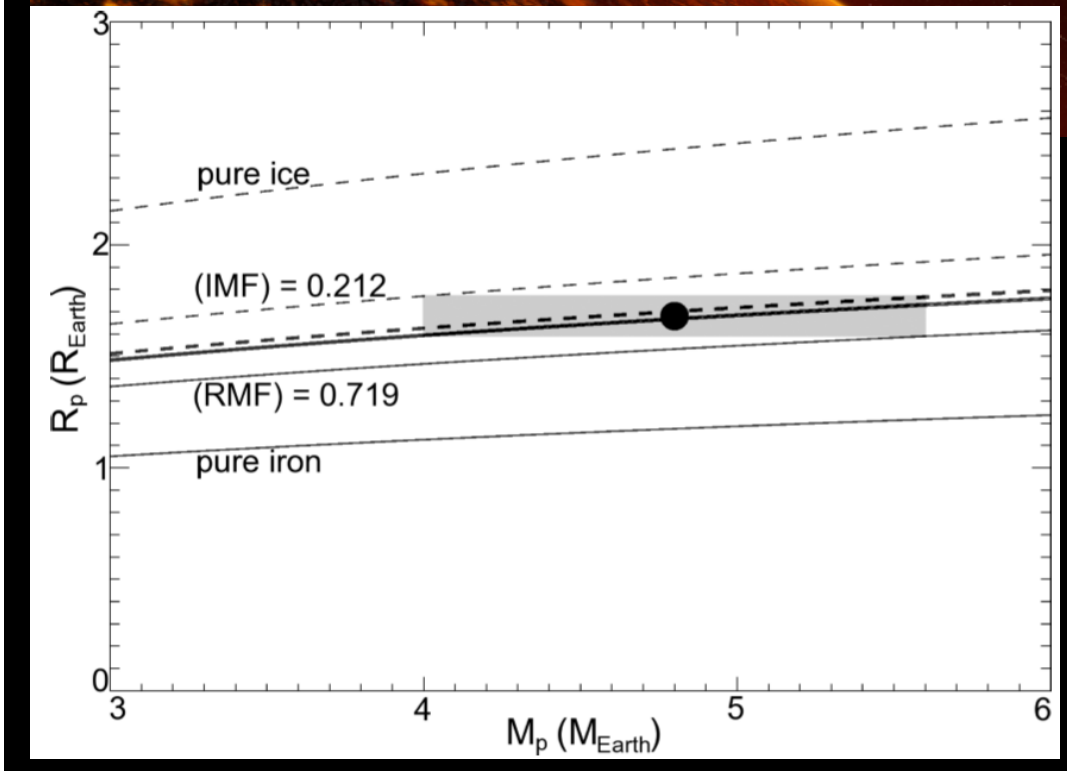
Era of Hot Rocky Exoplanets



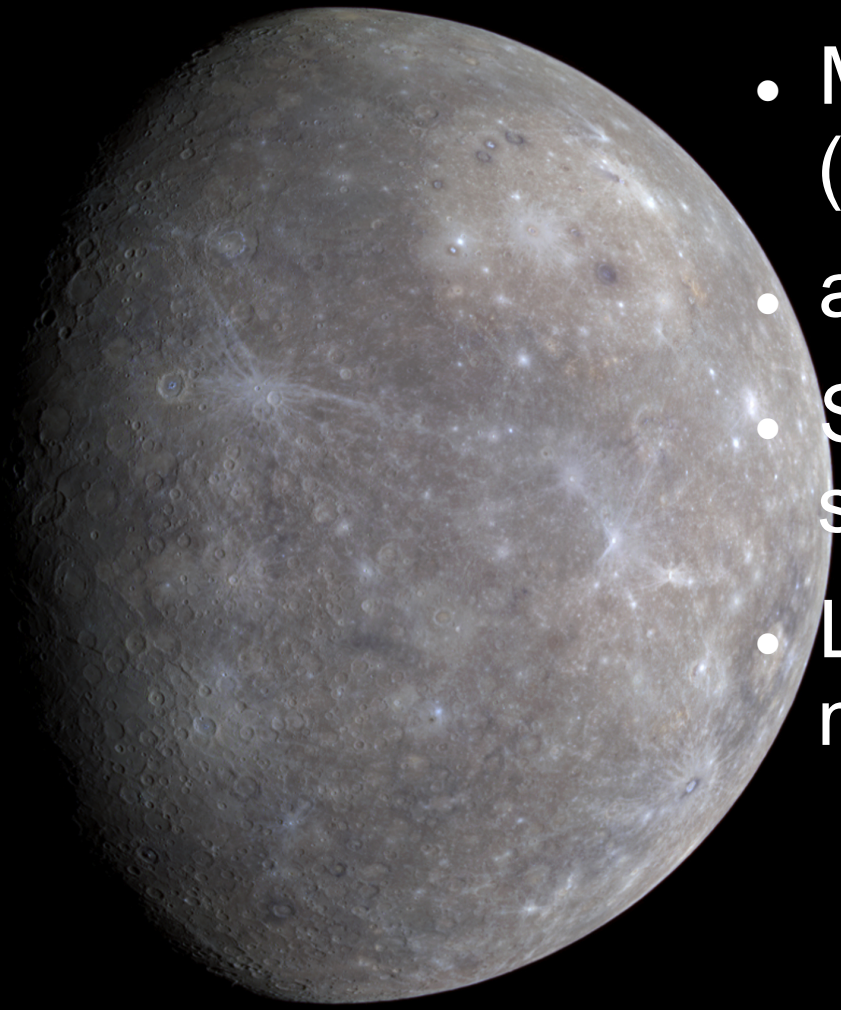
CoRoT-7 b



- $M_p = 5\ M_{earth}$
- $R_p = 1.68\ M_{earth}$
- a = 0.0172 AU, P = 0.89 d

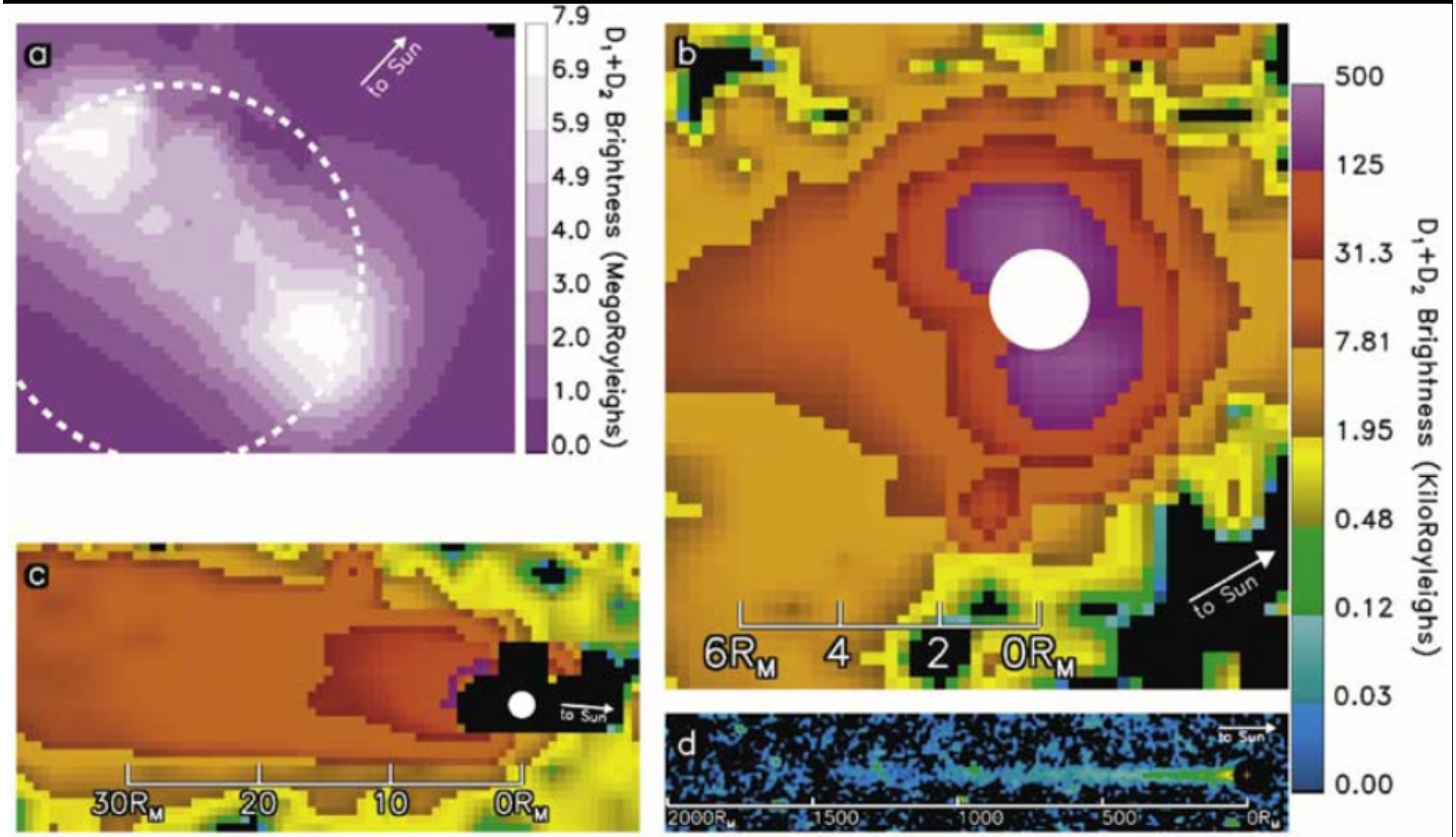


Hot Rocky Endoplanets: Mercury



- Mass: 3.3022×10^{23} kg (0.055 Earths)
- a = 0.3 AU; e = 0.21
- Surf. Temp: 700 K in sun, 70 K in shadow
- Large iron core (70% of mass)

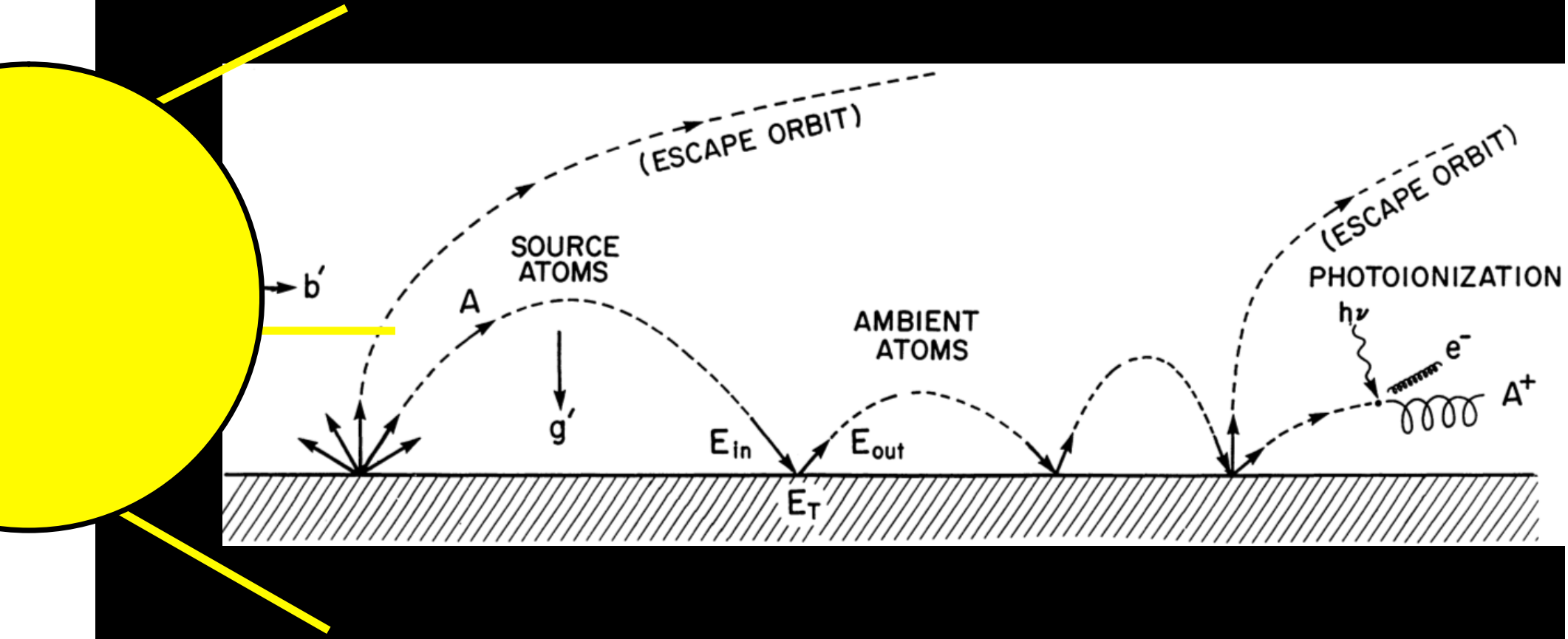
Mercury's Exosphere

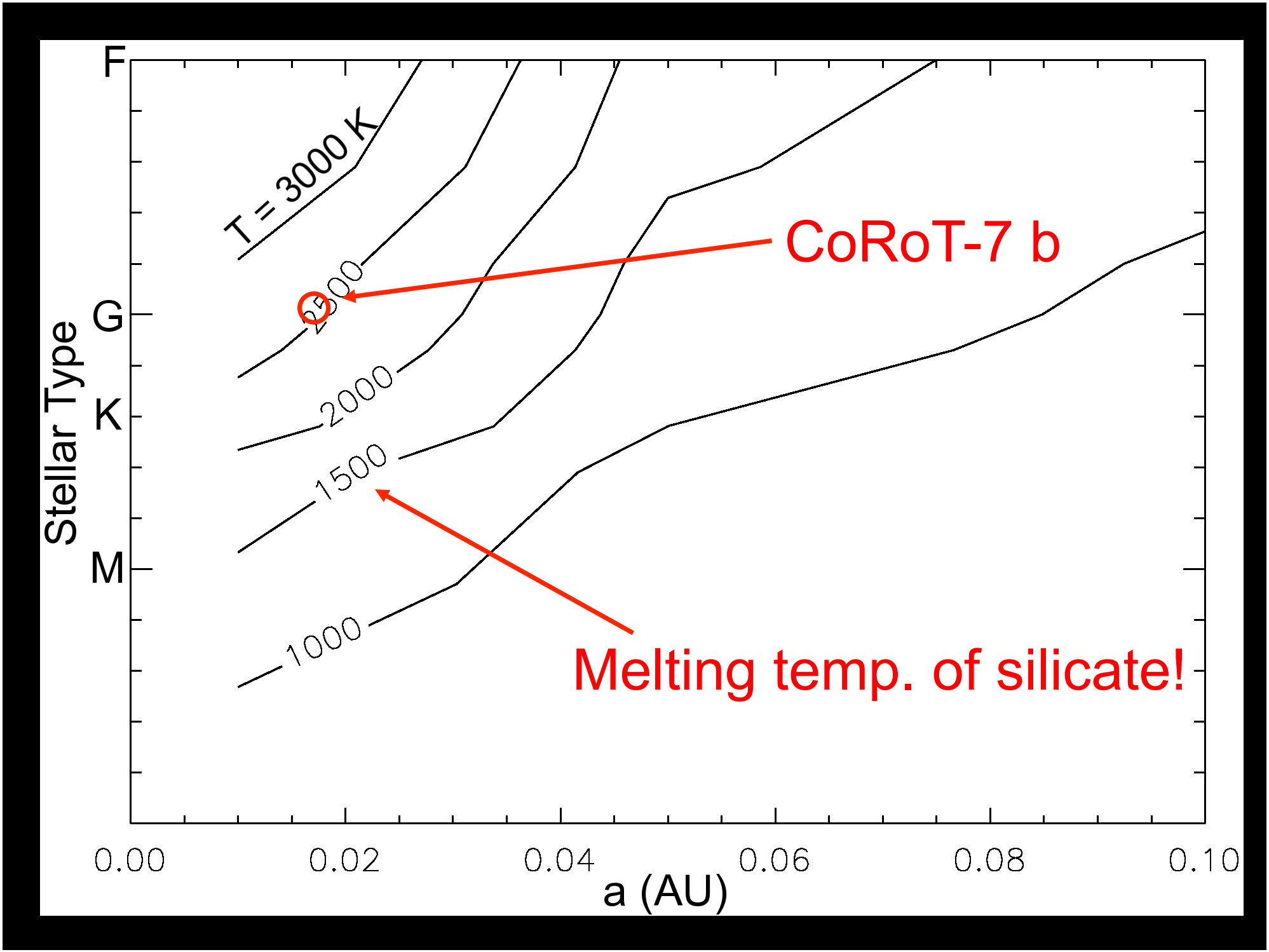


From Baumgardner et al. (2008)

~ 10^{11} cm^{-2} of Na

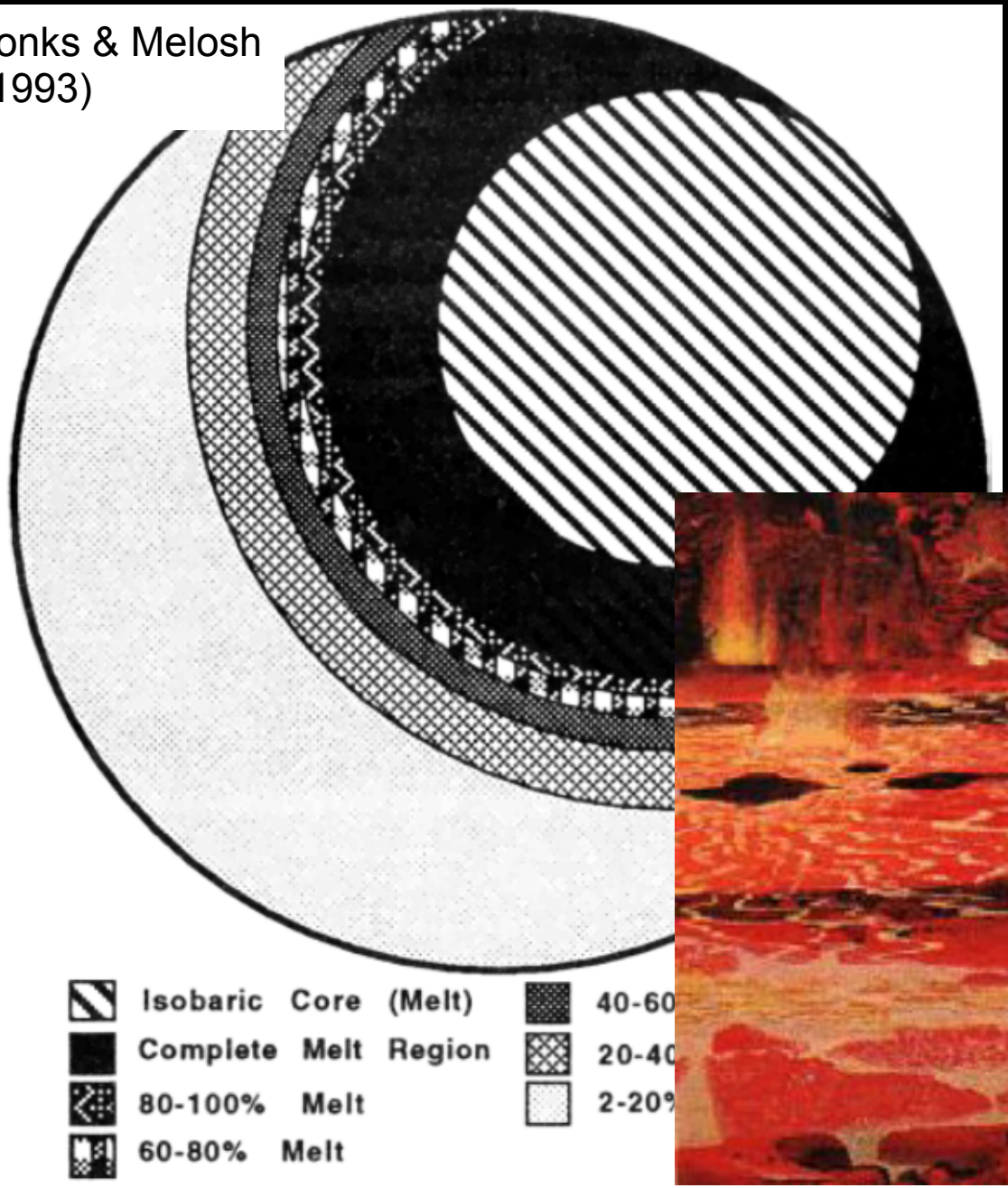
Mercury's Exosphere

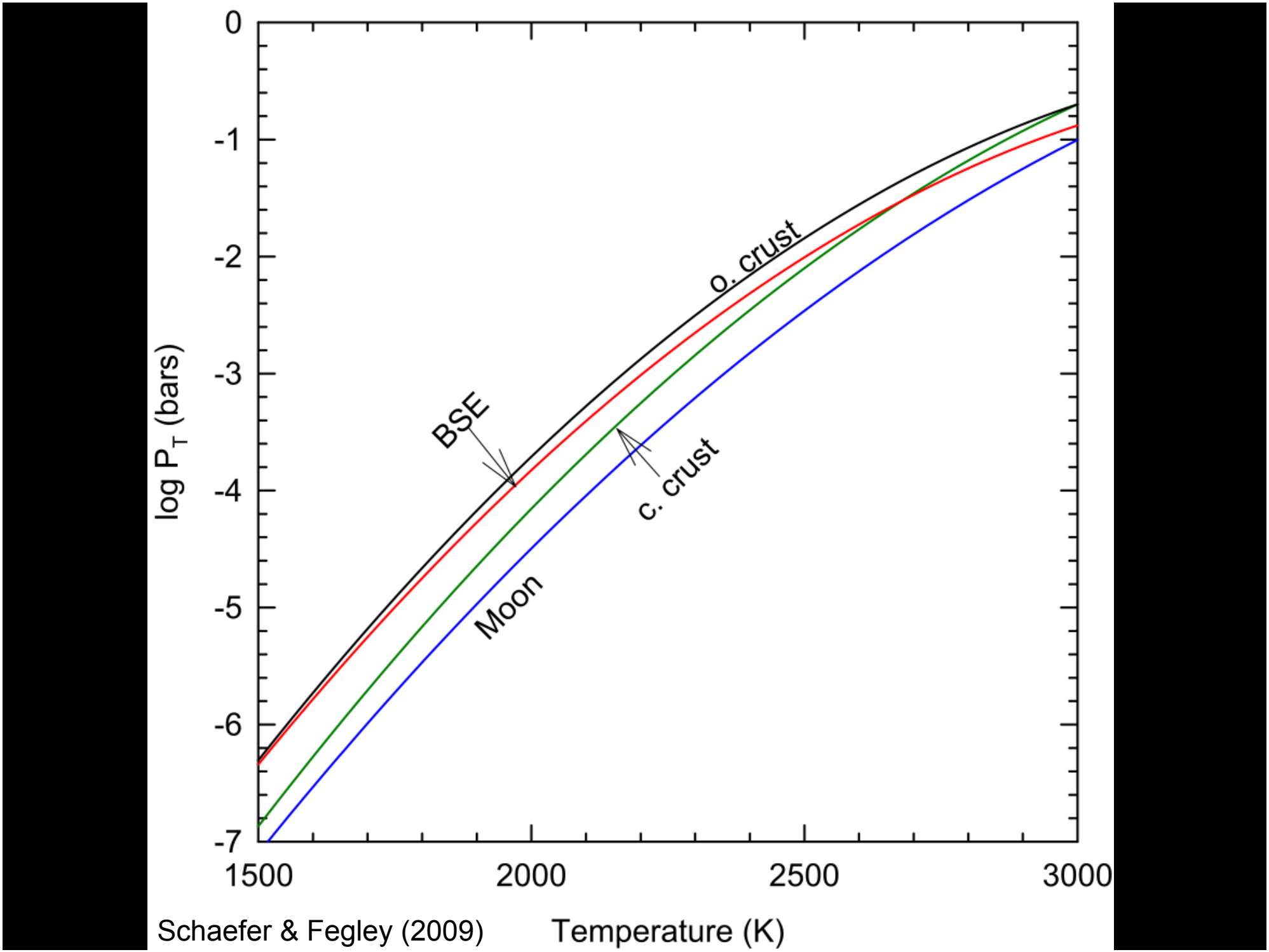



F
G
K
M
Stellar Type
T = 3000 K
2500
2000
1500
1000
CoRoT-7 b
Melting temp. of silicate!
0.00
0.02
0.04
0.06
0.08
0.10
a (AU)

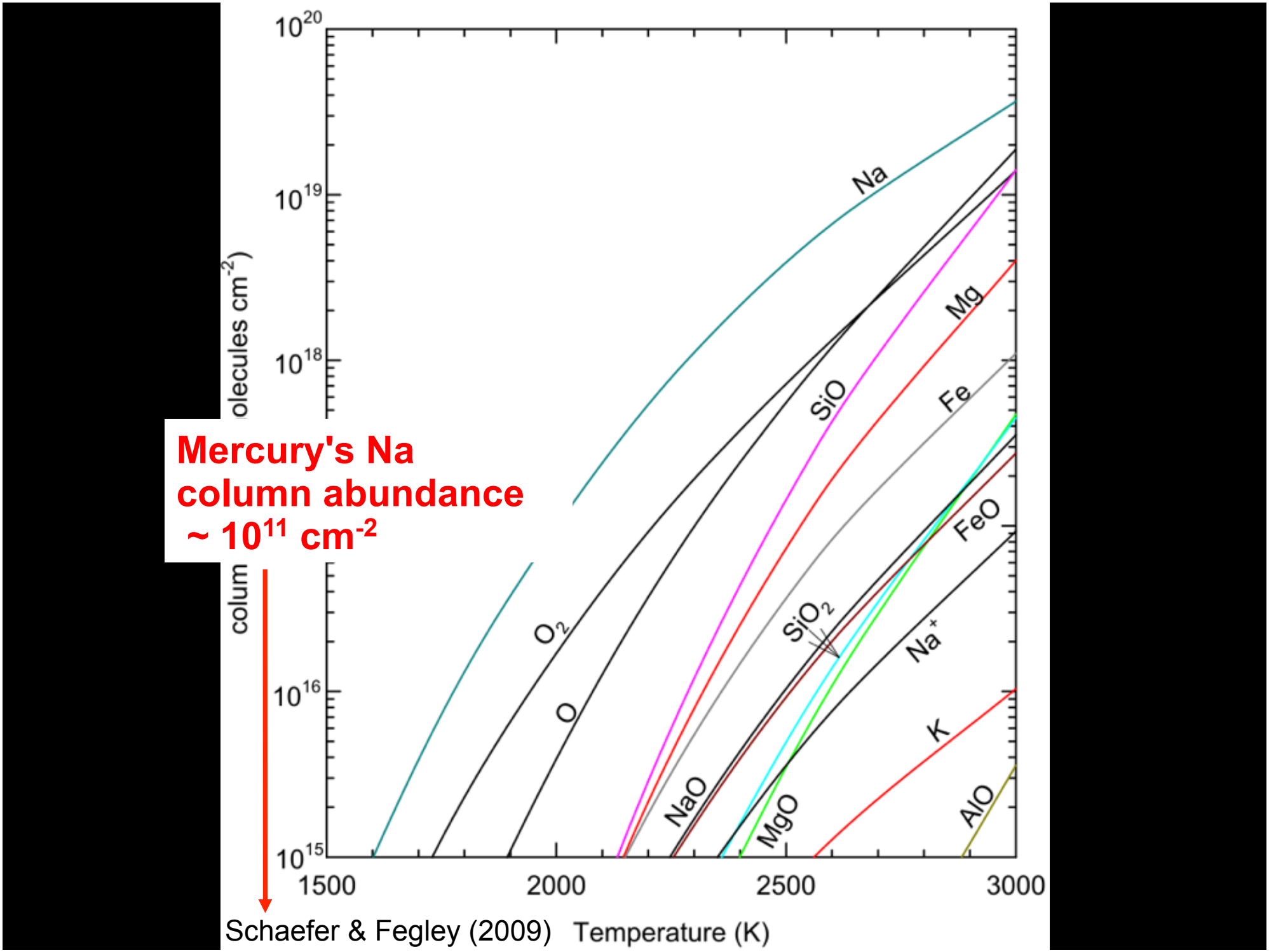
Magma Oceans

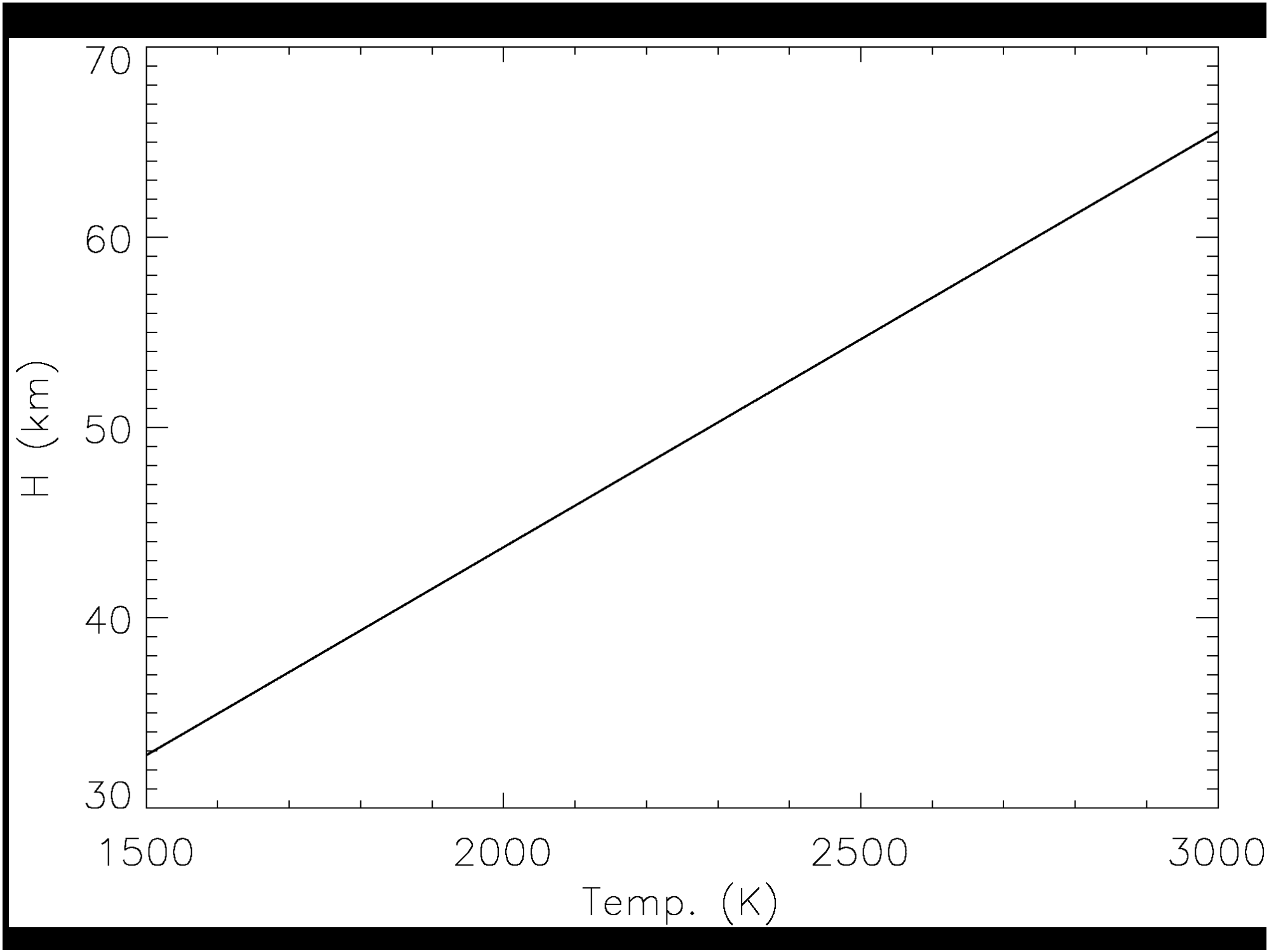
Tonks & Melosh (1993)

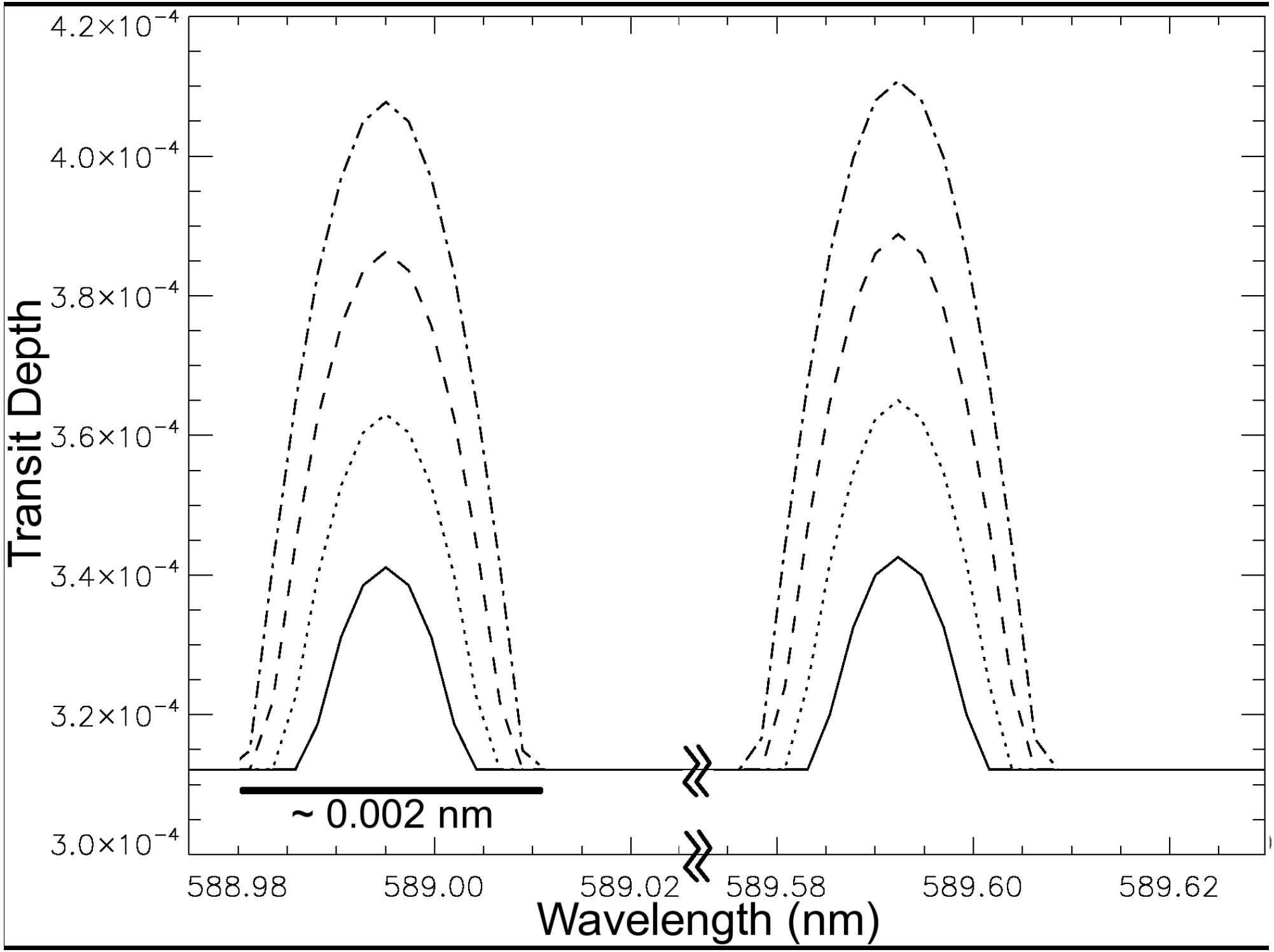


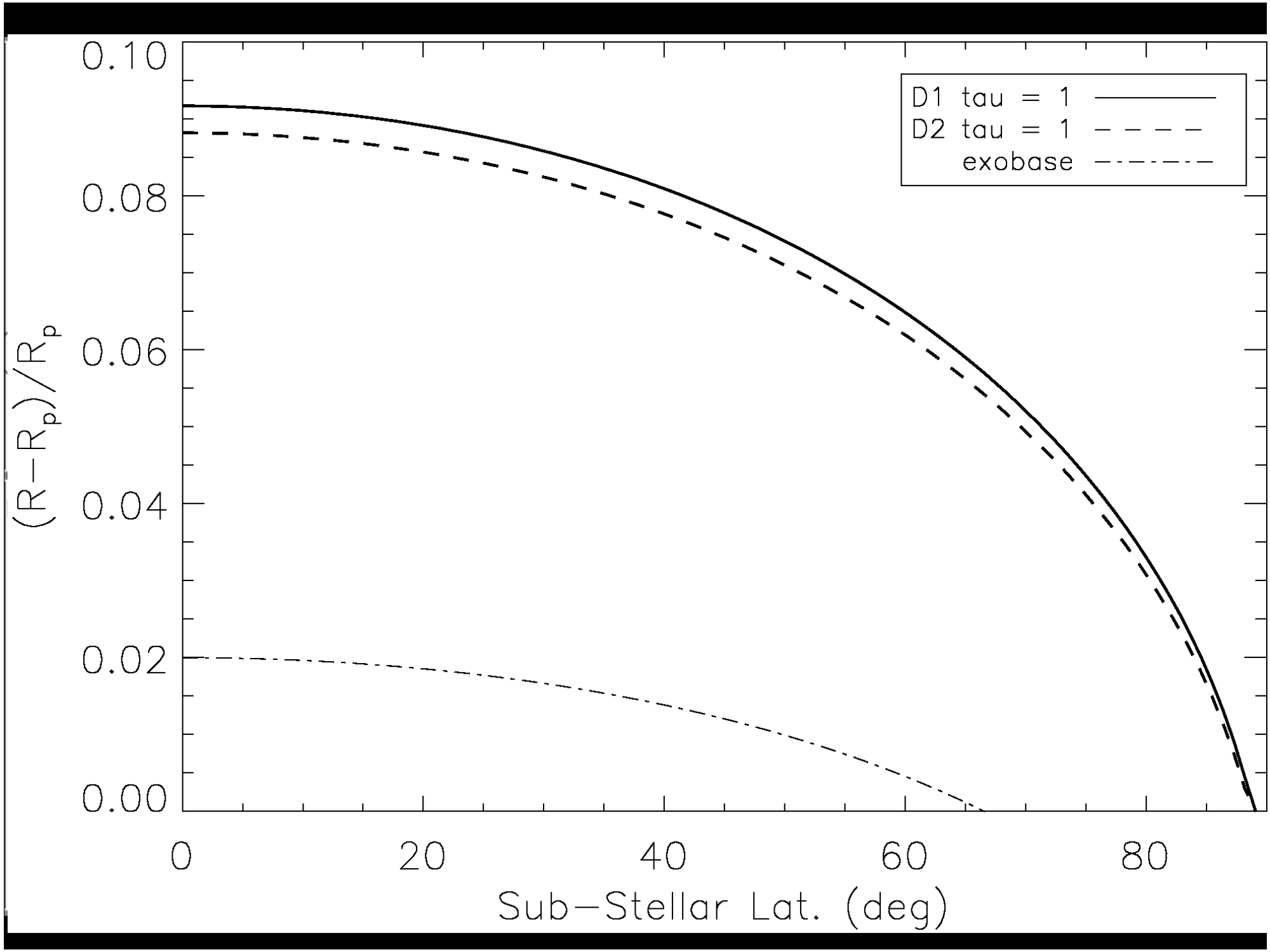


Schaefer & Fegley (2009)


Mercury's Na
column abundance
~ 10^11 cm^-2
olecules cm^-2)
colum
10^20
10^19
10^18
10^16
10^15
1500
2000
2500
3000
Temperature (K)
Na
SiO
Mg
Fe
FeO
O2
O
SiO2
Na+
NaO
MgO
K
AlO
Schaefer & Fegley (2009)


70
60
50
40
30
H (km)
1500
2000
2500
3000
Temp. (K)


4.2×10⁻⁴
4.0×10⁻⁴
3.8×10⁻⁴
3.6×10⁻⁴
3.4×10⁻⁴
3.2×10⁻⁴
3.0×10⁻⁴
Transit Depth
~ 0.002 nm
588.98
589.00
589.02
589.58
589.60
589.62
Wavelength (nm)


D1 tau = 1
D2 tau = 1
exobase
0.10
0.08
0.06
0.04
0.02
0.00
(R−Rp)/Rp
0
20
40
60
80
Sub−Stellar Lat. (deg)

Implications

- Hot rocky exoplanets are hot!
  - Magma oceans
  - Melted surfaces → rock vapor atmosphere
- Rocky atmosphere may be visible, with sufficient spectral resolution
- Observations of transit spectra may tell us about surface compositions

To Do List

- Photoionization!
  - May significantly reduce neutral sodium abundance and line optical depths
  - Will also help determine temperature structure
- Transport
  - Do volatiles get trapped on nightside? (For CoRoT-7 b, non-synch. rot. may prevent)
  - How big a cloud of sodium?
- Other volatiles
- Planets around smaller stars