

Structure and
evolution
of the CoRoT (Like)
exoplanets:

-

Probing the brown dwarf -
planet overlapping domain

Jeremy Leconte

Gilles Chabrier

Isabelle

Baraffe

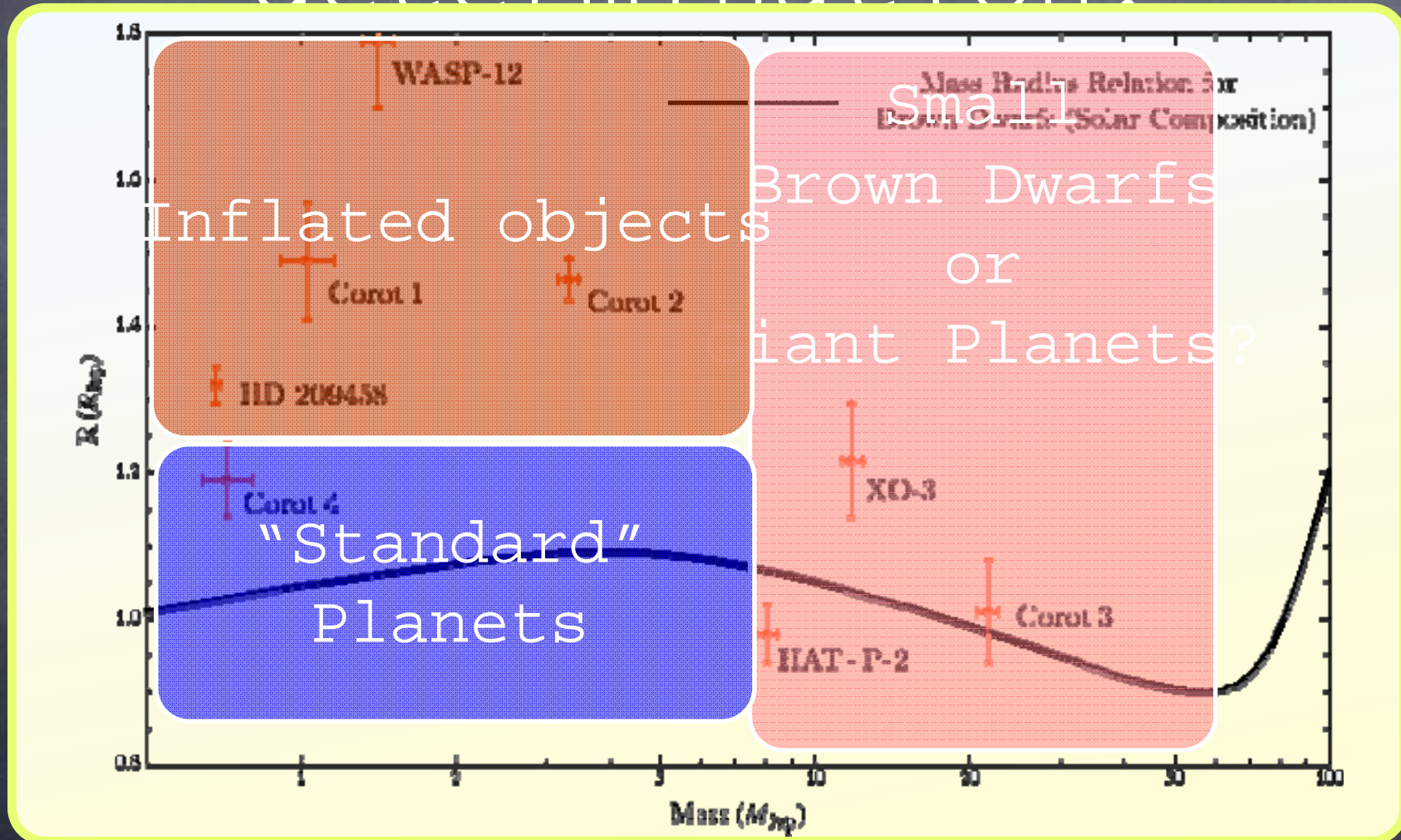
Travis Barman

Benjamin

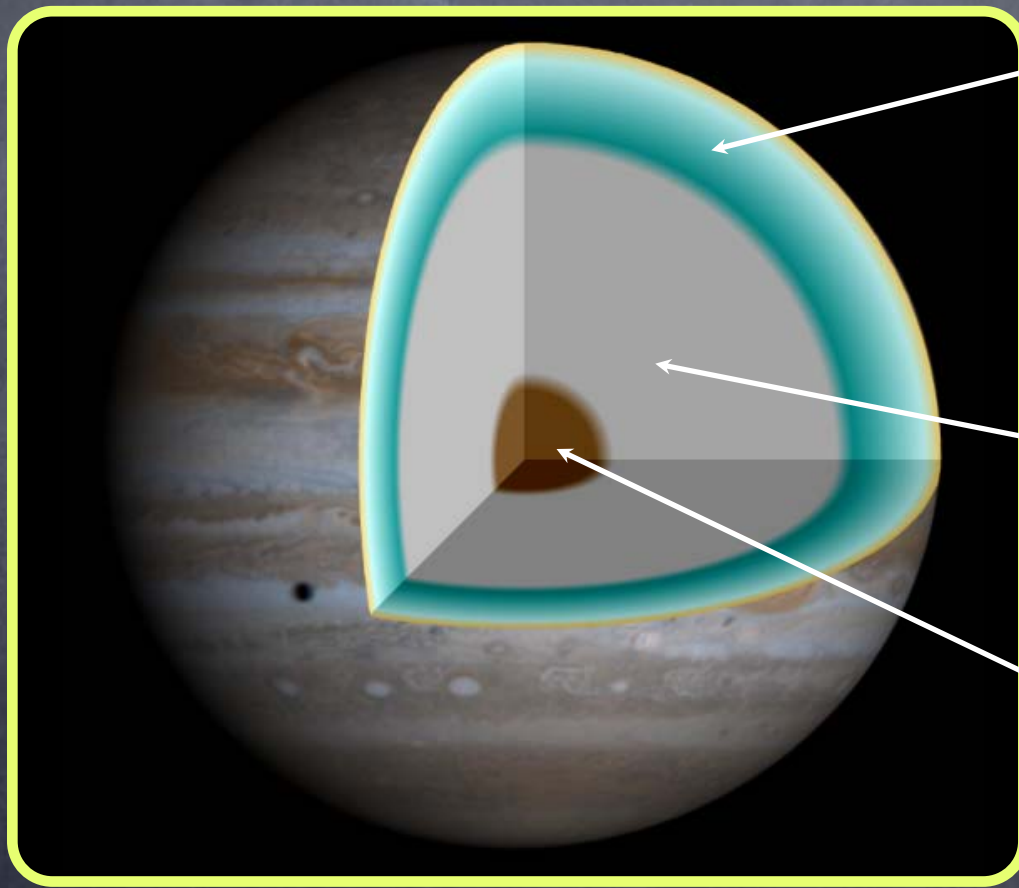
Levrard

CRAL/ENS Lyon

What can we learn from Mass-Radius determination?



Model Hypothesis



Irradiated
Atmosphere!!!

H/He envelop
($Z=2\%$):

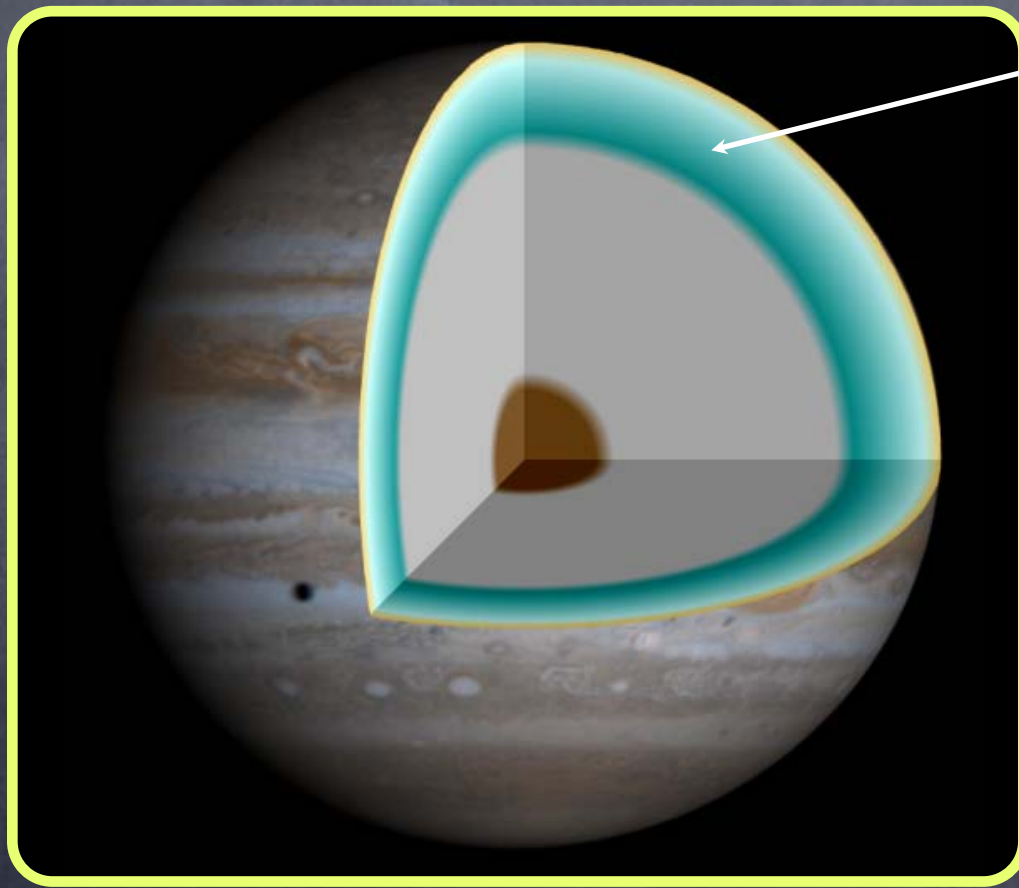
Saumon/Chabrier
EOS

Water Core:

ANEOS/SESAME

(Baraffe et al. 08)

Model Hypothesis



Irradiated
Atmosphere!!!

From Barman et al.

Consistent
calculation:
Structure

–
Radiative Transfer
(Including impinging
flux from the star)

–
Dust settling

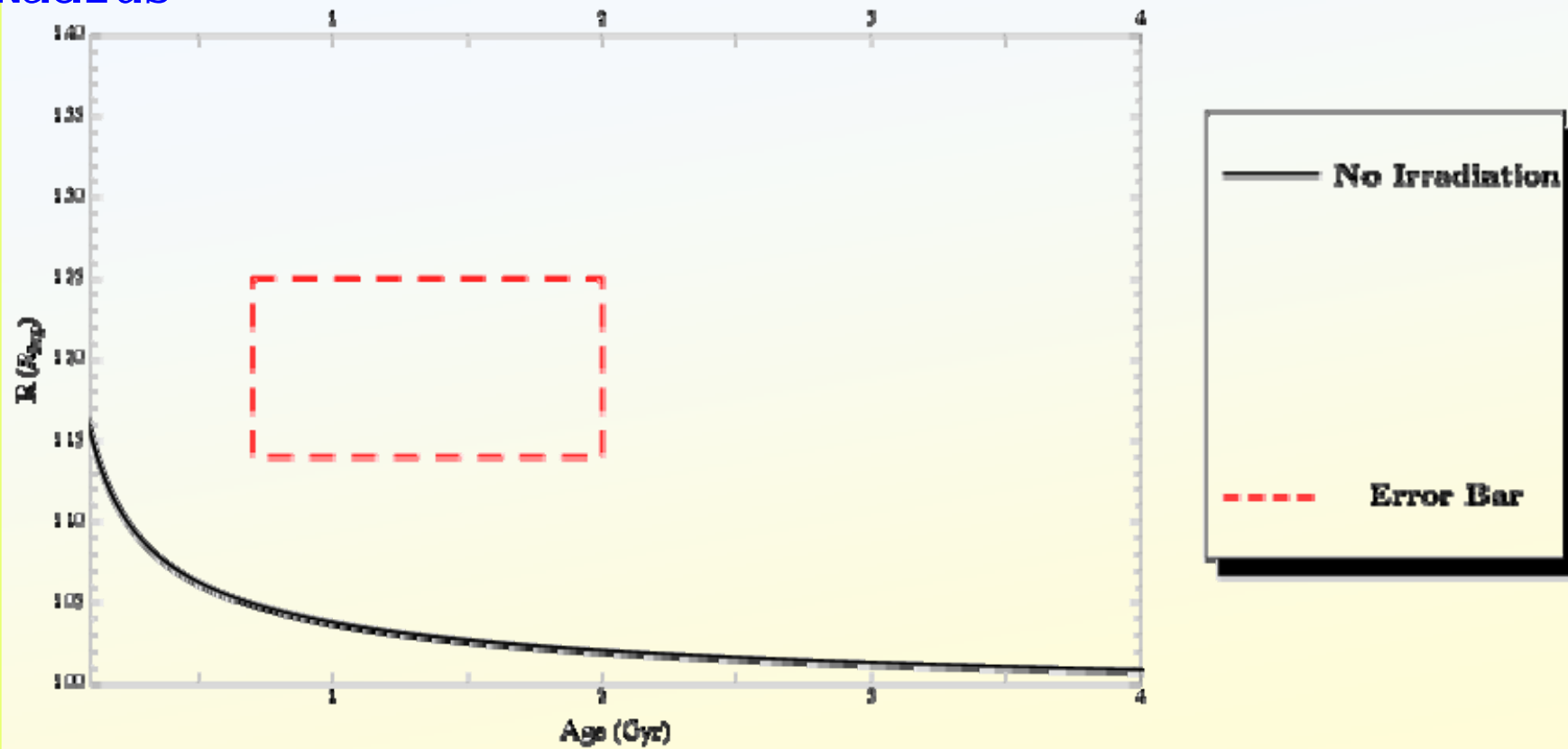
–
Boundary
conditions with
the interior

“Standard” Planets

CoRoT-4b

($0.72M_{\text{Jup}}$)

Radius

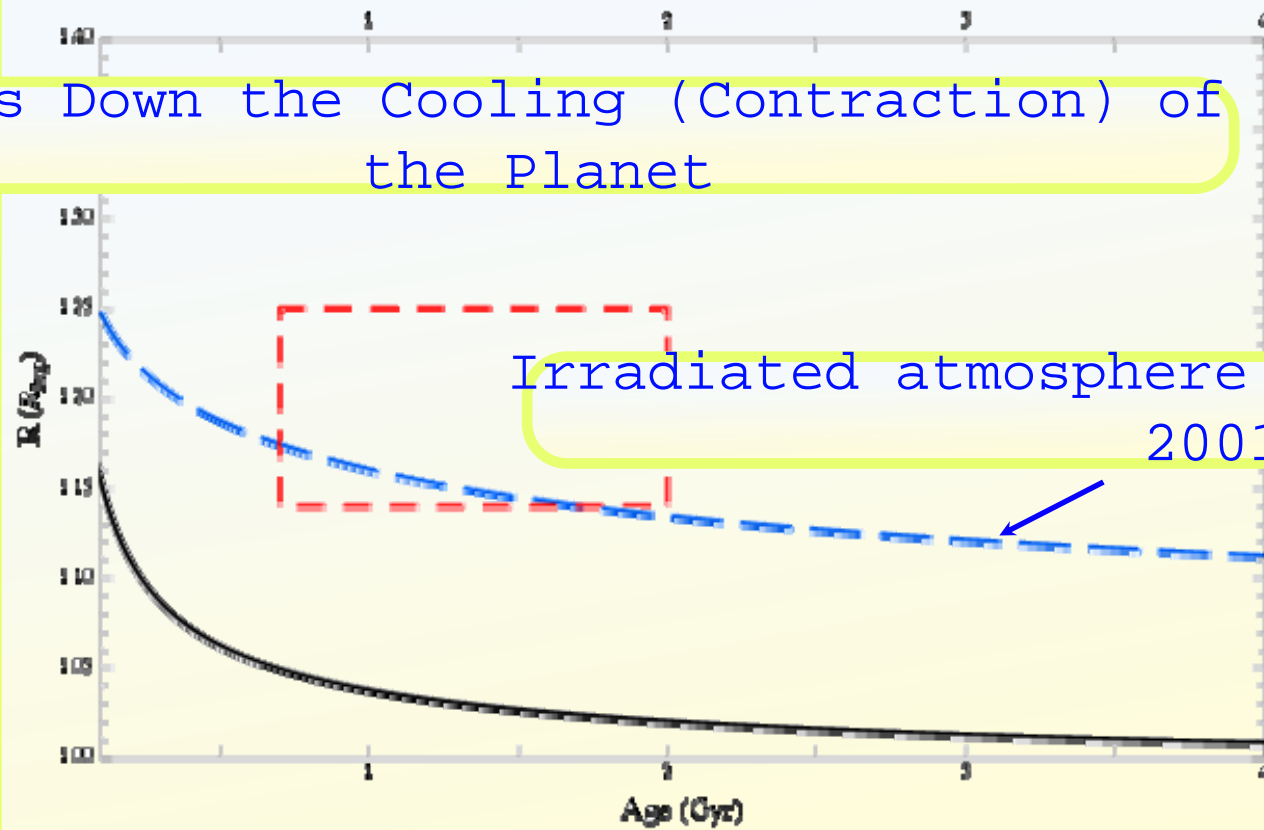


Mass

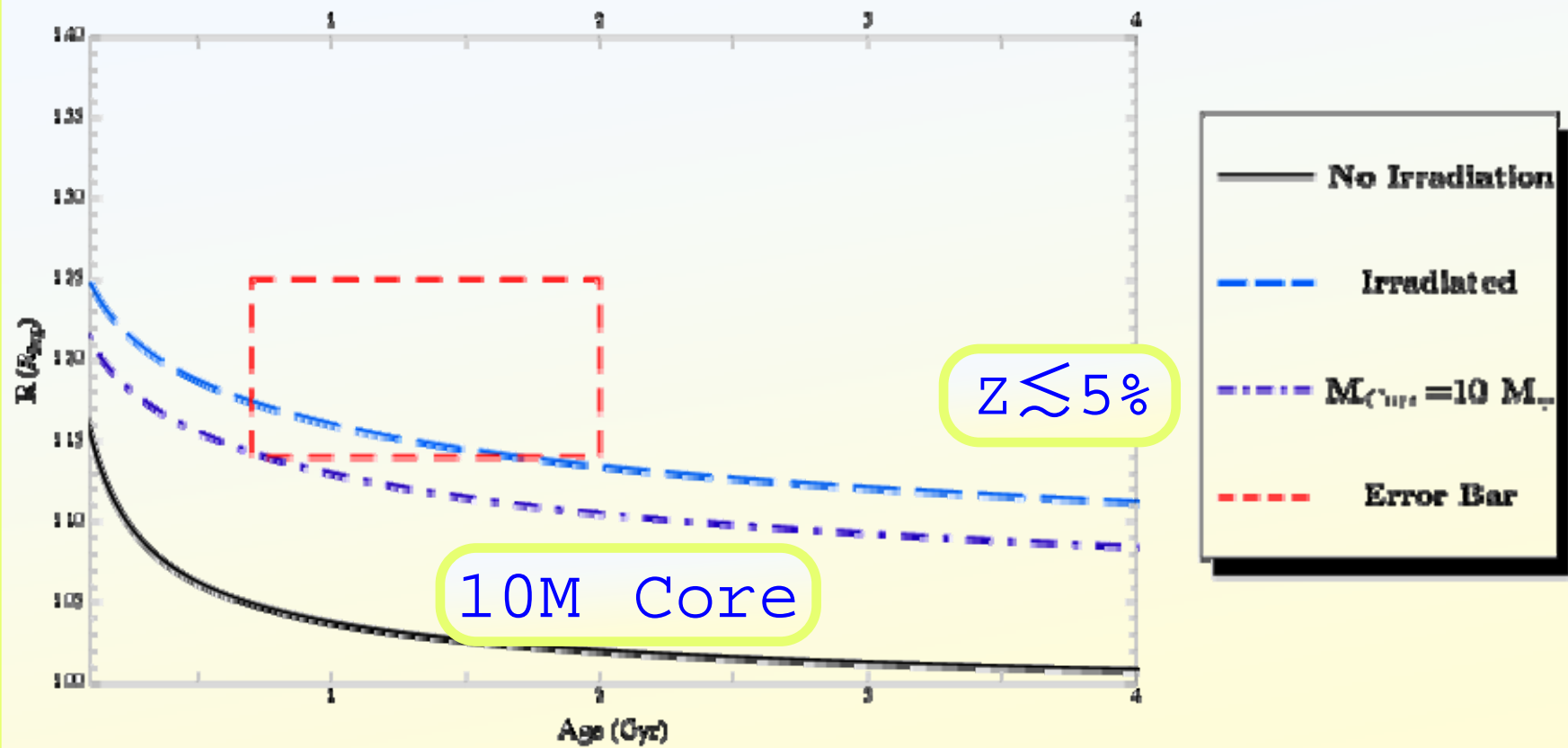
CoRoT-4b

($0.72M_{\text{Jup}}$)

Slows Down the Cooling (Contraction) of the Planet



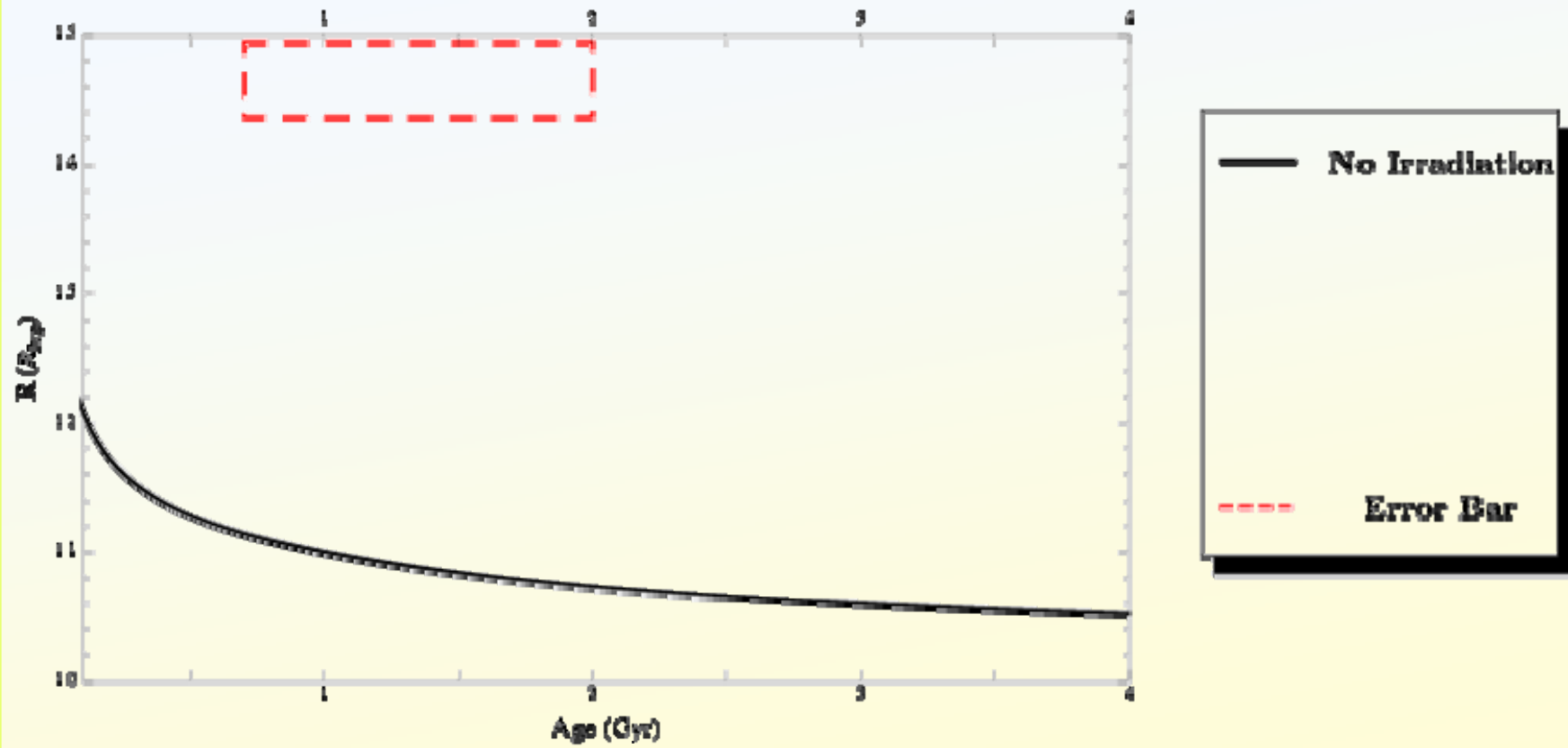
CoRot-4b ($0.72M_{\text{Jup}}$)



Inflated Objects

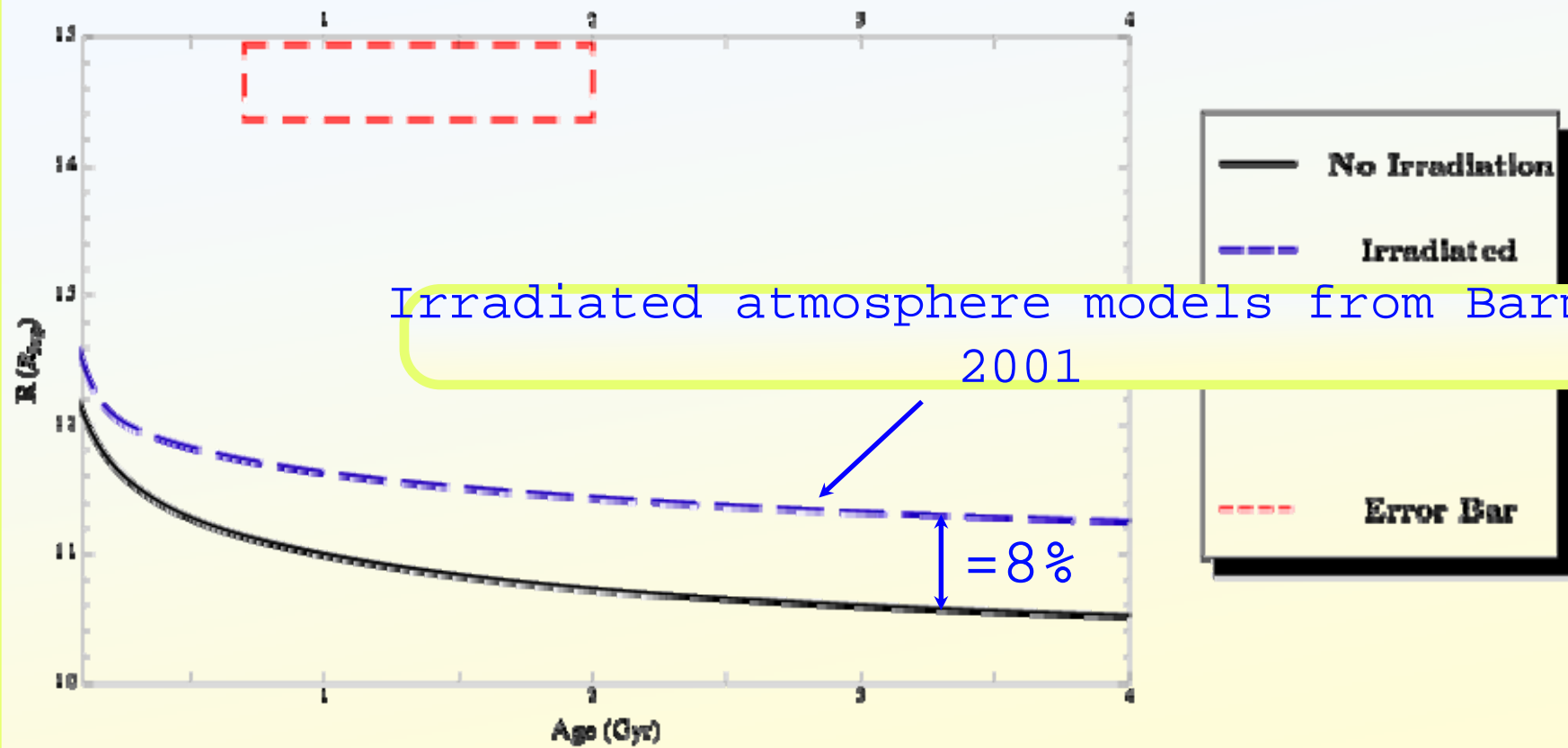
CoRoT-2b

($3.31 M_{\text{Jup}}$)



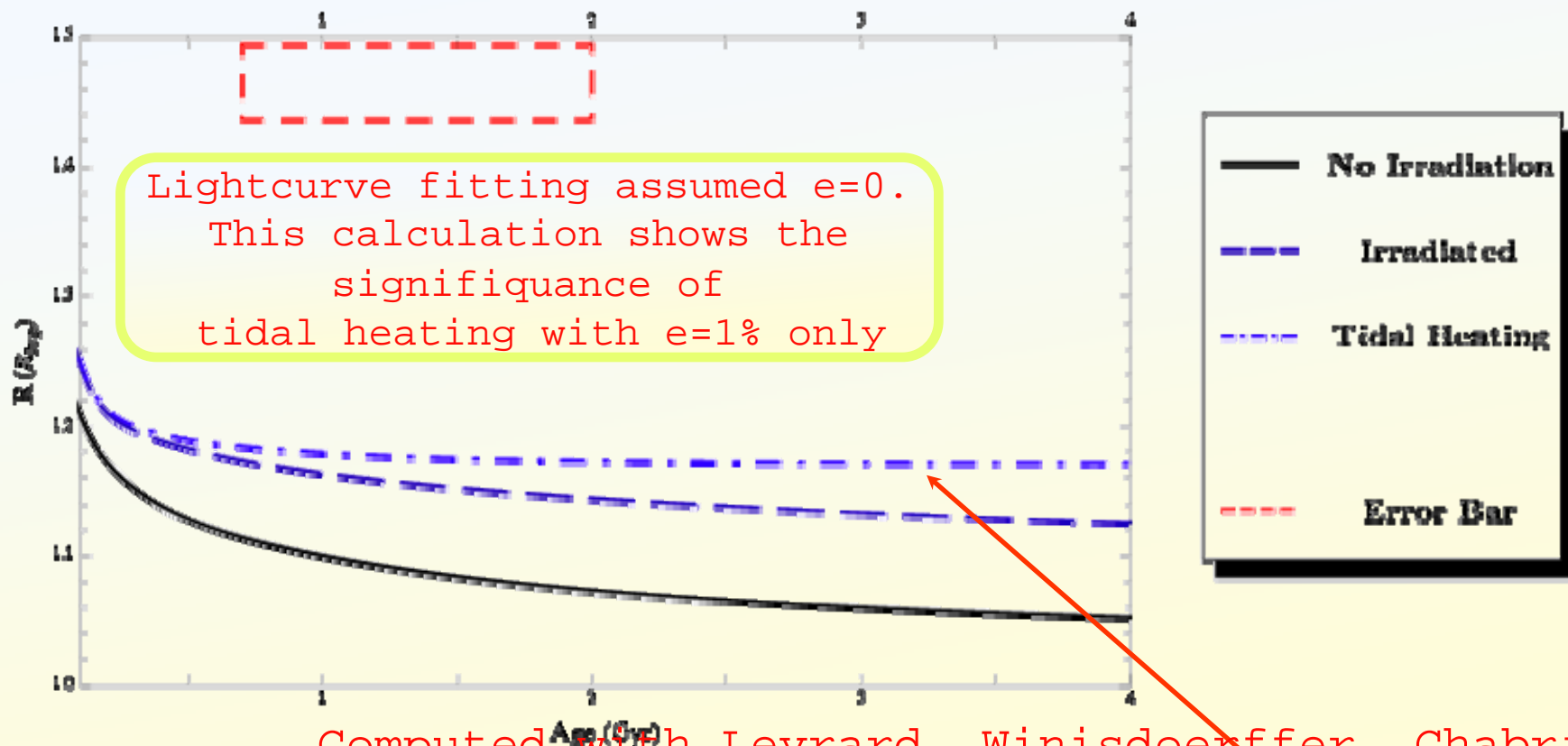
CoRoT-2b

($3.31 M_{\text{Jup}}$)



CoRoT-2b

($3.31M_{\text{Jup}}$)



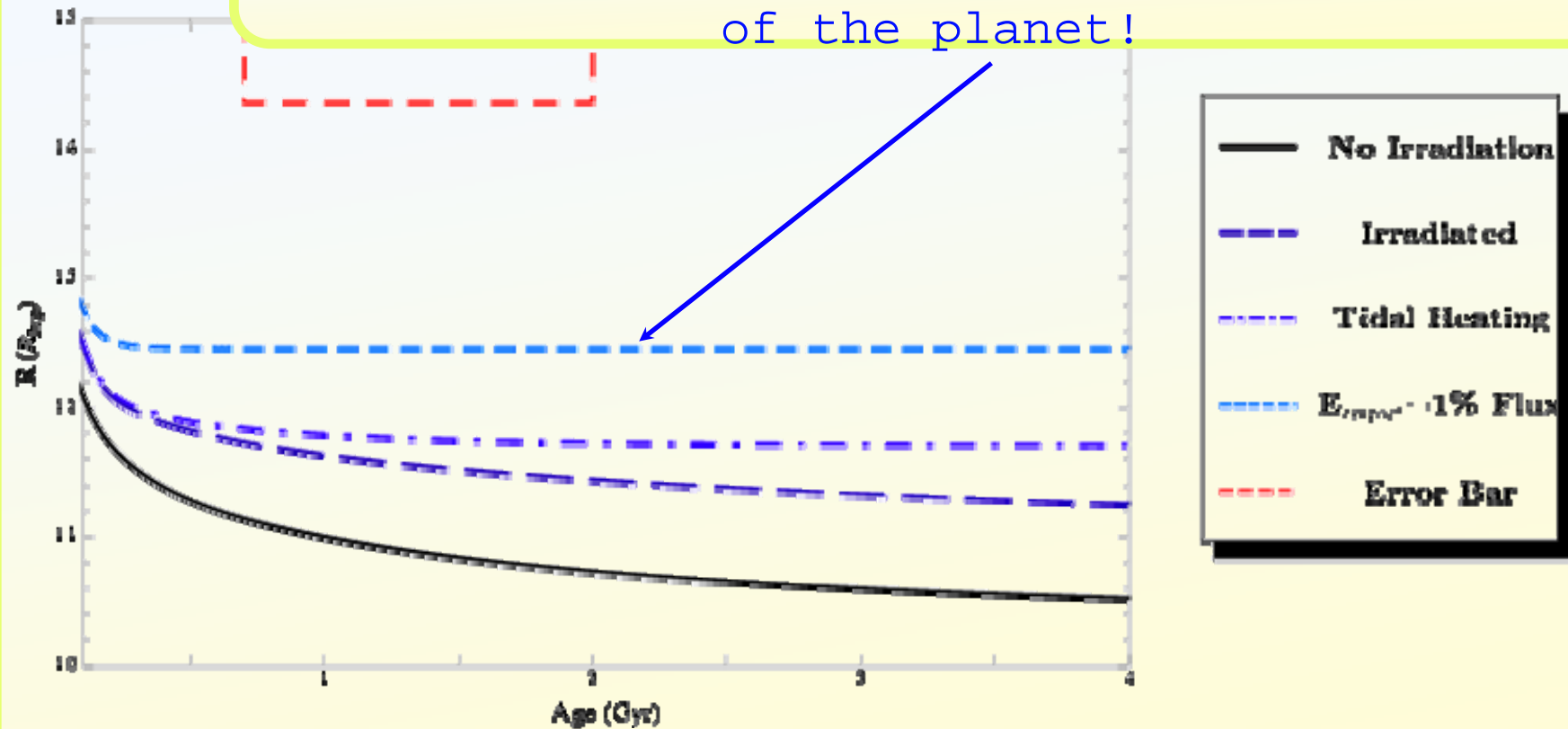
Computed with Levrard, Winisdoerffer, Chabrier 2009.

Non-zero eccentricity can remain during the planet lifetime

CoRoT-2b

($3.31M_{\text{Jup}}$)

Computed with Showman & Guillot 2002. 1% of Stellar Flux dissipated in the interior of the planet!



CoRot-2b

Missing Mechanism:

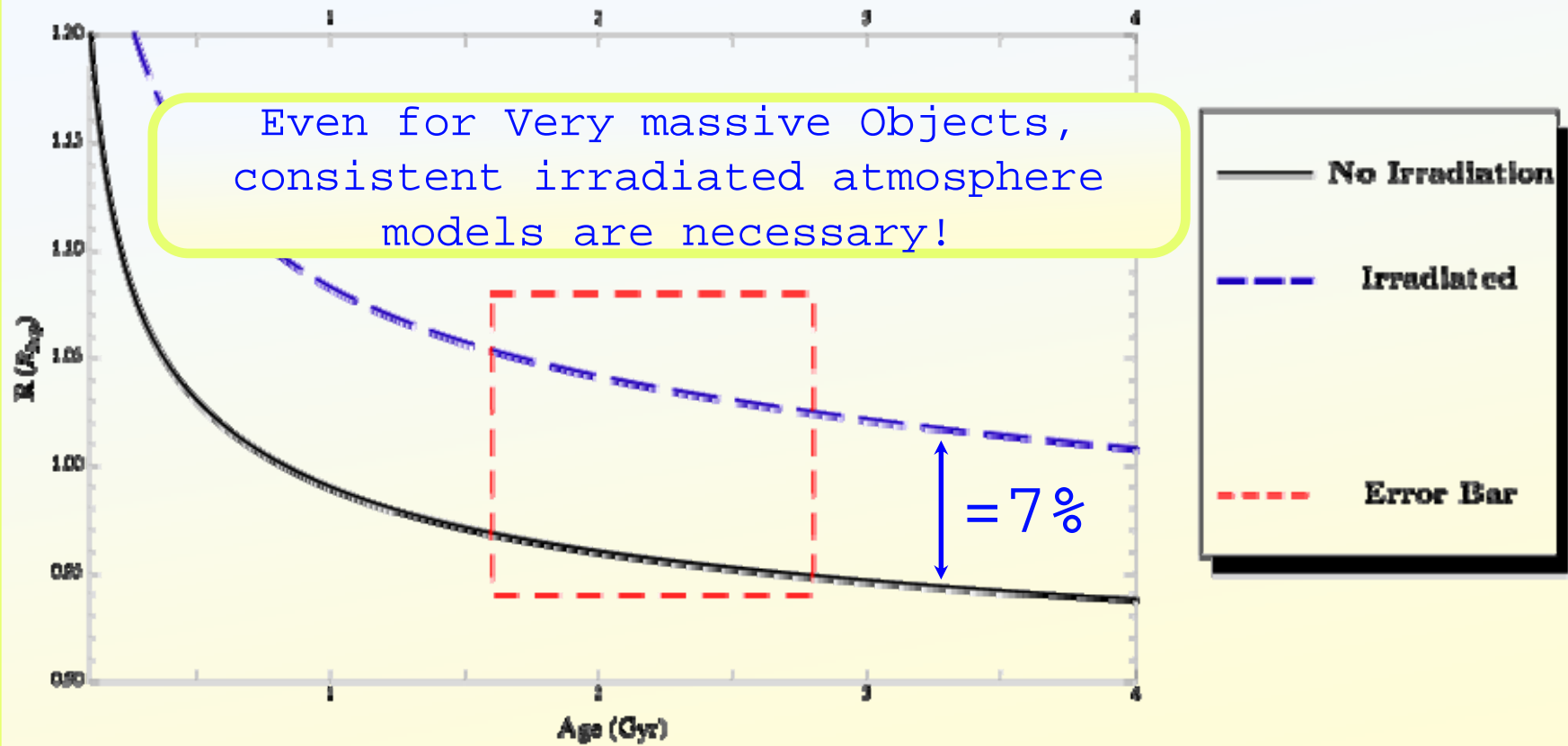
-Tidal Heating ?
(need a proper measurement of e)

-Double diffusive
convection ?
(Chabrier, Baraffe 07)

Age (Gyr)

Massive Substellar
objects:
Brown Dwarfs
or
Giant Planets?

CoRot-3b ($21.6M_{\text{Jup}}$)



Maximal Mass of Heavy Elements available for Planet Formation

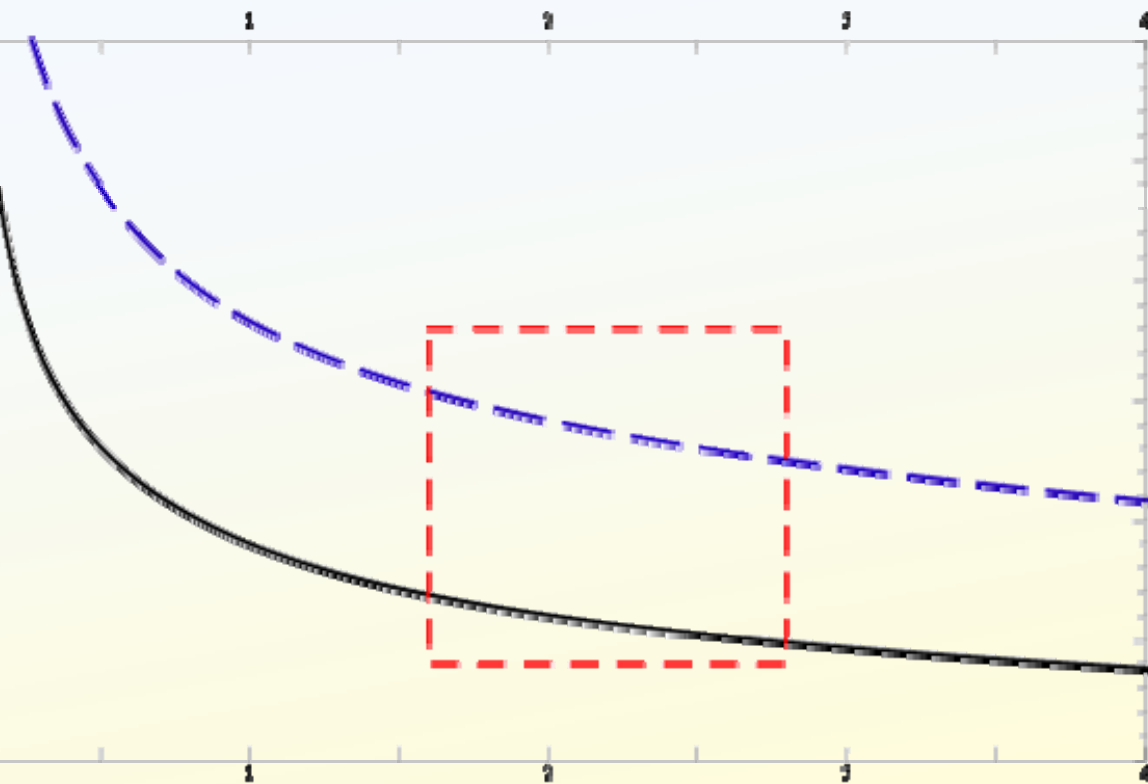
Metal mass fraction

$$M_Z \approx \eta \cdot Z \cdot f \cdot M_\star$$

ion Efficiency $\approx 30\%$ Maximal Mass
(Libert et al.) for a Stable Disk

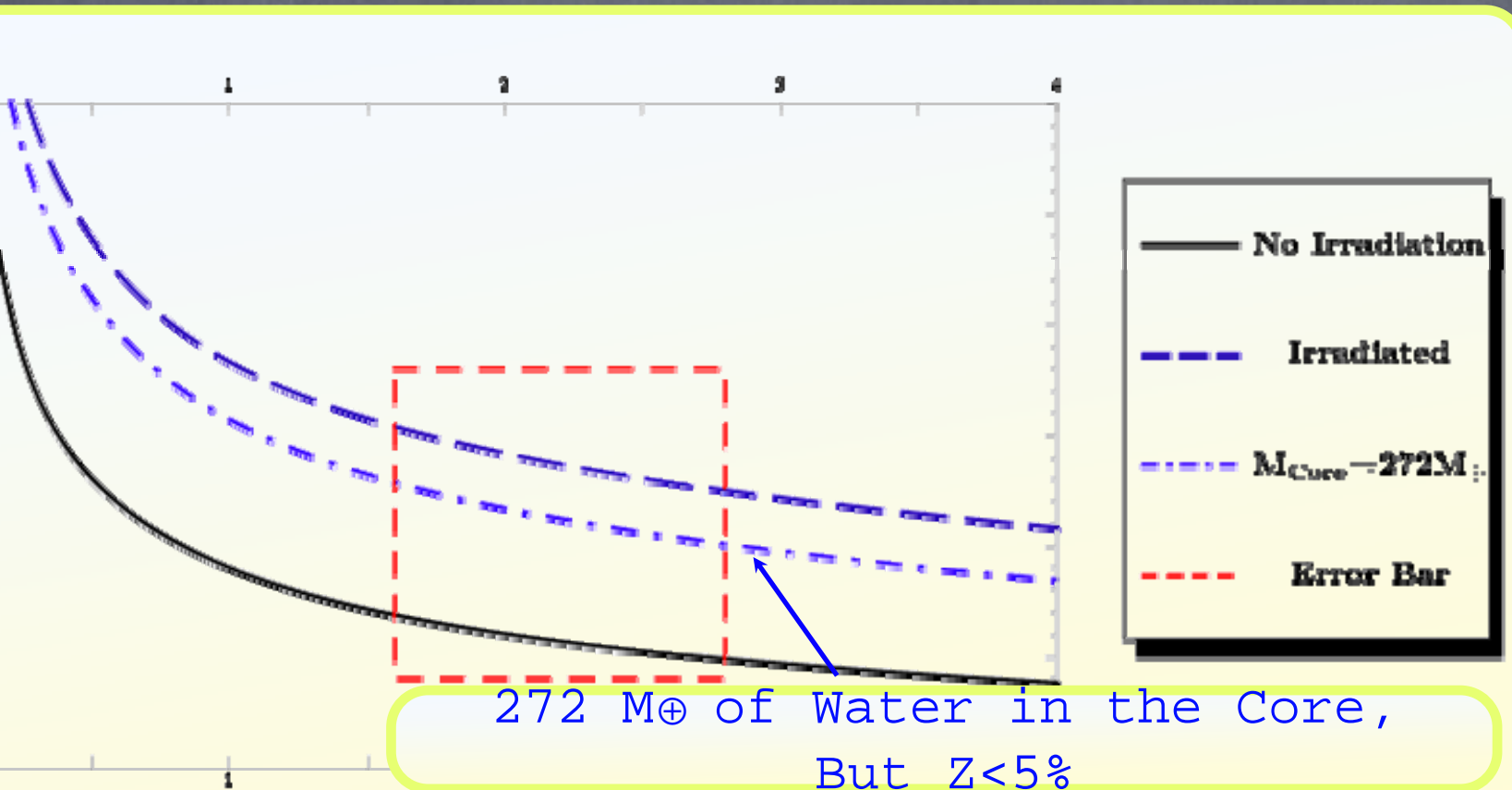
CoRoT-3b

($21.6 M_{\text{Jup}}$)



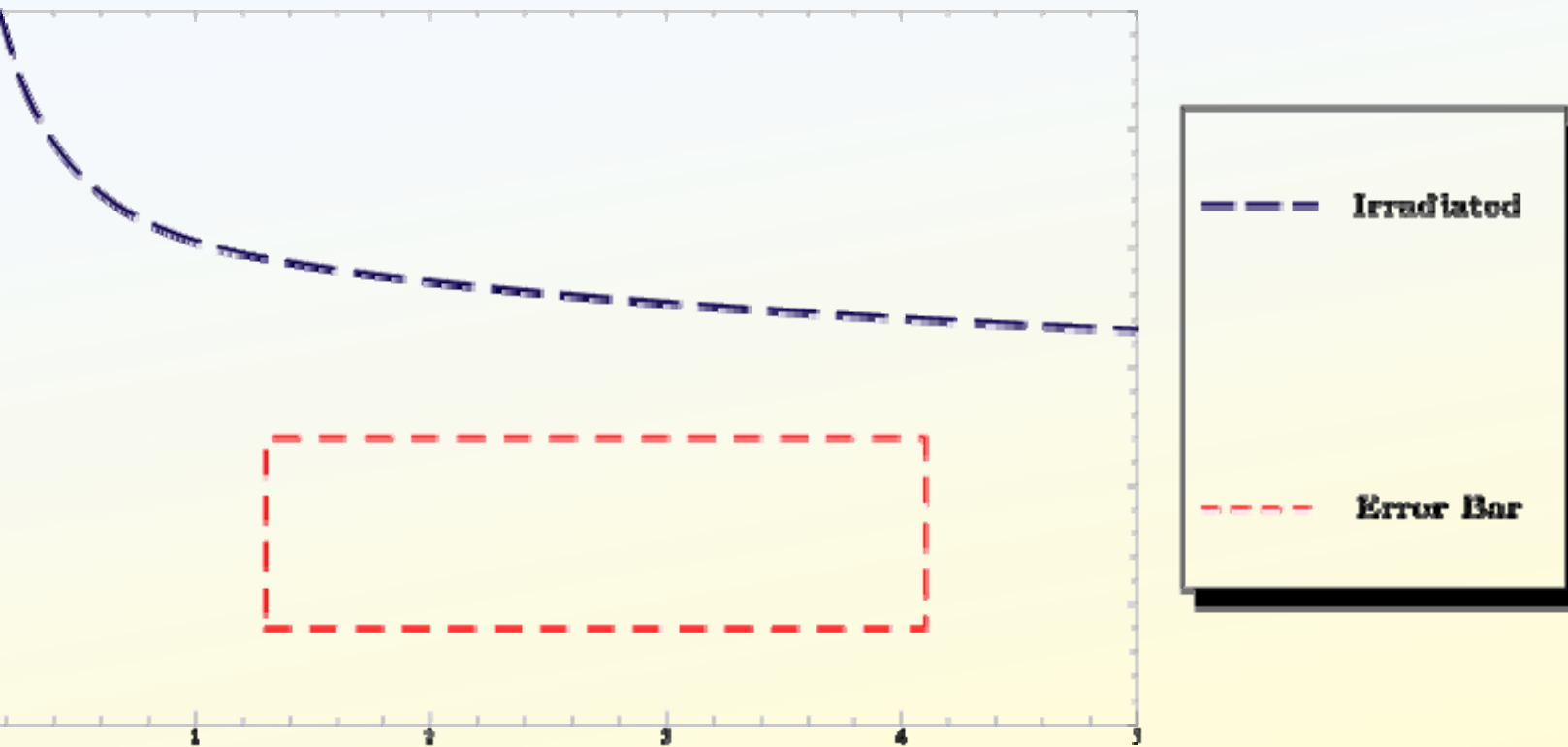
CoRot-3b

($21.6 M_{Jup}$)



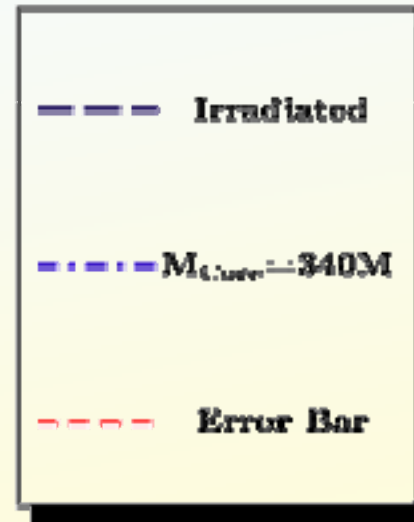
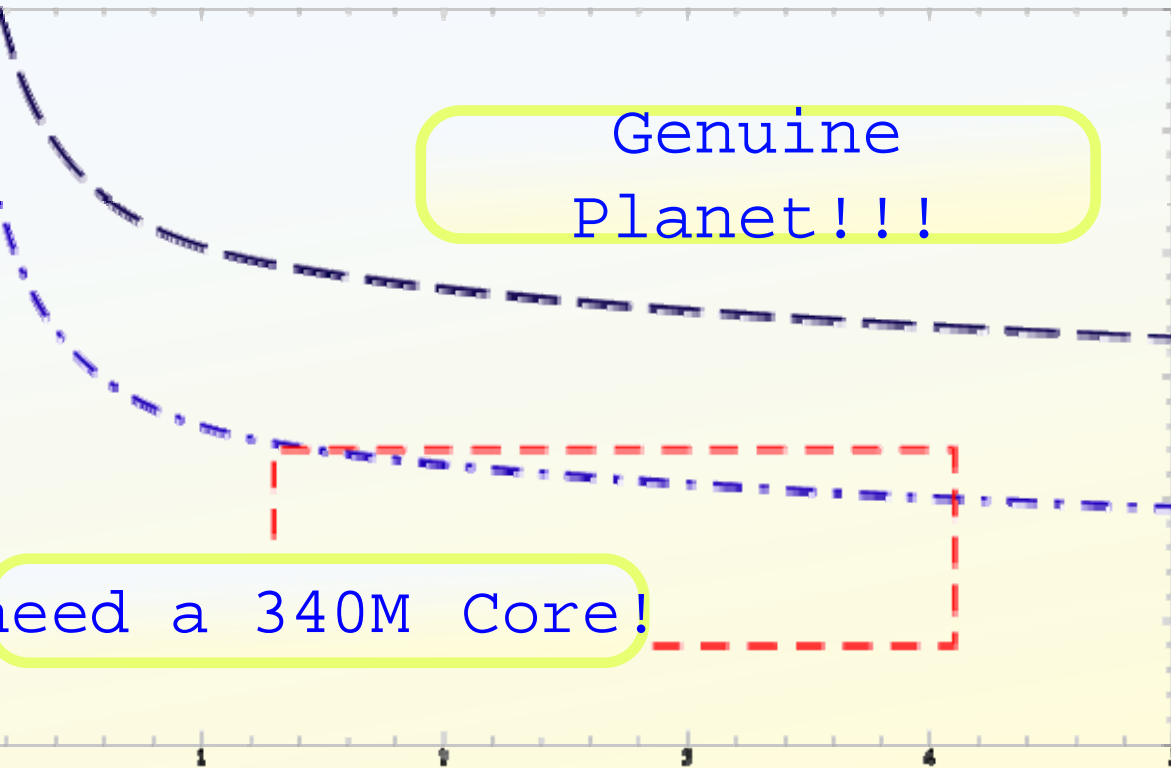
Hat-P2 b

($8.04 M_{\text{Jup}}$)

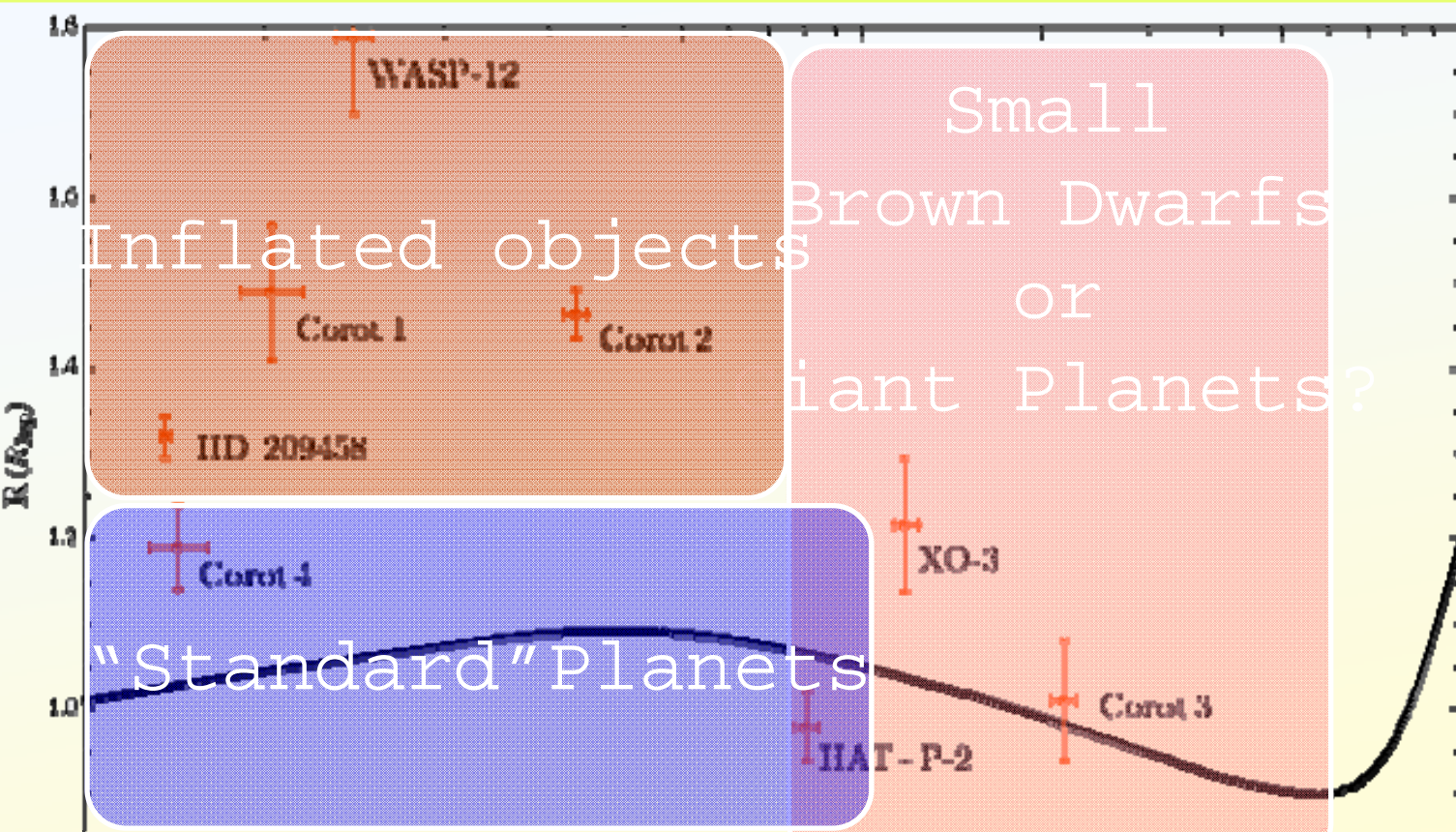


Hat-P2 b

($8.04 M_{\text{Jup}}$)



What can we learn from Mass-Radius determination?



Summary

- 1°) Lightly Inflated Planets can be explained by using consistent Interior/Irradiated atmosphere boundary conditions and detailed Internal composition
- 2°) Bulk composition can be inferred

Summary

3°) Inflated objects tell us of a
Missing Mechanism:

- Tidal Heating ? (need e)
- atmospheric circulation?
- Double diffusive convection ?

4°) Brown Dwarf / Giant planet
overlapping domain:

- Dinstinction possible (HAT-P2 b)