7th HP4 Berlin, 11 October 2018

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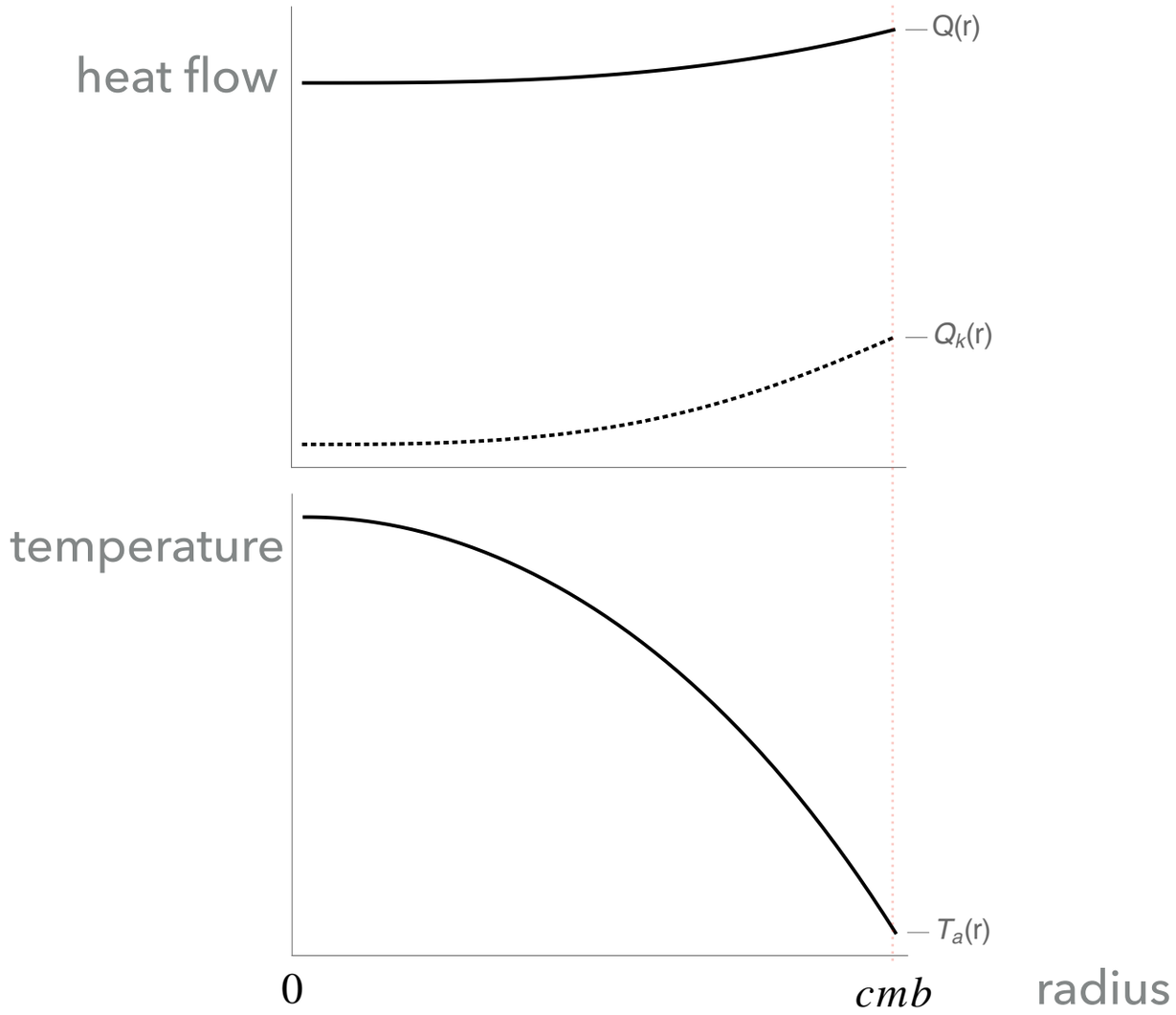
STRATIFICATION OF MERCURY'S CORE

THE CORE IS CONVECTING

t = t0



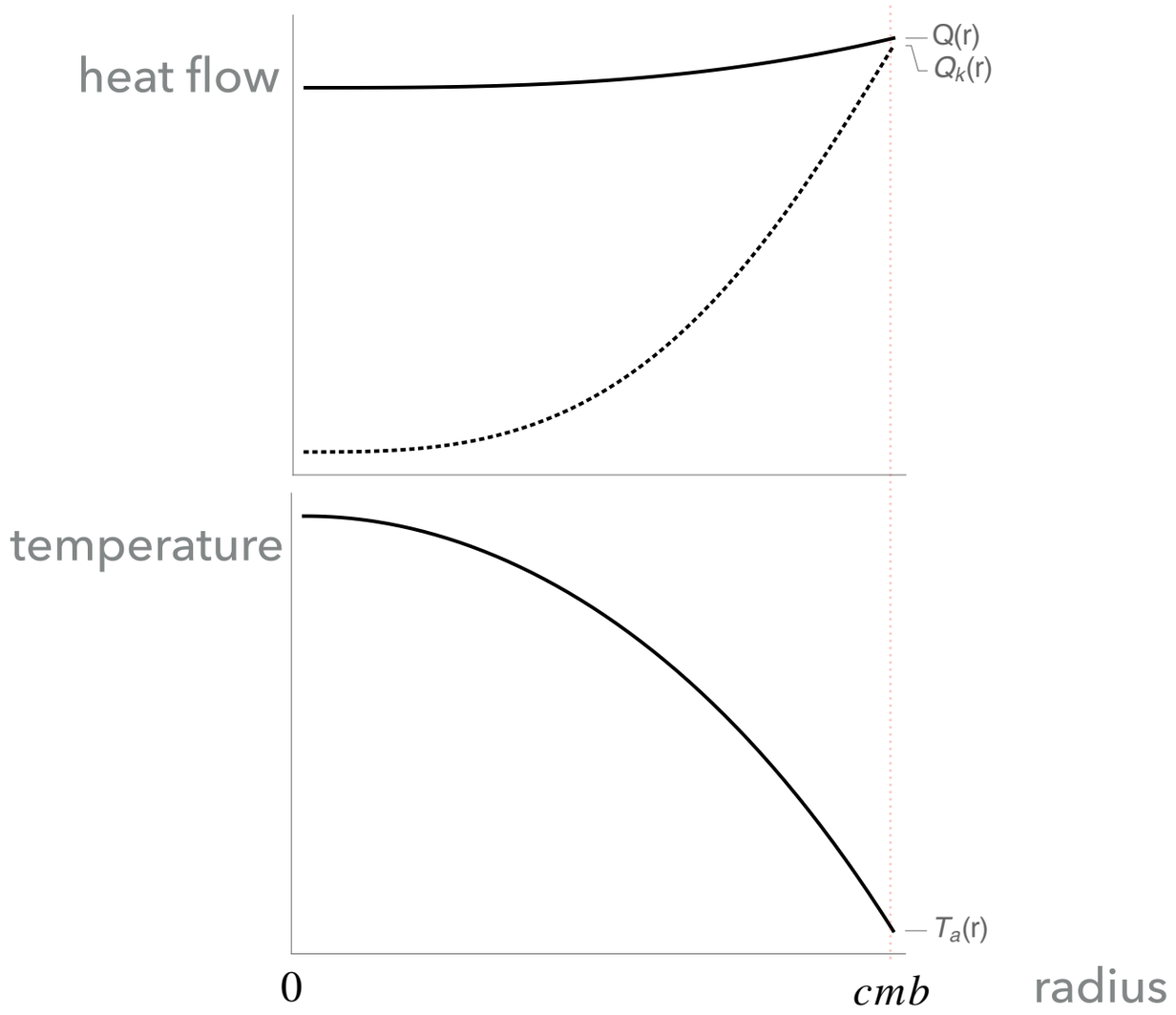
Super adiabatic heat flow

Adiabatic temperature profile

convective core

STRATIFICATION APPEARS AT THE TOP OF THE CORE

t = t1

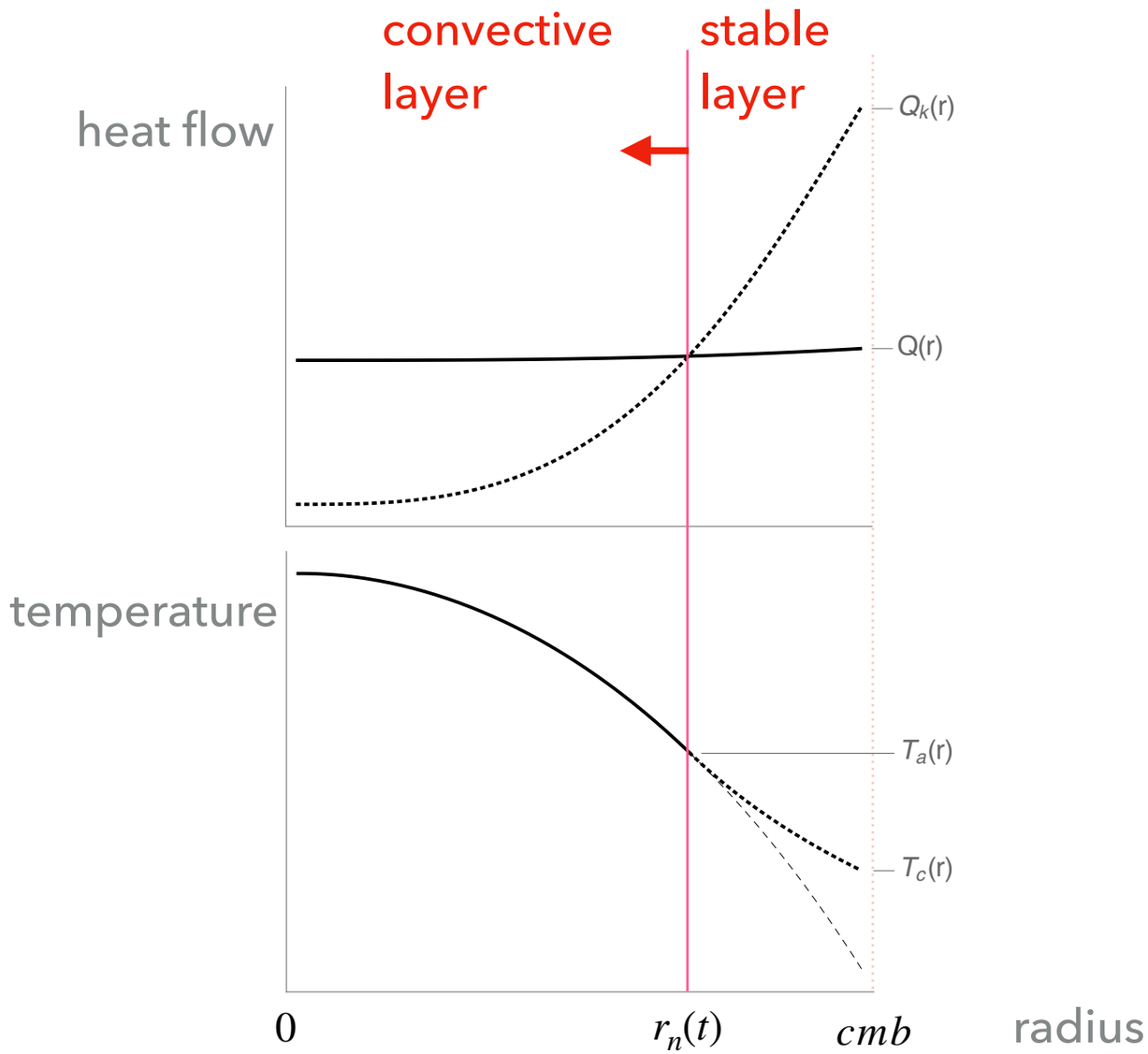


Adiabatic temperature profile

convective core

THE STRATIFIED LAYER GROWS

t = t2



Sub-adiabatic heat flow

convective core

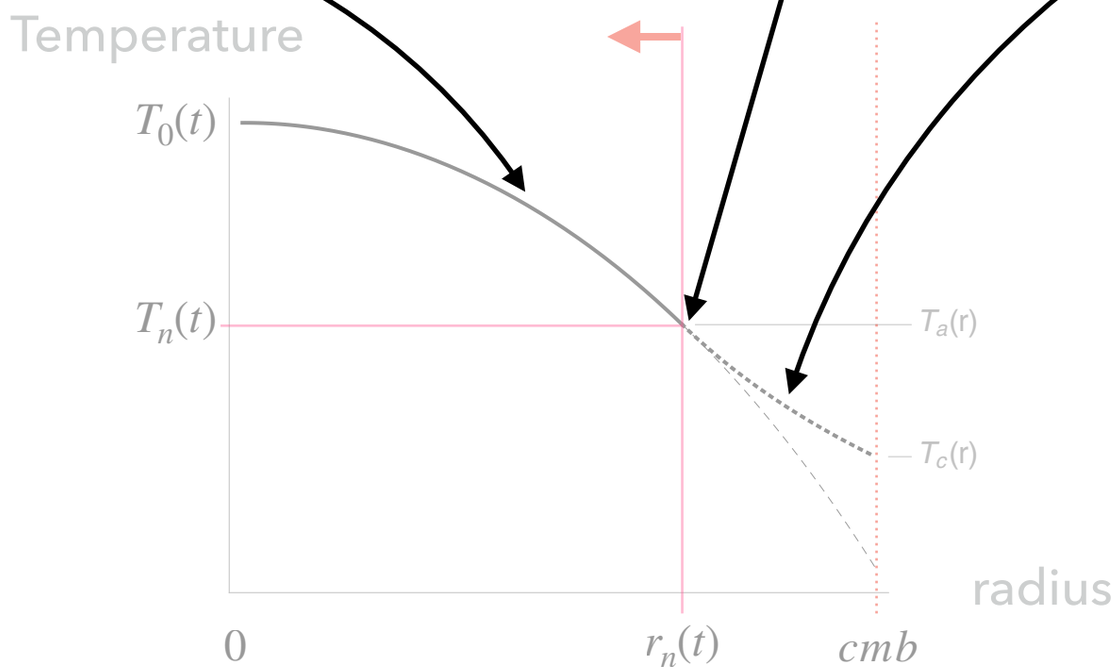
STABLE LAYER AND CONVECTING LAYER EVOLUTION

$$Q_s + Q_L + Q_g = -k\frac{\partial T_a}{\partial r}(r_n)$$

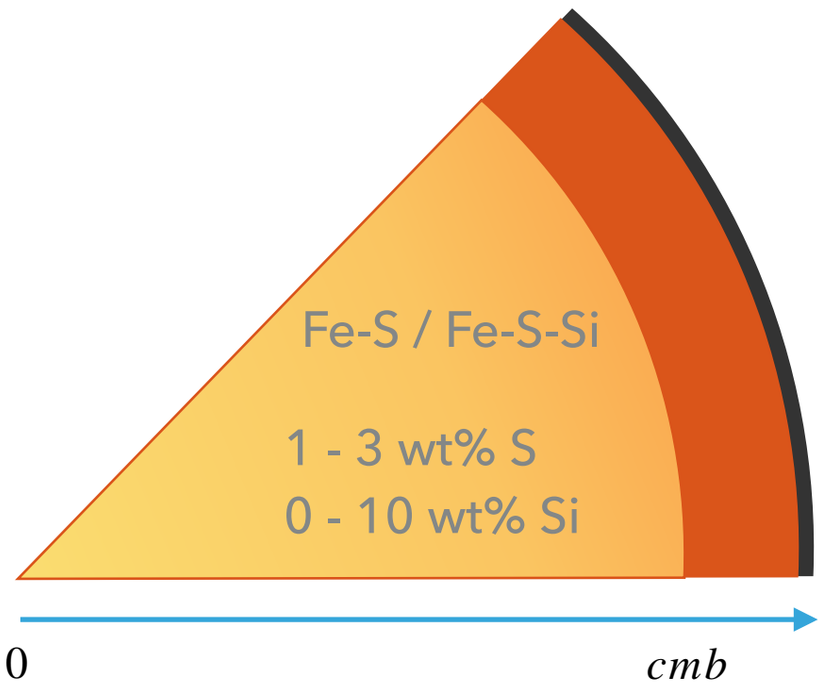
$$T_a(r_n) = T_c(r_n)$$

$$-k\frac{\partial T_a}{\partial r}(r_n) = -k\frac{\partial T_c}{\partial r}(r_n)$$

$$\rho C_p \frac{\partial T_c}{\partial t} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(kr^2\frac{\partial T_c}{\partial r}\right)$$



CORE MODEL

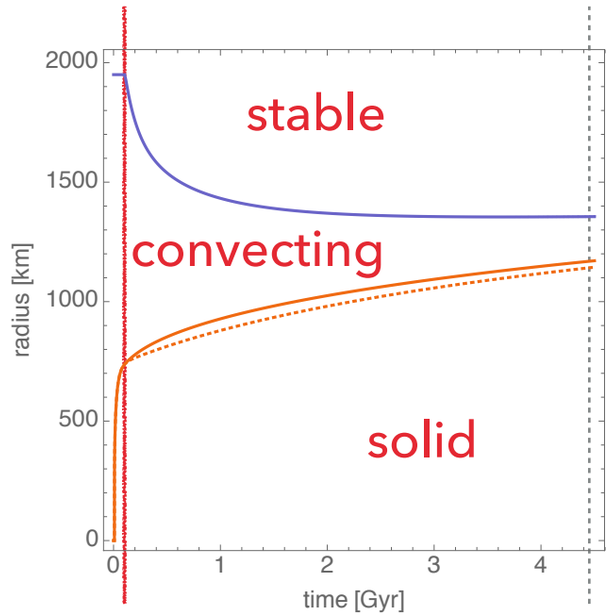


- core radius: 1950 km - 2050 km
- cmb temperature at t = 0: 2000 - 2100 - 2200 K
- thermal conductivity: k ~30-50 W/m.K
- exponential law for cmb heat flow:

$$Q_{cmb} = C + A\mathrm{e}^{-t/\tau}$$

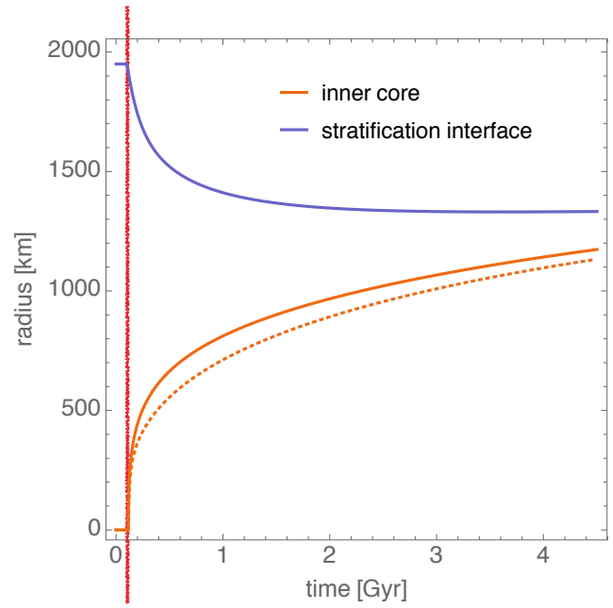
SIMILAR INNER CORE GROWTH

Tcmb = 2000 K



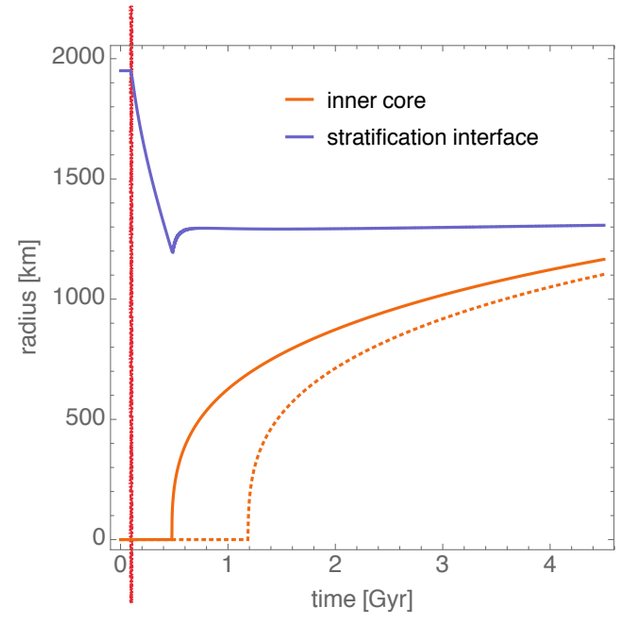
stratification onset — today

Tcmb = 2100 K



stratification onset

Tcmb = 2200 K



stratification onset

- inner core size: ~1200 km today
- stratified layer thickness: ~600 km today
- convecting layer thickness: ~100-200 km

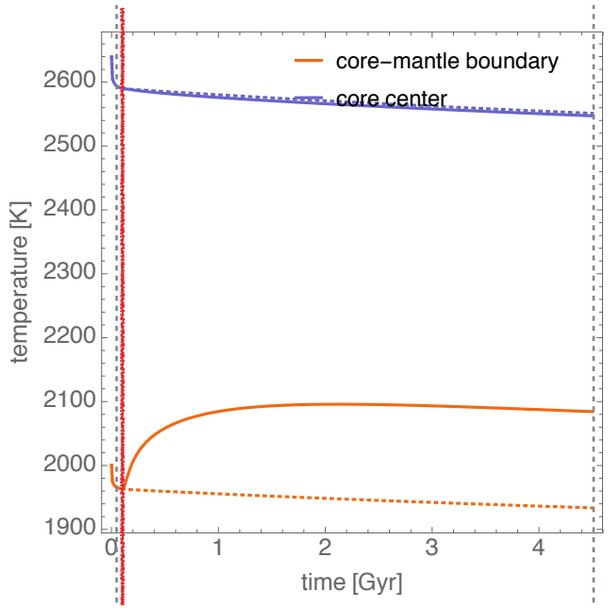
Large Fe-S cores and Fe-S-Si cores:

- no inner core
- core entirely stratified after 1.2 - 1.6 Gyrs

STABLE LAYER MORE AFFECTED THAN CONVECTING LOWER CORE

Tcmb = 2000 K

ic onset

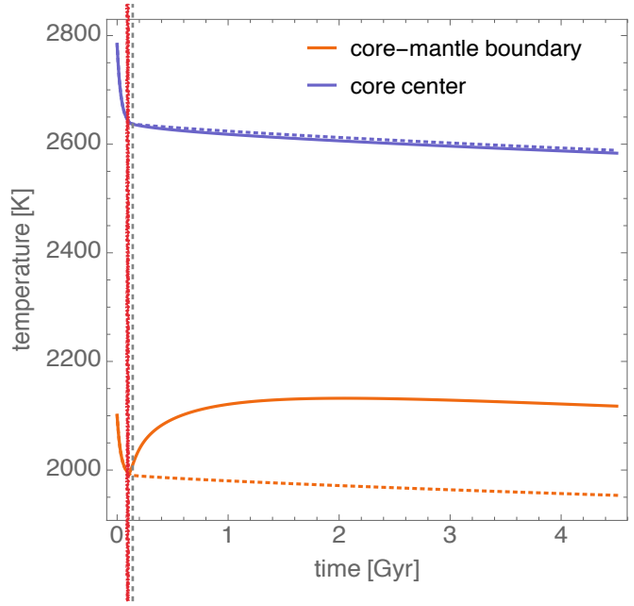


stratification onset

today

Tcmb = 2100 K

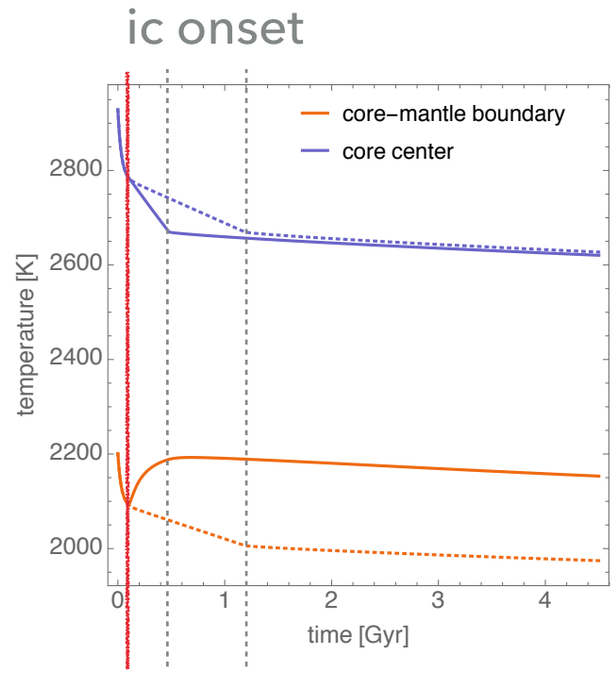
ic onset



stratification onset

Tcmb = 2200 K

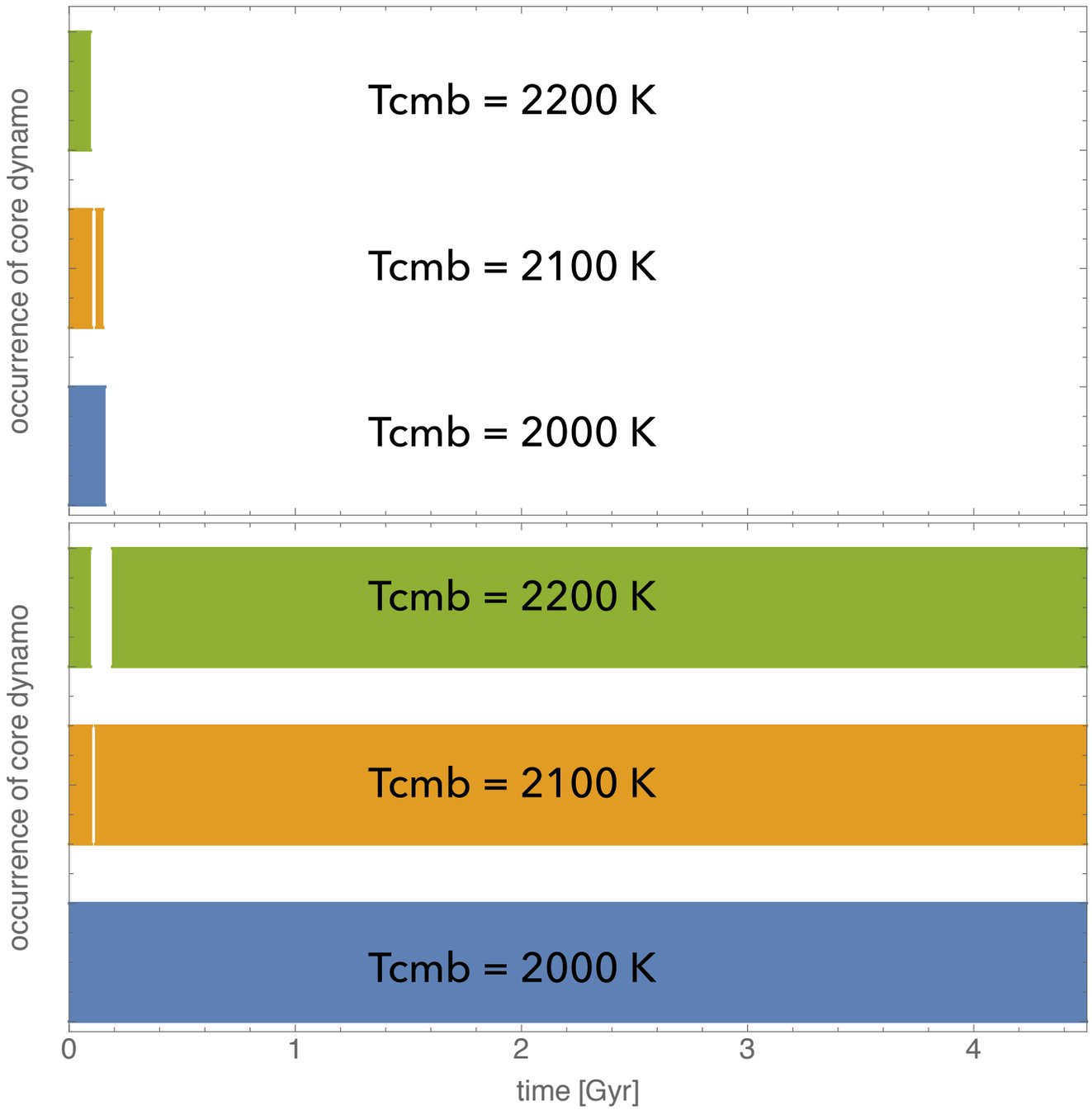
ic onset



stratification onset

- cmb temperature: 100 K higher

A DYNAMO DURING THE WHOLE EVOLUTION

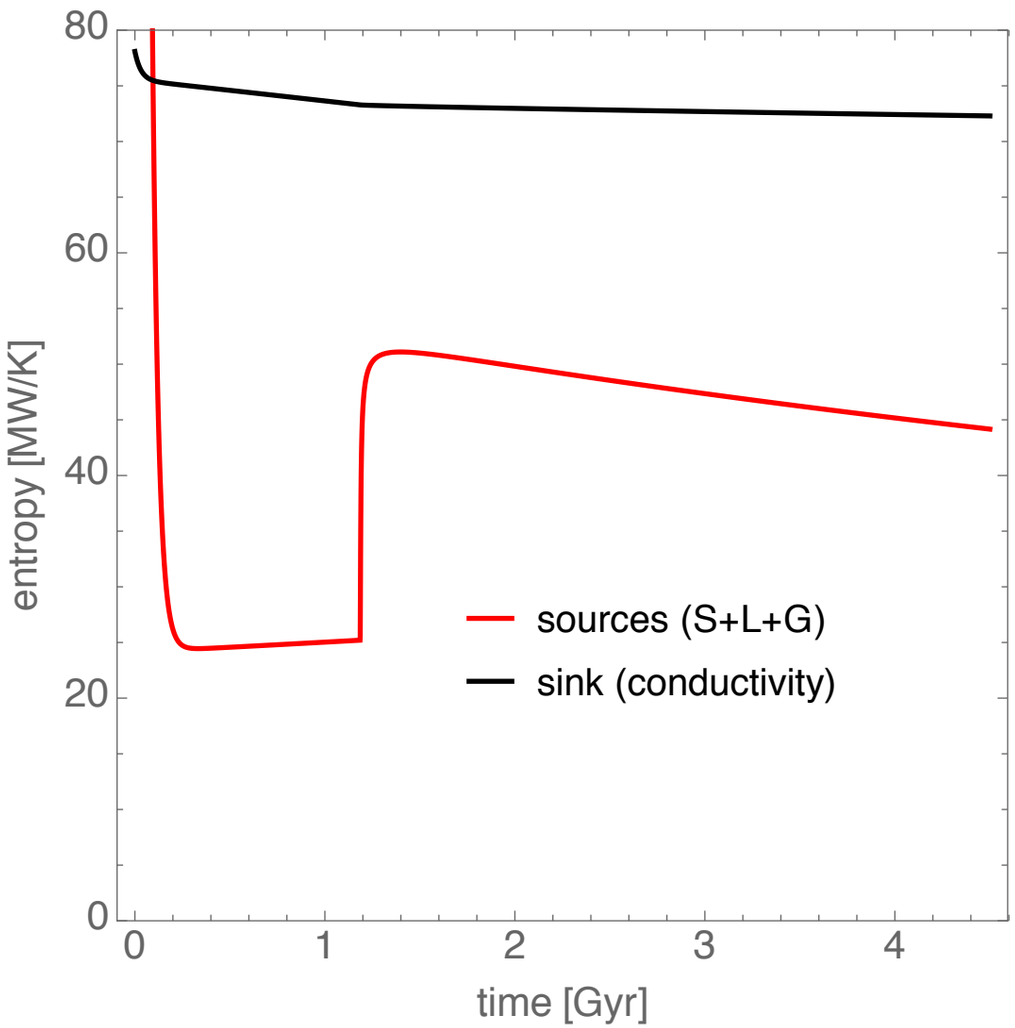


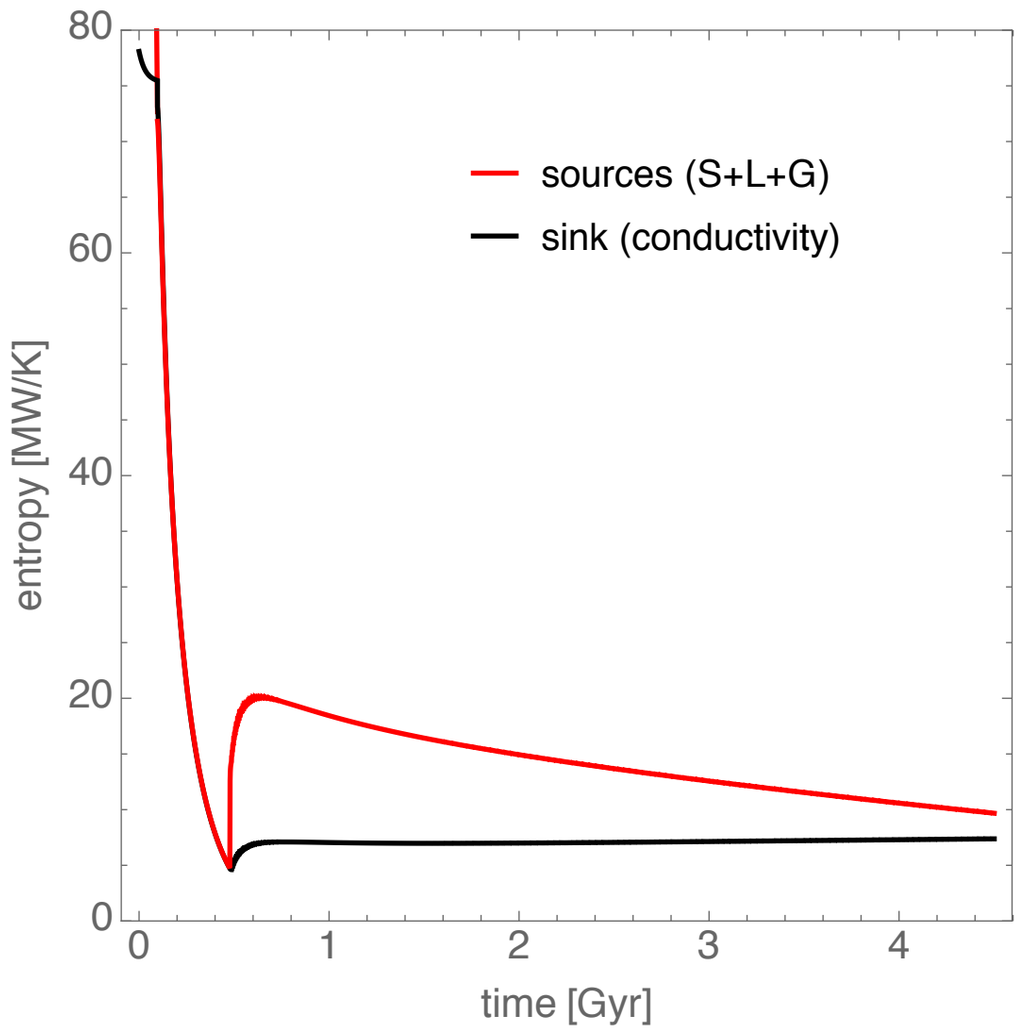
without stratification

with stratification

SMALLER SINK ENTROPY

Without stratification Tcmb = 2200 K With stratification



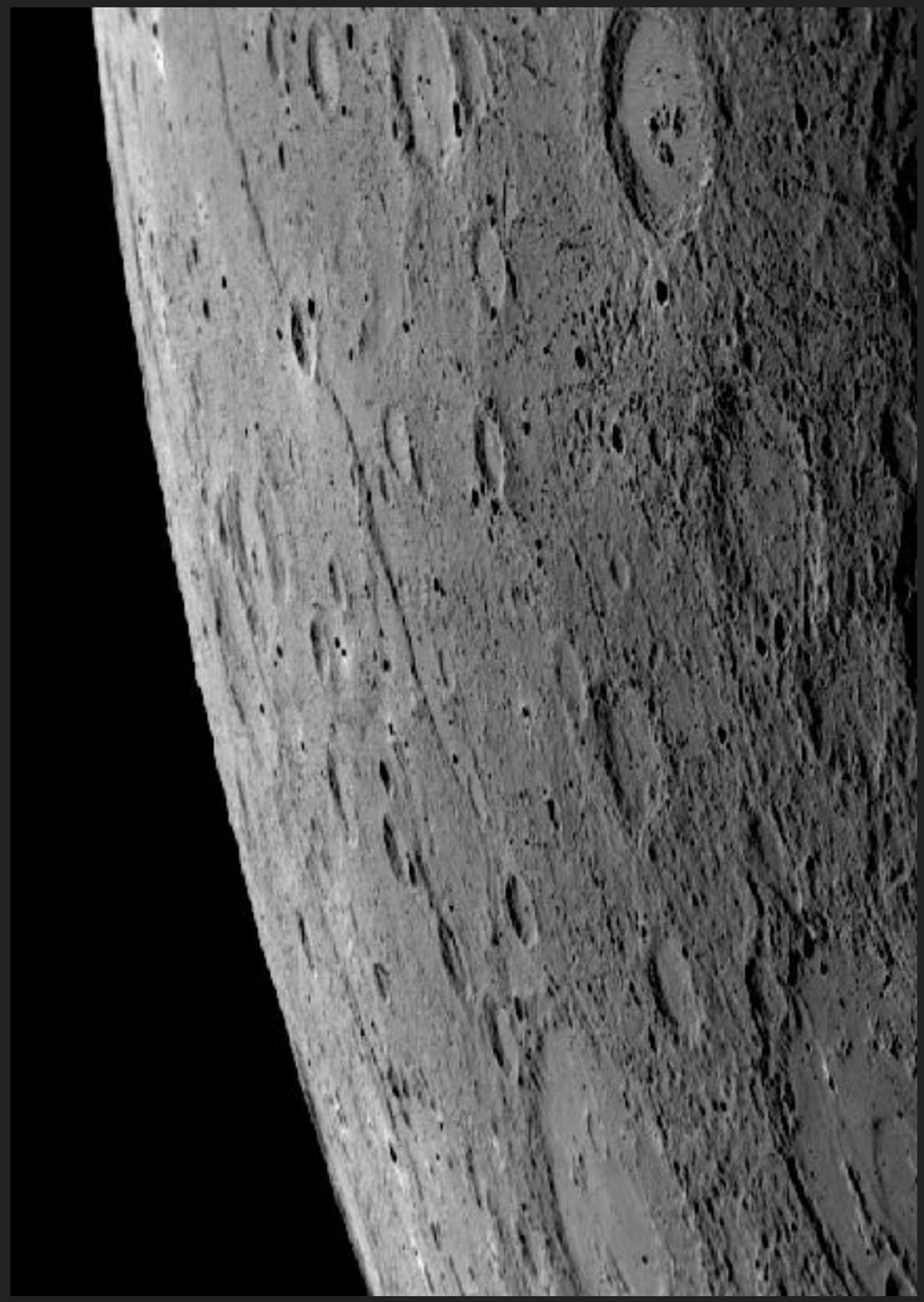


PRELIMINARY RESULTS

- Mercury's core likely thermally stratified
- cmb temperature rises by ~100 K
- minor impact on the adiabatic lower core
- more power available to drive a dynamo during the whole evolution

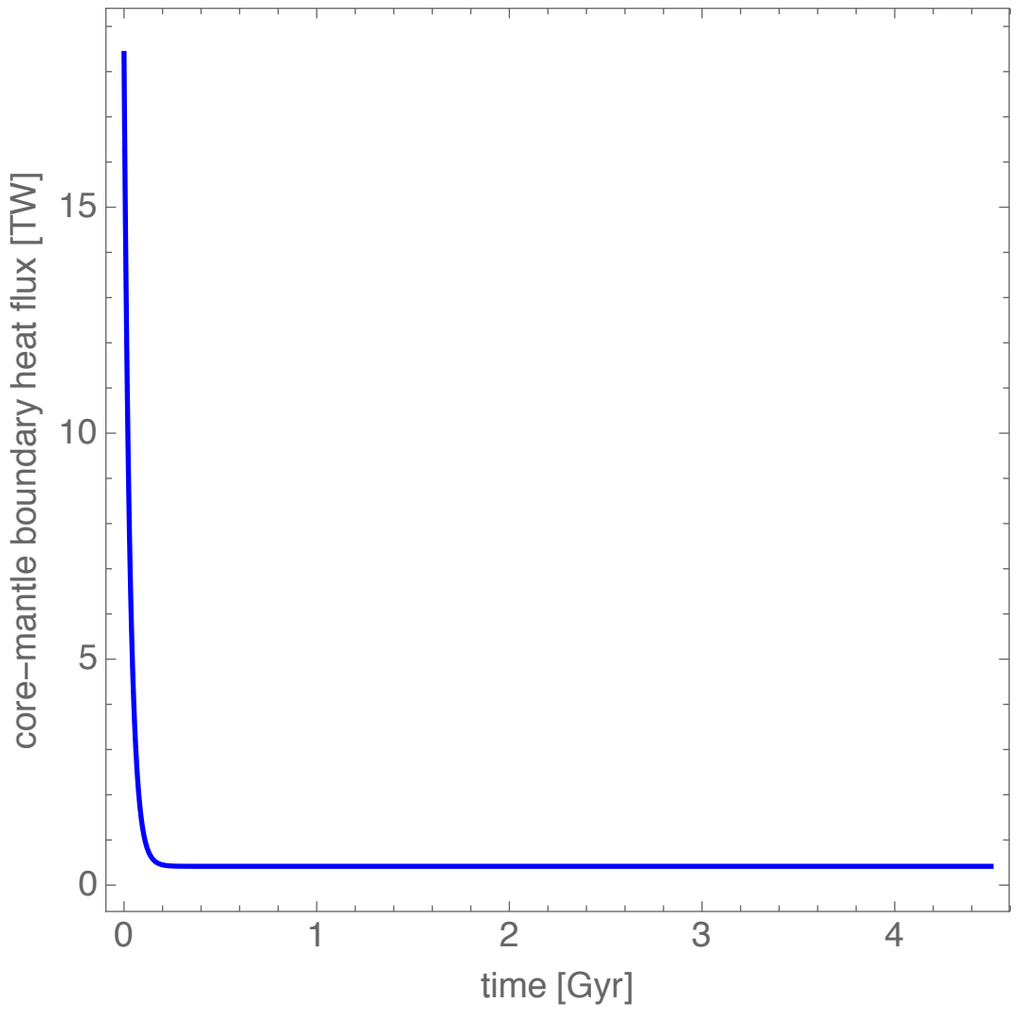
NEXT...

- coupled core-mantle model
- surface magnetic field



BACK-UP

CORE-MANTLE BOUNDARY HEAT FLOW



From a coupled core-mantle evolution (rc = 2050 km, Tc = 2100 K)