

Emergence lec 19 2011.

— Thermodynamic properties (Temperature) emerge from mechanics of "atoms".

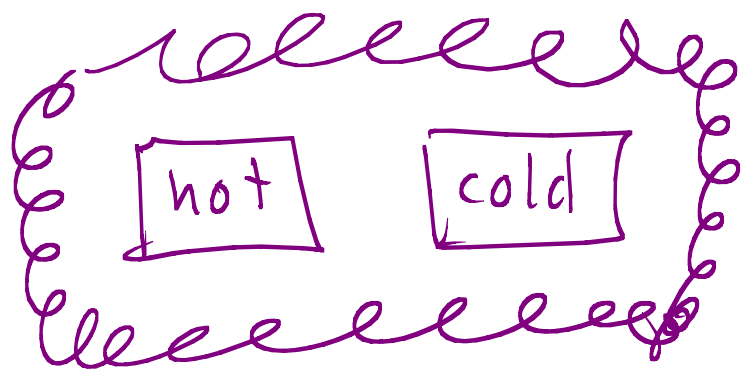
— irreversibility — thermo is
Irreversible → mechanics
is reversible.

Entropy S
— new quantity at macroscale

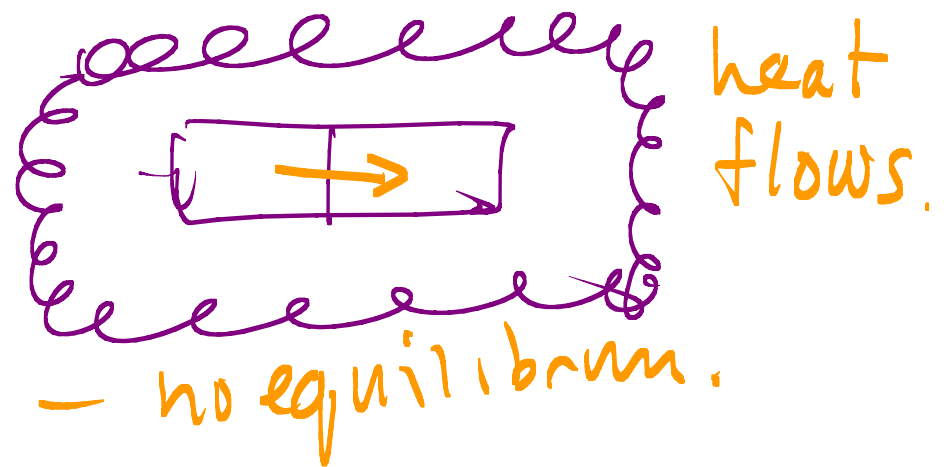
time \rightarrow entropy increase.
"arrow" of time.

"2ND Law" \rightarrow S increases

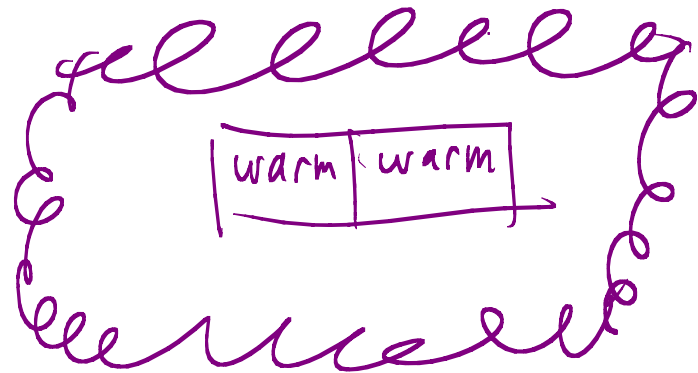
for a closed system



open in the
PAST! - Setup



... later



equilibrium -

closed

— cut off from the universe
— no heat gets in/out.
— no matter gets in/out

$$S = k \log W. \quad \text{— Boltzmann's tomb.}$$

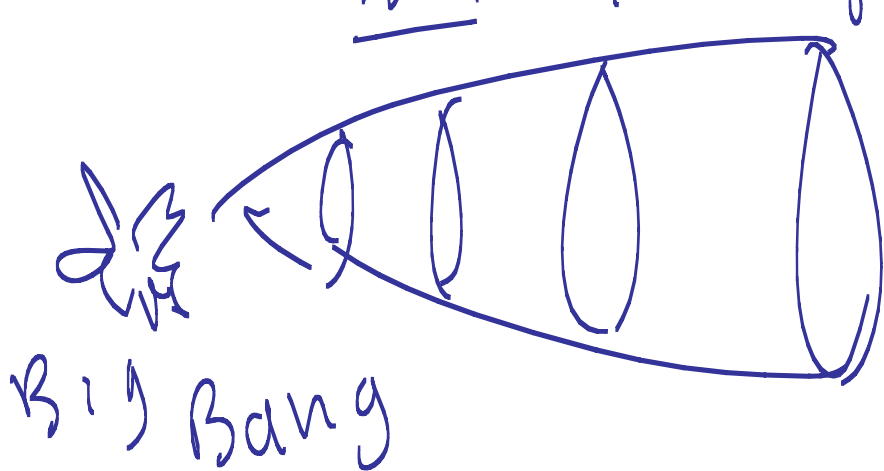
→ nothing happens after this

the UNIVERSE itself!

- open or closed?

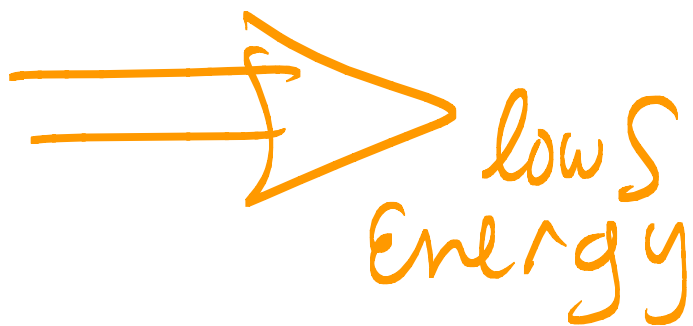
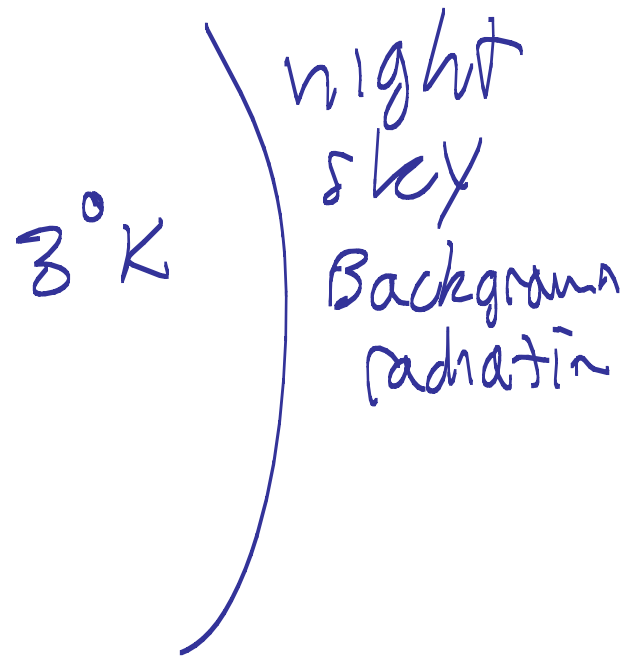
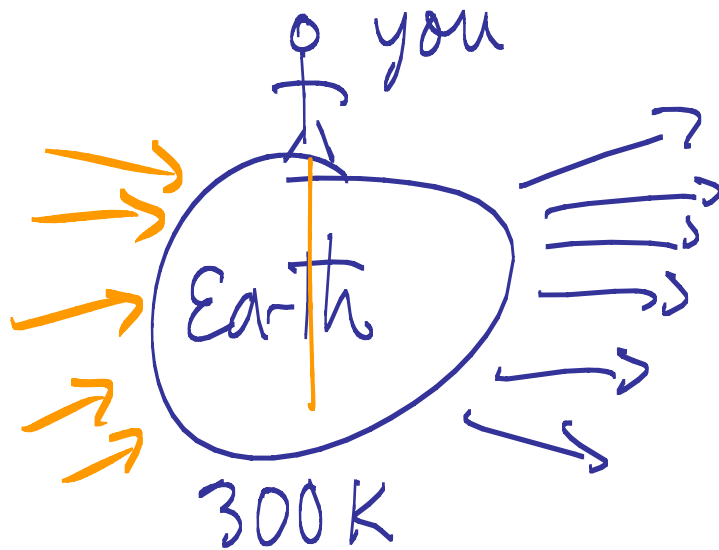
closed in 'space time' by the finite time since the Big Bang

- not in Equilibrium.

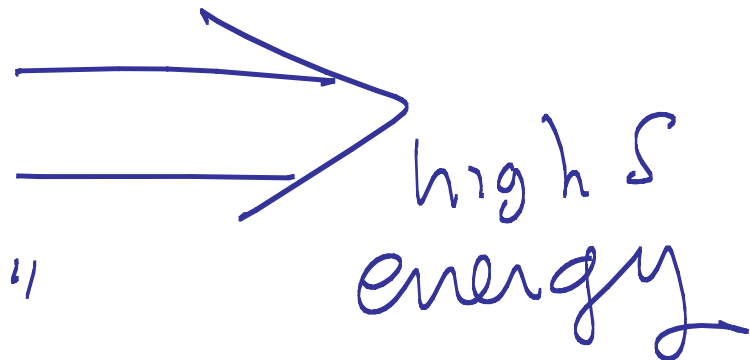


→ entropy is
INCREASING
but it is NOT
near a maximum

OPEN system



"flux"



Open systems:

entropy can
be PRODUCED!

→ exported to
universal
"sink".

- digestion

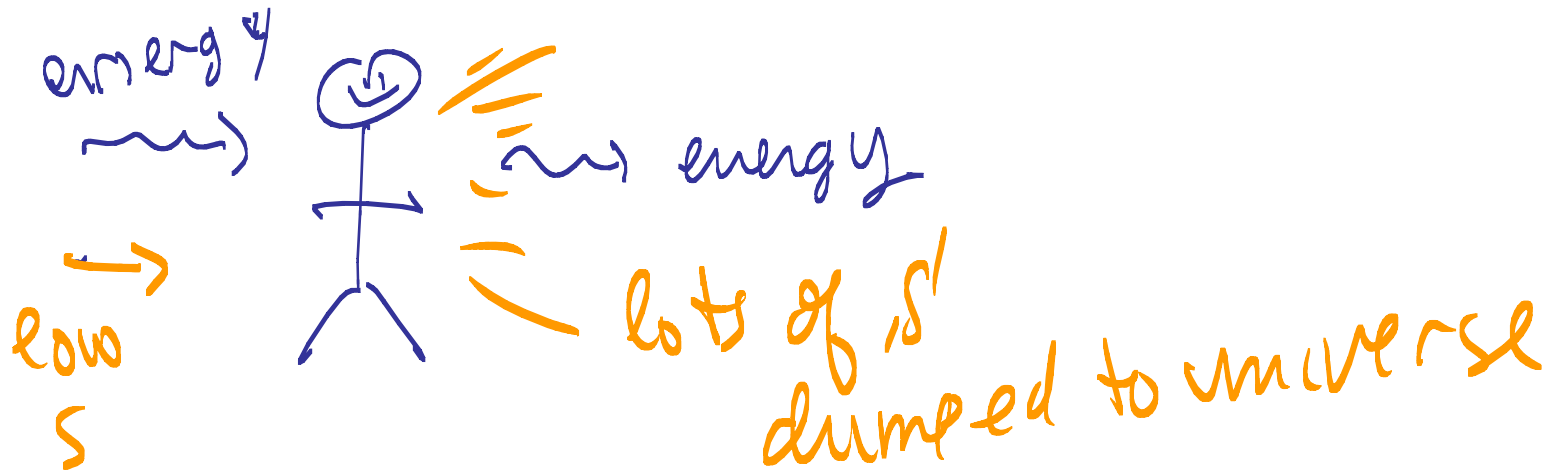
- combustion

- big molecules → smaller ones.

- MIX up gases
or anything
else.

2ND law → subsystems.

open subsystem — S might decrease



matter → highest entropy state of that matter?
throw it in a Black hole