Big-bang nucleosynthesis in a nutshell

Cyril Pitrou (IAP, Paris), ESO duologue, 2021.

Big-bang nucleosynthesis in a ~~nutshell~~ 5 minutes

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The Origin of Chemical Elements ?

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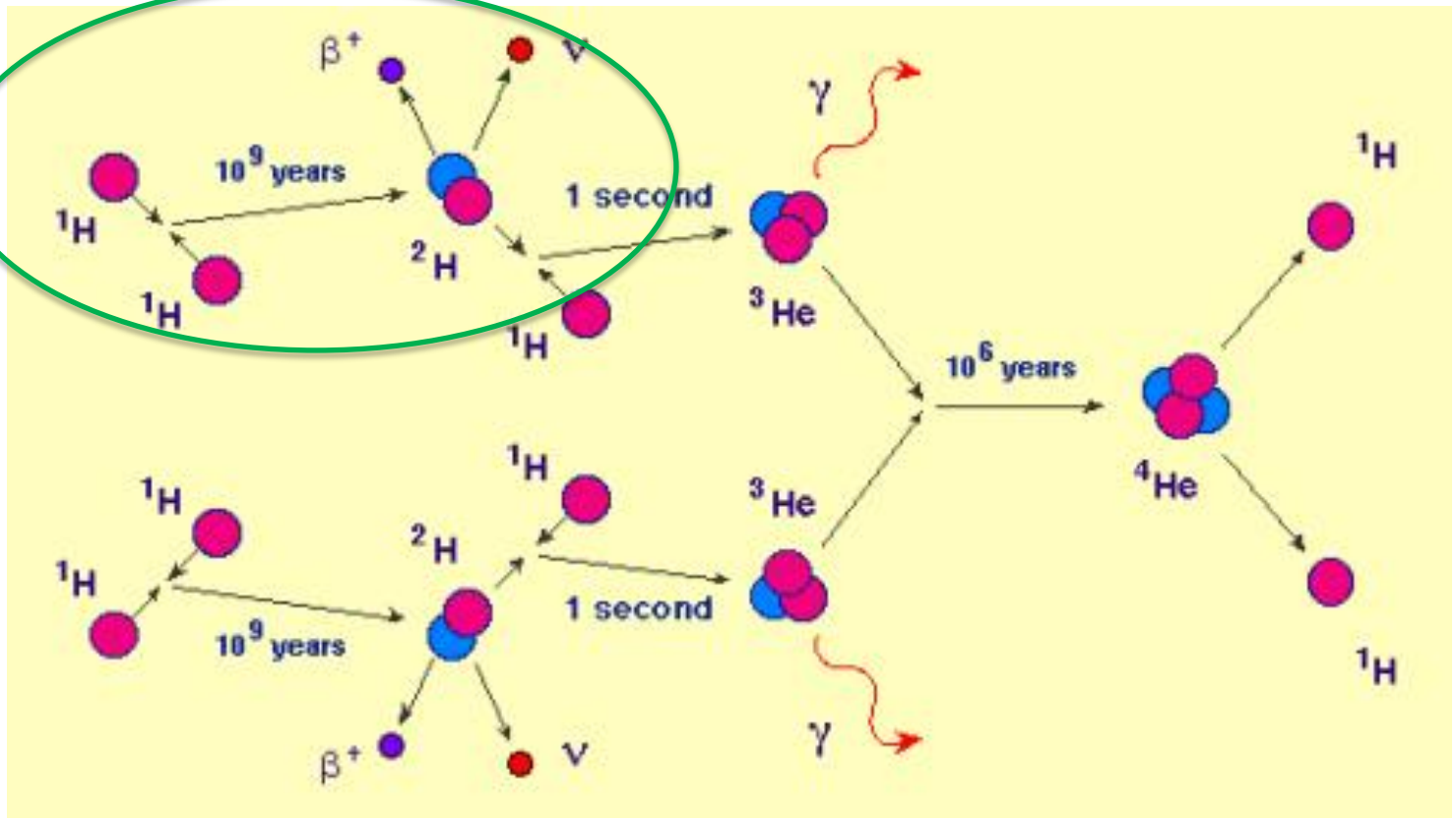
1) Stellar nucleosynthesis : there are no neutrons…

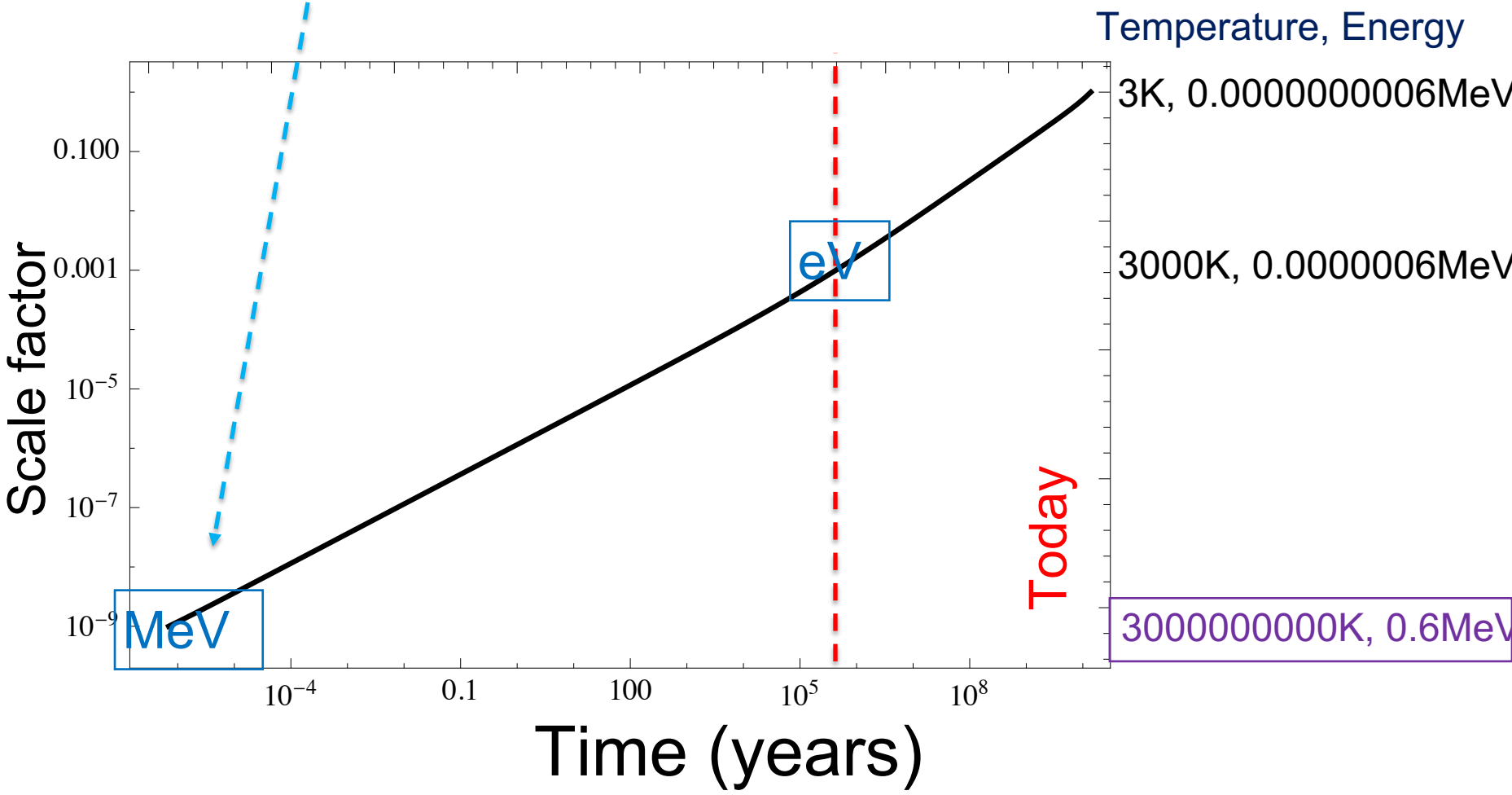


2) Primordial nucleosynthesis : there was plenty of neutrons !

$$p + n \leftrightarrow D + \gamma$$

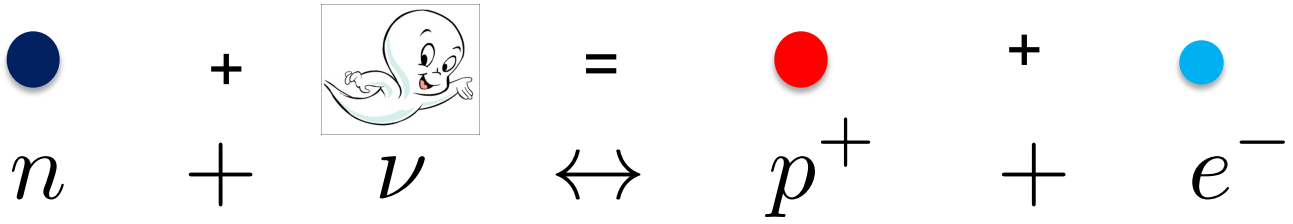
When does it happen ? How many neutrons were available ?

When does it happen ?



How many neutrons are available ?

Weak interactions



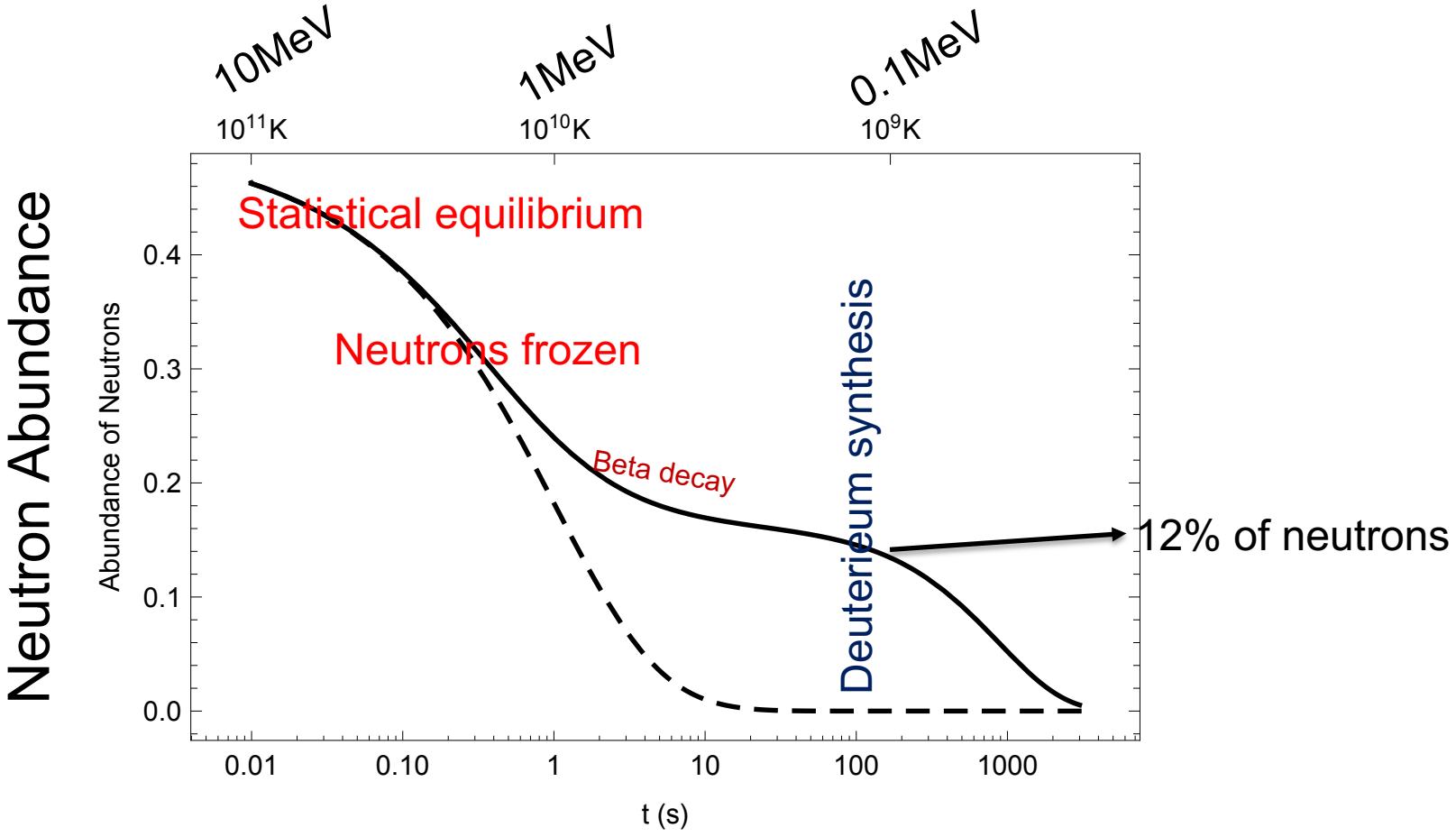
If enough interactions, then statistical equilibrium.

At low temperature, neutrons are less and less likely, because they are heavier than protons

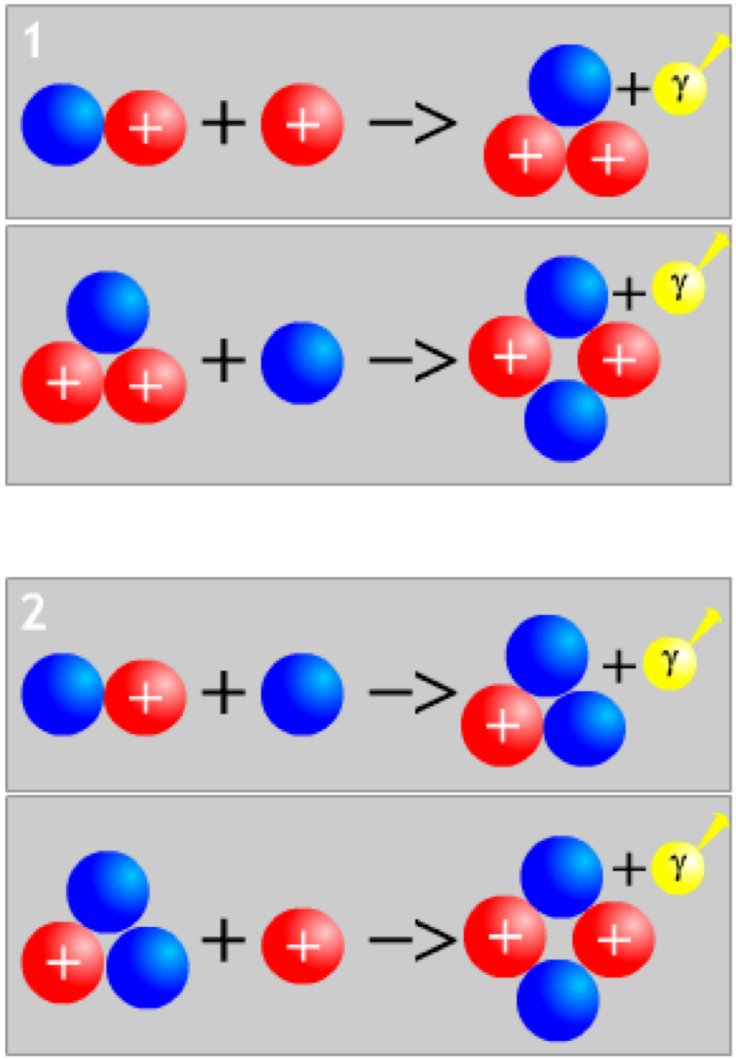
$$n/p = \mathrm{e}^{-(m_n - m_p)/(k_B T)}$$

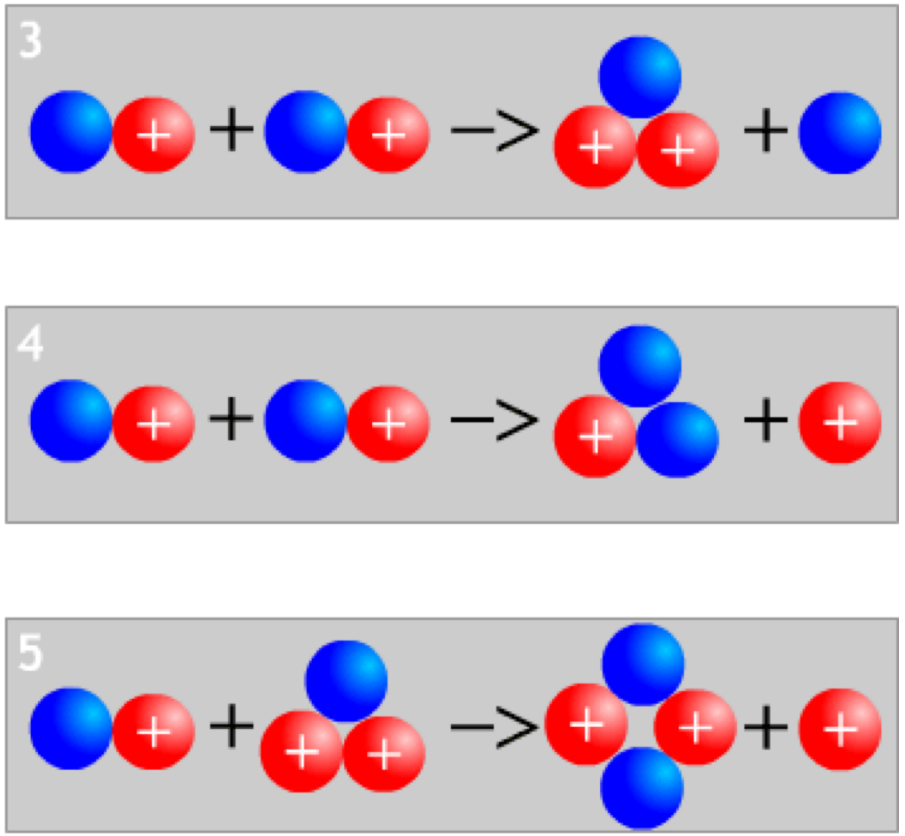
1.3MeV

Evolution of neutrons



Helium production



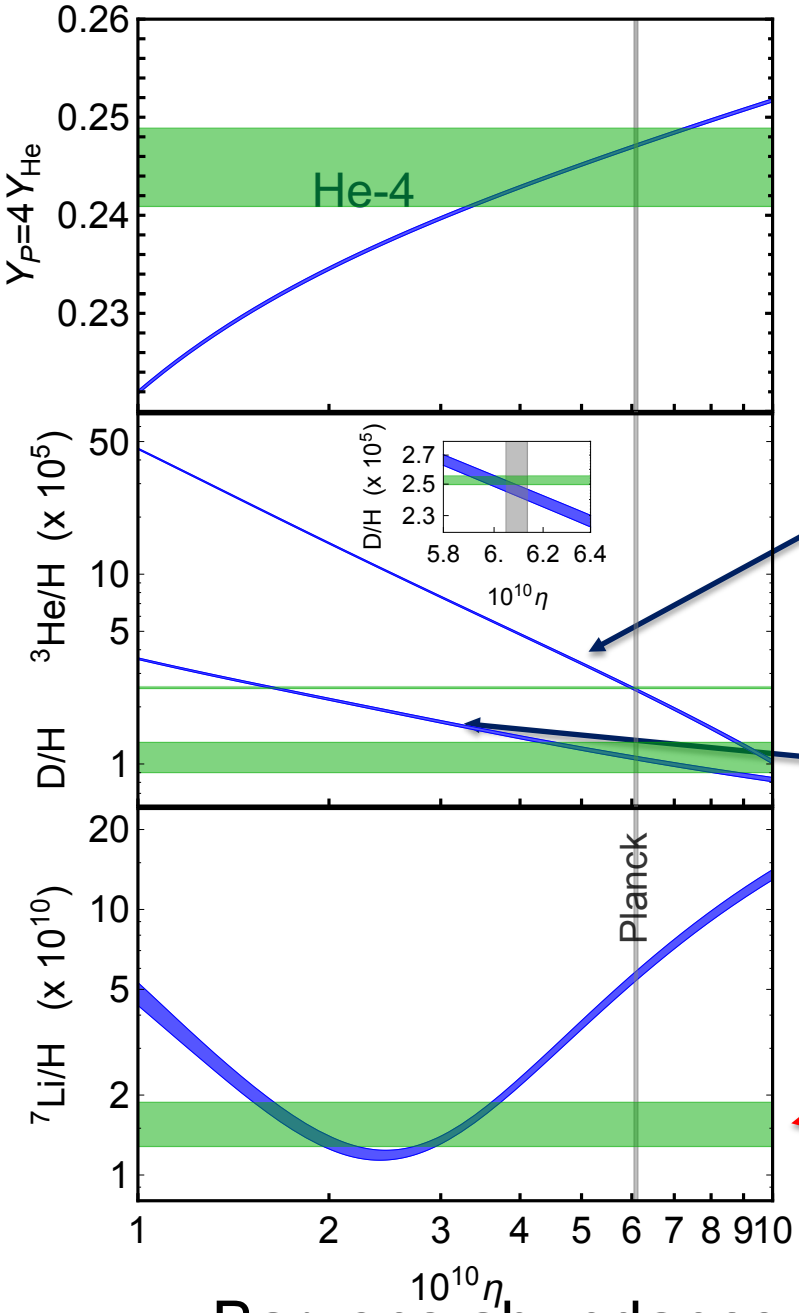


Stolen from E. Vangioni

Initially: 88 protons & 12 neutrons

Final state: 76 protons & 6 Helium

24 % of mass in Helium.



He-4

Deuterium

He-3

Li-7

Lithium problem !

Baryons abundance

Now let us listen to two specialists of BBN :

1) Brian Fields

University of Illinois, USA

2) Carlos Martins

CAUP, Porto, Portugal