The cosmic energy budget: the π-locked inventory is the $\Omega_m = 1/\pi$ crossing, 75 Myr before today

Bands always sum to 1 (flat universe). Only the matter:Λ split evolves; the baryon:dark-matter split is frozen for all time.

scale factor $a = 1/(1+z)$

radial / RG coordinate $r = \ln(E_{\rm GUT}/\mu) = r_{\rm now} + \ln a$ $(r_{\rm now} \simeq 66.6)$

10^{-7} 10^{-5} 10^{-3} 0.1 1 10^{10^3}

density fraction Ω_i $(\sum_i \Omega_i = 1$ always)

eternal (time-independent) ratios

$\frac{\Omega_b}{\Omega_m} = \frac{1}{2\pi} = 0.159$ $\frac{\Omega_{\rm dm}}{\Omega_m} = 1 - \frac{1}{2\pi} = 0.841$ $\frac{\Omega_b}{\Omega_{\rm dm}} = \frac{1}{2\pi - 1} = 0.189$

Baryons

Dark Energy

Dark Matter

Radiation

at the $\Omega_m = 1/\pi$ crossing:

$\Omega_\Lambda = 1 - \frac{1}{\pi} = 0.682$

$\Omega_m = \frac{1}{\pi} = 0.318$

$\Omega_b = \frac{1}{2\pi^2} = 0.0507$

$\Omega_{\rm dm} = \frac{1}{\pi} - \frac{1}{2\pi^2} = 0.268$

$\Omega_m = \frac{1}{\pi} = 0.318$

$\Omega_{\rm dm} = \frac{1}{\pi} - \frac{1}{2\pi^2} = 0.268$

m-r eq. $z = 3400$

recomb. $z = 1090$

accel. $q = 0$ $z = 0.62$

m-Λ eq. $z = 0.29$

$\Omega_m = 1/\pi$ at $t_0 - 75$ Myr

today ($t_0 \approx 13.9$ Gyr)

0.0 0.2 0.4 0.6 0.8 1.0

10^{-7} 10^{-5} 10^{-3} 10^{-1} 10^{1}

cosmic time t [billion years]

The same evolution in linear cosmic time: the matter → Λ handover, drawn gradually

scale factor $a = 1/(1+z)$

radial / RG coordinate $r = r_{\rm now} + \ln a$ $(r_{\rm now} \simeq 66.6)$

0.1 0.2 0.3 0.5 0.7 1 1.4

density fraction Ω_i $(\sum_i \Omega_i = 1$ always)

Radiation

Baryons

Dark Energy

Dark Matter

zoom: crossing vs. today (75 Myr apart; blur ±160 Myr)

$\Omega_m = 1/\pi$ $t_0 - 75$ Myr

today $\Omega_m = 0.315$

0.330 0.325 0.320 0.315 0.310

13.4 13.6 13.8 14.0 14.2 14.4 14.6

accel. $q = 0$ $z = 0.62$

m-Λ eq. $z = 0.29$

$\Omega_m = \frac{1}{\pi} = 0.318$

$\Omega_{\rm dm} = \frac{1}{\pi} - \frac{1}{2\pi^2} = 0.268$

0.0 0.2 0.4 0.6 0.8 1.0

0.0 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0

cosmic time t [billion years]

Radiation $\Omega_r \propto a^{-4}$ Dark Matter $\Omega_{\rm dm} \propto a^{-3}$ Baryons $\Omega_b \propto a^{-3}$ Dark Energy $\Omega_\Lambda =$ const