Cosmology physics

Cosmology :

Description of the composition, evolution, and nature of the *Universe*.

Standard Model :

Big-Bang theory.

Cosmology principle

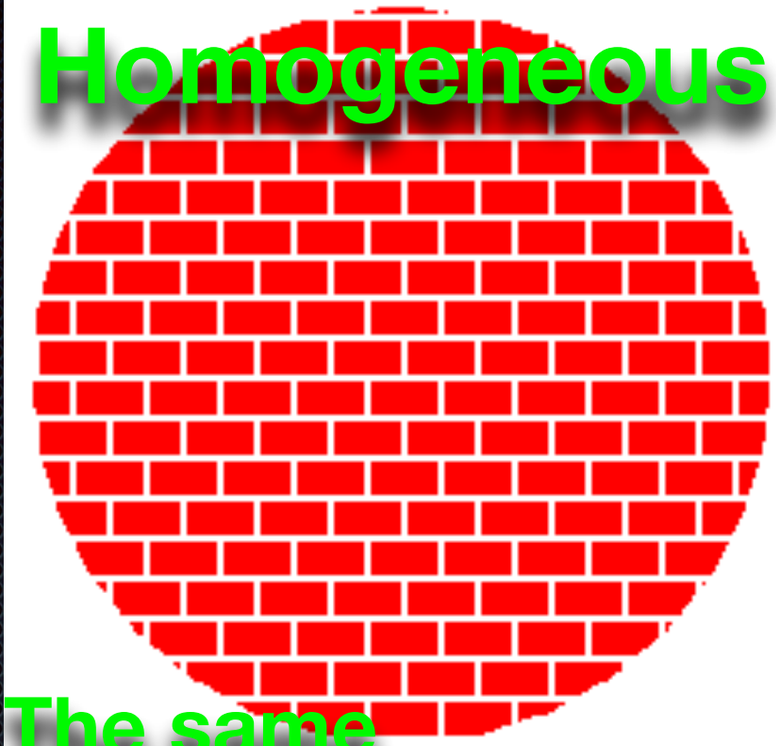
Cosmology principle

Homogeneous

The same everywhere

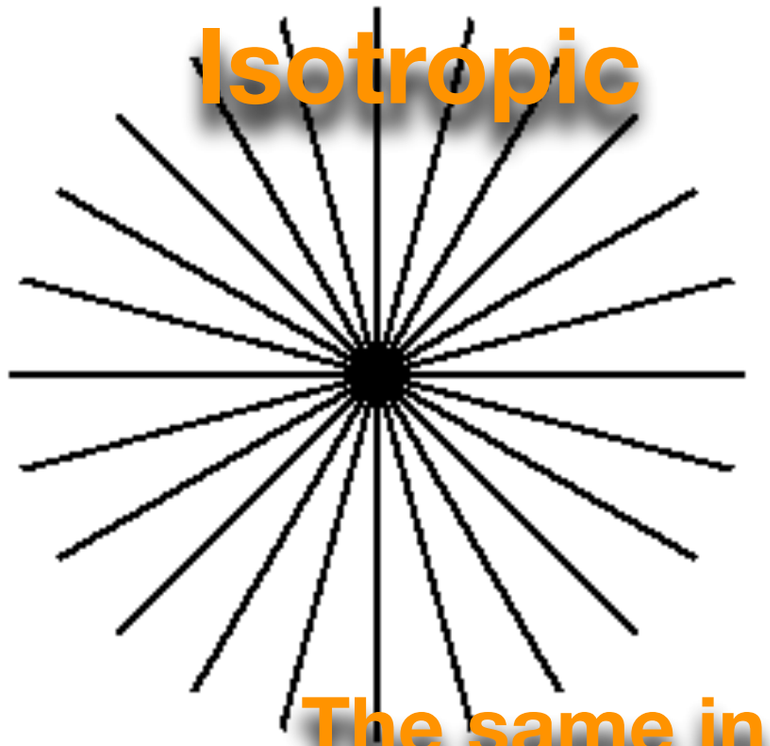
Cosmology principle

Homogeneous



The same everywhere

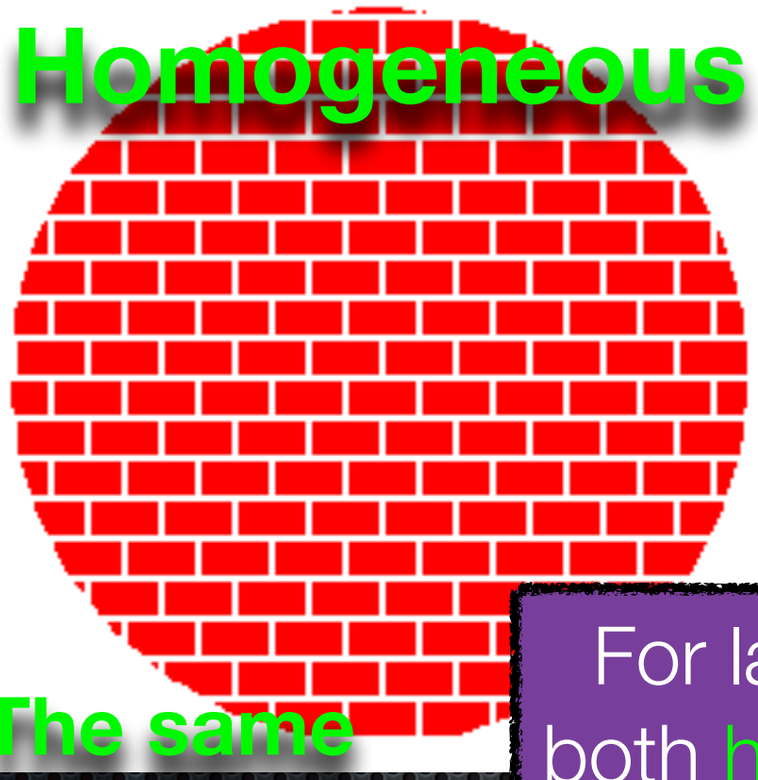
Isotropic



The same in every direction

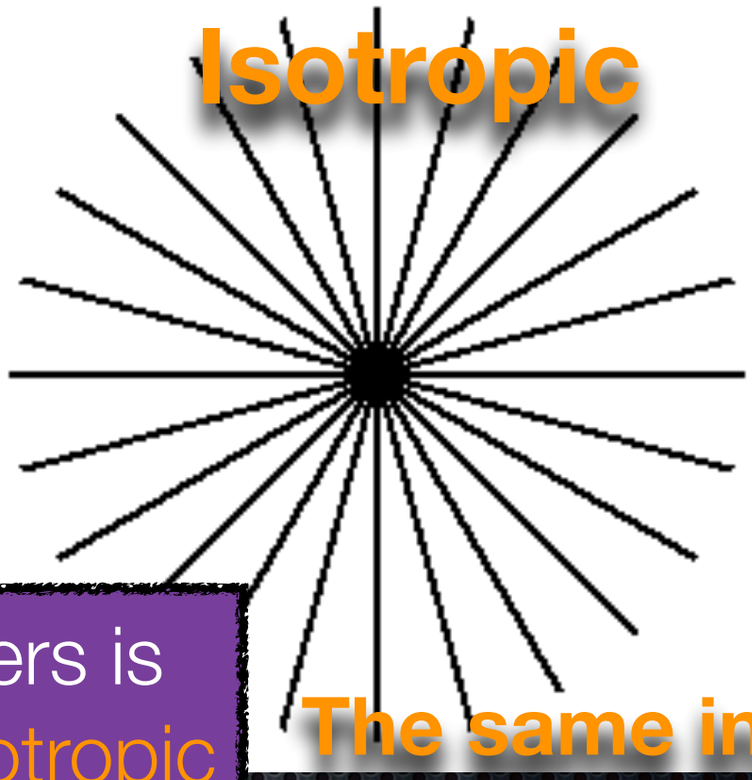
Cosmology principle

Homogeneous



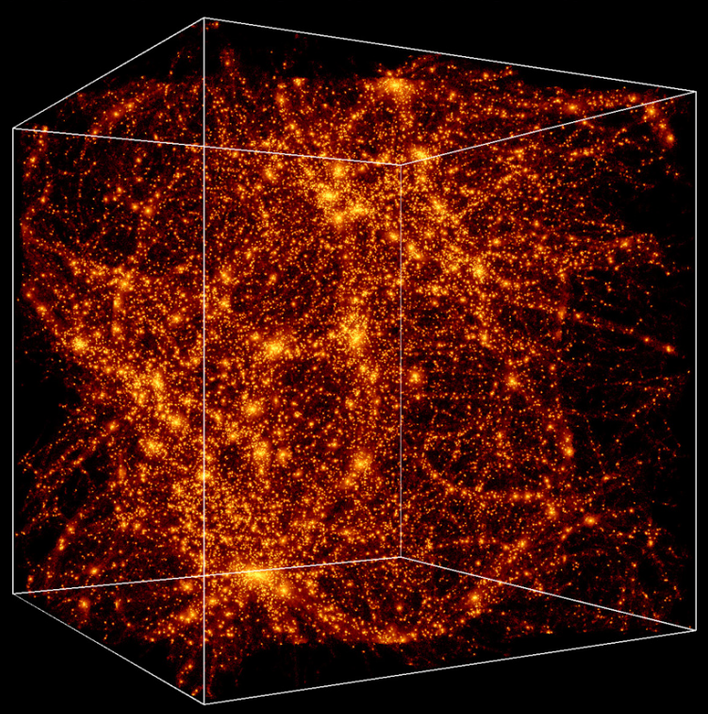
The same everywhere

Isotropic



The same in every direction

For large scales, our univers is both homogeneous and isotropic

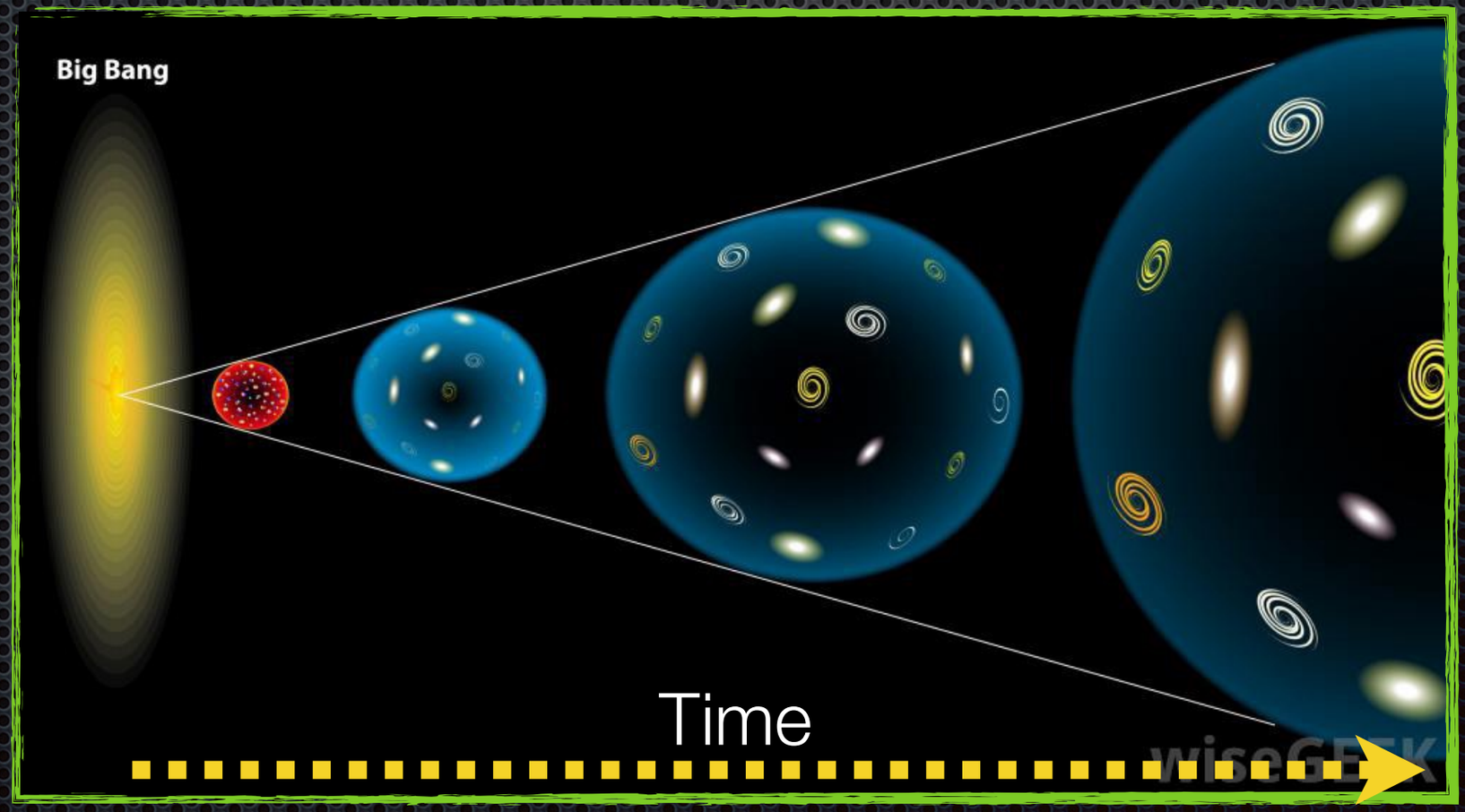


Big-Bang theory

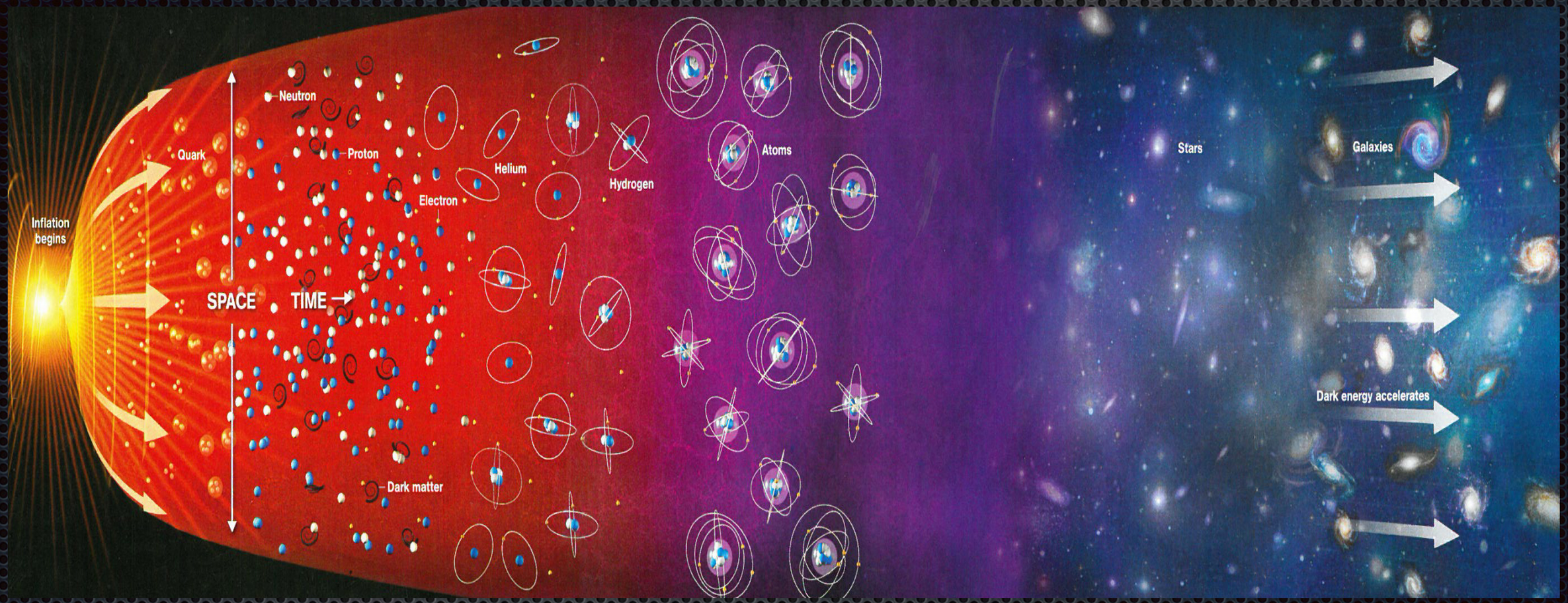
Geometric + force description :
General relativity

+

- 3 Pillars :
  1. Universe **expansion**
  2. Primordial **nucleosynthesis**
  3. **Cosmic Microwave Background**

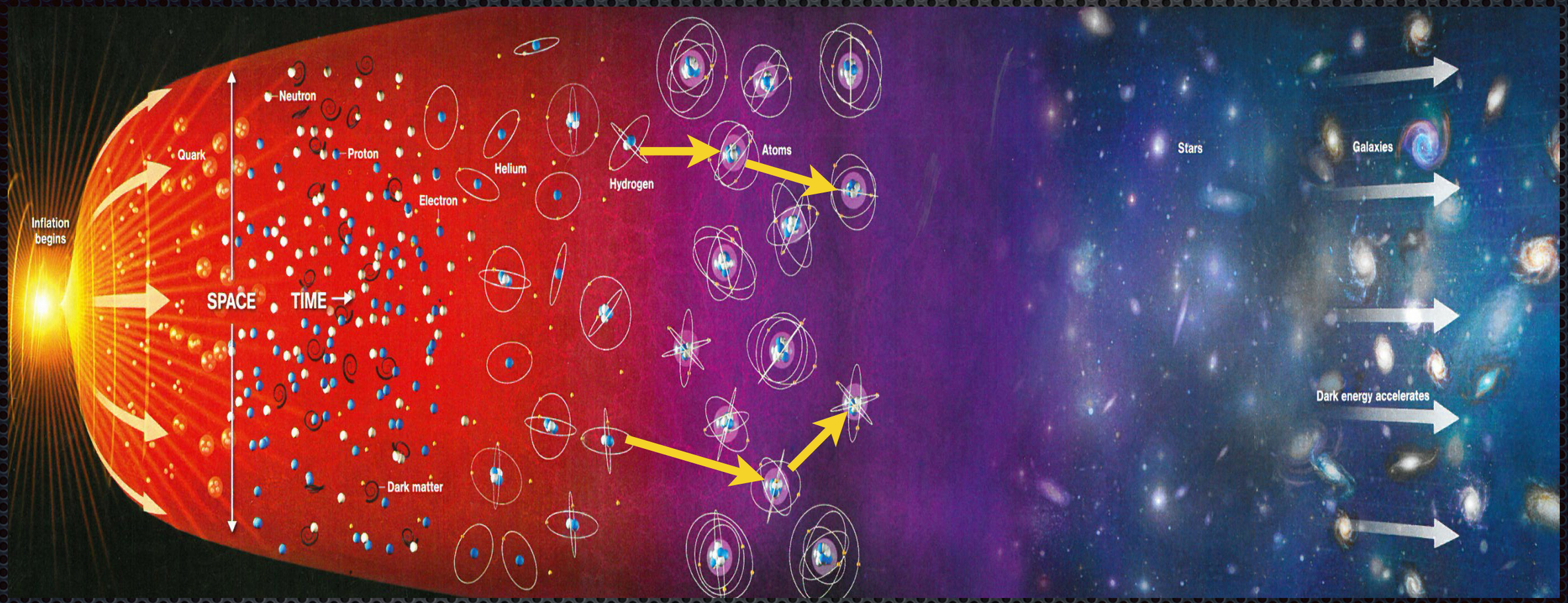


Universe history



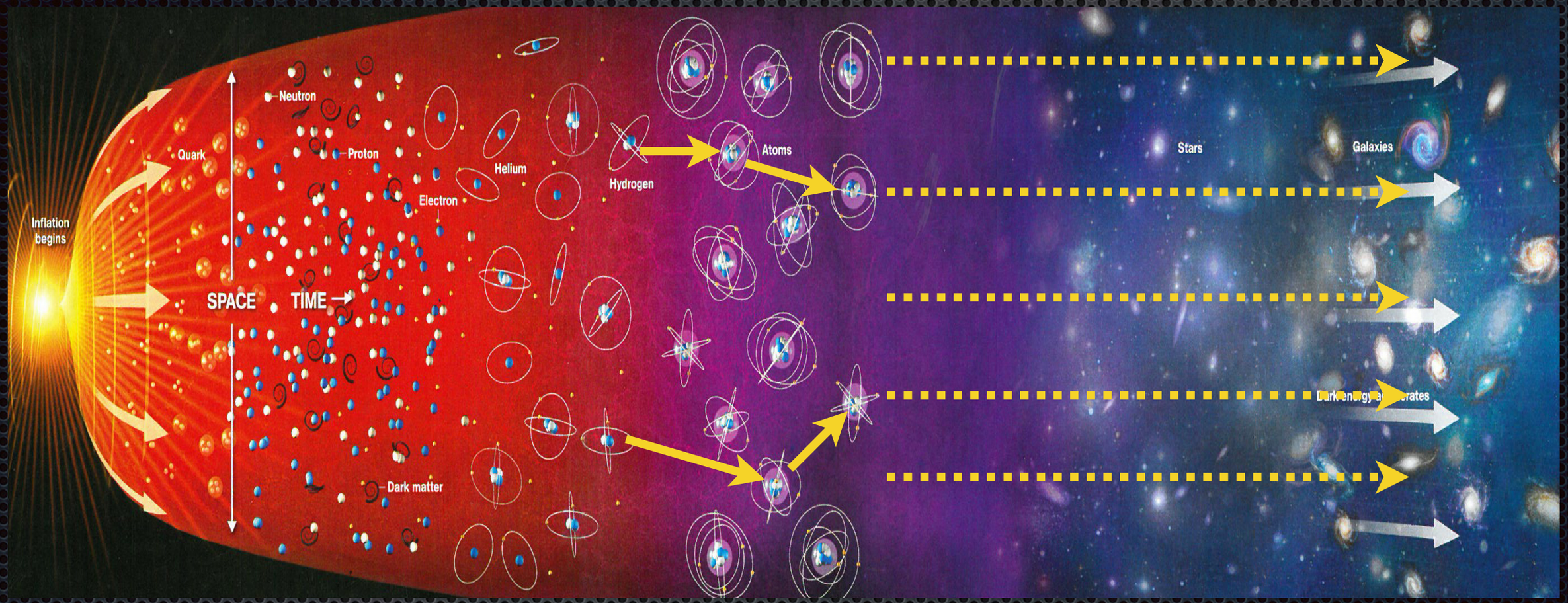
Time

Universe history



Time

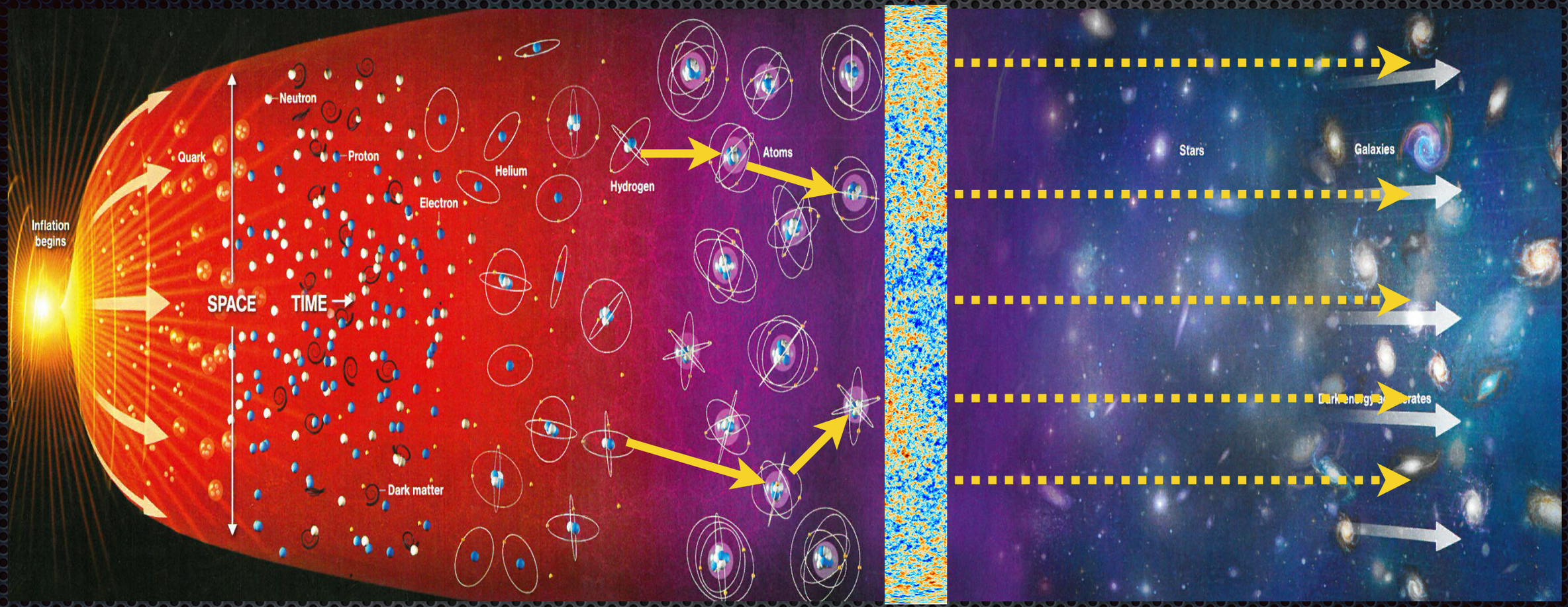
Universe history



Time

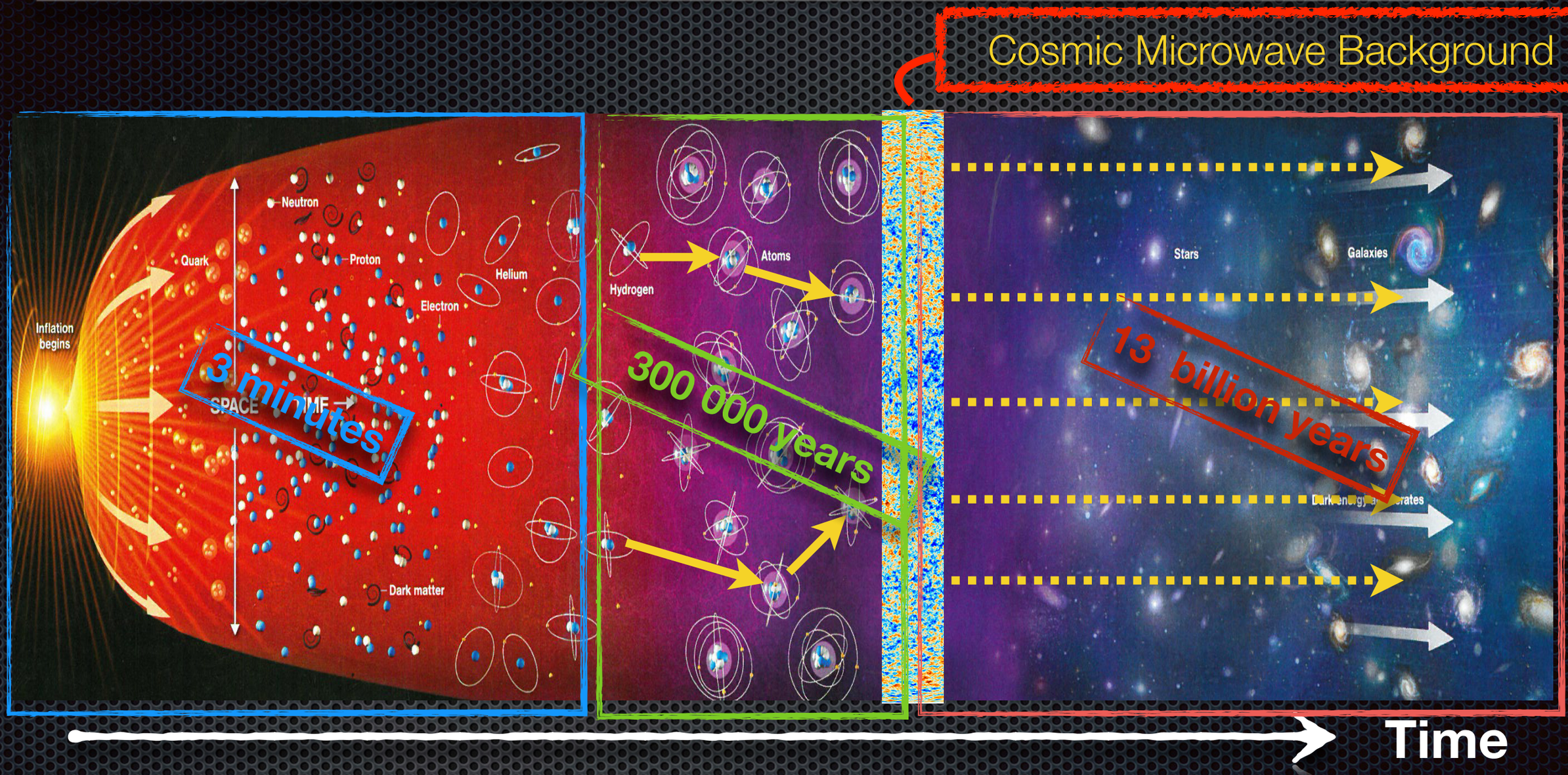
Universe history

Cosmic Microwave Background



Time

Universe history



Anisotropies of the CMB

At first order, **Photons** from the CMB have the **same temperature of 2.7 K.**

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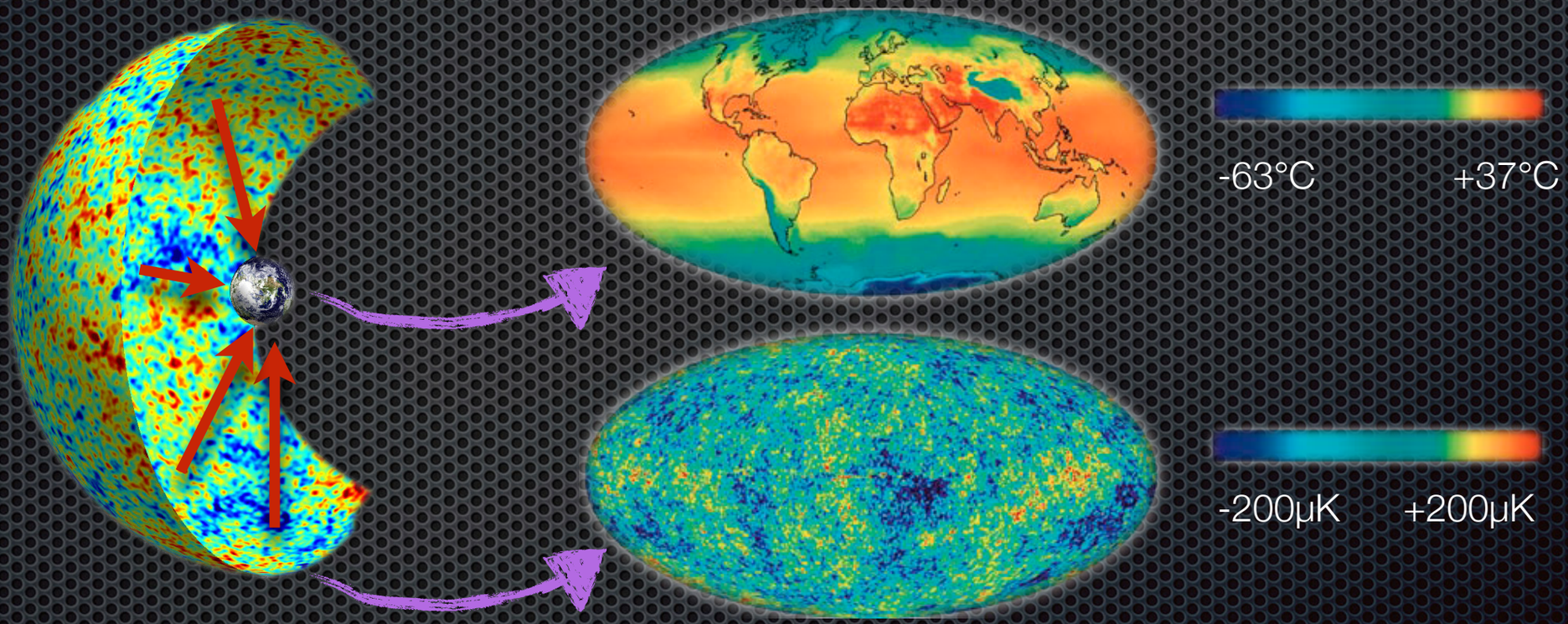
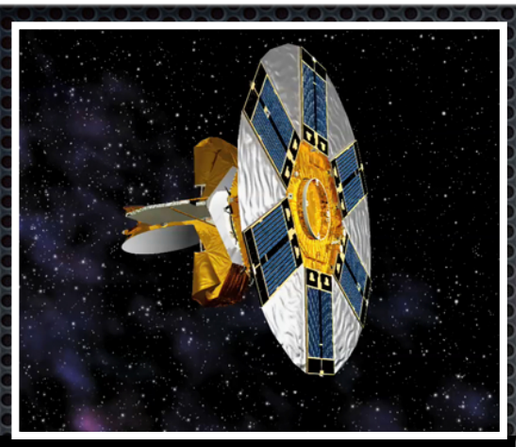
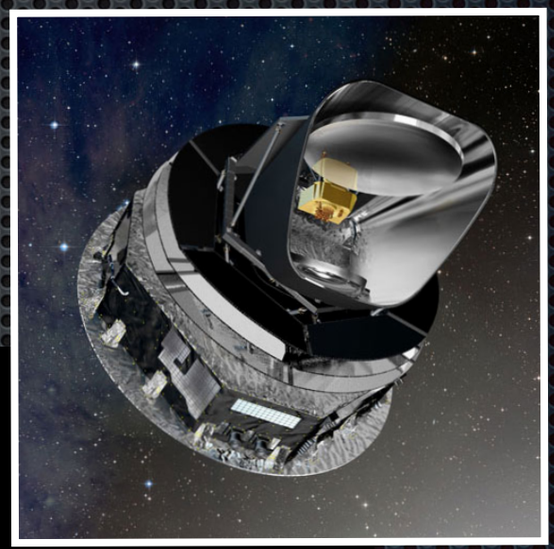
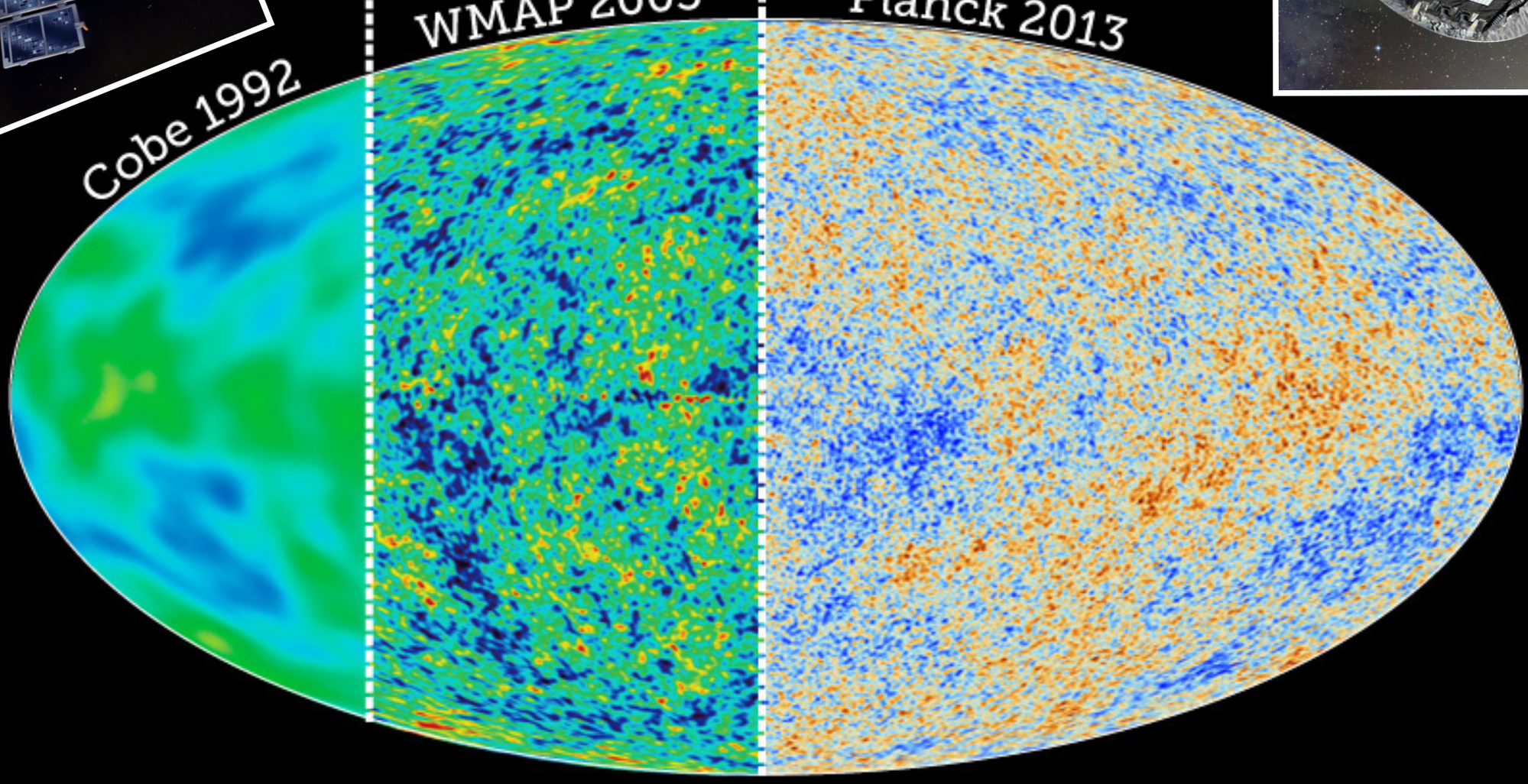


Those anisotropies reflect the **statistical distribution** of matter in early Universe.

CMB experiments





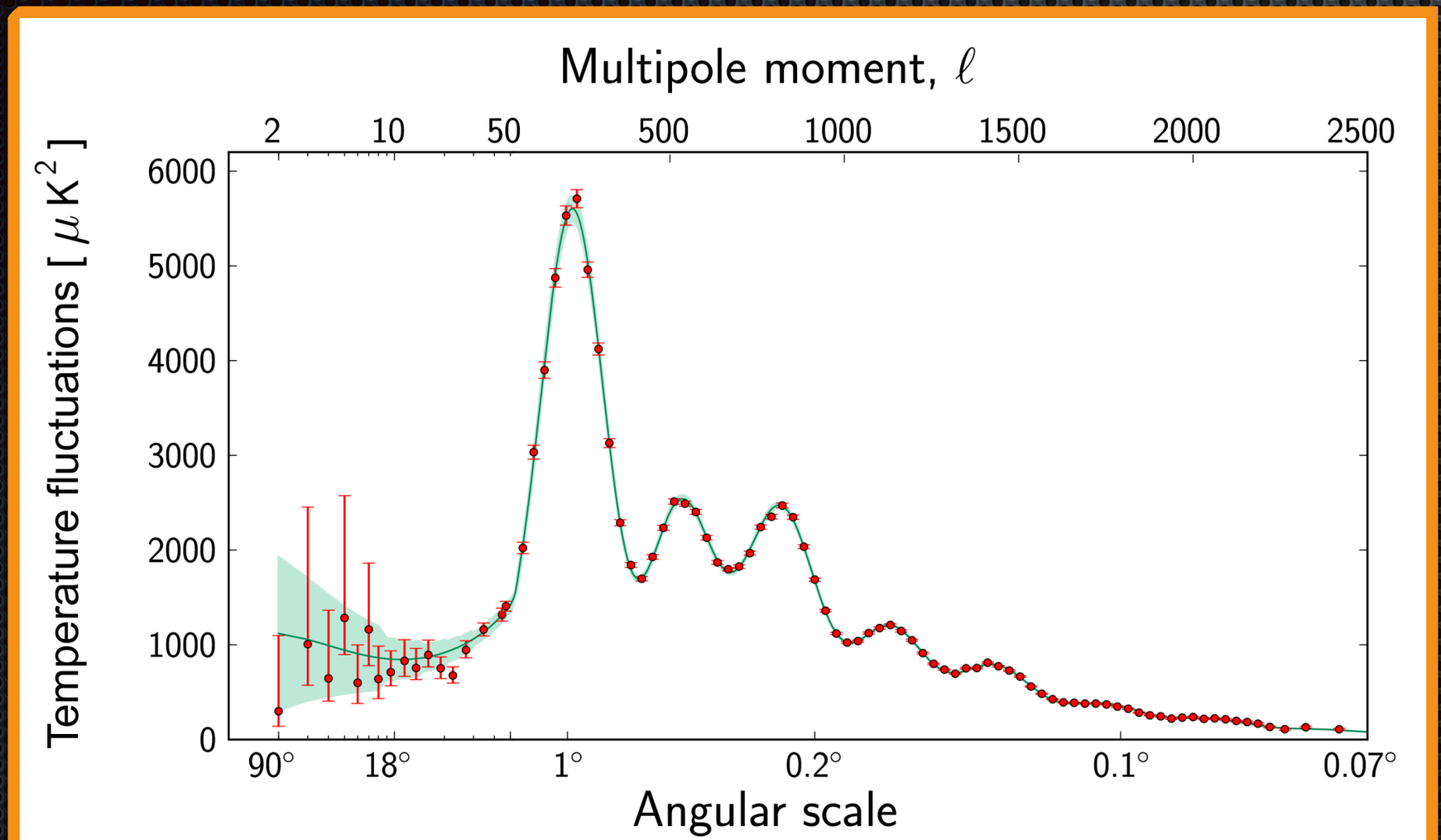


Cosmological Standard Model

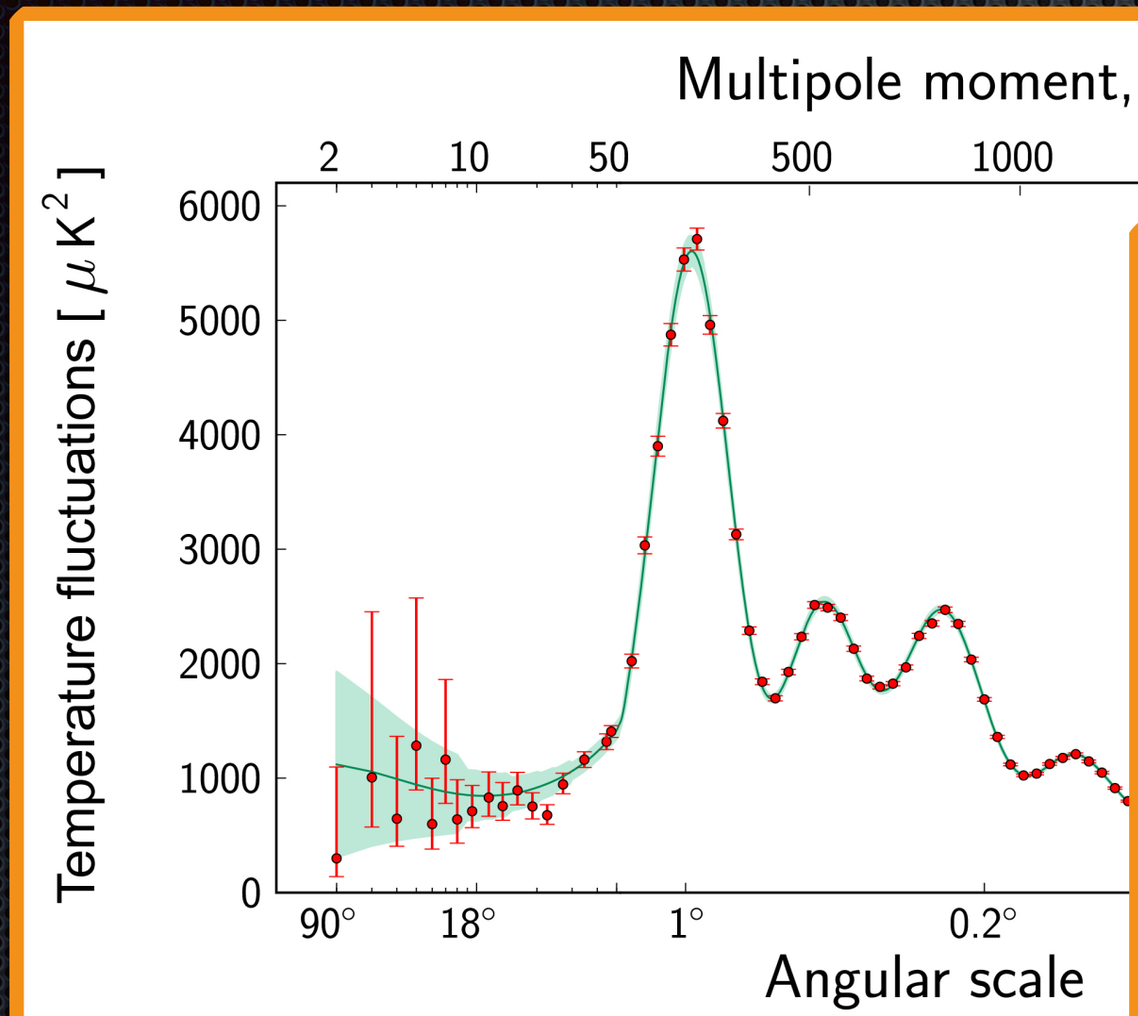
The standard cosmological model contains **6 main free parameters.**
Those can be constrained by the temperature anisotropies of the **CMB**.

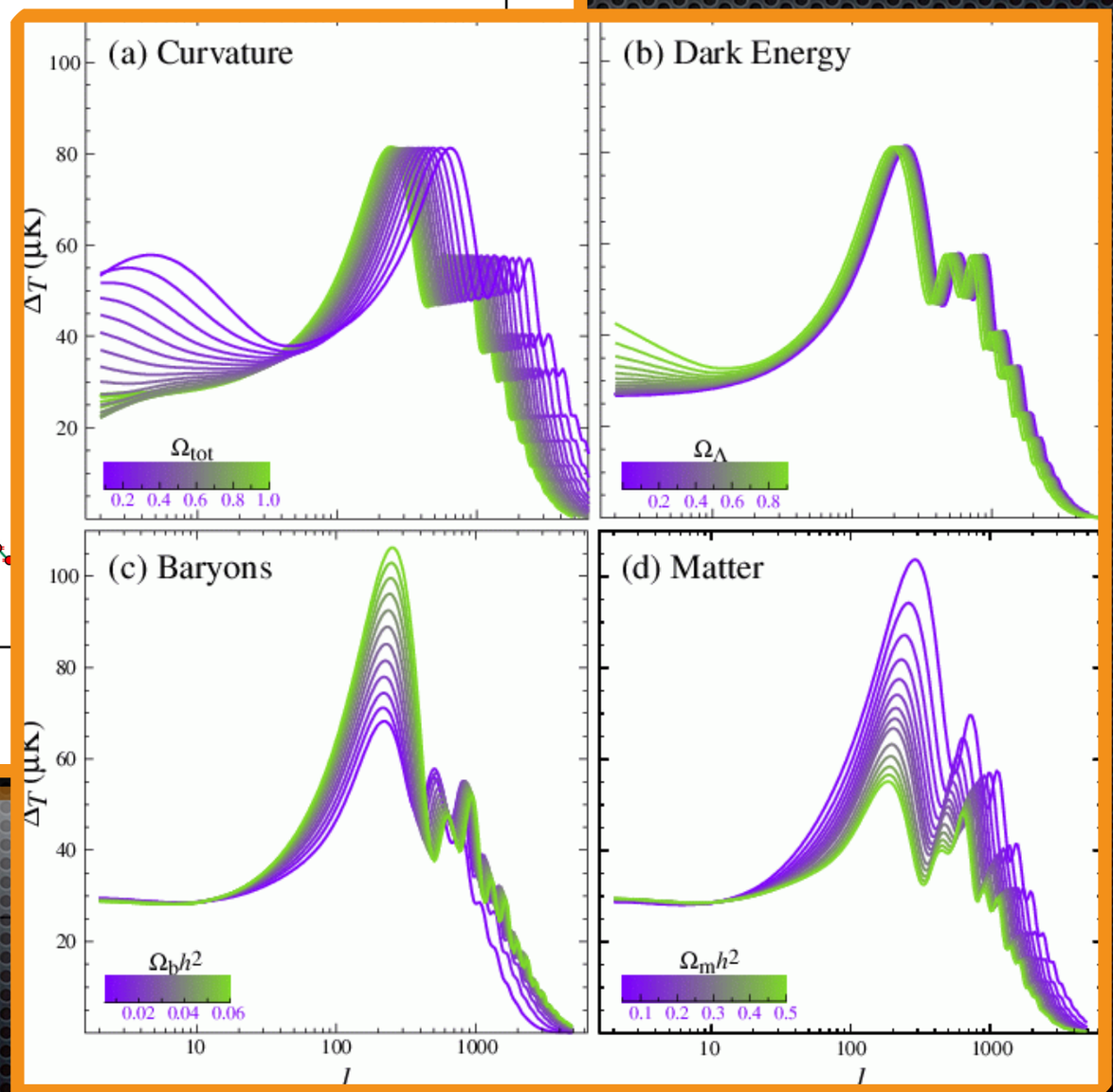
$\Omega_b h^2$	Baryons density
$\Omega_c h^2$	Cold dark-matter density
H_0	Curent expansion rate
τ	Ionization optical depth
n_s	Scalar spectral index
$10^9 A_s$	Primordial scalar amplitude

Anisotropies distribution



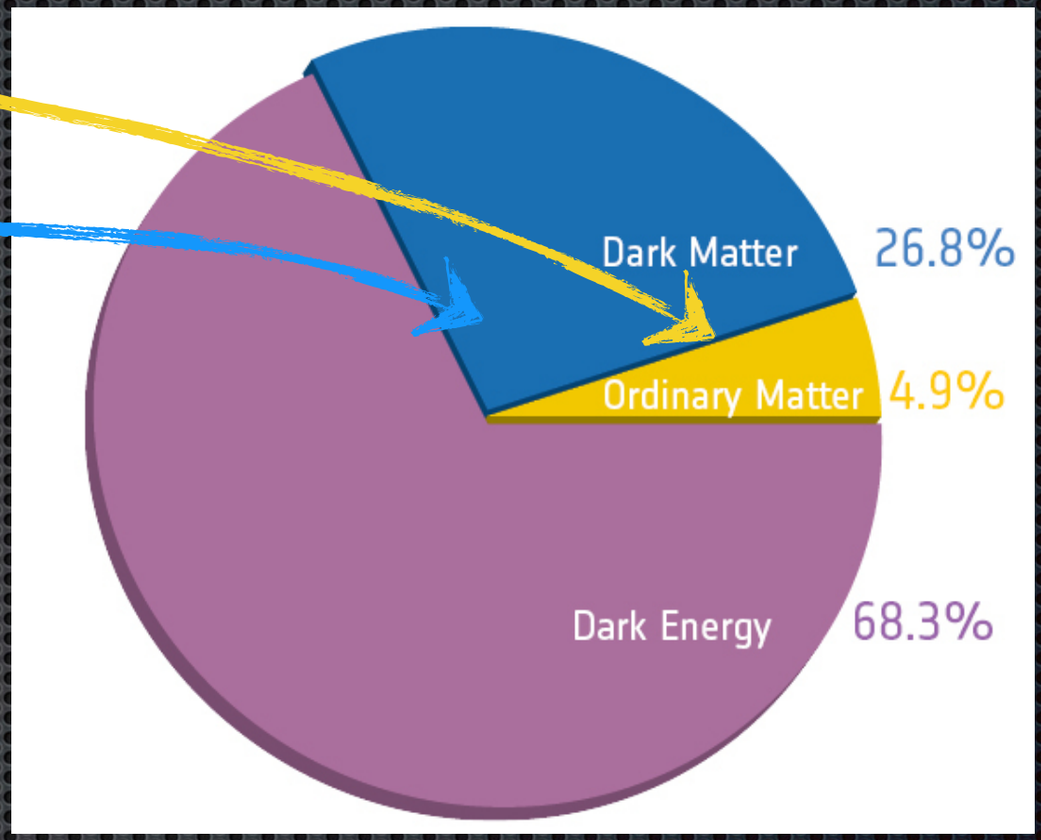
Anisotropies distribution





Parameters measurements

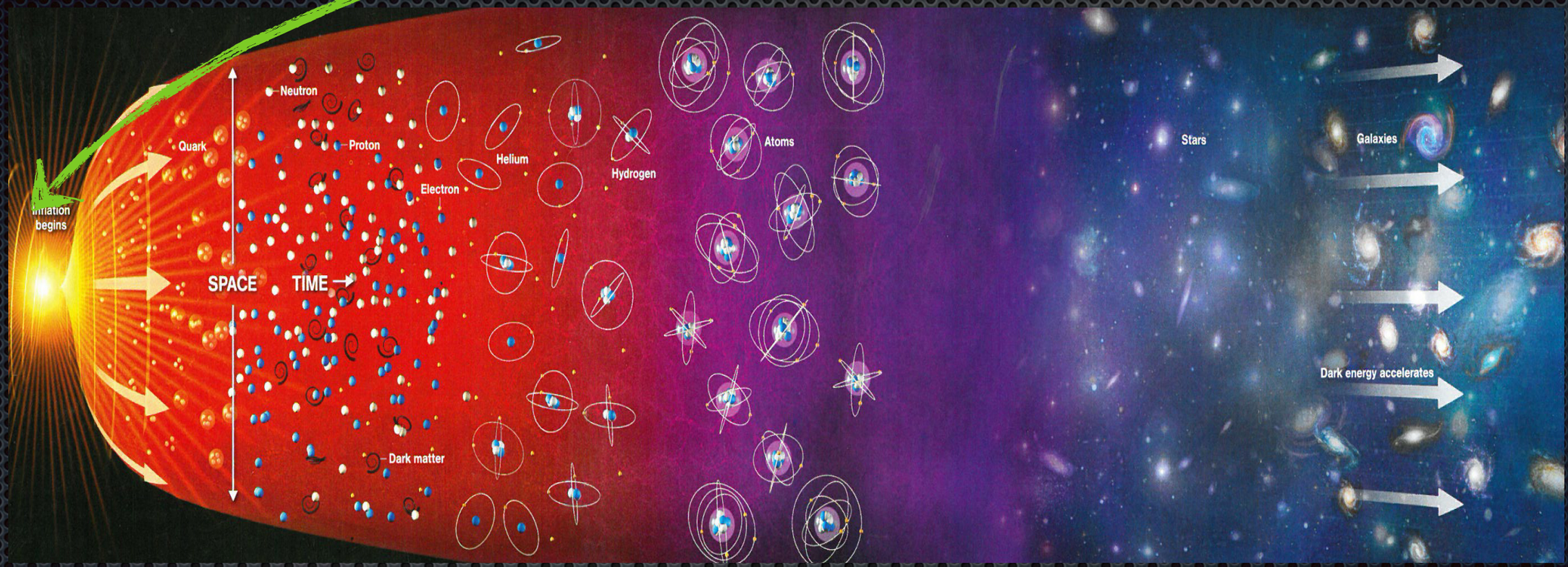
$\Omega_b h^2$	0.02205 ± 0.00028
$\Omega_c h^2$	0.1199 ± 0.0027
H_0	67.3 ± 1.2
τ	0.089 ± 0.014
n_s	0.960 ± 0.007
$10^9 A_s$	2.196 ± 0.06



The Standard Model works super fine !

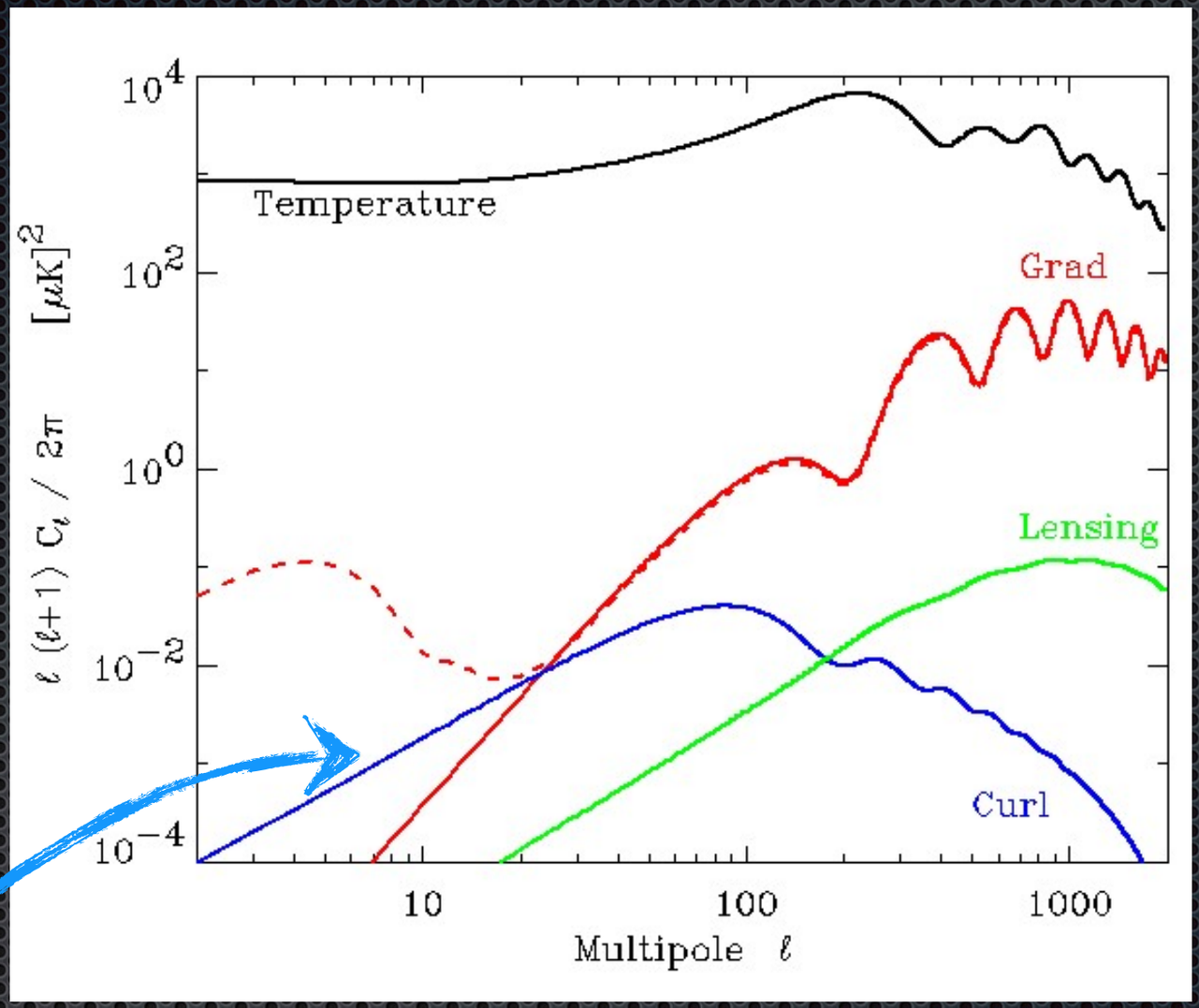
Beyond the SM…

Precise measurements of the CMB polarisation could inform us about an epoch *before Big-Bang*, named **Inflation**.



Inflation is a period of time (**10^{-33}** s after BB) during which the Universe expanded by a factor of **10^{26}** .

Beyond the SM…



Curl (or BB) spectrum is currently the best way to measure the inflation energy.
The signal almost 1000 time weaker than temperature.