

Cosmologie Primordiale

Patrick Peter

Institut d'Astrophysique de Paris



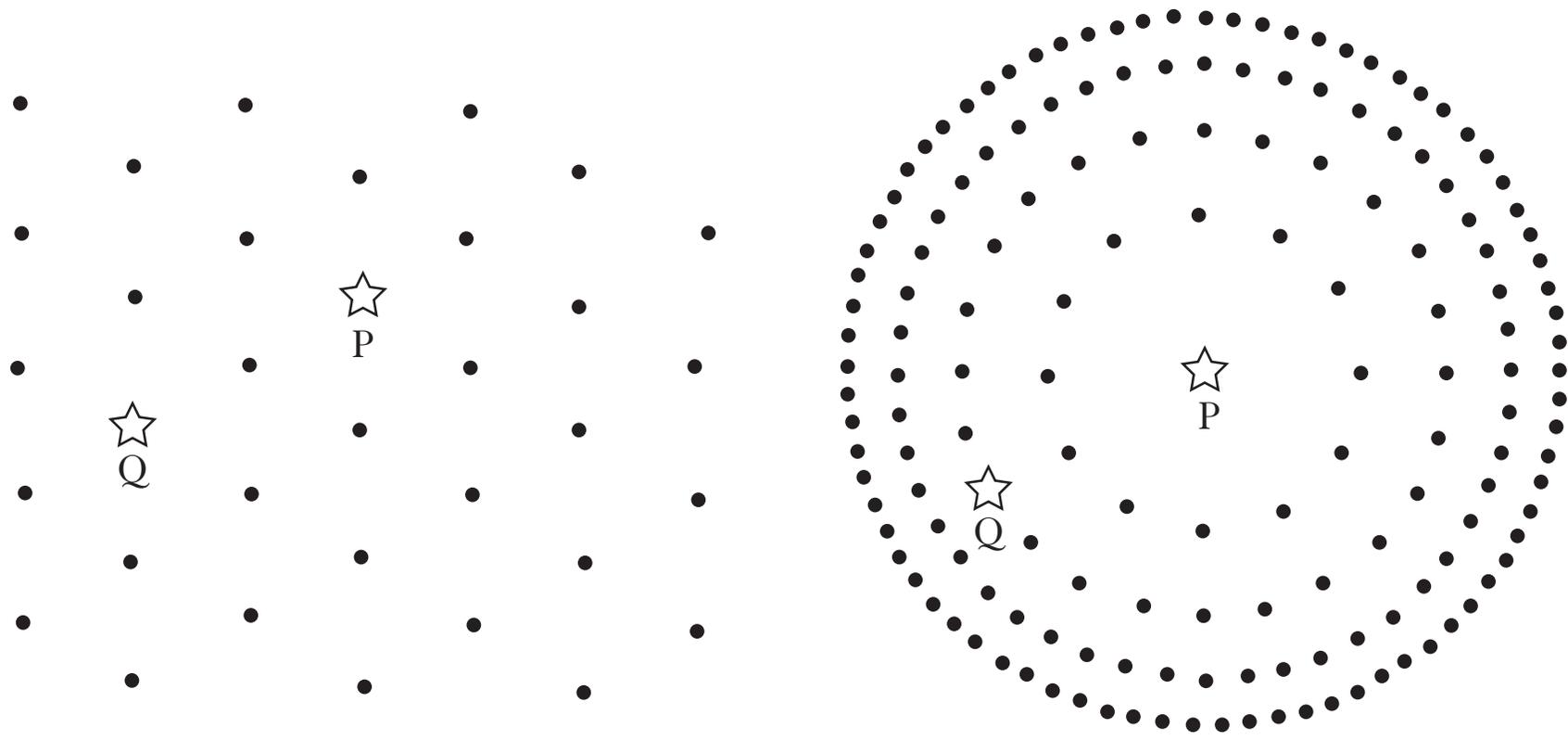
**Paris-Sud
1^{er} décembre 2009**

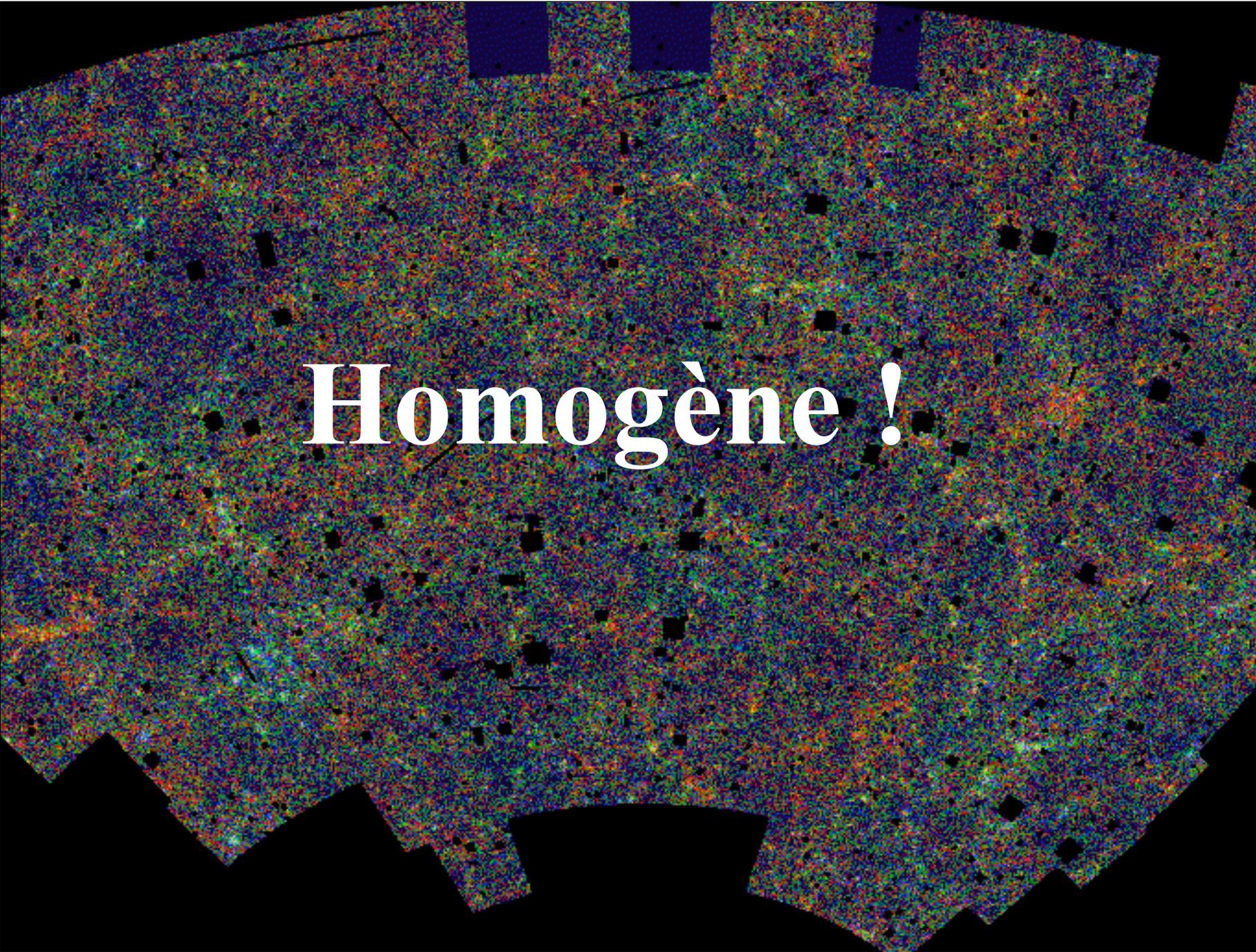


Carte du ciel à haute résolution



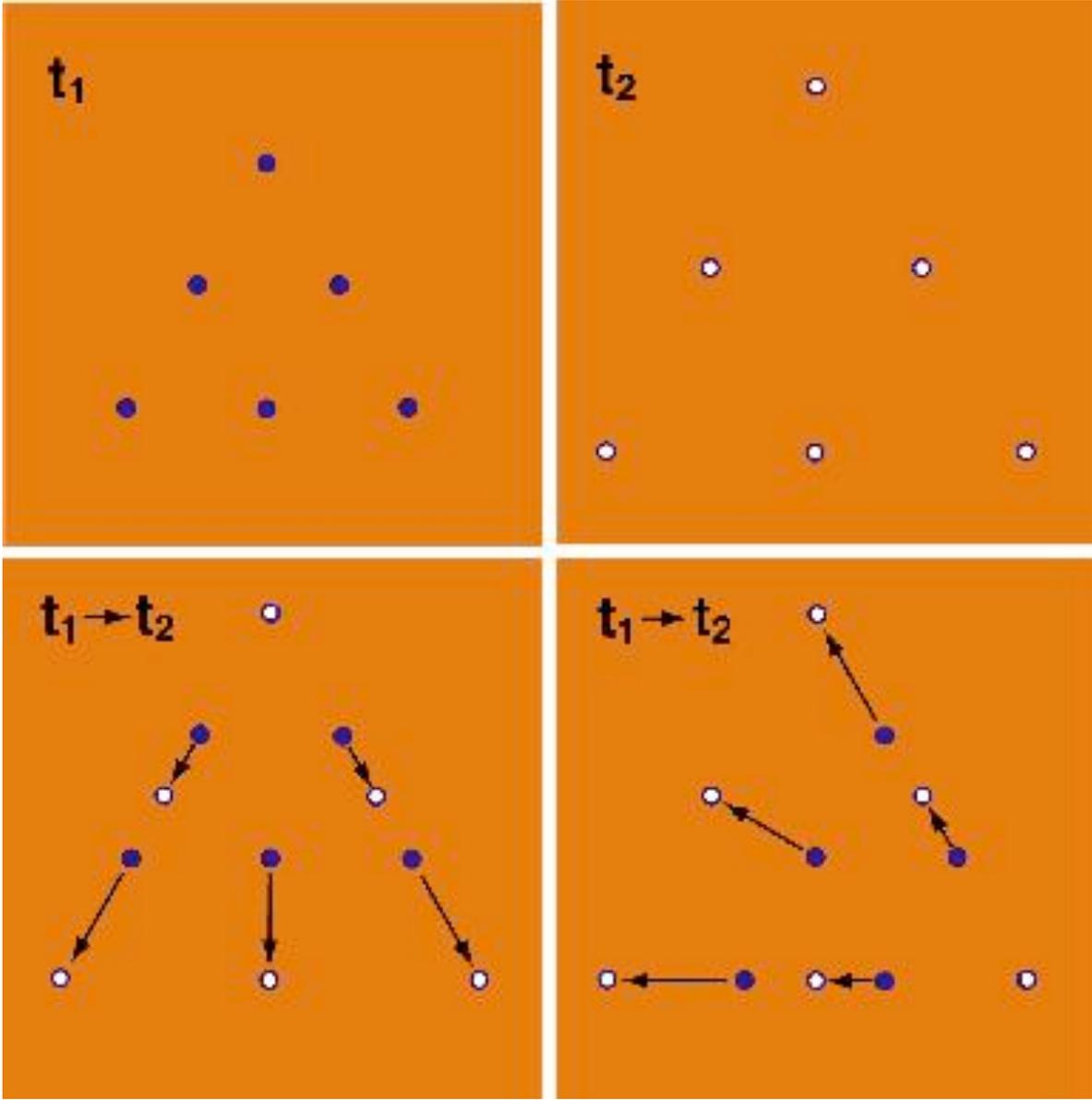
Isotrope !





Homogène !

Isotropie
+
Homogénéité
+
Relativité générale d'Einstein
=
Expansion de l'Univers



Techniquement ...

Métrie homogène & isotrope (FLRW):

$$ds^2 = -dt^2 + a^2(t) \left[\frac{dr^2}{1 - \mathcal{K}r^2} + r^2 (d\theta^2 + \sin^2 \theta d\phi^2) \right]$$

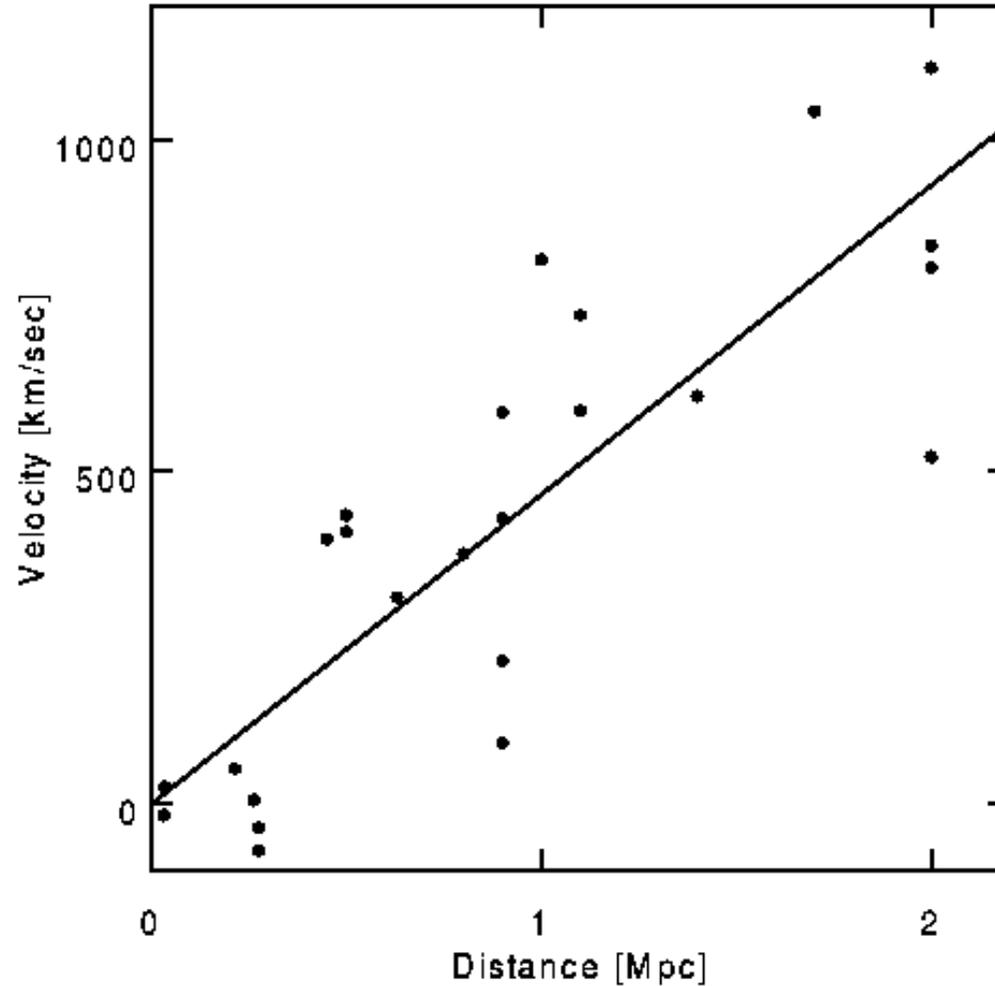
Matière = fluide parfait $T_{\mu\nu} = pg_{\mu\nu} + (\rho + p)u_\mu u_\nu$

$$p = \omega\rho \quad \left\{ \begin{array}{ll} \omega = 0 & \text{poussière} \\ \omega = \frac{1}{3} & \text{radiation} \end{array} \right.$$

+ cosmological constant = équations d'Einstein

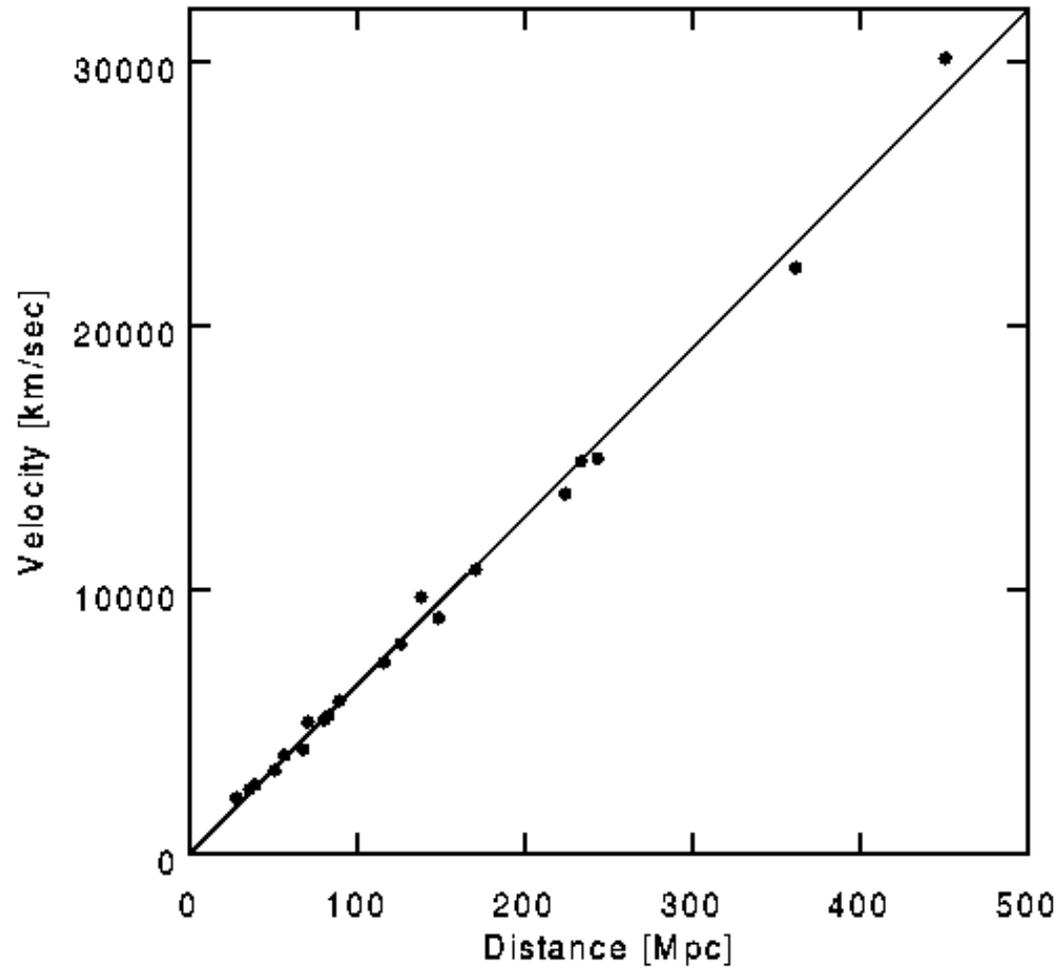
$$\frac{\ddot{a}}{a} = \frac{1}{3} [\Lambda - 4\pi G_N (\rho + p)] \qquad H^2 + \frac{\mathcal{K}}{a^2} = \frac{1}{3} (8\pi G_N \rho + \Lambda)$$

Hubble 1929

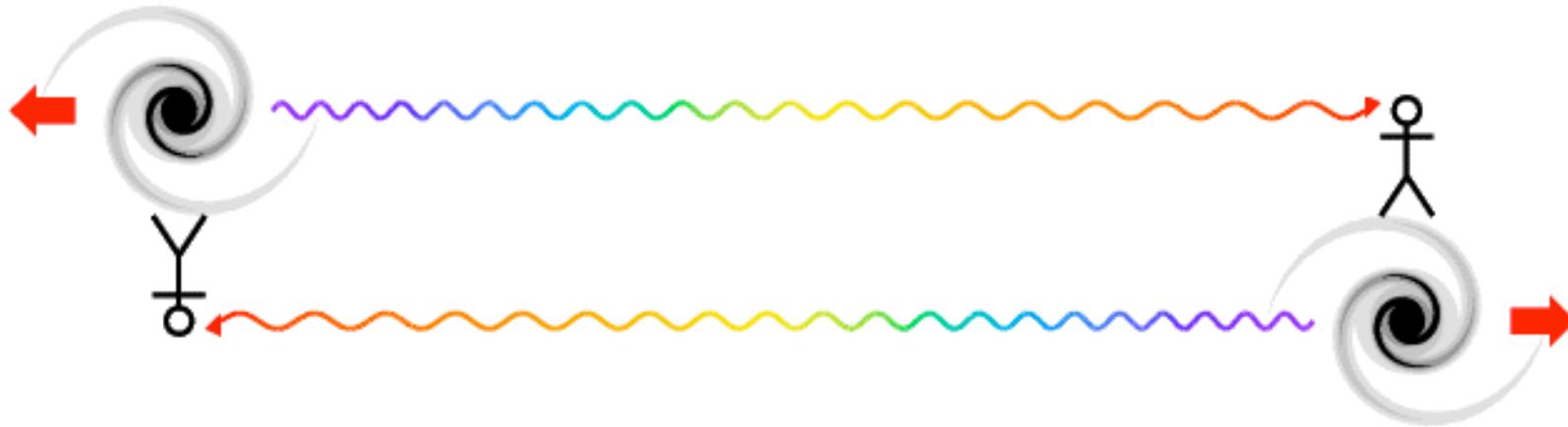


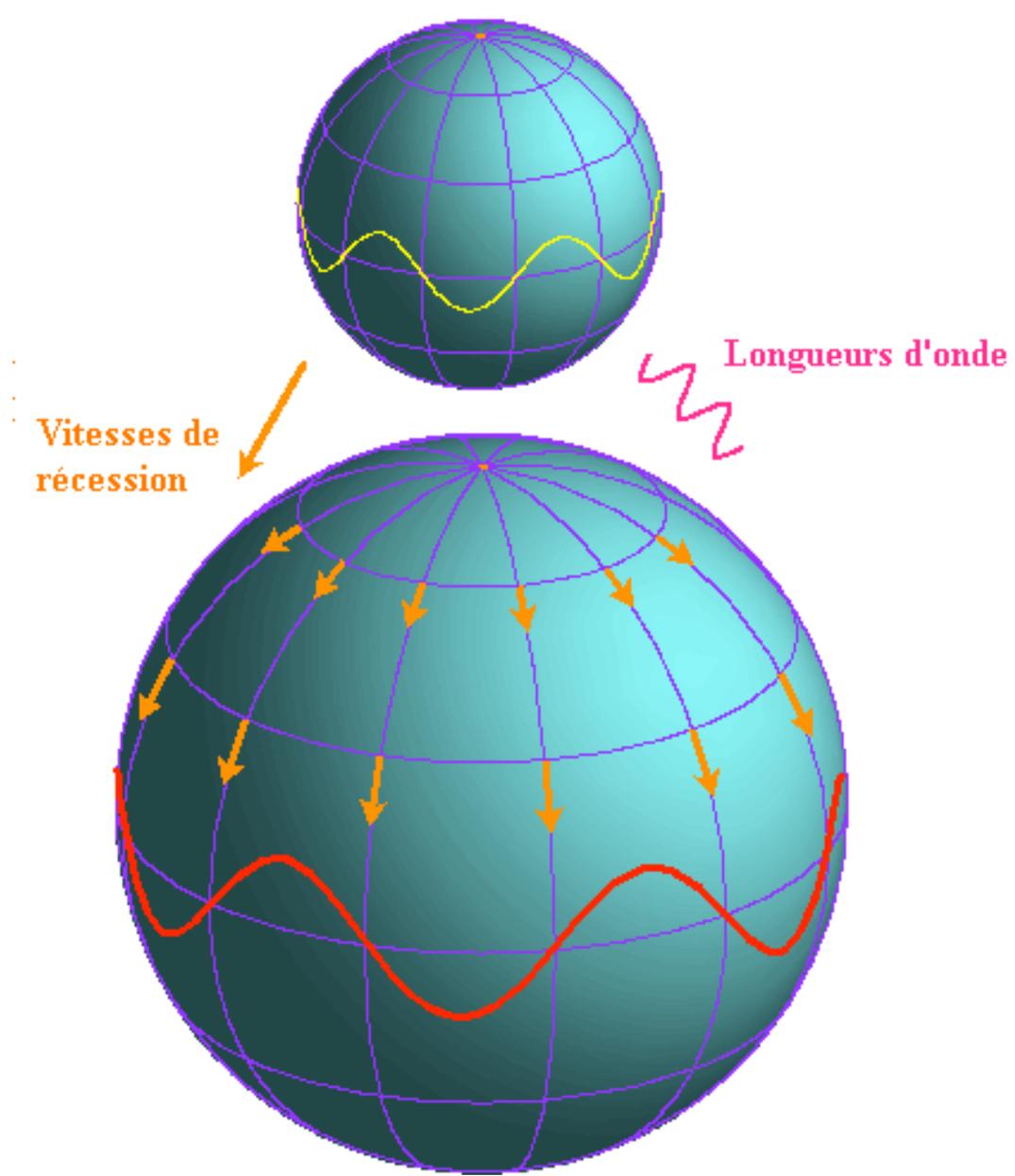
$$Vitesse = H \times Distance$$

Riess, Press et Kirshner (1996)

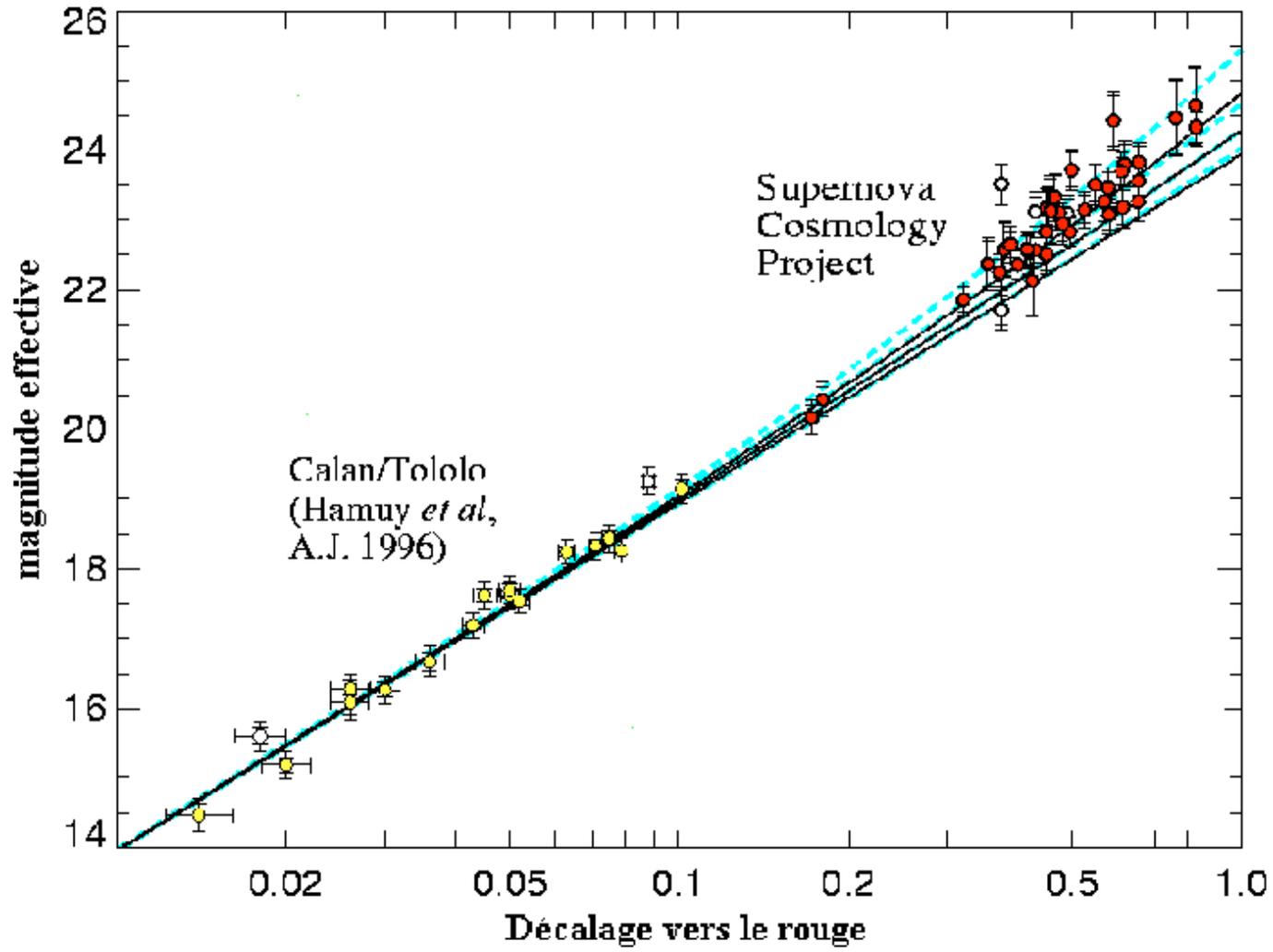


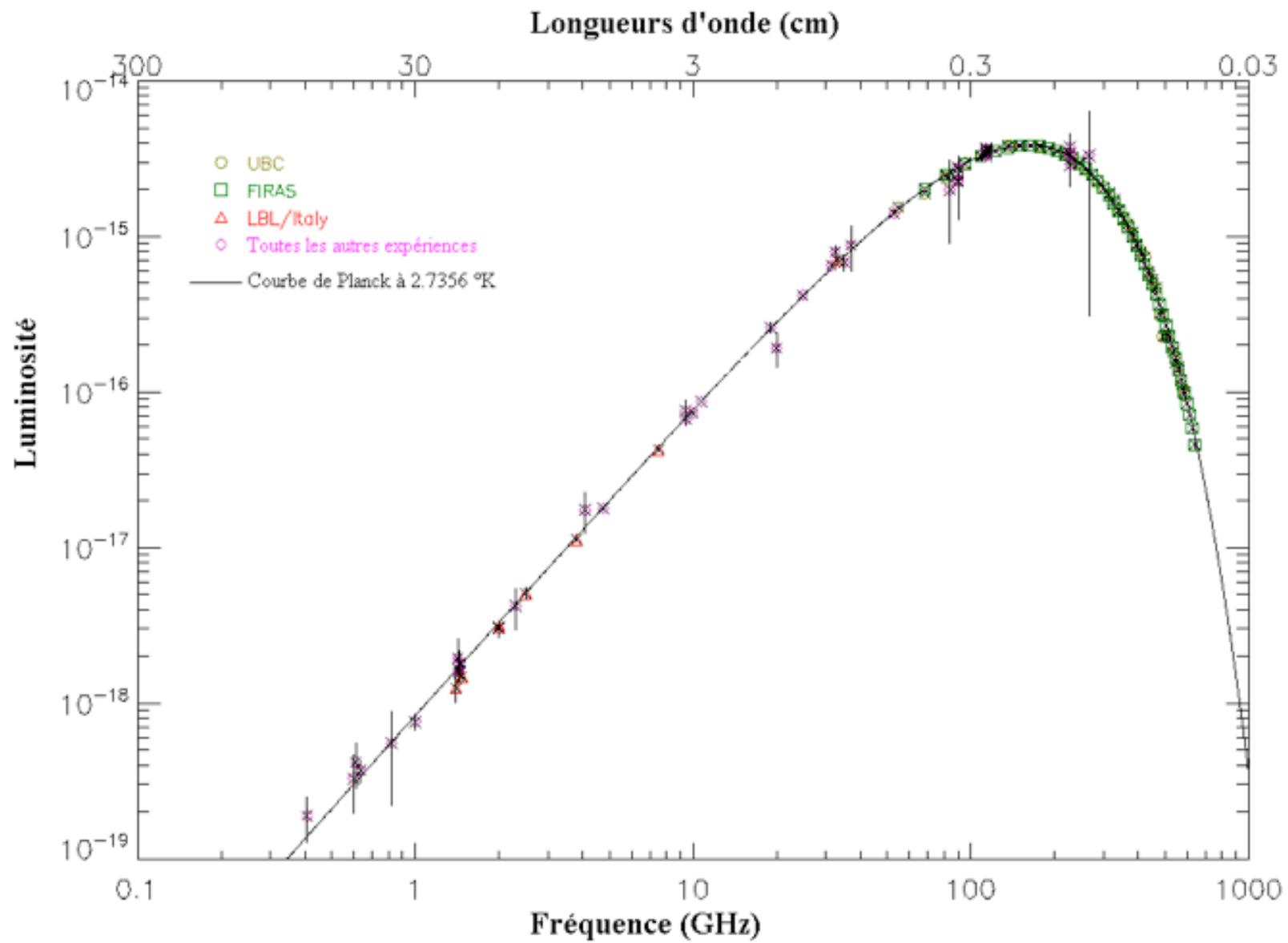
Le rougissement gravitationnel de l'expansion

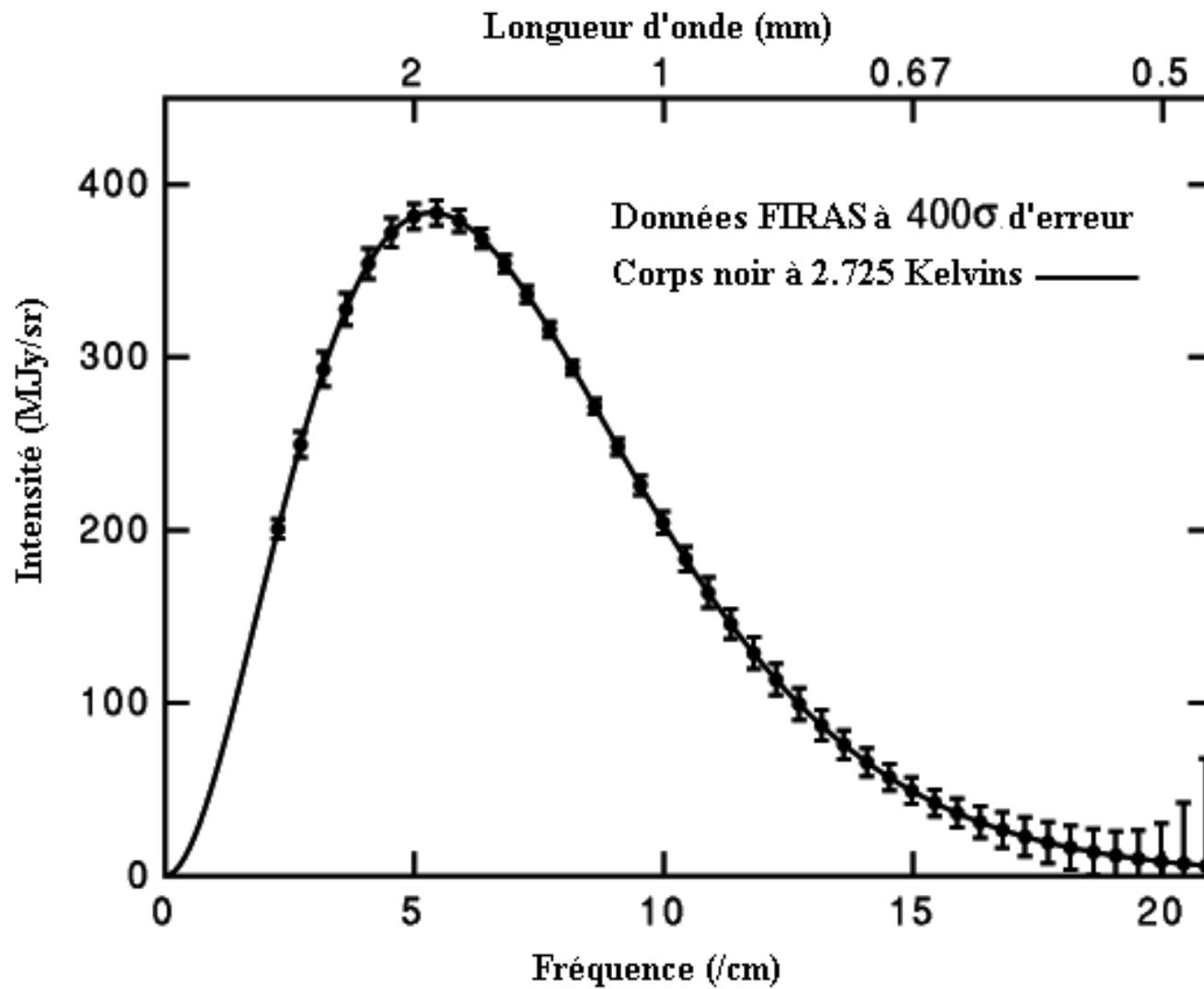


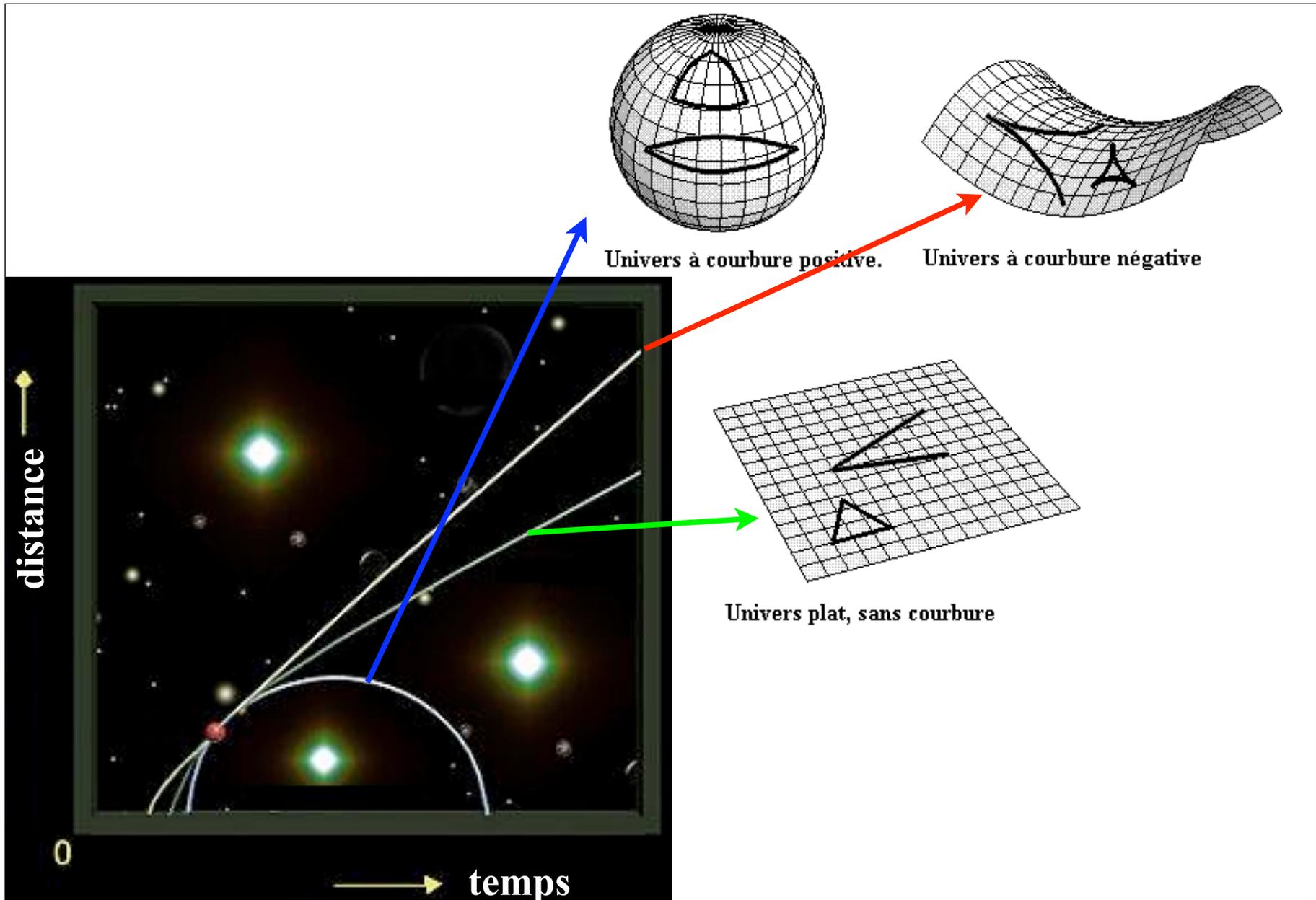


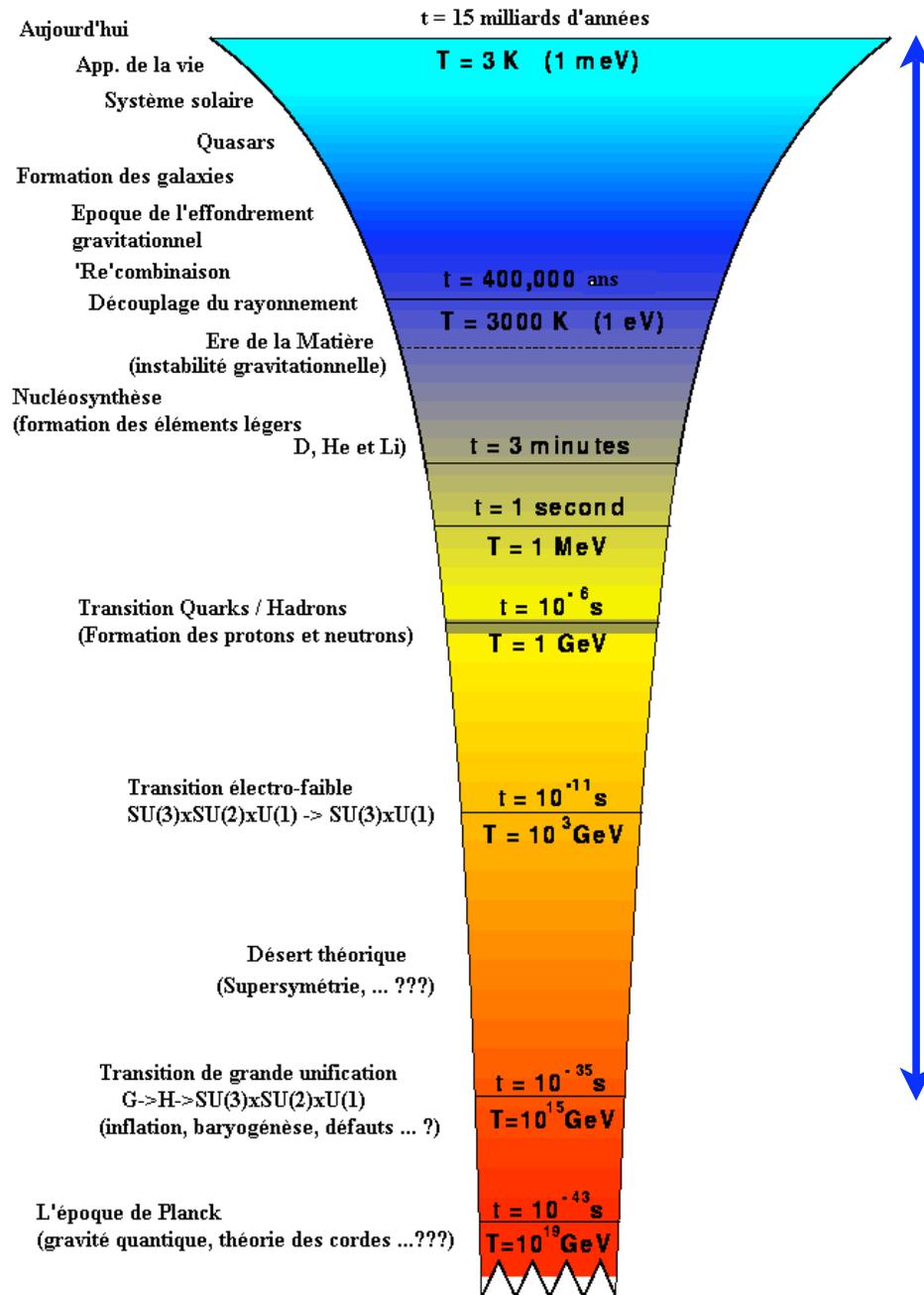
Perlmutter, *et al.* (1998)



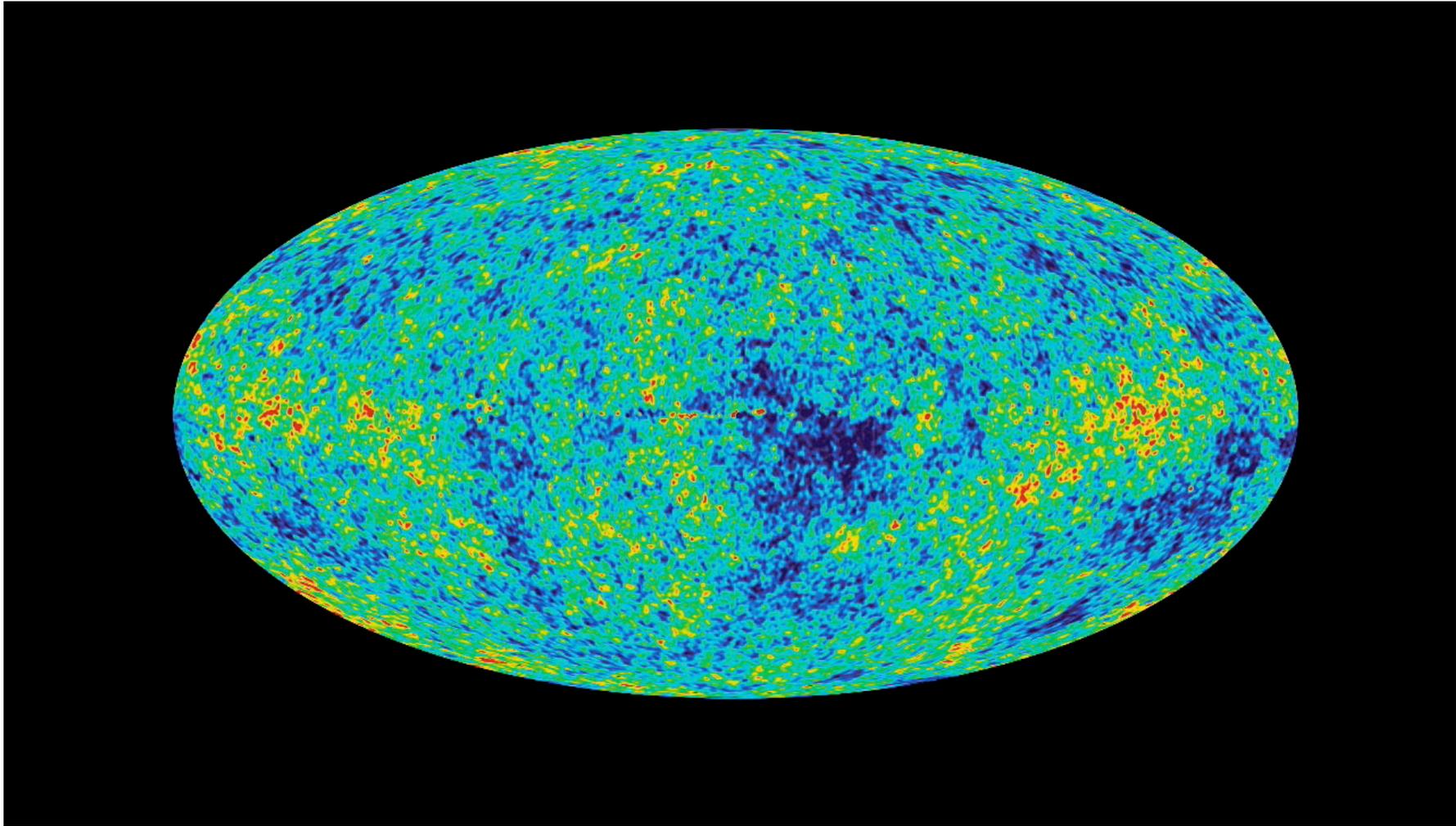




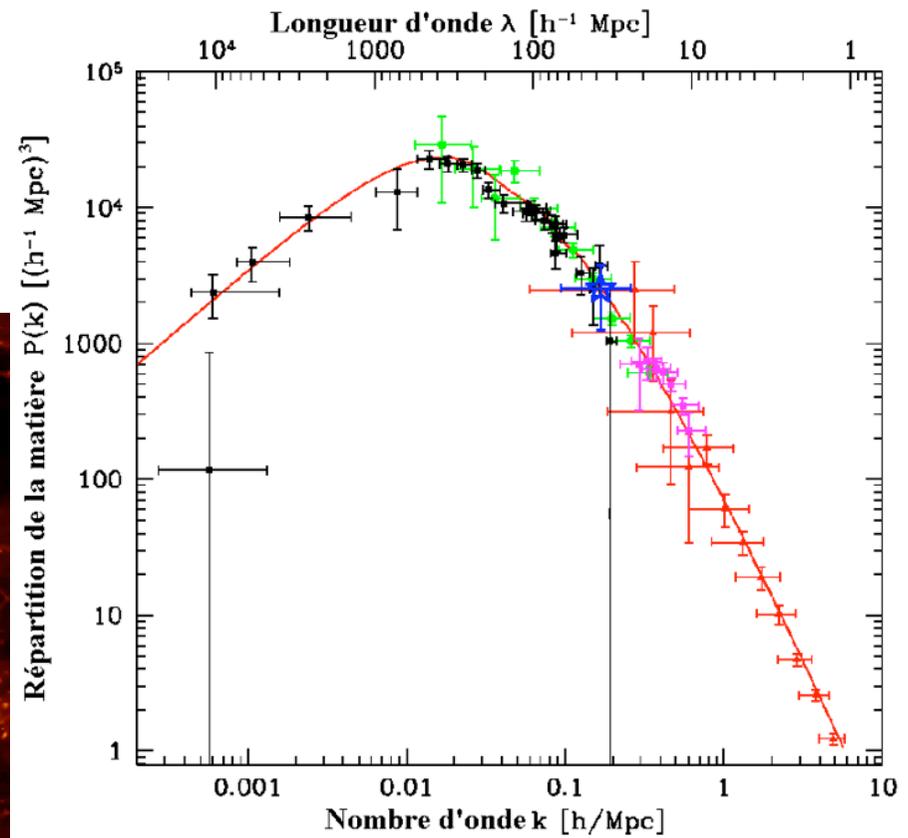
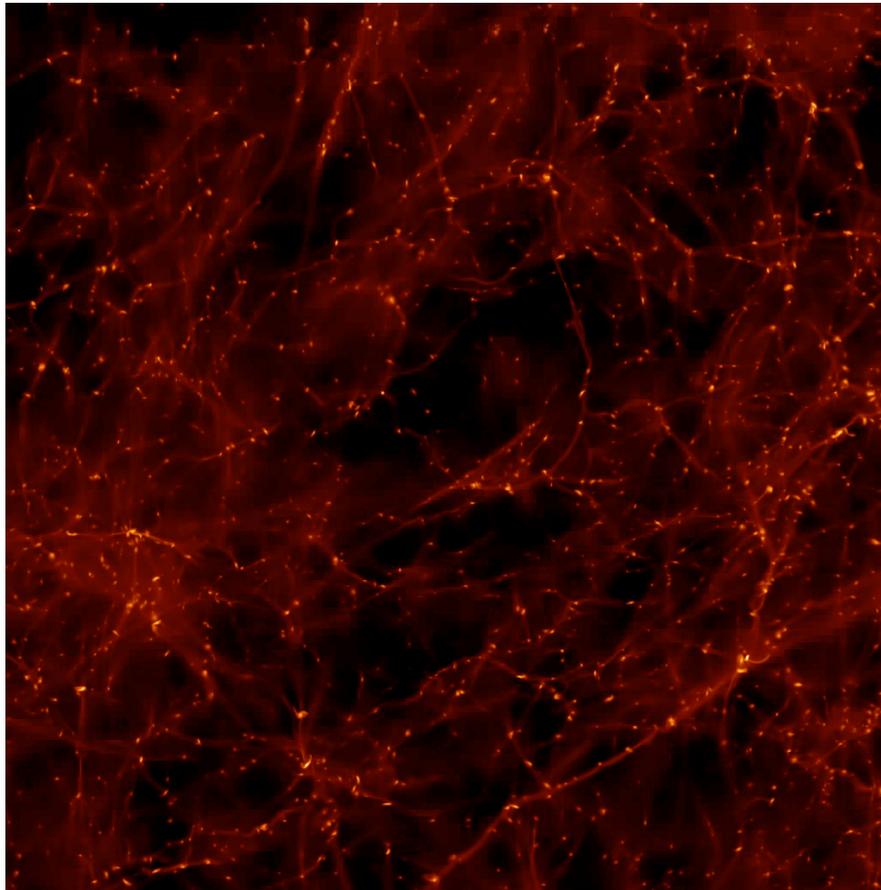




Bien connu
compris

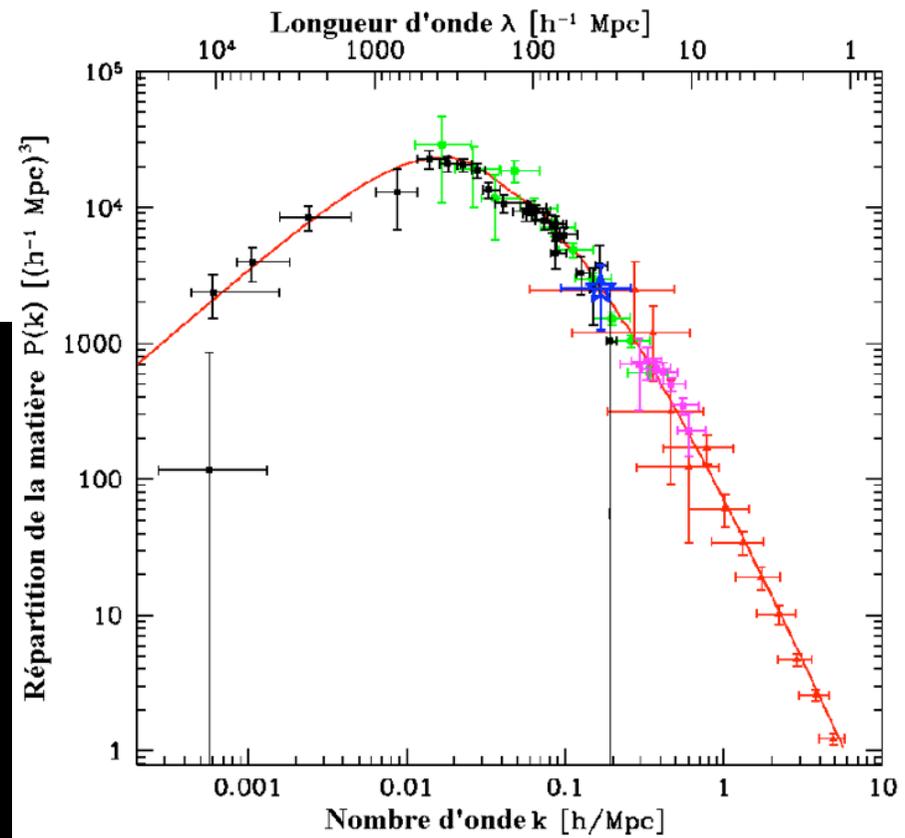
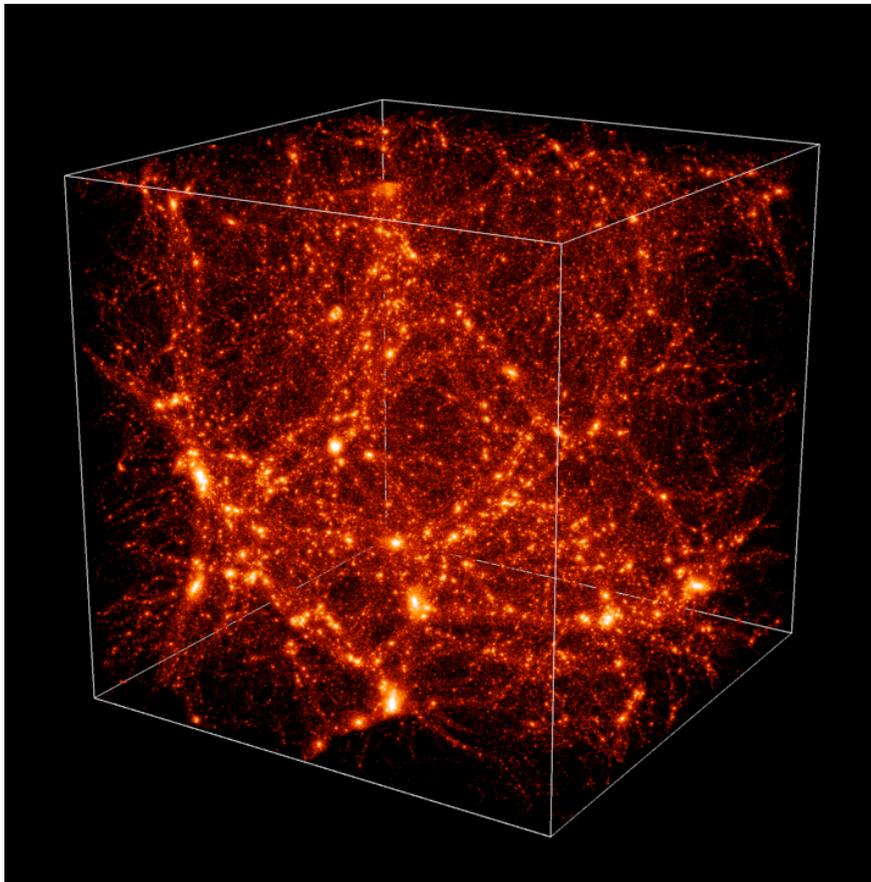


Simulation numérique de la formation des grandes structures



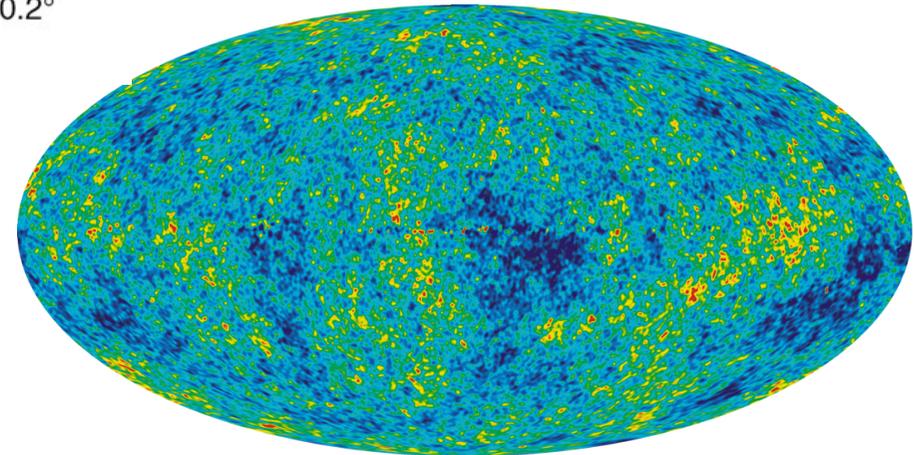
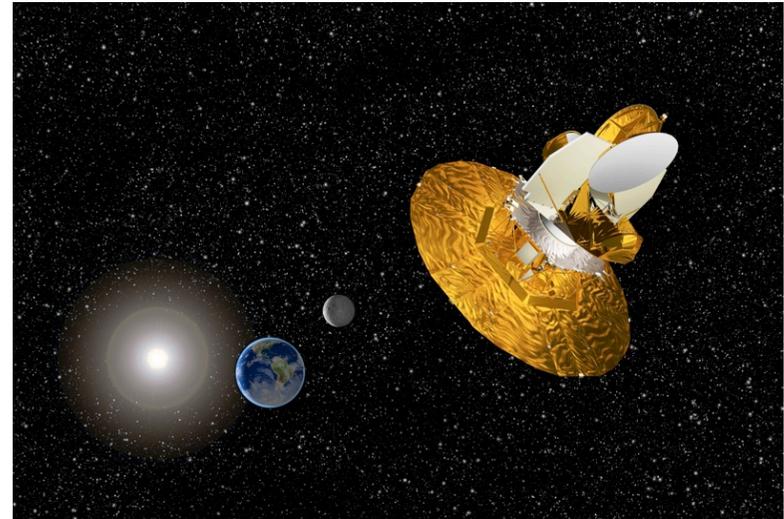
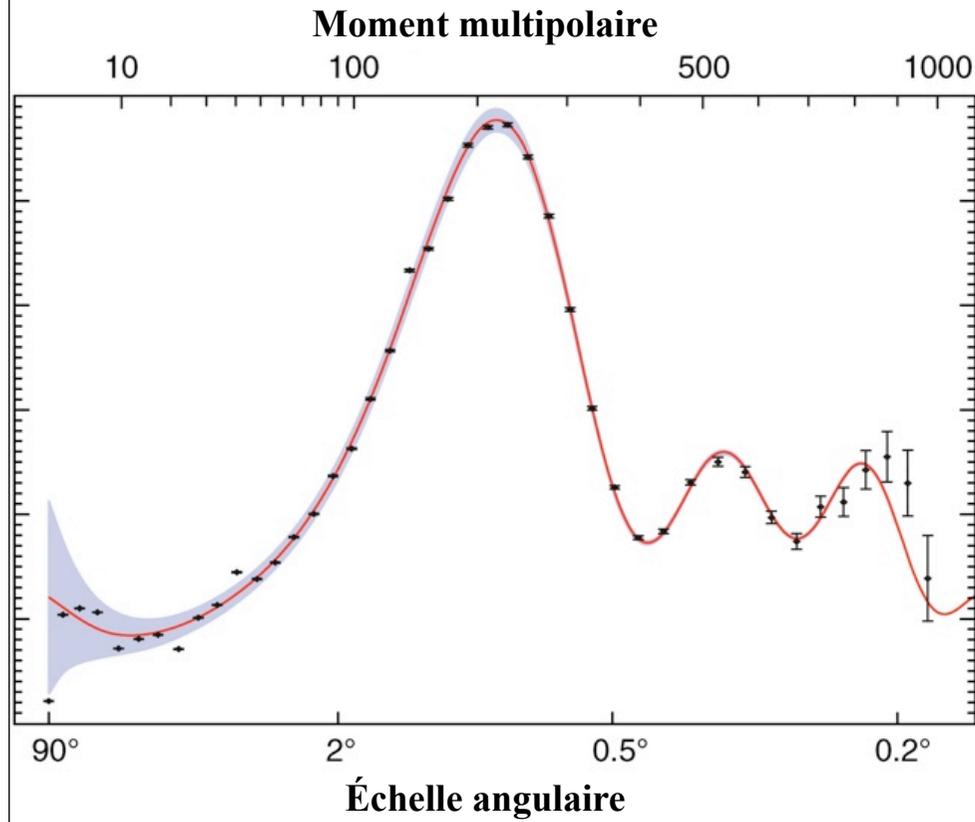
Comparaison avec
les données
observationnelles

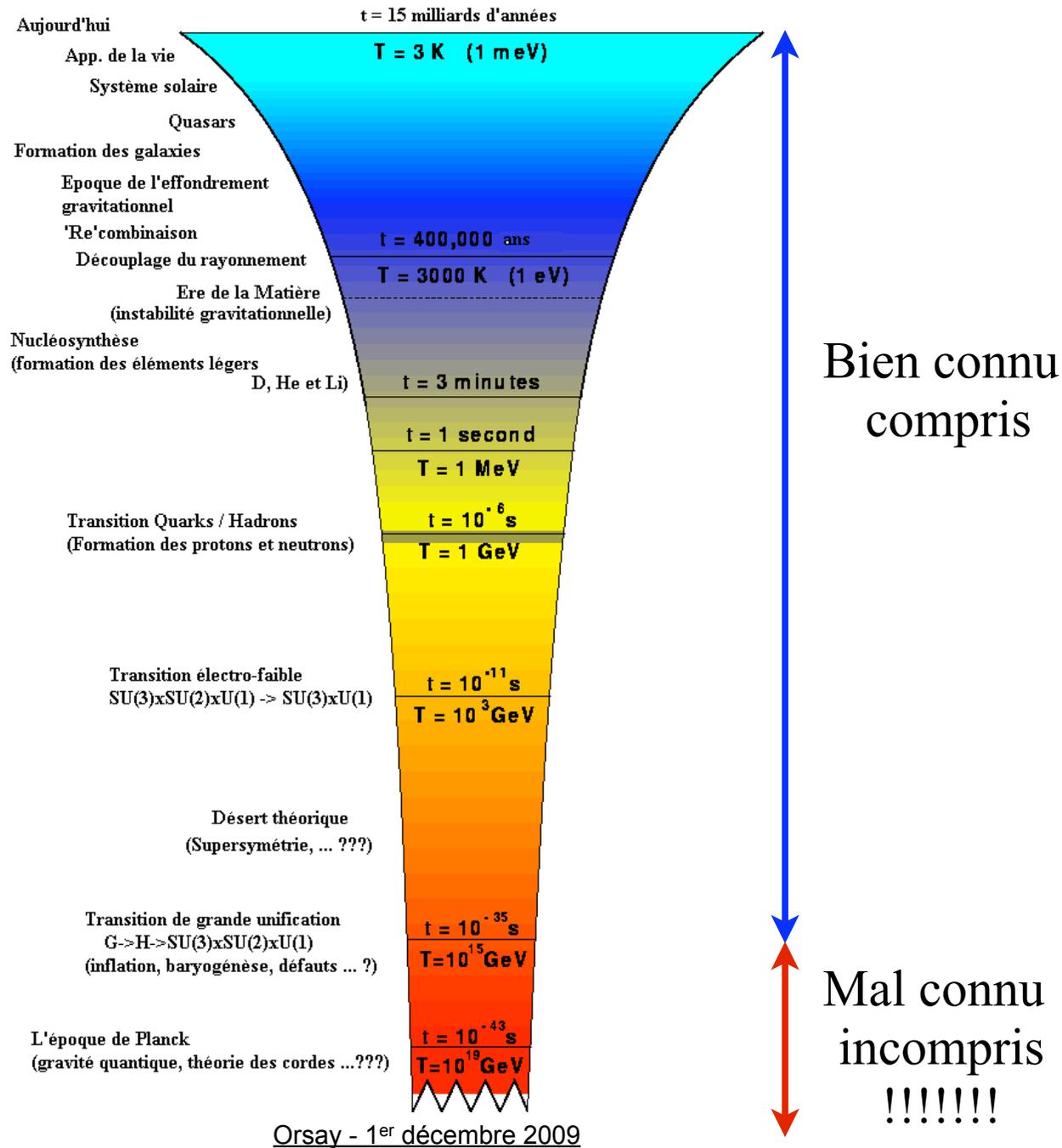
Simulation numérique de la formation des grandes structures

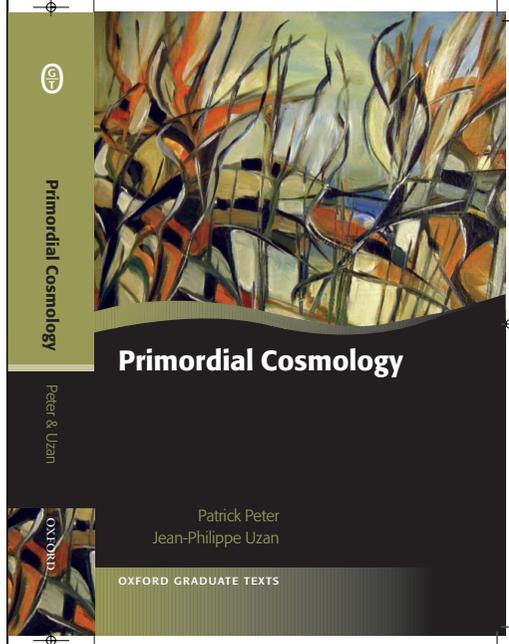


**Comparaison avec
les données
observationnelles**

Fluctuations attendues du rayonnement de corps noir







Problèmes de la cosmologie standard

Singularité

Horizon

Platitude

Homogénéité

Perturbations

Matière noire

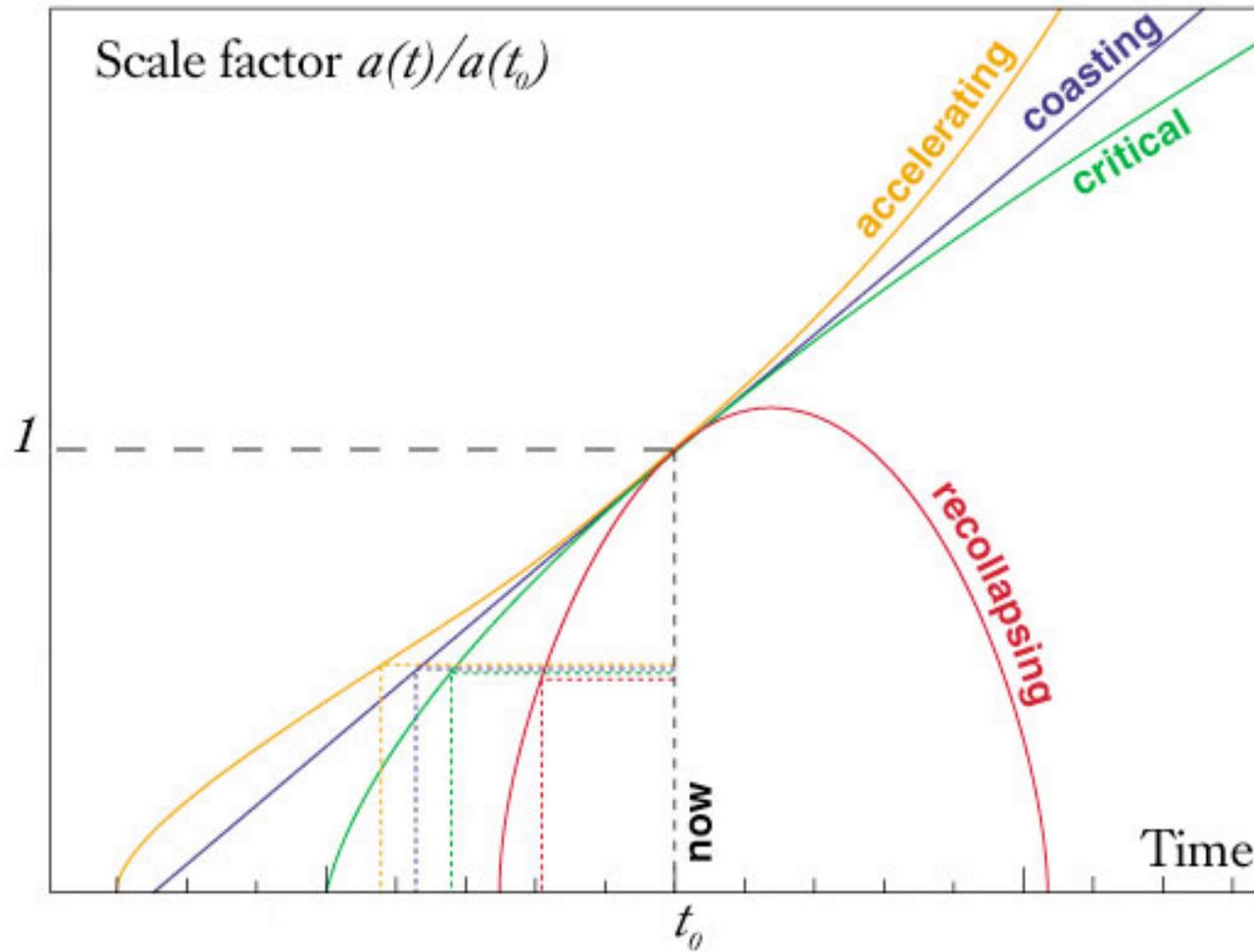
Énergie noire / constante cosmologique

Baryogénèse

...

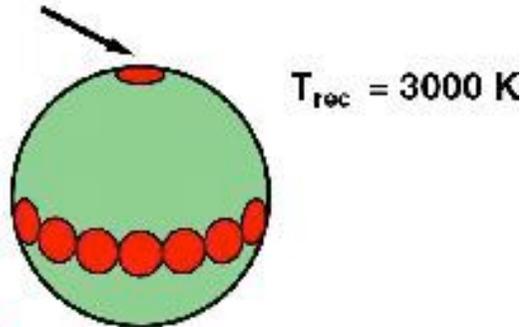
Défauts topologiques (monopôles)

Singularité

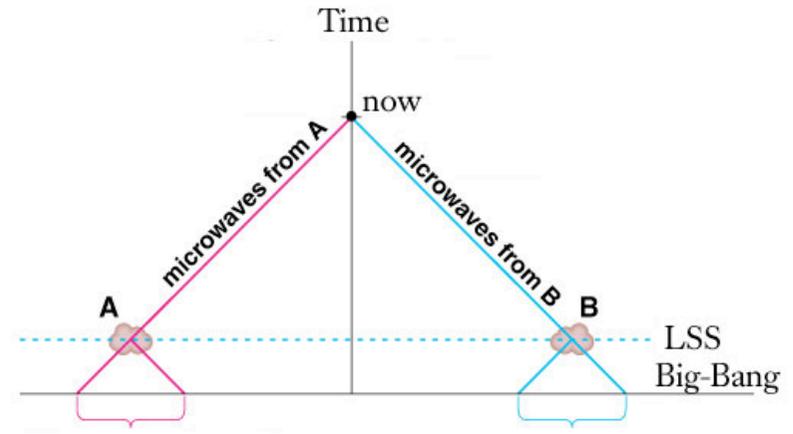
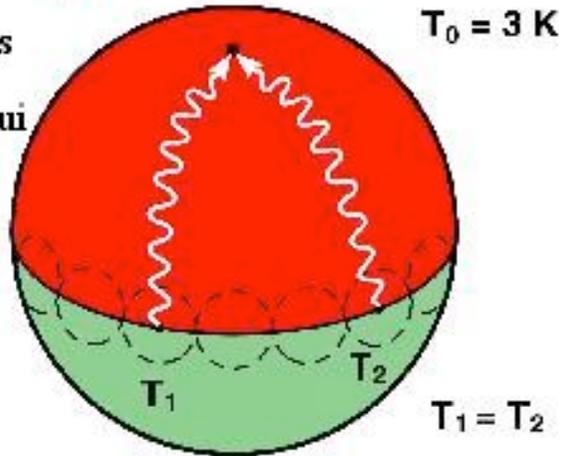


Horizon

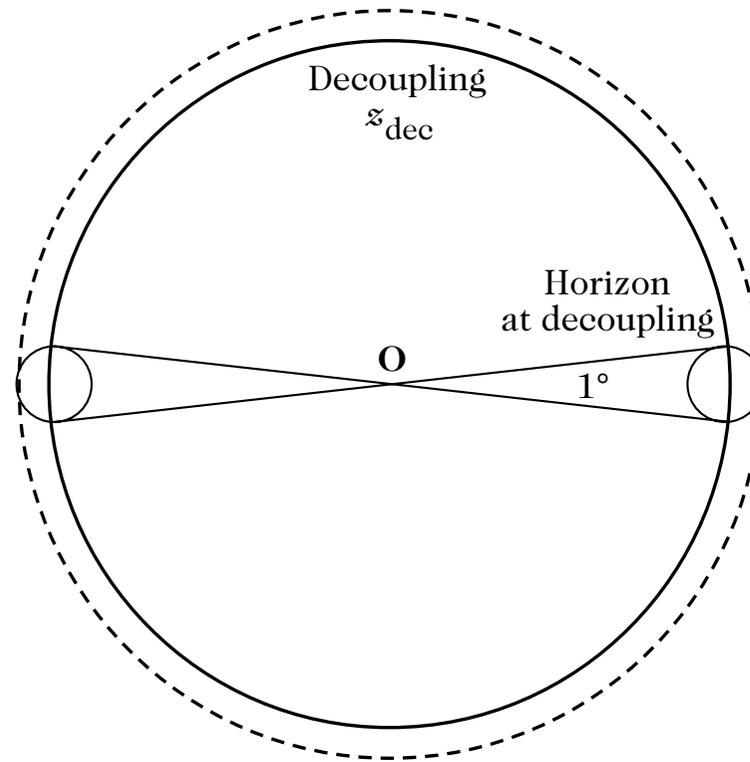
L'Univers observable à la recombinaison



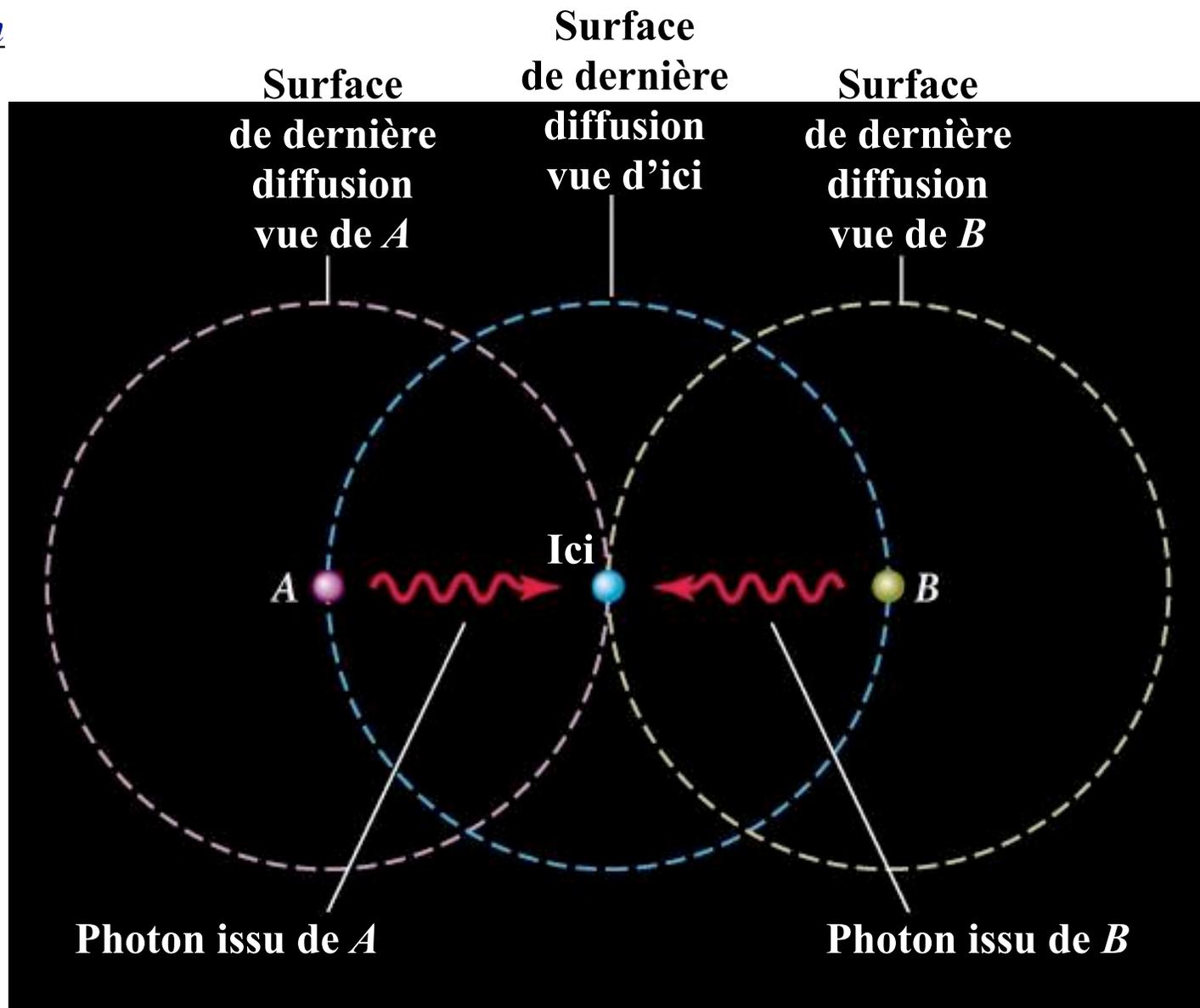
L'Univers aujourd'hui



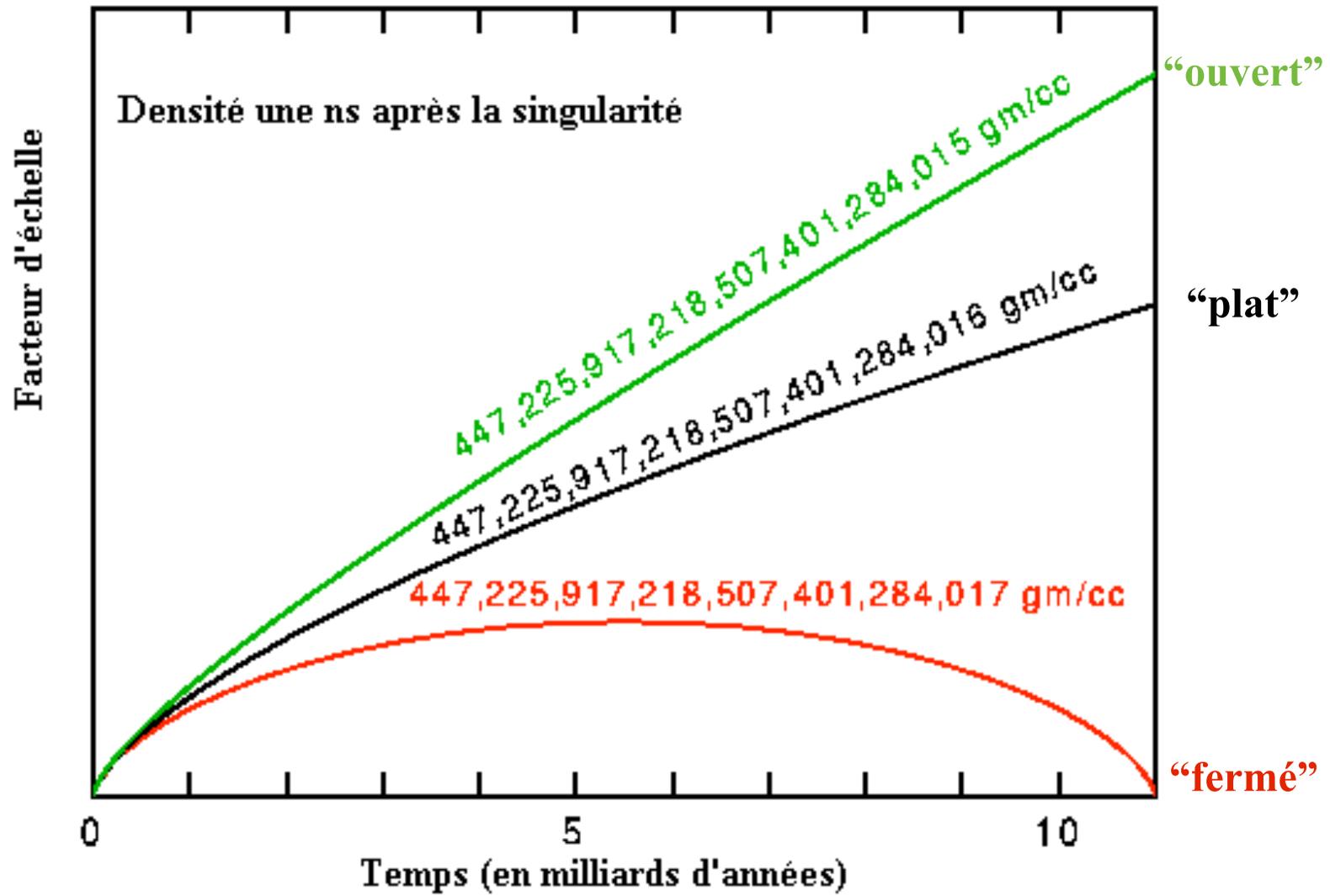
Infinite redshift



Horizon

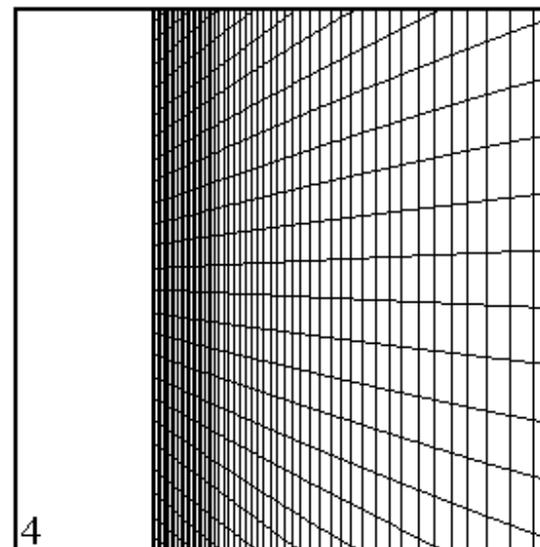
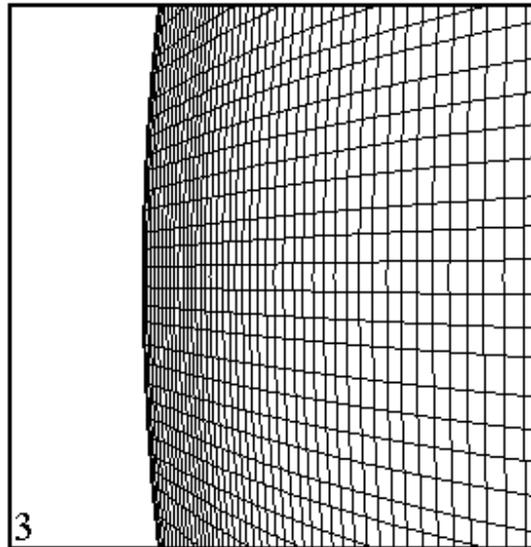
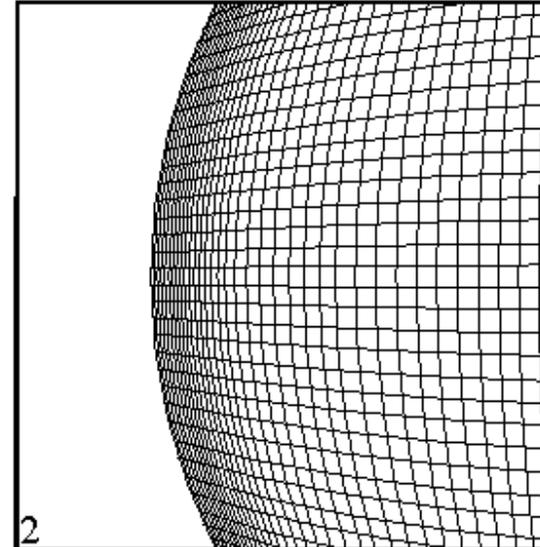
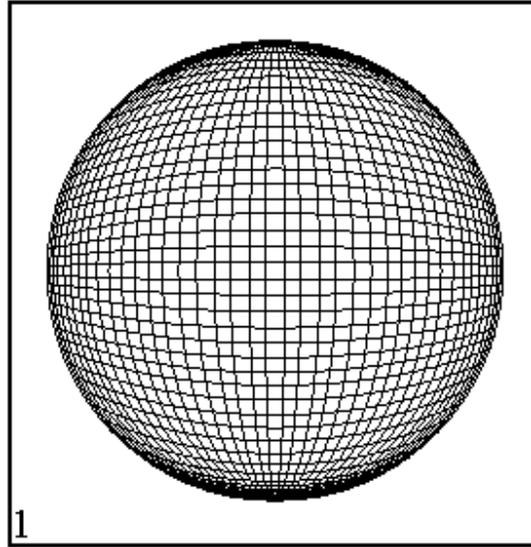


Platitude



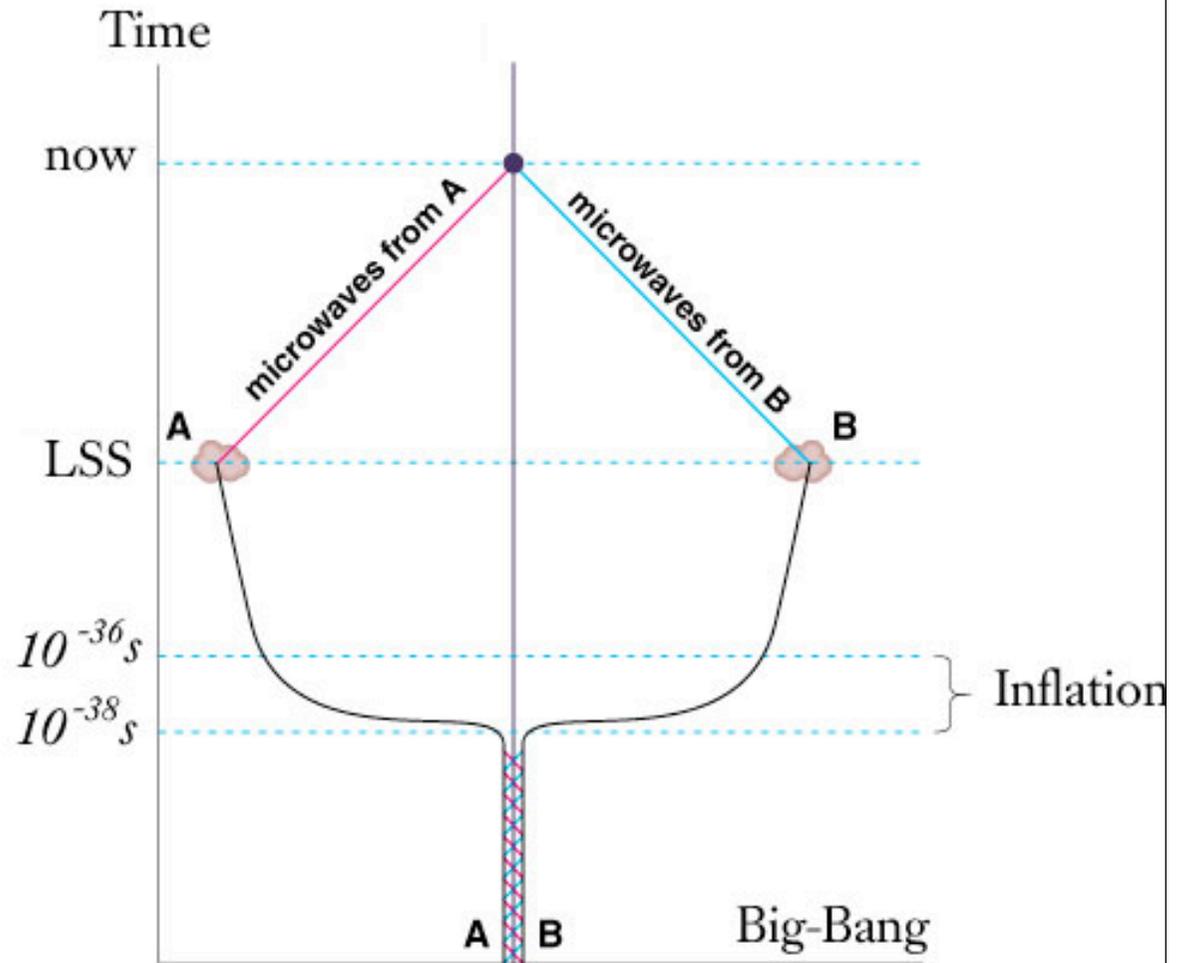
Inflation ... = la panacée !!!

Platitude



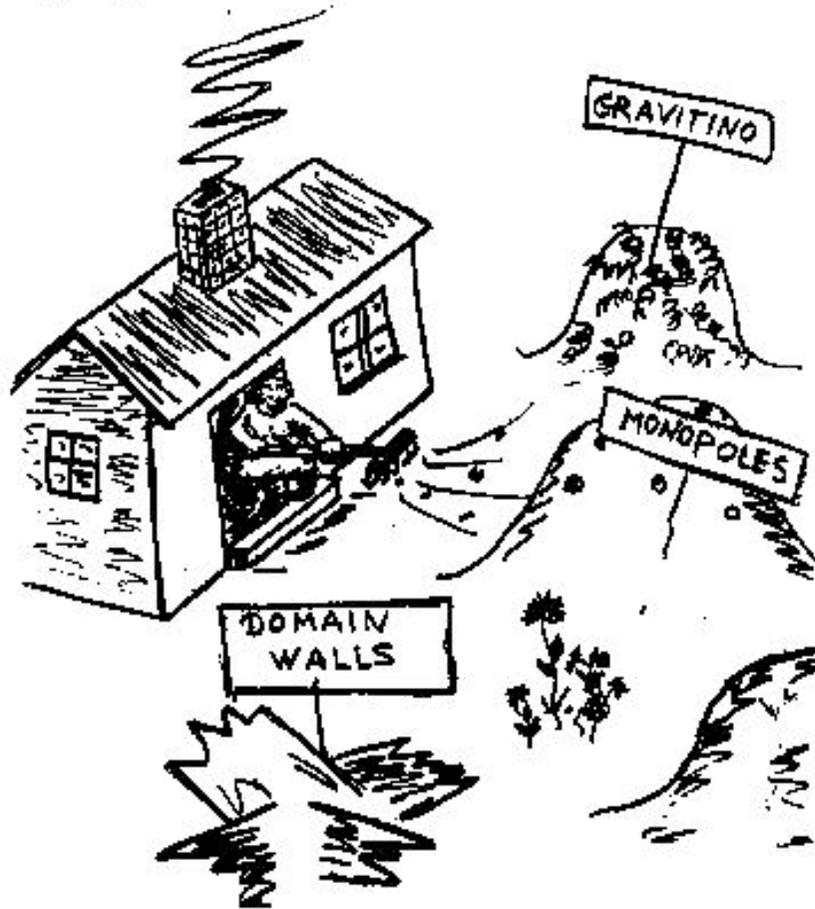
Inflation ... = la panacée !!!

Horizon



Inflation ... = la panacée !!!

THE MAIN IDEA OF THE
INFLATIONARY UNIVERSE SCENARIO



(Livre A. Linde)