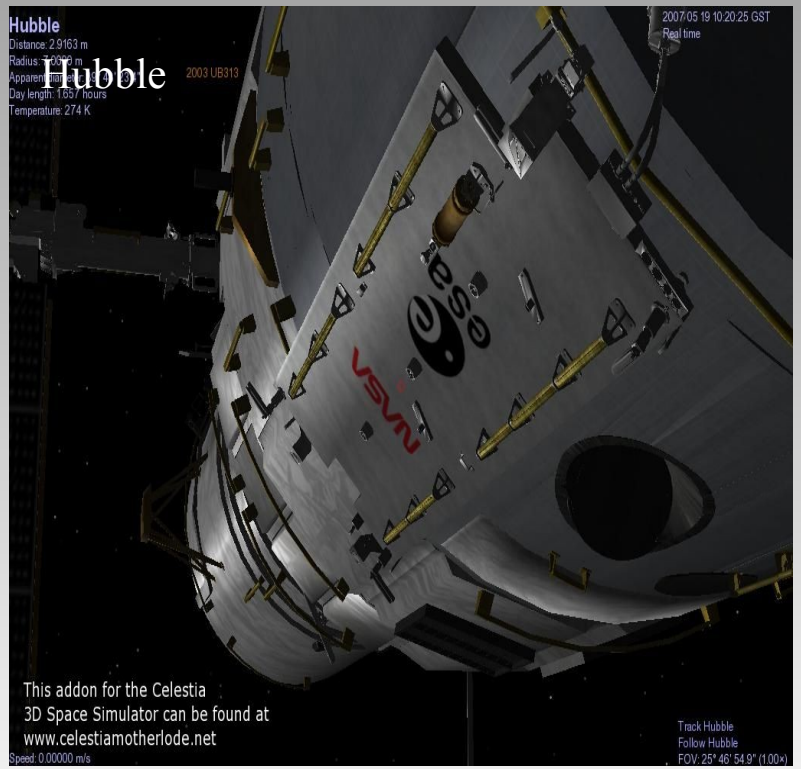
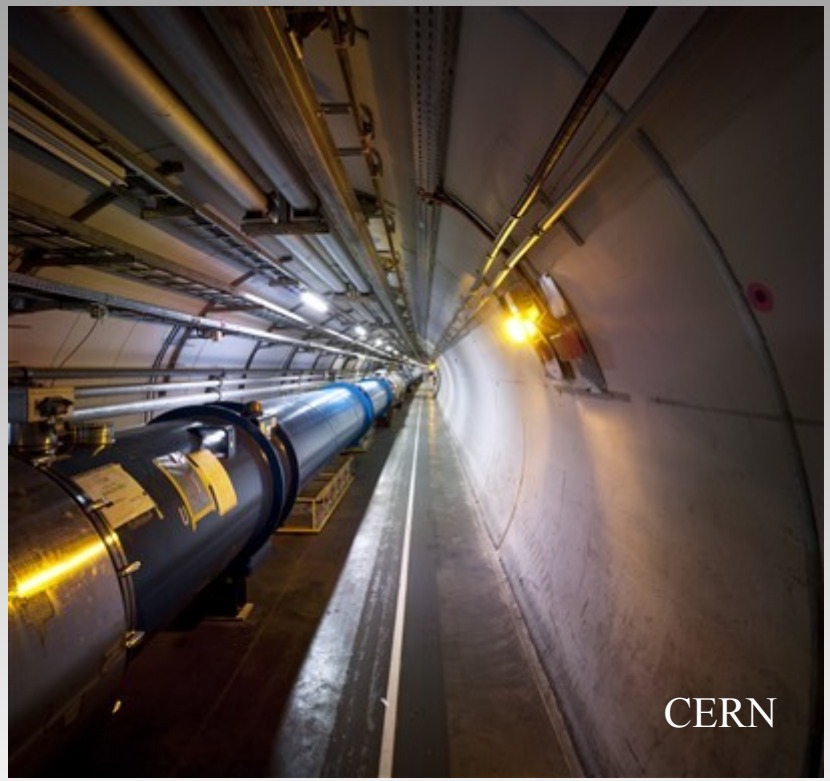

(niektóre)
FUNDAMENTALNE
PROBLEMY
KOSMOLOGII KWANTOWEJ

Dwie drogi penetrowania historii Wszechświata:

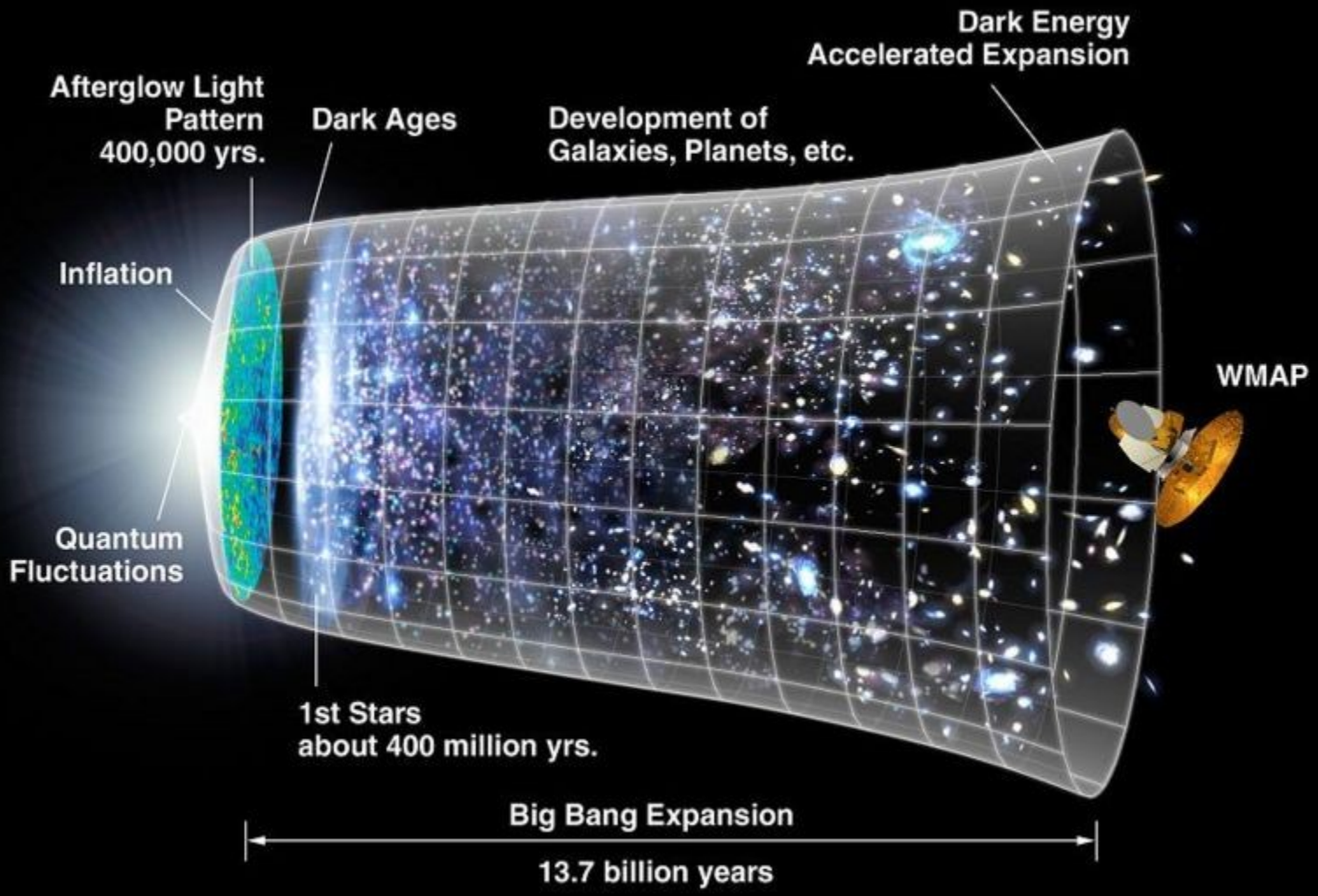
Astronomia



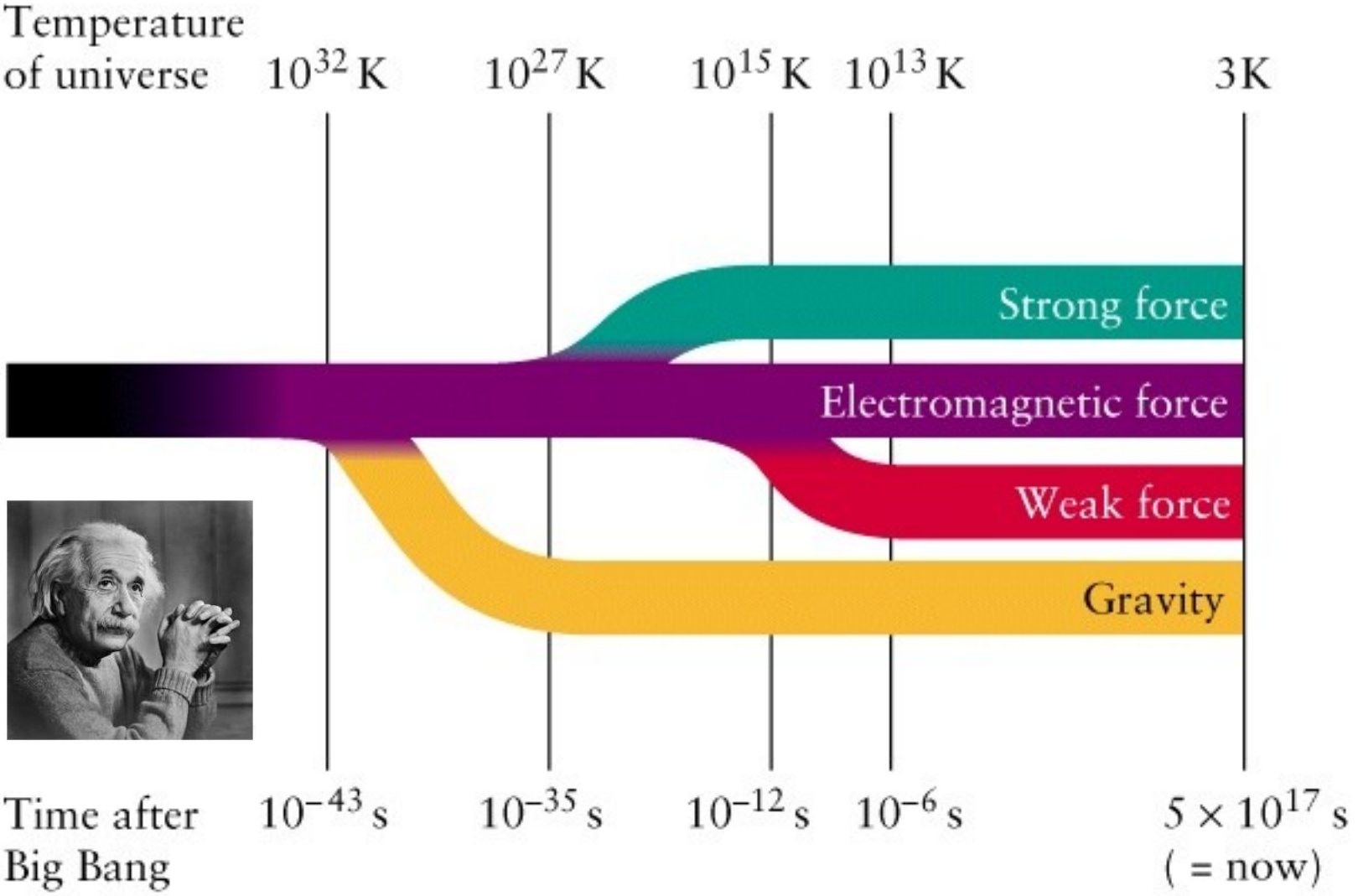
Fizyka cząstek elementarnych

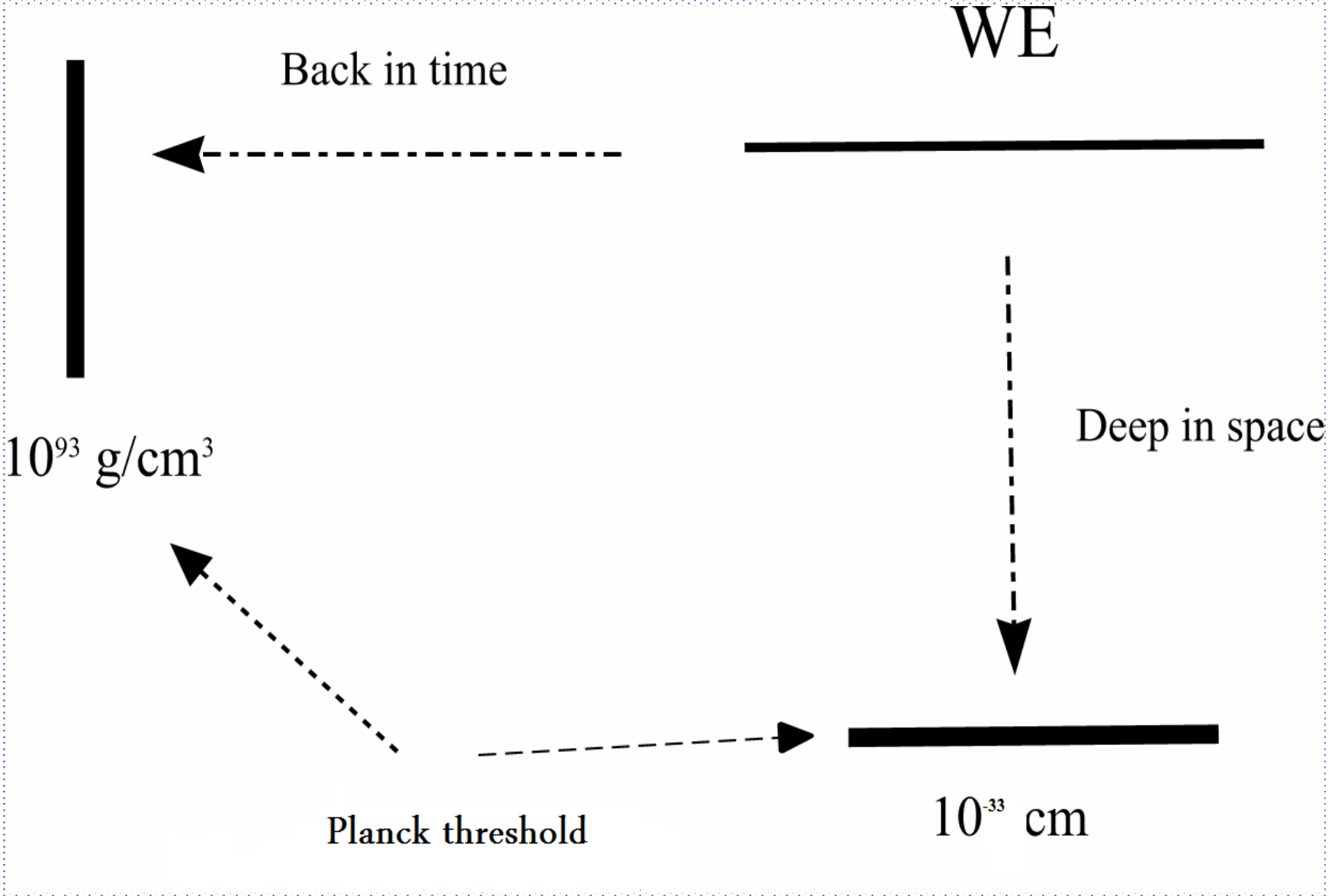


DROGA ASTRONOMÓW



DROGA FIZYKÓW



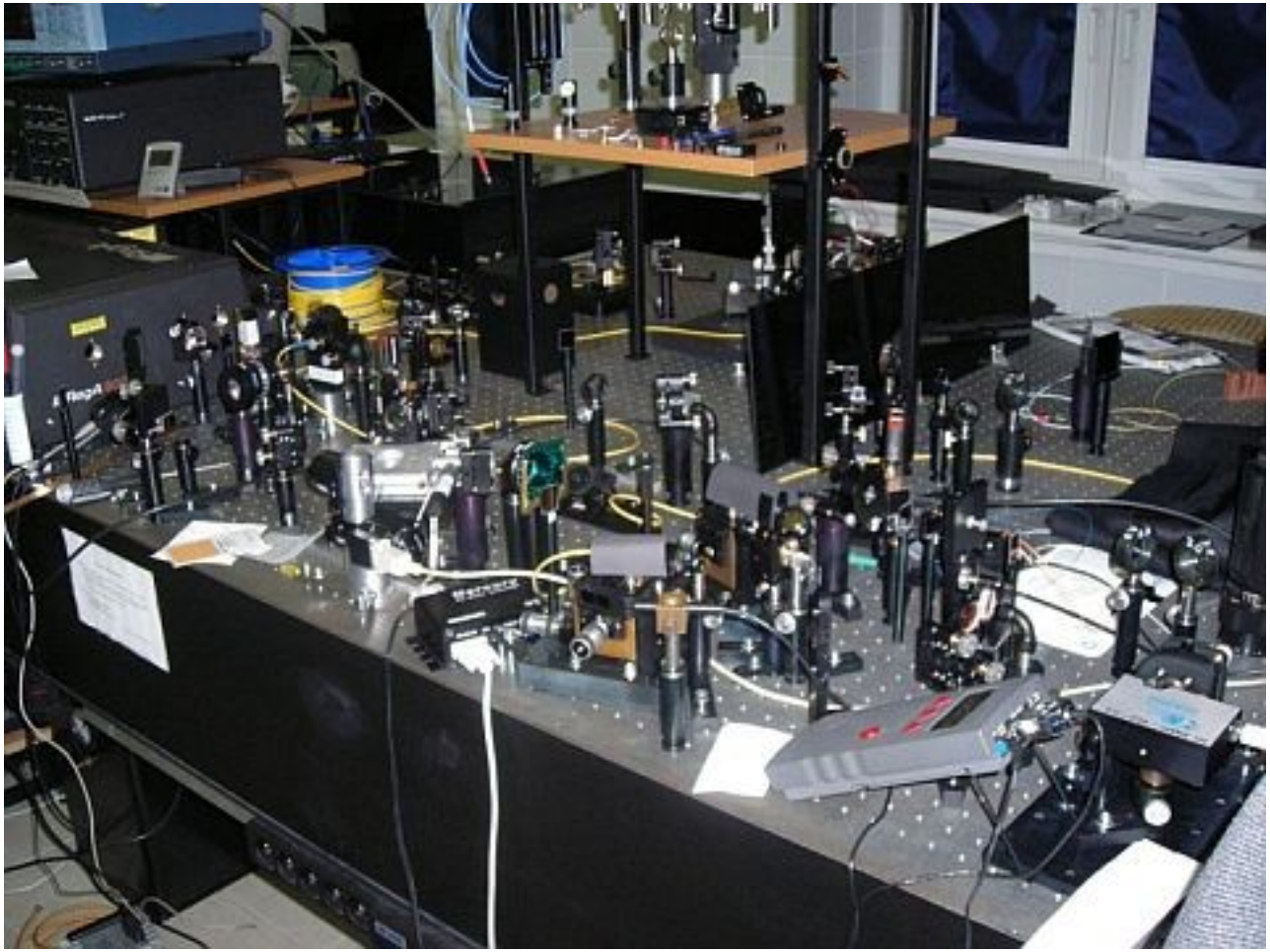


„Początek jest wszędzie”

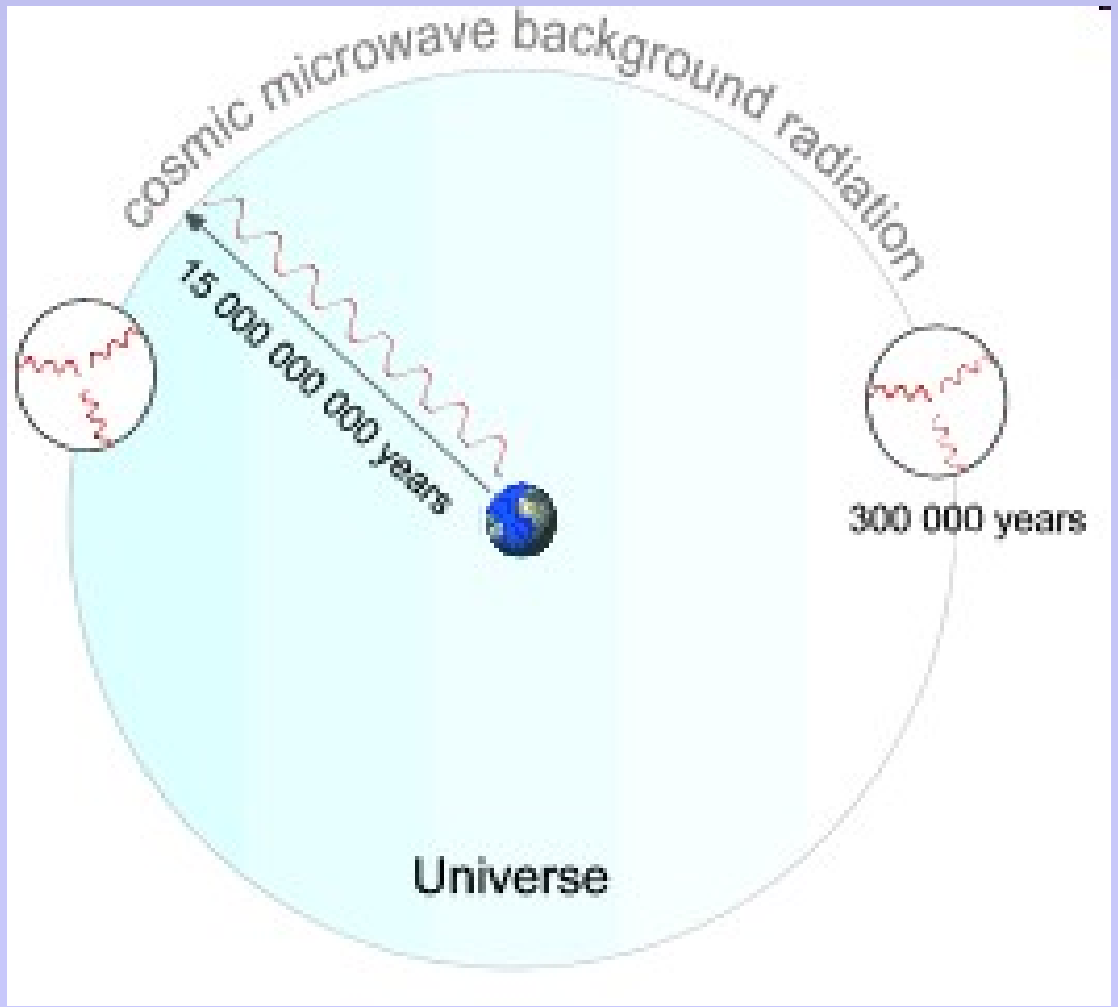
PROBLEM NIELOKALNOŚCI

Efekt typu EPS

PROBLEM NIELOKALNOŚCI

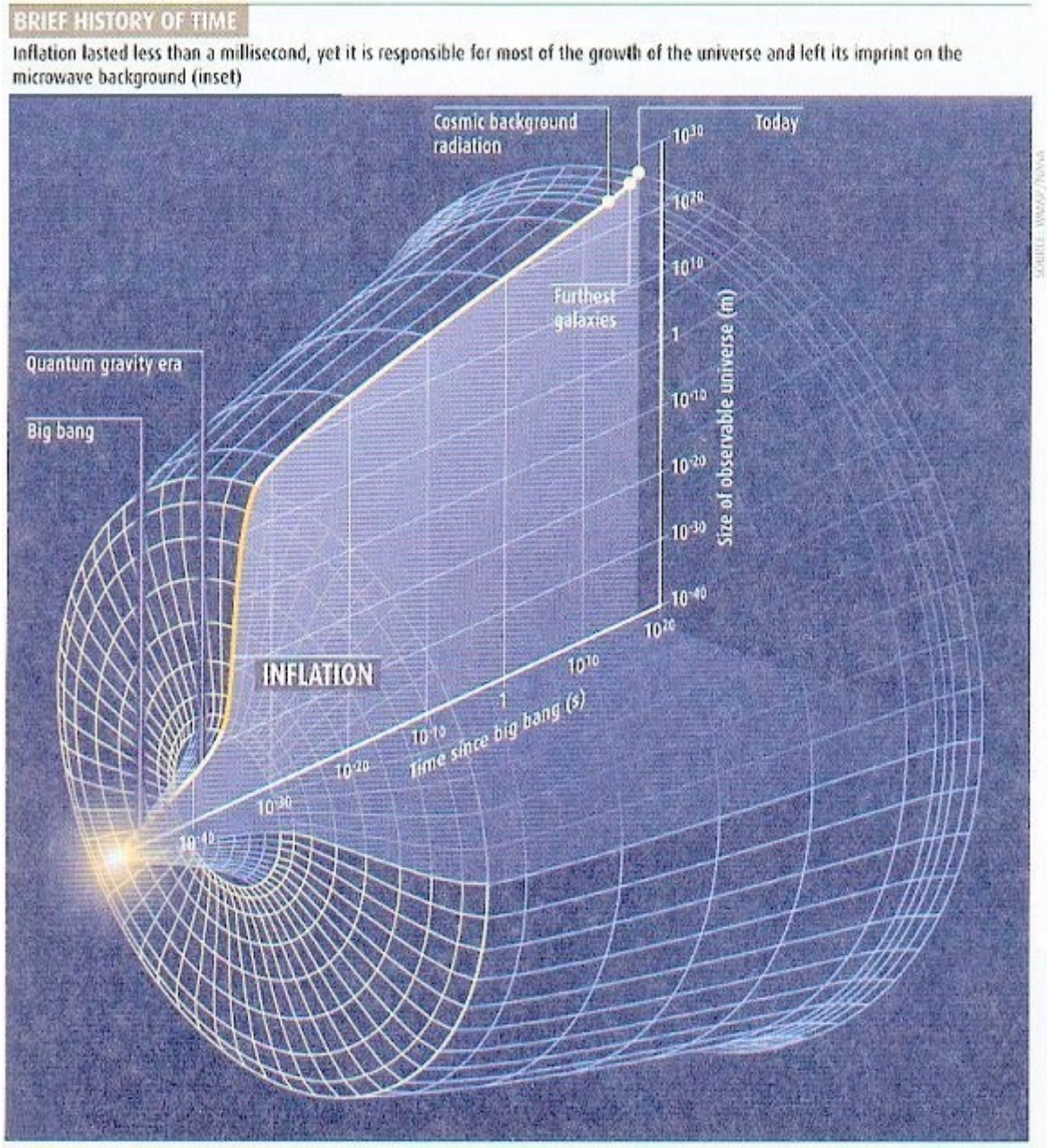


Nielokalność w kosmologii – problem horyzontu



Inflacja rozwiązuje problem horyzontu, ale nie rozwiązuje kwantowych nielokalności.

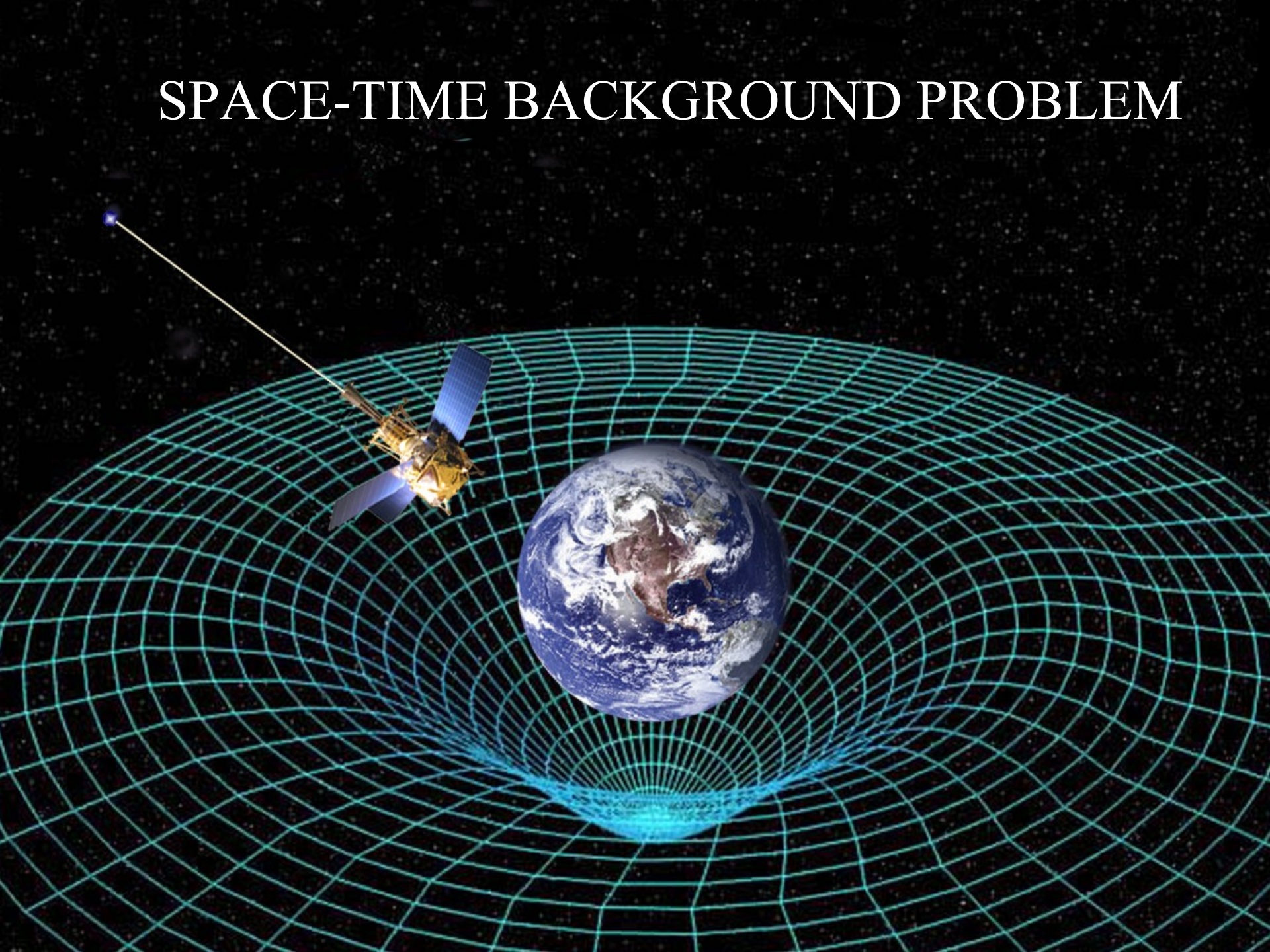
Czy problemy te nie mają jednej przyczyny?



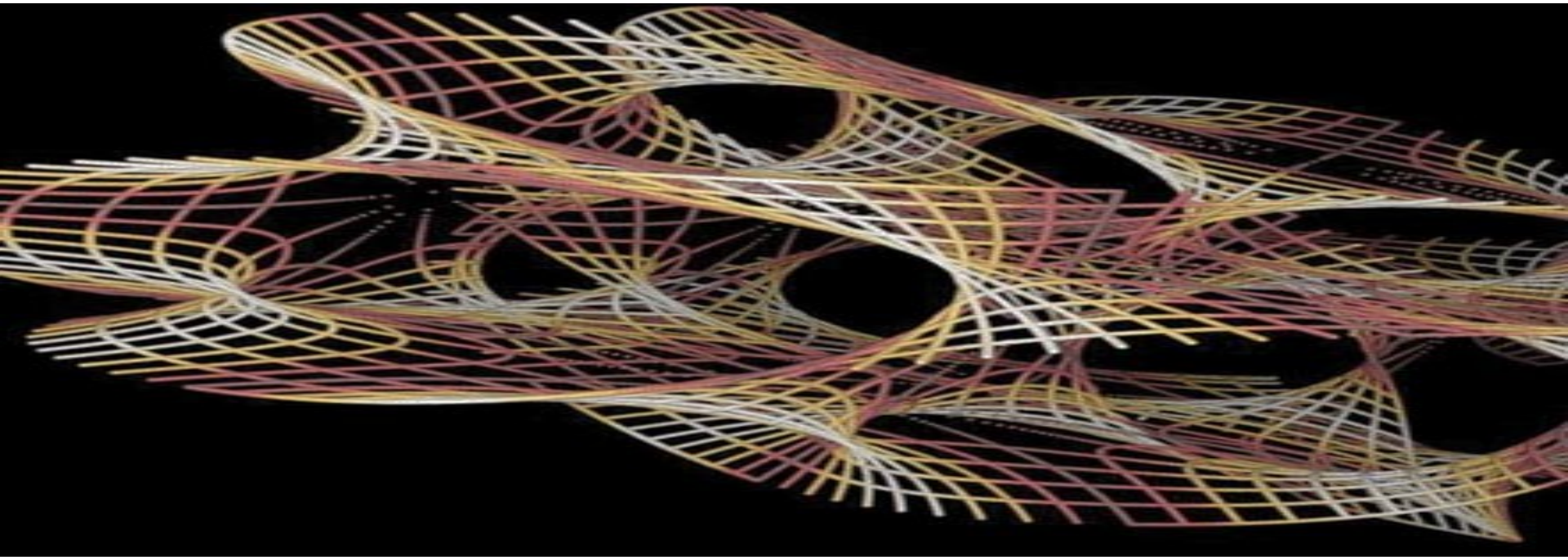
Przestrzeń absolutna i relacyjna

- Współczesna wersja problemu:
- Czy na poziomie fundamentalnym istnieje przestrzeń-tło?

SPACE-TIME BACKGROUND PROBLEM

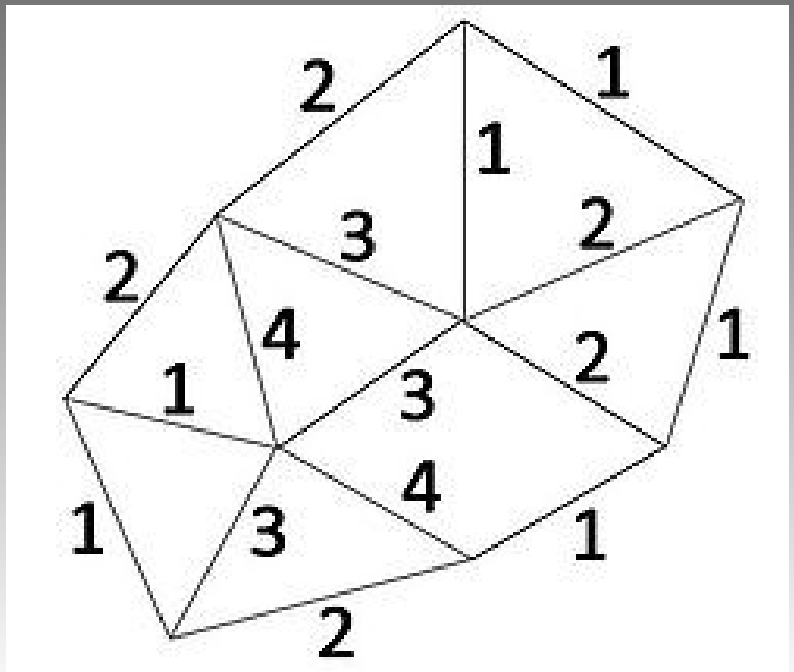


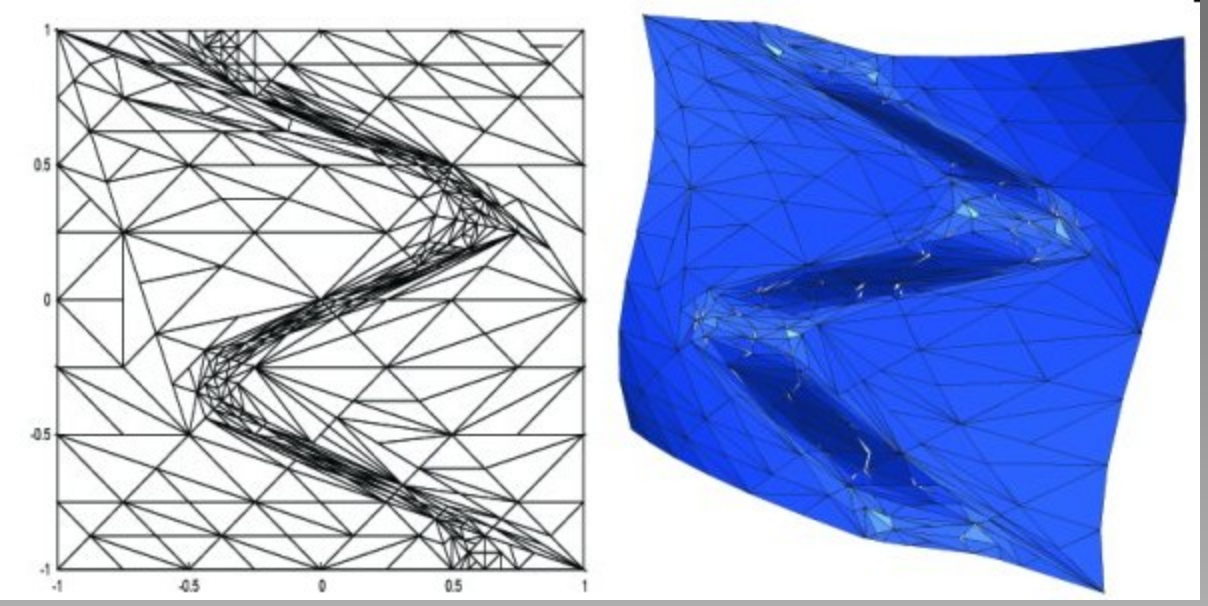
In **string theory** instead of point particles, string-like objects propagate in a fixed spacetime background.



It was shown that string spectrum contains the graviton, and that "condensation" of certain vibration modes of strings is equivalent to a modification of the original background. In this sense, string perturbation theory exhibits features one would expect of a weak form of background dependence.

Loop quantum gravity, also known as **loop gravity** is a proposed quantum theory of space-time which attempts to unify the theories of quantum mechanics and general relativity. Loop Quantum Gravity suggests that space can be viewed as an extremely fine fabric or network "weaved" of finite quantised loops (of excited gravitational fields) called spin networks.





Causal dynamical triangulation

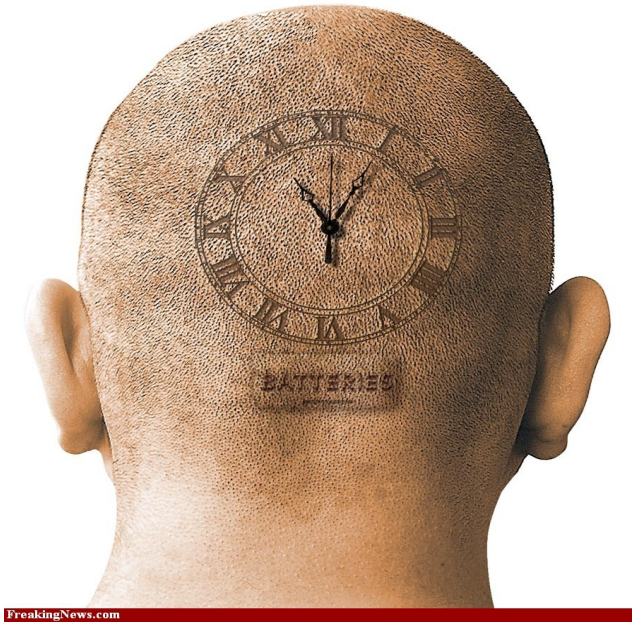
Near the Planck scale, the structure of space-time itself is constantly changing, due to quantum fluctuations. This theory uses a triangulation to map out how this can evolve into dimensional spaces similar to that of our universe.

Each simplex is geometrically flat, but simplices can be 'glued' together in a variety of ways to create curved space-times. Previous attempts at triangulation of quantum spaces have produced universes with far too many dimensions, or with too few, CDT avoids this problem by allowing only those configurations where cause precedes any event.

Problem czasu

Jeżeli nie ma czasoprzestrzennego tła, to co z czasem?

$$E = h\nu \qquad\qquad E = mc^2$$



$$\nu = m\frac{c^2}{h}$$

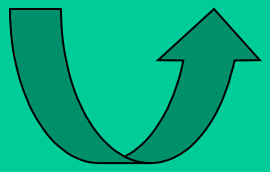
Teoria względności

Mechanika kwantowa

Na tej zasadzie zbudowany jest każdy zegar.
A co, jeśli nie ma cząstek masywnych?

Termodynamika w szklance kawy

- Entropia układu KAWA – POWIETRZE rośnie.



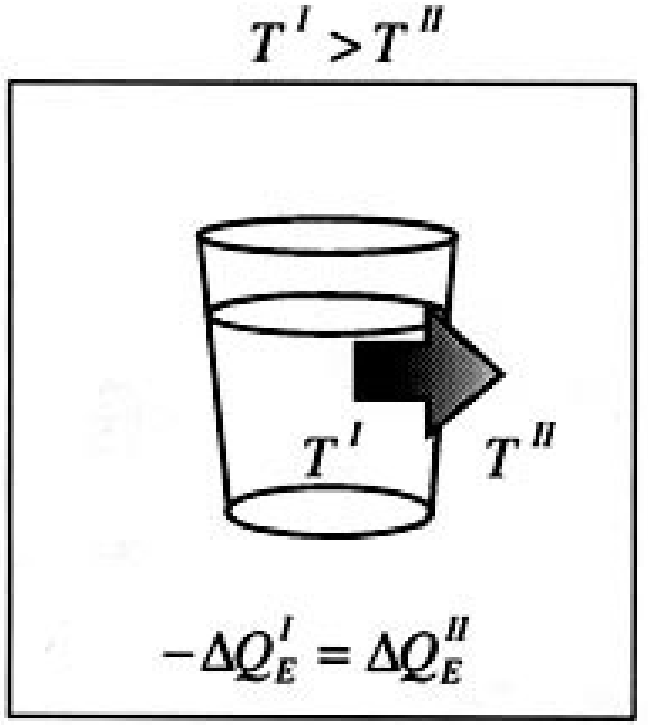
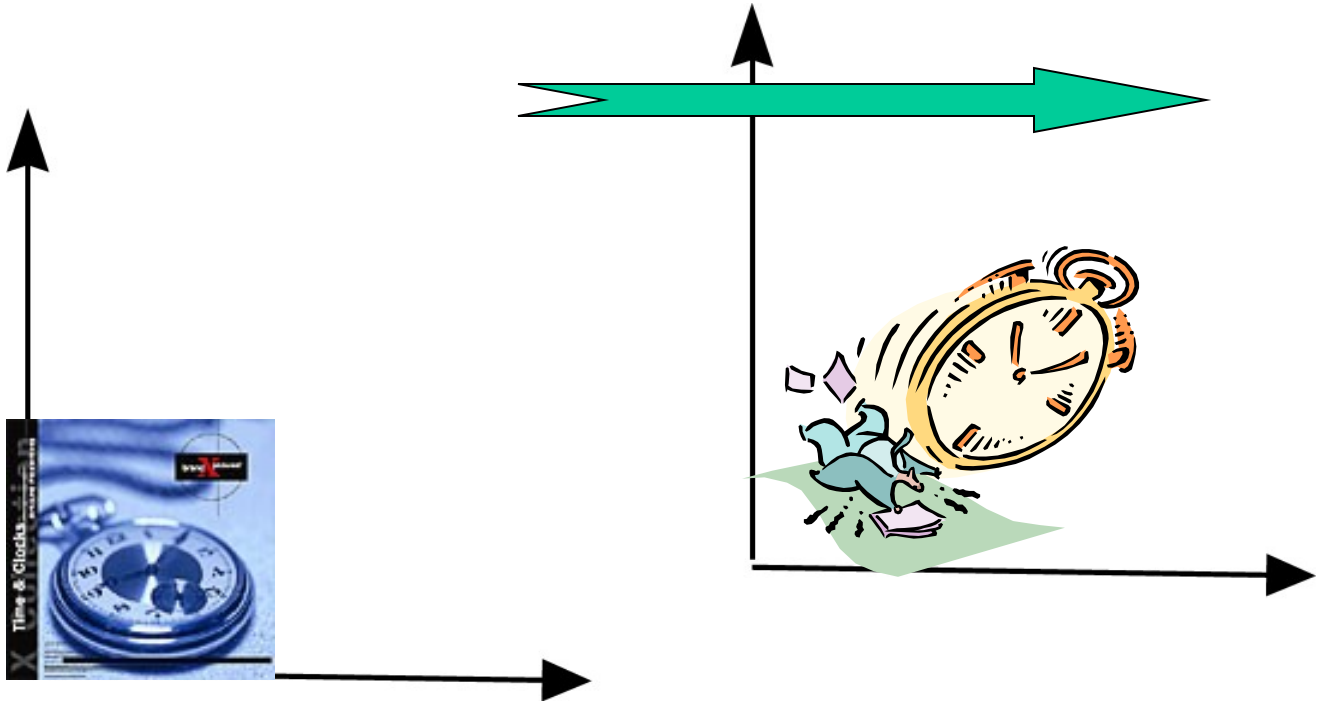


Figure 3

Szczególna teoria względności



DWIE HISTORIE:

W silnych polach grawitacyjnych mamy problem z czasem

Obserwator kolapsujący

Obserwator zewnętrzny

Czas na poziomie fundamentalnym

- **Nie istnieje**
- **Istnieje inaczej: skwantowany, popątany, zależny od stanu…**
- **Istnieje (mniej lub bardziej jak w świecie makroskopowym.**

PROBLEM PRAWDOPODOBIEŃSTWA

The basic definition in quantum probability is that of a quantum probability space, sometimes also referred to as an algebraic or noncommutative probability space.

Definition : Quantum probability space.

A pair (A , **P**), where A is a C*-algebra (or a von Neumann algebra) and **P** is a state, is called a quantum probability space.

This definition is a generalization of the definition of a probability space in Kolmogorovian probability theory, in the sense that every (classical) probability space gives rise to a quantum probability space if A is chosen as the C*-algebra of bounded complex-valued measurable functions on it.
The projections $p \in A$ are the events in A , and **P**(p) gives the probability of the event p.
[edit]

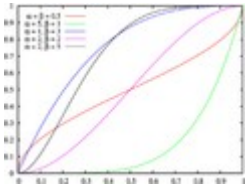
Nieprzemienny obiekt probabilistyczny to para:
(algebra von Neumanna M, stan na M)

Stan zaciekawienia

Stan znudzenia

W zwykłej teorii prawdopodobieństwa jedna miara probabilistyczna

W nieprzemiennej teorii prawdopodobieństwa tyle miar probabilistycznych, ile stanów na M



Jeżeli poziom fundamentalny

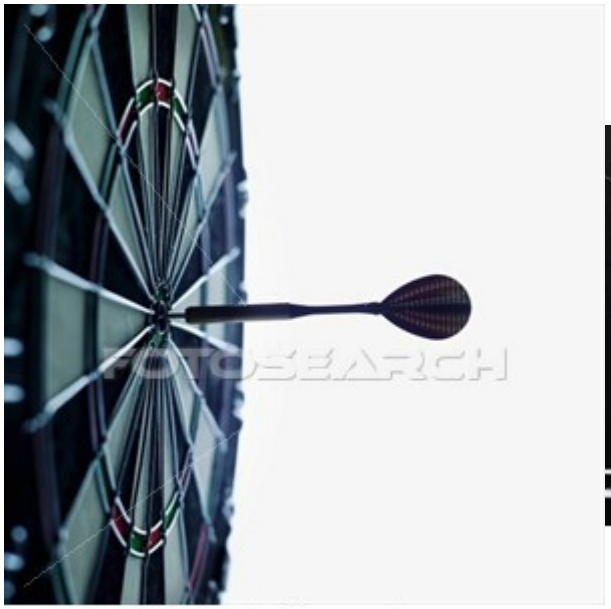
proba

bilistycz

jest

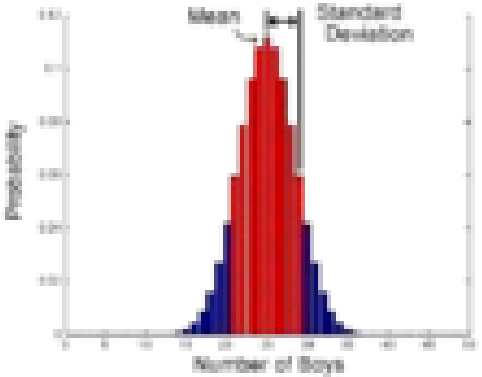
ny,

k2142632 www.fotosearch.com



283308sdc fotosearch.com

k1456623 www.fotosearch.com



to jaka miara probabilistyczna?

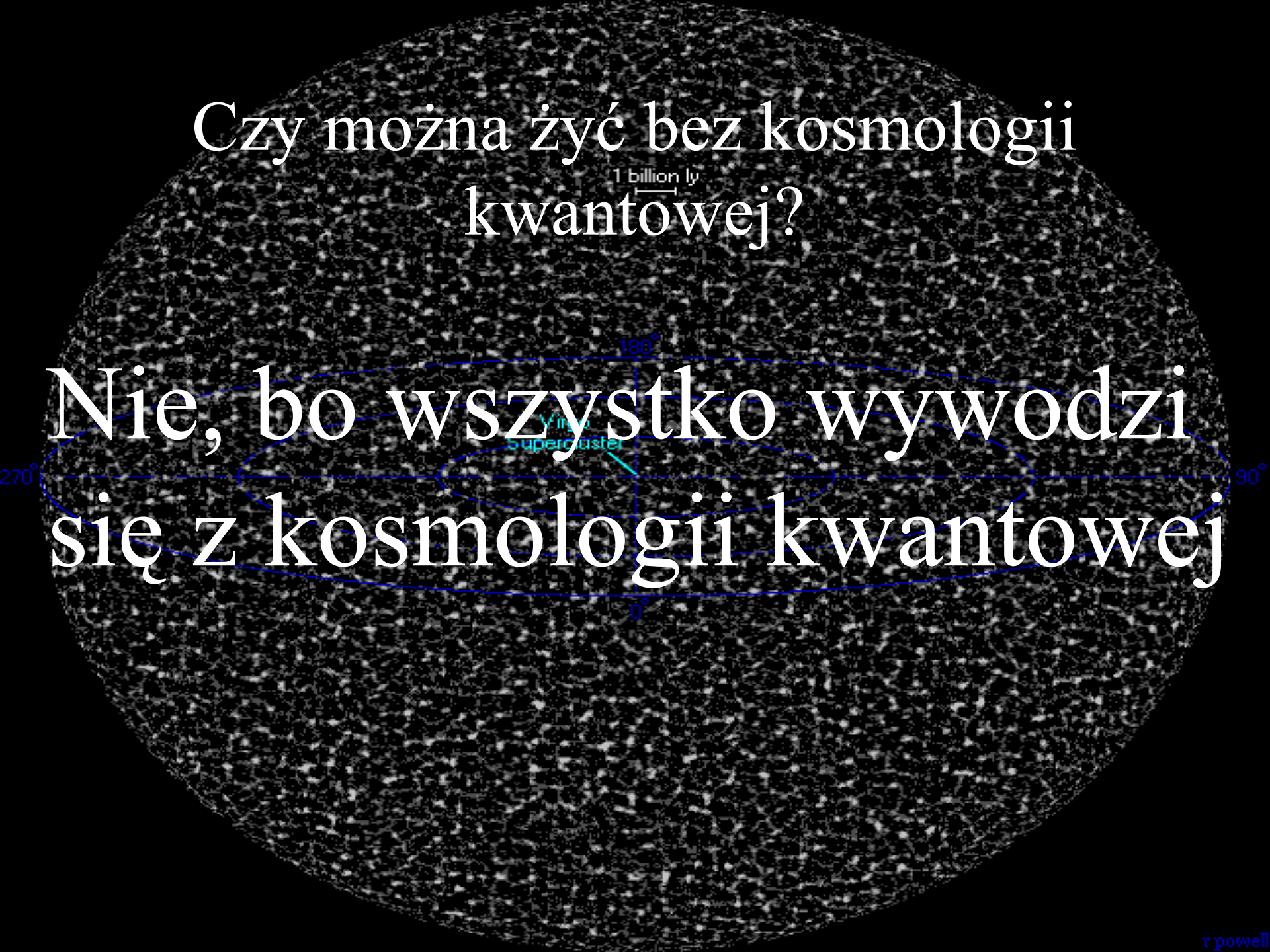
Czy można żyć bez kosmologii kwantowej?

Tak. Jej efekty są zaniedbywalnie małe. Wiek Wszechświata wynosi 13,7 miliardów lat, a pod kontrolą kosmologii kwantowej jest tylko $10^{-44}\,s$.

Tak. By sięgnąć do ery kosmologii kwantowej potrzeba $10^{16}\,TeV$

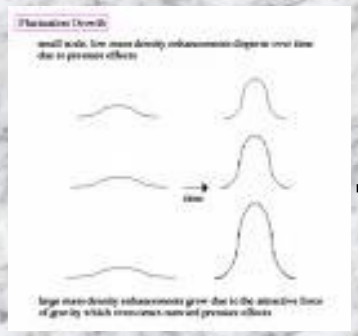
Dziś osiągane w (FermiLab) 2 *TeV*
Przewidywane na ten rok 7 TeV
Planowane maksymalnie 14 TeV

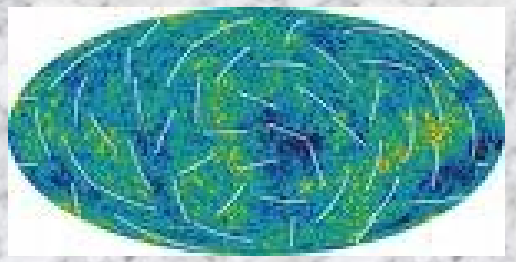
I tak nie ma szans na dotarcie do ery kosmologii kwantowej.

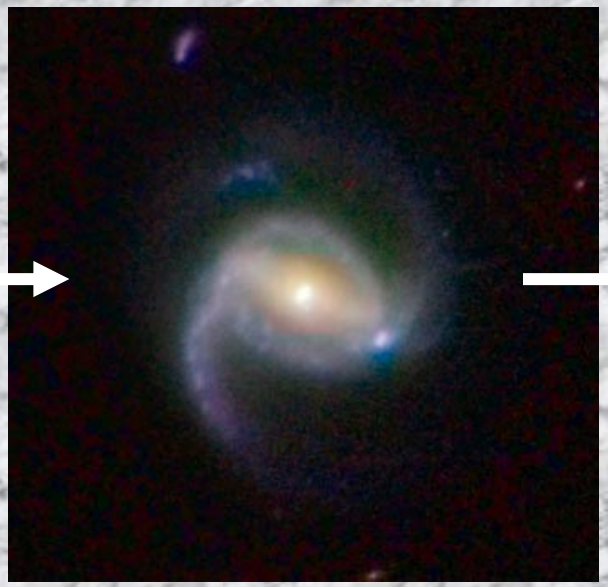


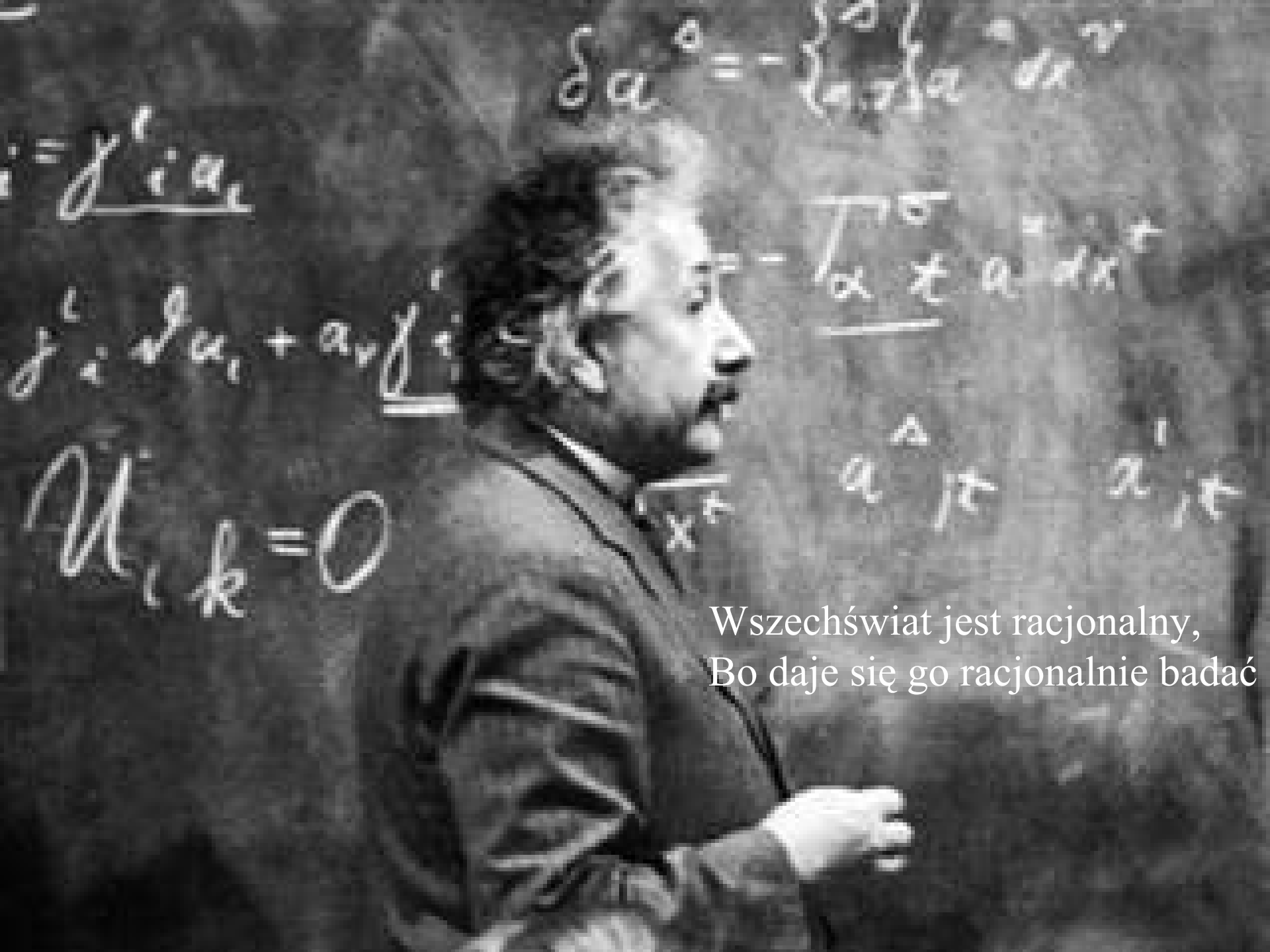
Czy można żyć bez kosmologii kwantowej?

Nie, bo wszystko wywodzi się z kosmologii kwantowej


Fluctuation Growth
time






Wszechświat jest racjonalny,
Bo daje się go racjonalnie badać

Logos (λόγος) was an important term in Greek philosophy.
Heraclitus established the term in Western philosophy as meaning both the source and fundamental order of the cosmos.
Aristotle applied the term to rational discourse. The **Stoic** philosophers identified the term with the divine animating principle pervading the Universe**.**
Philo of Alexandria adopted the term into Jewish philosophy.
In **Christian theology** LOGOS became a technical term.

LOGOS WSZECHŚWIATA

$$R_{ab} - \frac{1}{2} R\, g_{ab} = \frac{8\pi G}{c^4} T_{ab}.$$

$$\partial_t K = -\gamma^{ij} D_j D_i \alpha + \alpha(\tilde{A}_{ij}\tilde{A}^{ij} + \frac{1}{3}K^2) + 4\pi\alpha(\rho + S) + \beta^i \partial_i K$$

$$\partial_t \bar{\gamma}_{ij} = -2\alpha\tilde{A}_{ij} + \beta^k \partial_k \bar{\gamma}_{ij} + \bar{\gamma}_{ik}\partial_j \beta^k + \bar{\gamma}_{kj}\partial_i \beta^k - \frac{2}{3}\bar{\gamma}_{ij}\partial_k \beta^k.$$

$$\begin{aligned}\partial_t \bar{\Gamma}^i = & -2\tilde{A}^{ij}\partial_j \alpha + 2\alpha\left(\bar{\Gamma}^i_{jk}\tilde{A}^{kj} - \tfrac{2}{3}\bar{\gamma}^{ij}\partial_j K - 8\pi\bar{\gamma}^{ij}S_j + 6\tilde{A}^{ij}\partial_j\phi\right) \\ & + \beta^j\partial_j\bar{\Gamma}^i - \bar{\Gamma}^j\partial_j\beta^i + \tfrac{2}{3}\bar{\Gamma}^i\partial_j\beta^j + \tfrac{1}{3}\bar{\gamma}^{li}\beta^j_{,jl} + \bar{\gamma}^{lj}\beta^i_{,lj}.\end{aligned}$$

$$\begin{aligned}\partial_t \tilde{A}_{ij} = & \, e^{-4\phi}\left(-(D_i D_j \alpha)^{TF} + \alpha(R^{TF}_{ij} - 8\pi S^{TF}_{ij})\right) \\ & + \alpha(K\tilde{A}_{ij} - 2\tilde{A}_{il}\tilde{A}^l{}_j) \\ & + \beta^k\partial_k\tilde{A}_{ij} + \tilde{A}_{ik}\partial_j\beta^k + \tilde{A}_{kj}\partial_i\beta^k - \tfrac{2}{3}\tilde{A}_{ij}\partial_k\beta^k.\end{aligned}$$