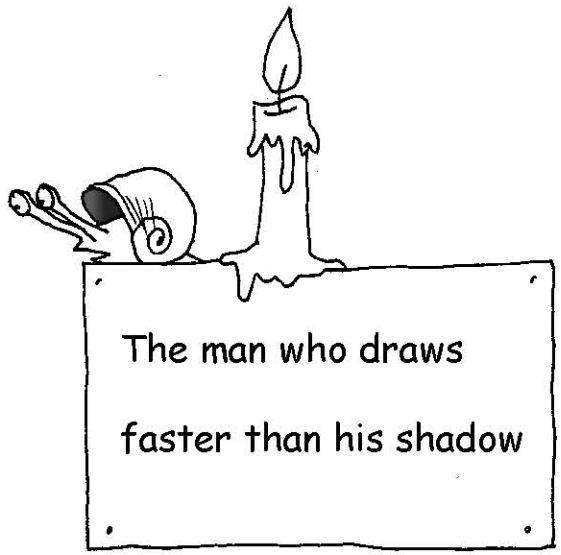
http://www.savoir-sans-frontieres.com

FASTER THAN LIGHT

Jean-Pierre Petit



2008

The Association Knowledge without Borders, founded and chaired by Professor Jean-Pierre Petit, astrophysicist, aims at spreading scientific and technical knowledge in as many countries as possible and in as many languages as possible. To this end, all his popular scientific works, which cover a period of thirty years, and more particularly the illustrated albums he has created, are now freely accessible. Anyone is now free to duplicate the present file, either in digital form or in the form of printed copies and circulate these copies to libraries , within the context of schools or universities or associations whose aims would be the same as the association , provided that they do not derive any profit from this circulation and that they do not have any political, sectarian or confessional connotations. These pdf files may also be put on line in the computer networks of school and university libraries.

Jean-Pierre Petit intends to create numerous other works which will be accessible to a larger audience. Even illiterate people will be able to read them because the written parts will “speak” when the readers click on them. Thus it will be possible to use these works to support literacy schemes. Other albums will be "bilingual" in so far as it will be possible to switch from one language to another selected language with a mere click. Hence another tool made available to develop language skills.

Jean-Pierre Petit was born in 1937. He made his career in French research. He worked as a plasma physicist, he directed a computer science centre, he has created softwares, he has published hundreds of articles in scientific magazines, dealing with subjects ranging from fluid mechanics to theoretical cosmology. He has published about thirty books which have been translated in numerous languages.

The association can be contacted on the following internet site:

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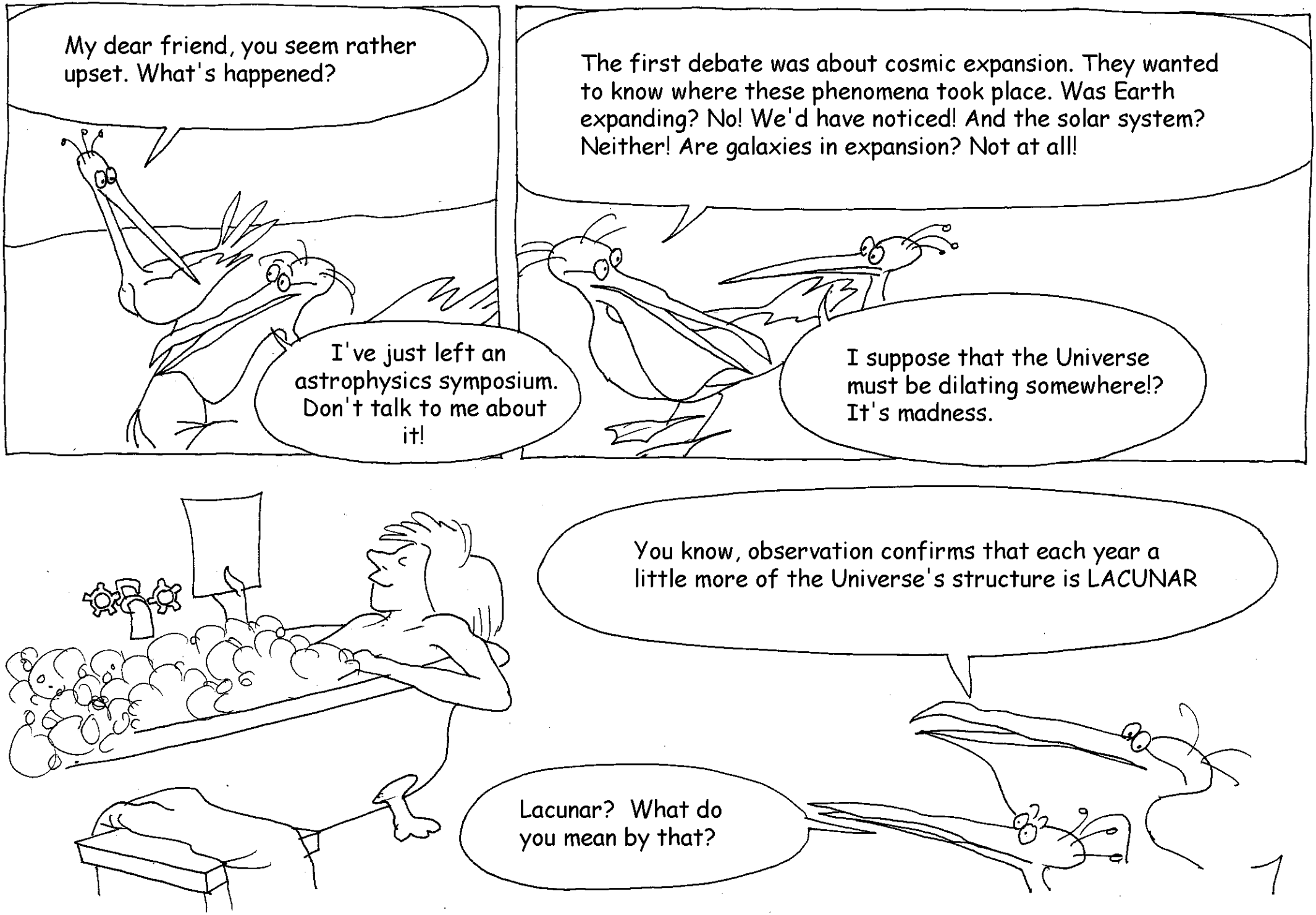

My dear friend, you seem rather upset. What's happened?
I've just left an astrophysics symposium. Don't talk to me about it!
The first debate was about cosmic expansion. They wanted to know where these phenomena took place. Was Earth expanding? No! We'd have noticed! And the solar system? Neither! Are galaxies in expansion? Not at all!
I suppose that the Universe must be dilating somewhere!? It's madness.
You know, observation confirms that each year a little more of the Universe's structure is LACUNAR
Lacunar? What do you mean by that?
1

After discovering that galaxies could assemble into **CLUSTERS**, like the Virgo cluster, or the Coma cluster, which contain a thousand galaxies, we thought that the universe might present a **HIERARCHICAL** structure.

What's amusing in the scientific world is the fact that words appear, inflate, and then pop like bubbles. There was a time when the word super-cluster never left their lips. Then, suddenly, pfft! It disappeared!

Exactly!

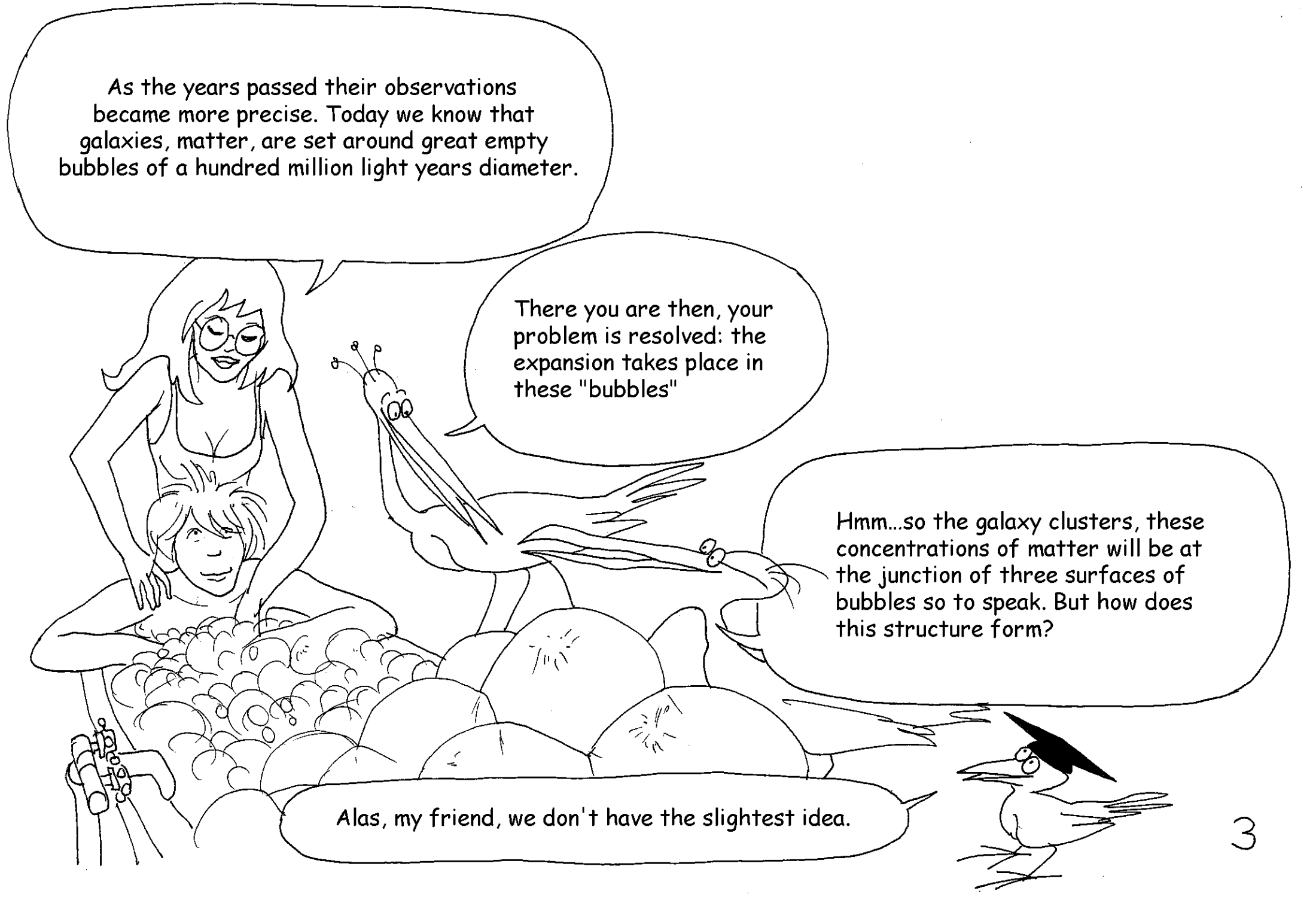
I suppose it is because they've never found them.

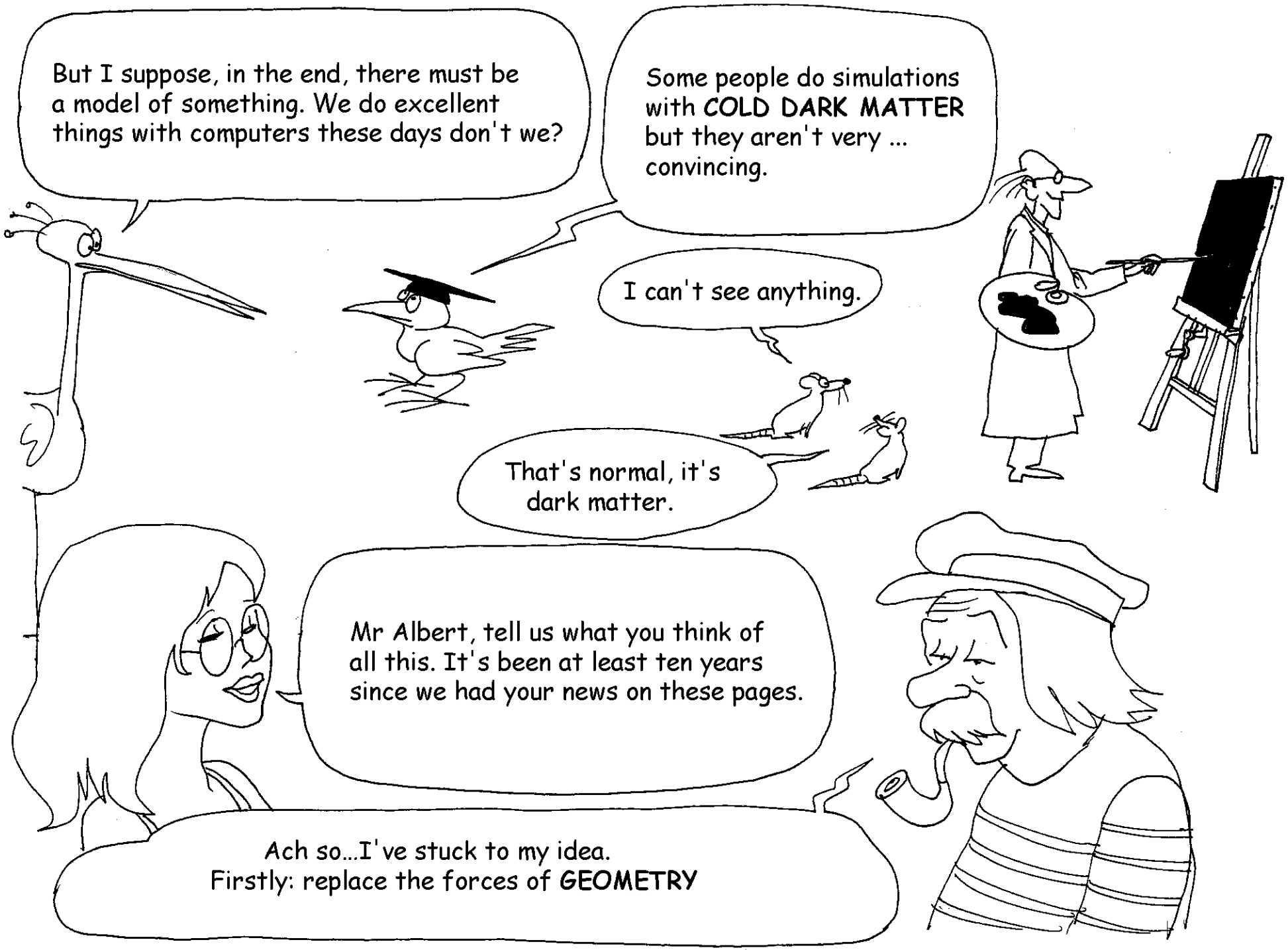
However astronomers did discover a place where galaxies were assembled according to a sort of plate, that they called THE GREAT WALL.

We started looking for **SUPER-CLUSTERS**, "clusters of clusters" etc.

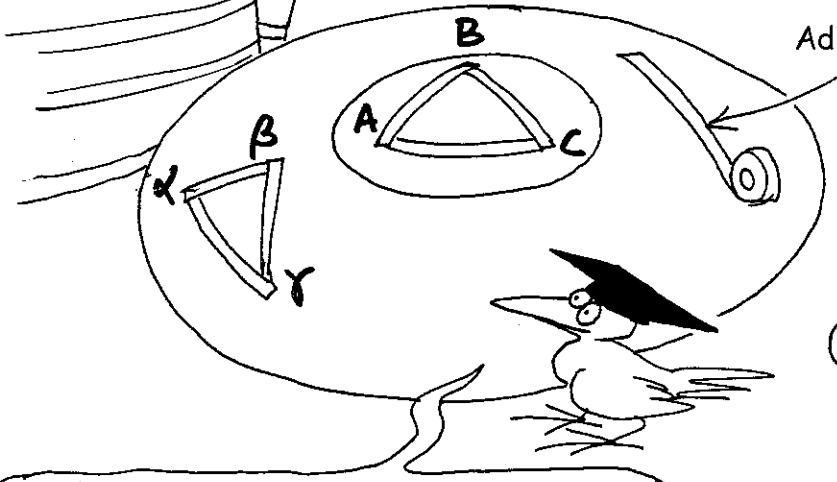
And what did they find?

In other words, in this "plate" there were lots of galaxies and around it was empty?


As the years passed their observations became more precise. Today we know that galaxies, matter, are set around great empty bubbles of a hundred million light years diameter.
There you are then, your problem is resolved: the expansion takes place in these "bubbles"
Hmm...so the galaxy clusters, these concentrations of matter will be at the junction of three surfaces of bubbles so to speak. But how does this structure form?
Alas, my friend, we don't have the slightest idea.

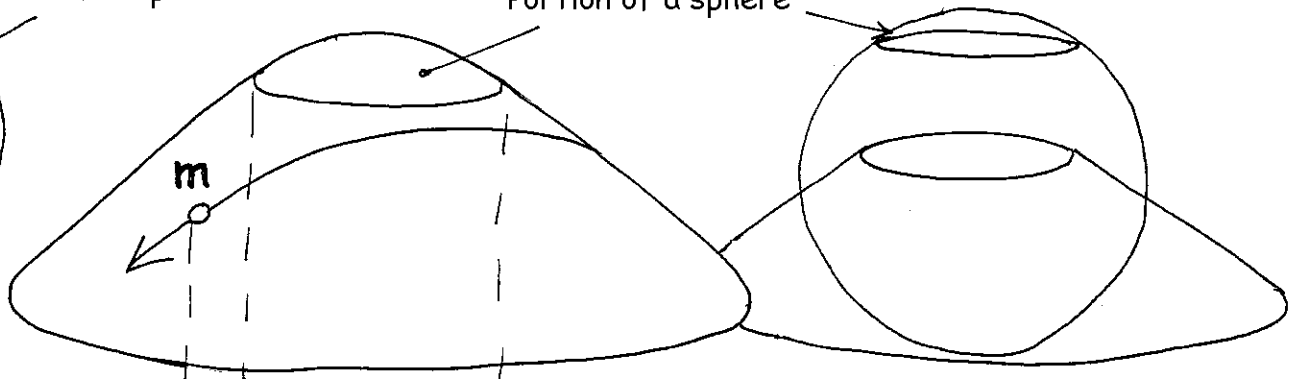

But I suppose, in the end, there must be a model of something. We do excellent things with computers these days don't we?
Some people do simulations with COLD DARK MATTER but they aren't very ... convincing.
I can't see anything.
That's normal, it's dark matter.
Mr Albert, tell us what you think of all this. It's been at least ten years since we had your news on these pages.
Ach so...I've stuck to my idea.
Firstly: replace the forces of GEOMETRY

Take an object of mass **M**, a star, a planet, anything with a mass **m** orbiting in proximity. Its trajectory is influenced by the force of attraction, Newtonian, that mass **M** exercises on it. We could replace it, in two dimensions, by a blunted cone. Using adhesive tape we can inscribe a **GEODESIC** on its surface which, when projected onto a plane, will give the same trajectory. The mass is then a portion of space (the spherical cap) which possesses a certain **curvature**.

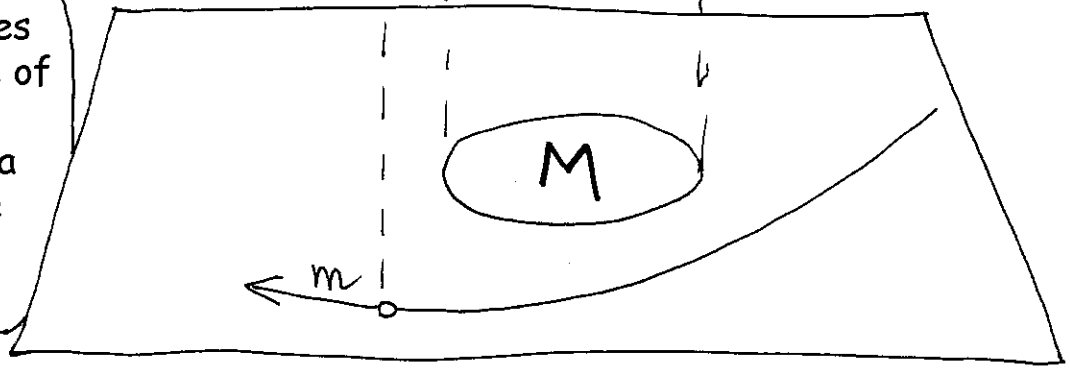


Adhesive tape

Portion of a sphere



Portion of a cone



Reminder (*): The sum of the angles of a triangle drawn on the surface of the blunted part is $\hat{A}+\hat{B}+\hat{C} > \pi$ whereas the sum of the angles of a triangle drawn on the trunk of the cone is $\hat{\alpha}+\hat{\beta}+\hat{\gamma} = \pi$

-*) See EUCLID RULES OK ? and BLACK HOLE

As **MASS** = **CURVATURE**, we are in agreement, if the universe is **LACUNAR** it means that it's **PAVED** with 3d space regions presenting curvature separated by **NON-CURVED**, flat, Euclidian regions. That's right isn't it?

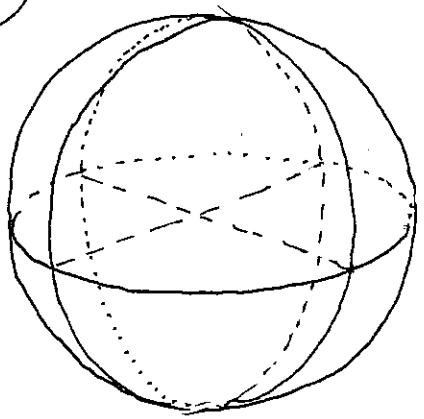
Of course, but what are you getting at?

This lad never stops...

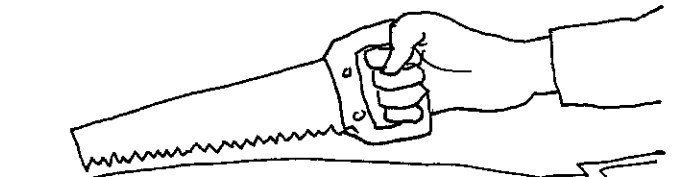
It's...hmm...exact but it would be very difficult to join portions of 3d curved space with portions of 3d Euclidian space?

Yes but as in your picture earlier, we can do it in 2d.

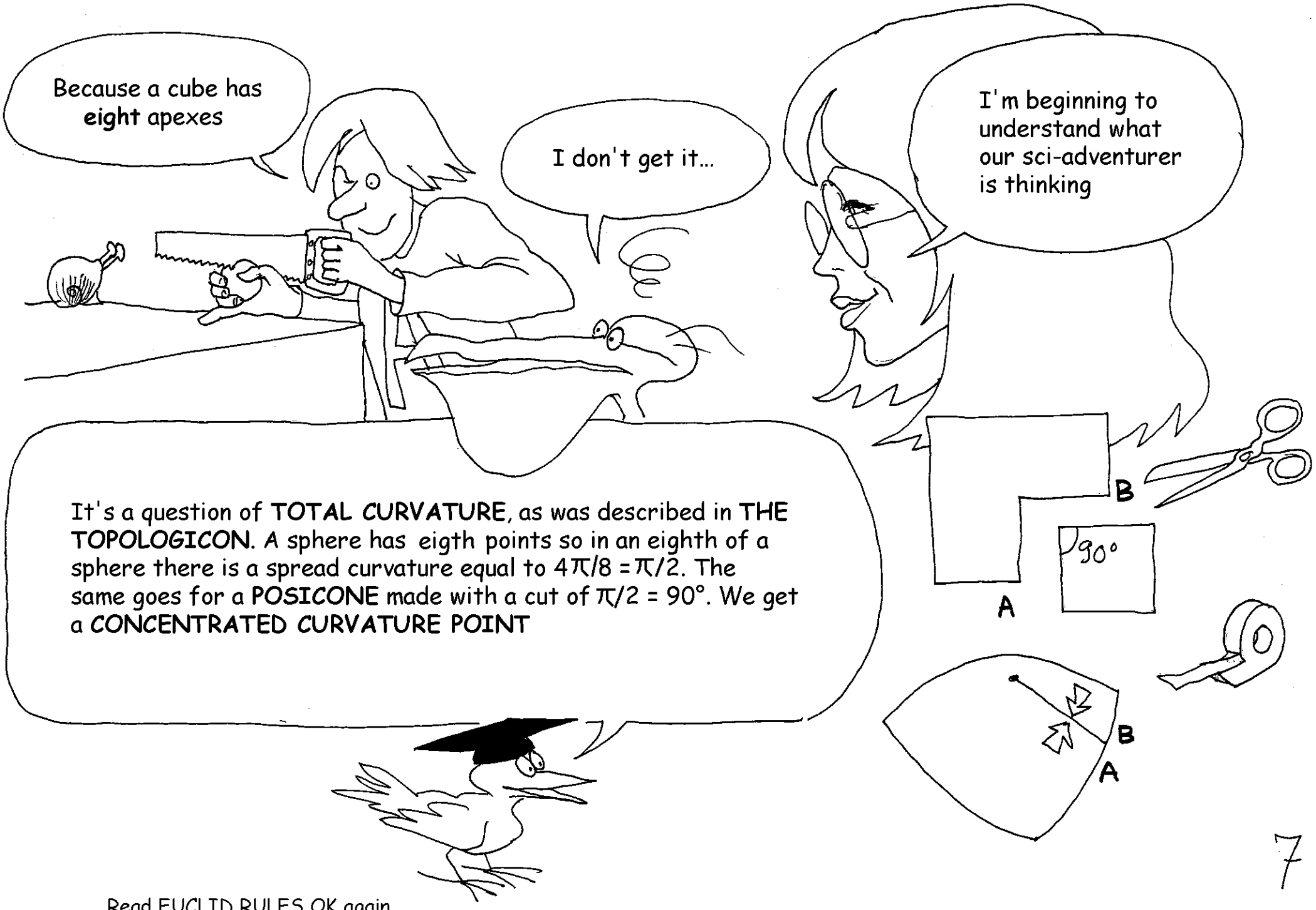
Look, I take a ping-pong ball



I cut it in eight

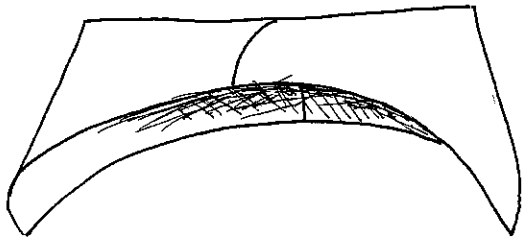


Why eight?

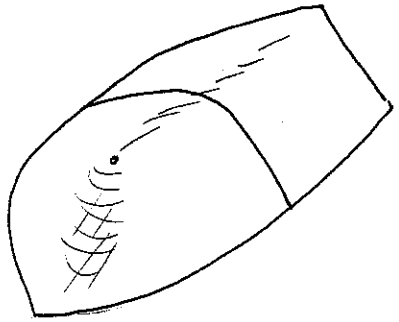


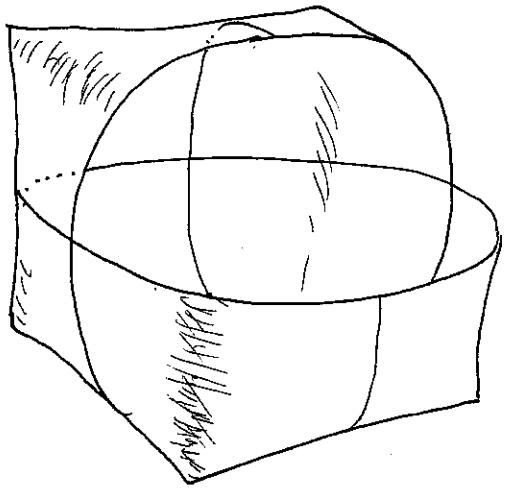
Read EUCLID RULES OK again

A CUBE WITHOUT EDGES

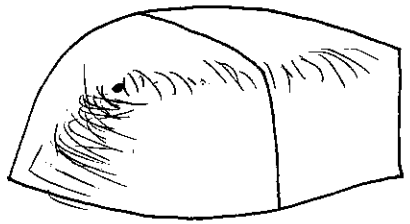


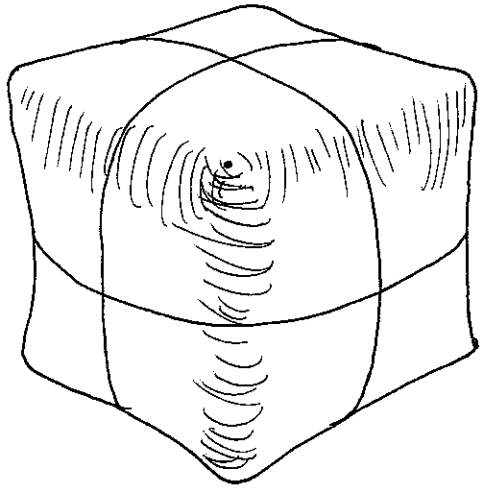
Two joined POSICONES



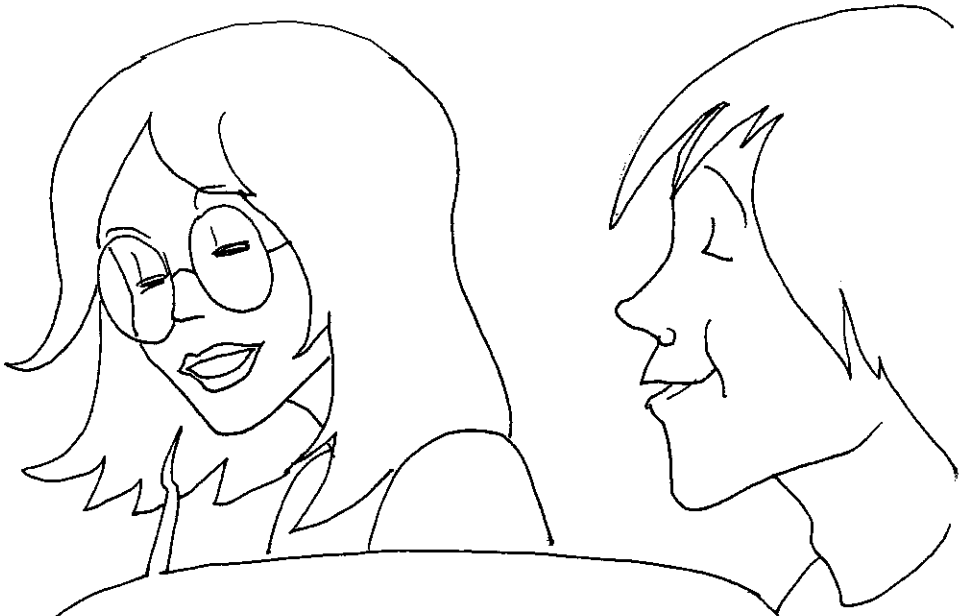


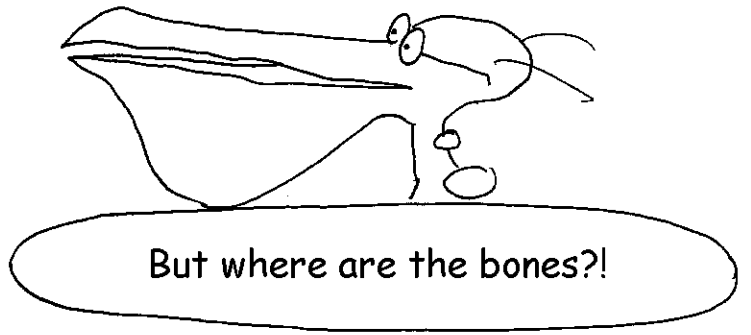
Six...,



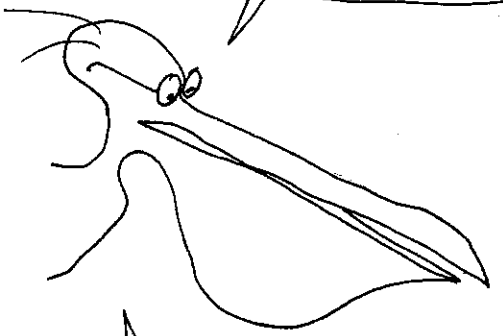


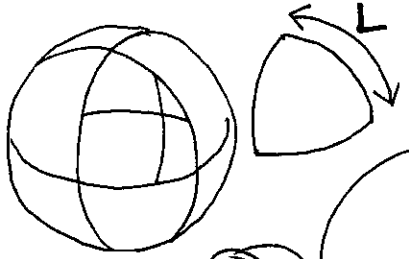
Eight...,





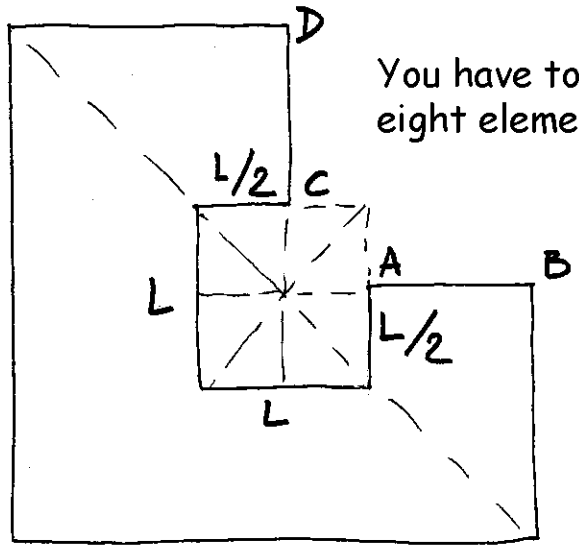
Very pretty. But what are we supposed to do with the eighths of the ping-pong ball?



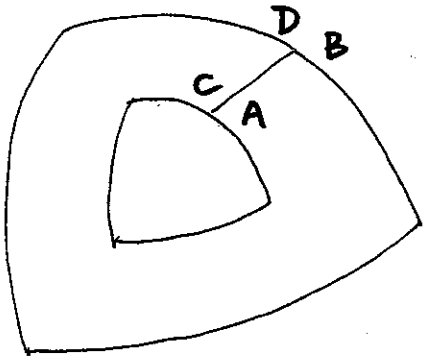


No, no, I understood. You'll see.

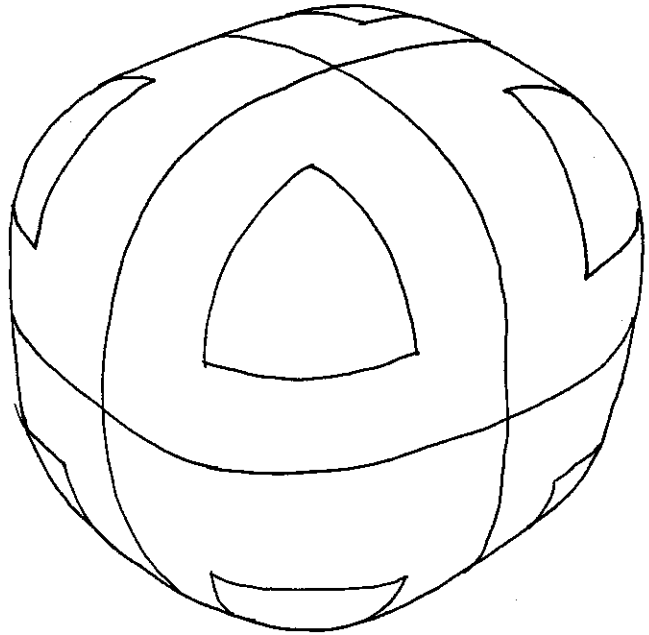
You have to prepare eight elements like this:



I must have missed something

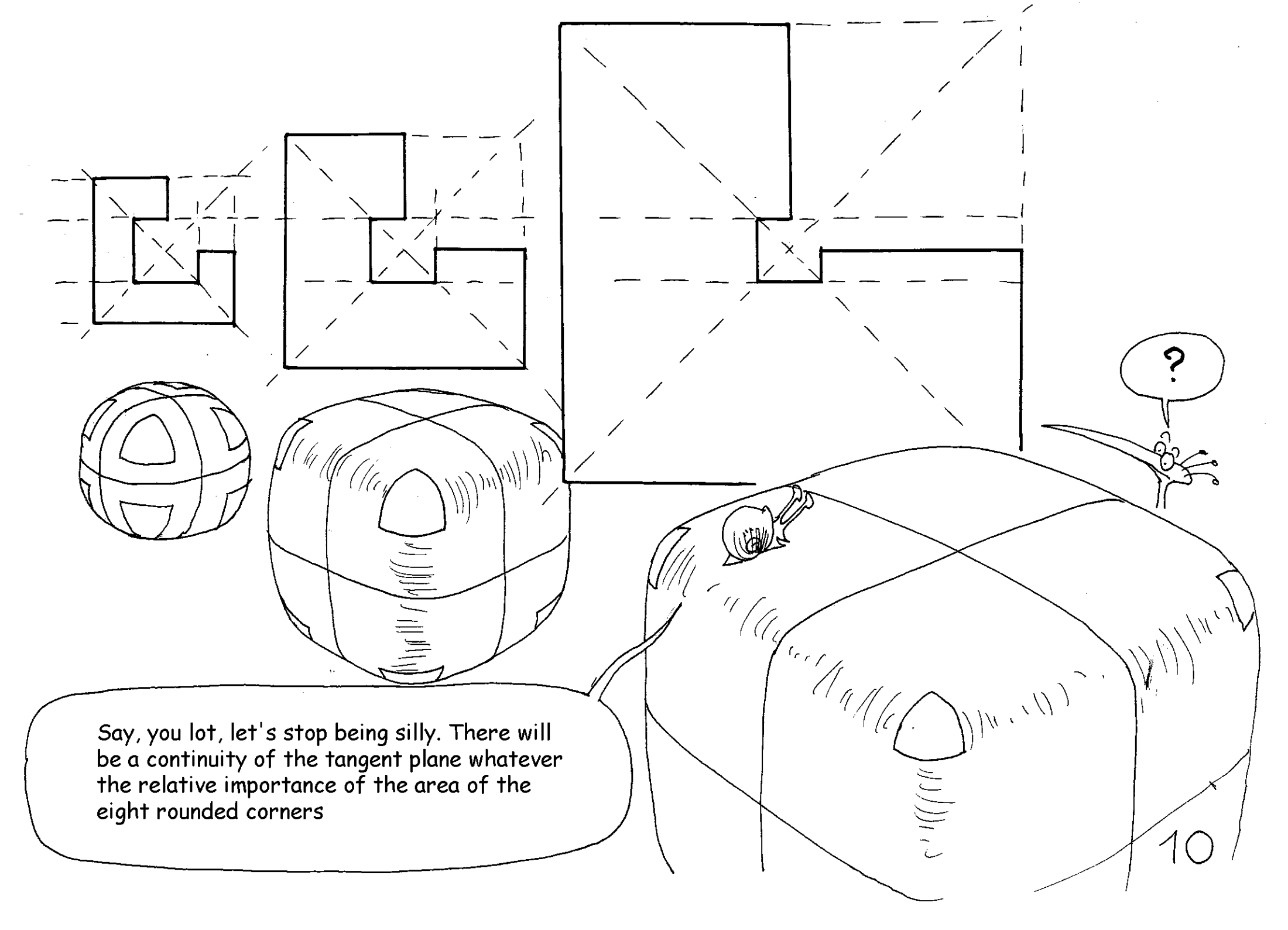


Now all we have to do is adapt the spheroidal corners.



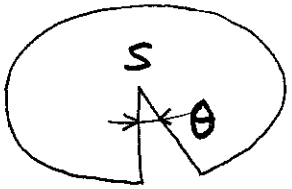
The tangent planes join !!!

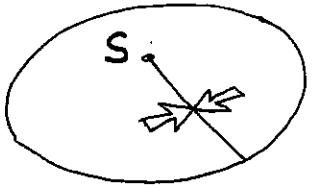
Hmm, a bit of luck

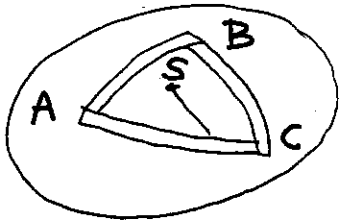

?
Say, you lot, let's stop being silly. There will be a continuity of the tangent plane whatever the relative importance of the area of the eight rounded corners

But ... why? ...

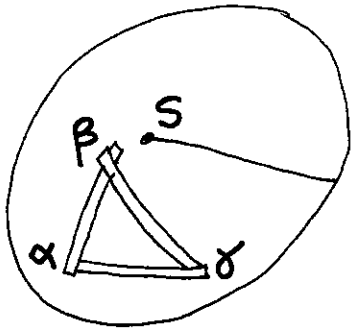
(*) Go back and re-read the comic books you've appeared in over thirty years (THE BLACK HOLE, page 8 onwards). You are creating a POSICONE by making a cut at and angle θ . If you draw a triangle with three geodesics there will be two possibilities. Either the triangle contains the sum S, in which case the sum of the angles is $\theta + \pi$, or it doesn't contain it and the sum of the angles at the apex is the EUCLIDIAN SUM which equals π If you stick together two posicones corresponding to cuts of $\theta 1$ and $\theta 2$, the sum of the angles of a triangle containing the two summits S1 and S2 will be the Euclidian sum increased by $\theta 1 + \theta 2$



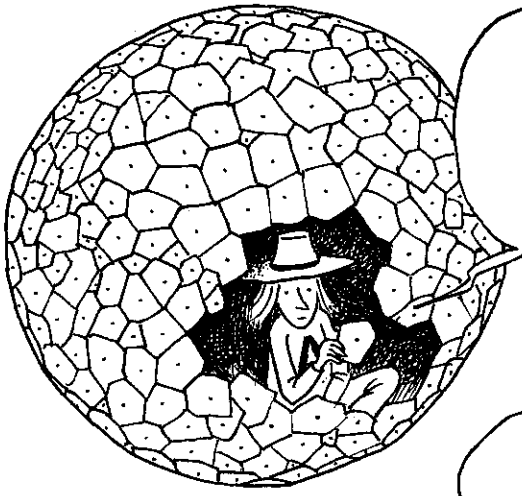




$\hat{A} + \hat{B} + \hat{C} = \pi + \theta$



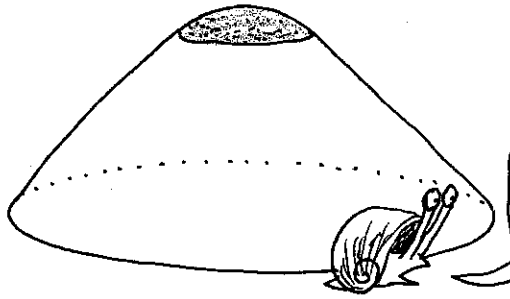
$\hat{\alpha} + \hat{\beta} + \hat{\gamma} = \pi$



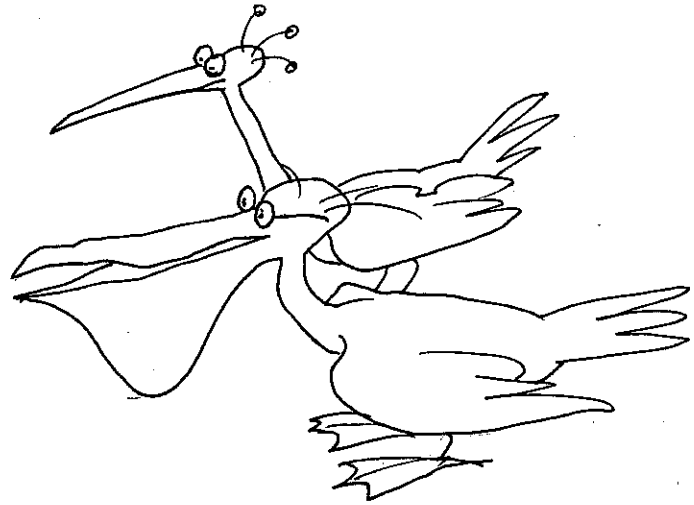
By assembling a number N of microcones with angles of θ as regularly as possible I observe that when $N \times \theta = 720°$. I get... a sphere.

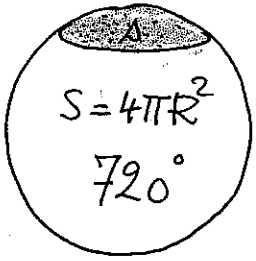
That's normal. The value of the TOTAL CURVATURE of a sphere is 720°.

Now come out of there my friend.



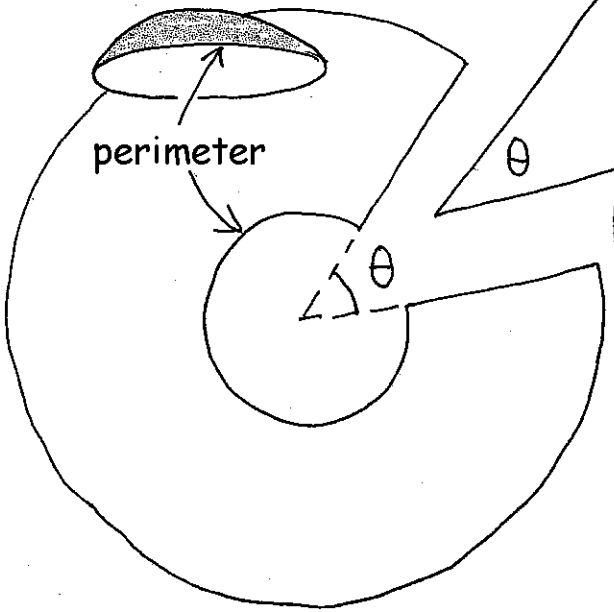
When you want to put a curved thing into the Euclidian you just have to make sure that the curvatures are compatible. For example, suppose that you wanted to make a blunted cone.



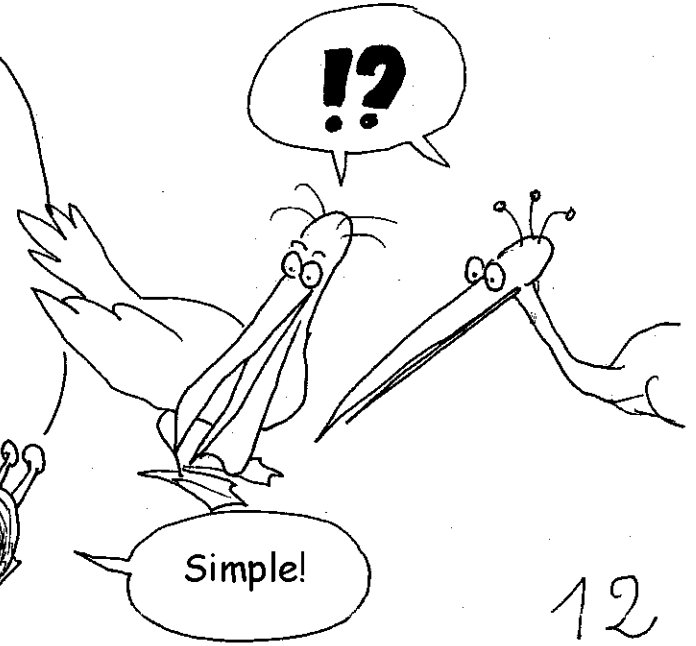


The quantity of curvature contained in the spherical cap is equal to:

$$\theta = 720° \times \frac{S}{4\pi R^2}$$

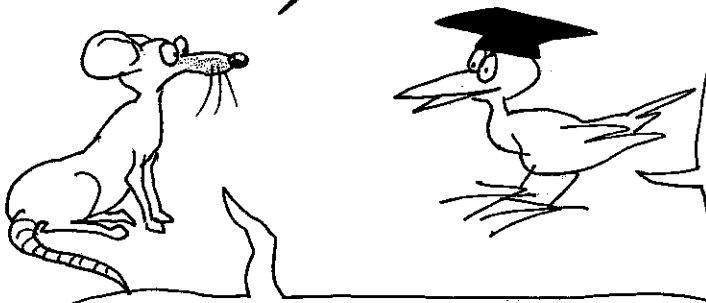


The flank of the blunted cone is a part of a cone corresponding to a cut at this angle θ . You just have to cut the top of the cone in such a way that the perimeters adjust with each other and Bob's your uncle.



MATTER, VACUUM ...

So, If I understand it, in the Universe matter occupies sorts of islets with lots of emptiness around or between. But emptiness, the **VOID**, what is it?



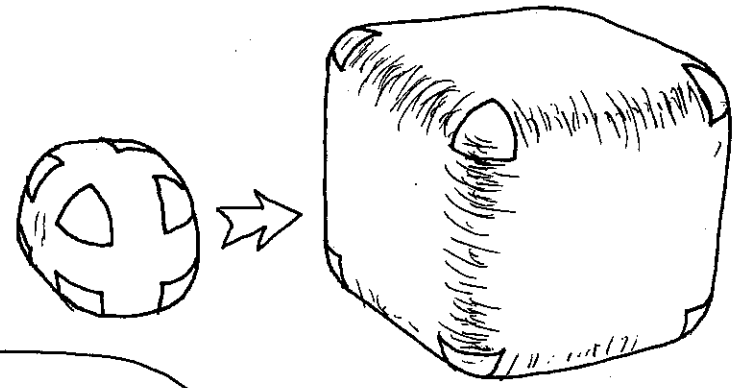
For a physicist, the perfect void, full of **NOTHING**, cannot exist. For that the entire universe would need to be at absolute zero. This perfect emptiness would be impossible to isolate, even with a perfectly hermetic surround for this would radiate and the "void" would fill with photons emitted by its 'wall' (*).

In other words, these great voids between galaxies are full of photons emitted by... the stars.

It is worth rereading BIG BANG. Observations made in 1967 have shown the presence of a great number of photons in the universe (a thousand million times more numerous that particles of matter) which form the **COSMOLOGICAL BACKGROUND RADIATION at 3K**. Bumping into each other, the photons constitute what we call the "cosmic void" and they are what populate these 100 million light year diameter bubbles.

(*) Corresponding to $h\nu = hc/\lambda = kT$ where T is the absolute temperature of the wall, c the speed of light, h Planck's constant and k, Boltzmann's constant.

In sum, the image proposed by Archibald that of a cube with rounded corners of constant area made from eights of a sphere and joined by and extendable surface, a "void" made up of "joiner photons", is not such a bad one.



But photons move. I don't get this image of a "tissue of joiner photons".

You're right, waves also move. Perhaps it would be better to imagine a sort of "CLAPBOARD" constantly agitated by the waves and whose wavelength is five millimetres (*)

So, if this "**CLAPBOARD**" dilates, it means that new waves will appear.

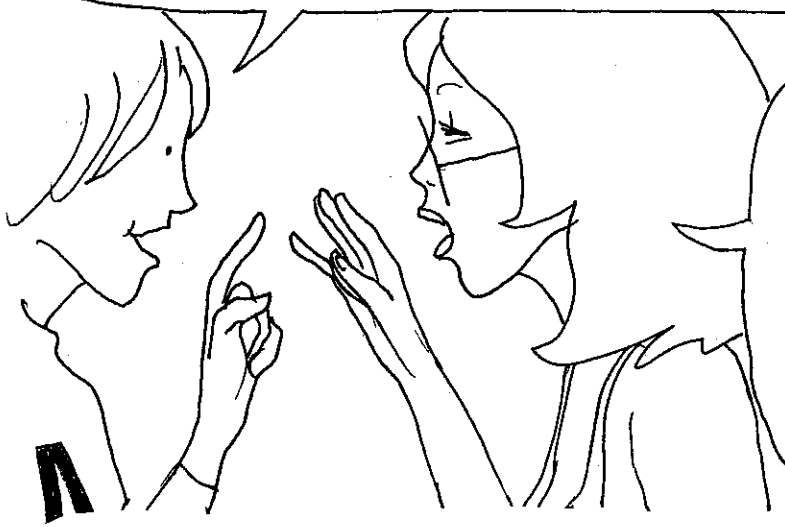
(*) $\lambda = \frac{hc}{kT}$; $h = 6{,}63\,10^{-34}$

$c = 3\,10^{8}\ m/s$; $k = 1{,}38\,10^{-23}$

$T = 3°K \Rightarrow \lambda = 5\,10^{-3}\ m$

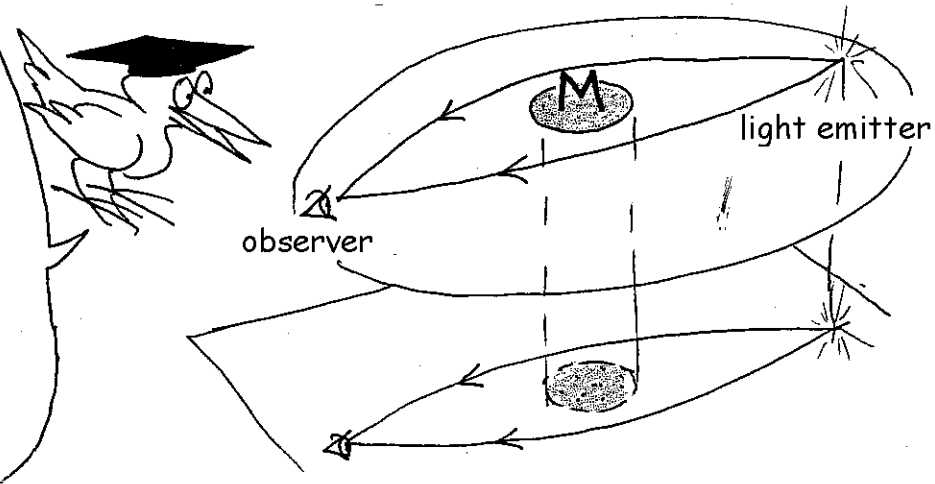
No, it's the "waves" which dilate. The λ wavelength of these "cosmological" photons increases with the dimension R of the Universe.

Sophie, the energy contained in the Universe is the sum of all the particles of mass **m**, so mc^2, which doesn't vary if **m** and **c** are constants, and the energy $h\nu = hc/\lambda$ of the cosmological photons. If their number doesn't vary then their wavelength λ increases with the **CHARACTERISTIC DIMENSION R** of the universe which means that their energy decreases. Therefore **THE COSMOS IS LOSING ENERGY**



Don't imagine that everything is as simple and as good. Understood? The **COSMOLOGICAL MODEL** is a simple **GEOMETRIC OBJECT**, a solution of **EINSTEIN'S EQUATION** which is incapable of handling the existence of particles; those are dealt with by **QUANTUM MECHANICS**. And as you know, their marriage hasn't yet been consummated.

In other words, we take a **HYPERSURFACE 4d** and we put particles in it, in supposing that these follow geodesics. This **HYPOTHESIS** allows **PREDICTIONS** to be made. As for the photons: their deviation by a mass produces the **GRAVITATIONAL LENSING EFFECT**, as confirmed by observation in 1915 during a total solar eclipse.

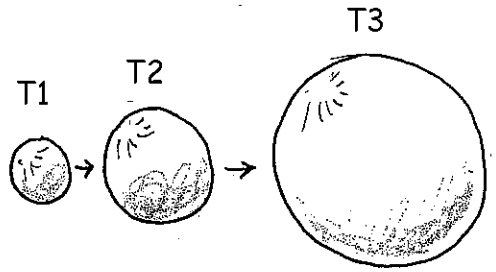


GRAVITATIONAL MIRAGE effect

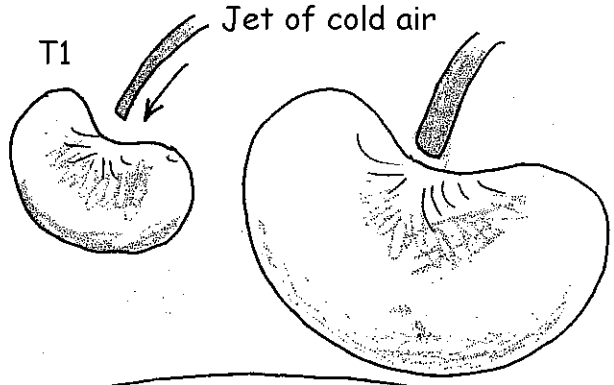
COSMOLOGICAL MODEL

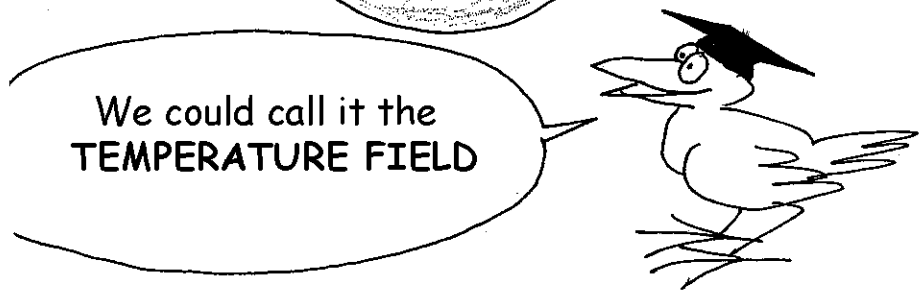
A COSMOLOGICAL MODEL is a solution to a field equation such as EINSTEIN'S equation S⇐ xT which should be read in the "direction of the arrow". **T** represents the Universe's **CONTENT OF ENERGY-MATTER** which **DETERMINES THE GEOGRAPHY** of a four dimensional **HYPERSURFACE**, which will be **SPACE-TIME**. Let us show how the distribution of energy in an object can determine its geometry. Imagine an enclosure in the shape of a sphere at ordinary temperature. Let us now heat it in a non-uniform manner, by putting it in a gaseous atmosphere that is becoming increasingly hotter for instance but at the same time cooling part of it with a jet of cold air. The object will dilate and its shape, its geometry, will depend on the value of the temperature at every point in the metal enclosure.

The Management



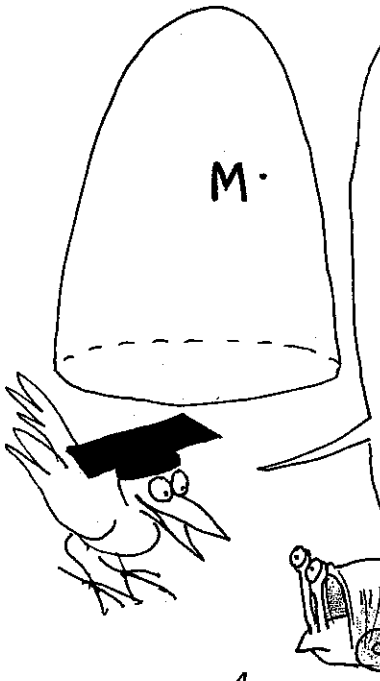
A hollow sphere, in metal, placed in a gaseous atmosphere with increasing temperature will dilate while conserving its **SPHERICAL SYMMETRY**. But if, for example, locally part of this dilation is thwarted with a jet of cold air, it'll start to look like a peanut.



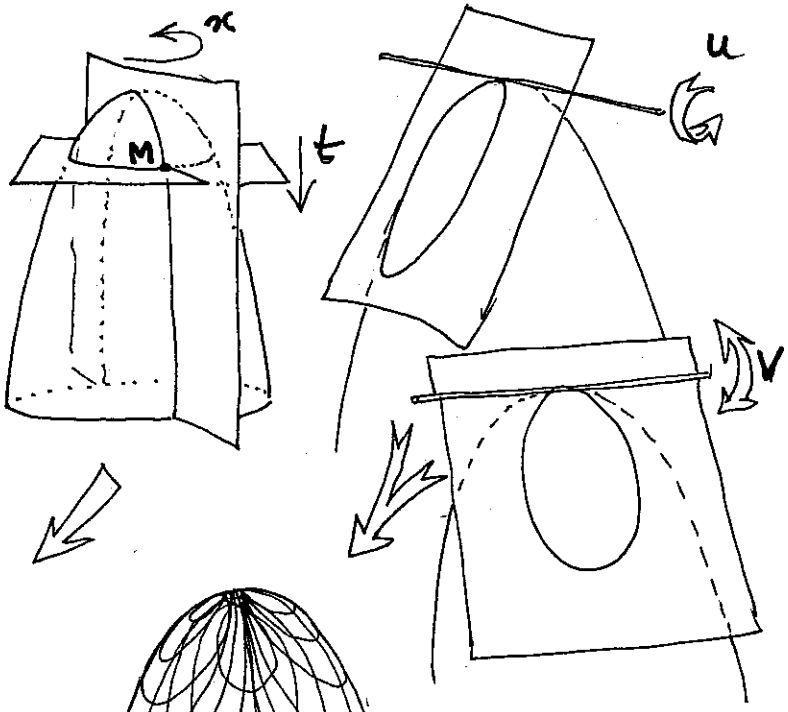


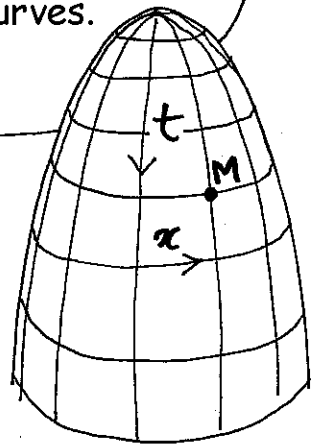
Archibald has built a 2d geometric model of an inhomogeneous universe with regions that don't dilate surrounded by immense expanding voids. This is one of the key aspects of the cosmos as we know it today. Before, cosmologists represented the universe a sort of gas, uniform, whose "molecules" were the galaxies (*). This model has had its day. But no one today is capable of building a solution to Einstein's equation which doesn't have the symmetry of the S3 sphere. People have therefore tried to describe a fundamentally inhomogeneous world, lacunar, by invoking perfectly "smooth", homogenous solutions. When we use Einstein's field equation to build a solution, it is a four dimensional hypersurface. We still need to MAP it, put a system of coordinates (x,y,z,t) on it. The first three refer to the **POSITION** of a point of the hypersurface and the 4th is supposed to represent TIME. That's when GEOMETRY passes the relay baton to the **PHYSICIST**.

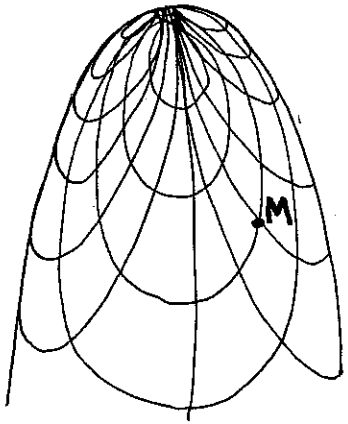
CARTOGRAPHER



Let us consider a surface with a parabolic shape, a "pat of butter". We can get the position of a point **M** with the help of two numbers, that we'll call **COORDINATES**. But for the same surface there is infinity of choices of possible **SYSTEMS OF COORDINATES**. For example, we can cut this with two families of planes, the sections being made up of two families of curves.

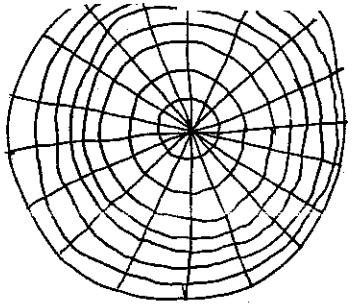


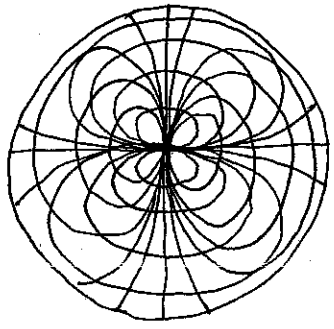




If this pat of butter is supposed to make an image of a 2d space-time then there has to be a particular choice of coordinates which unambiguously define **SPACE** and **TIME**, isn't it?

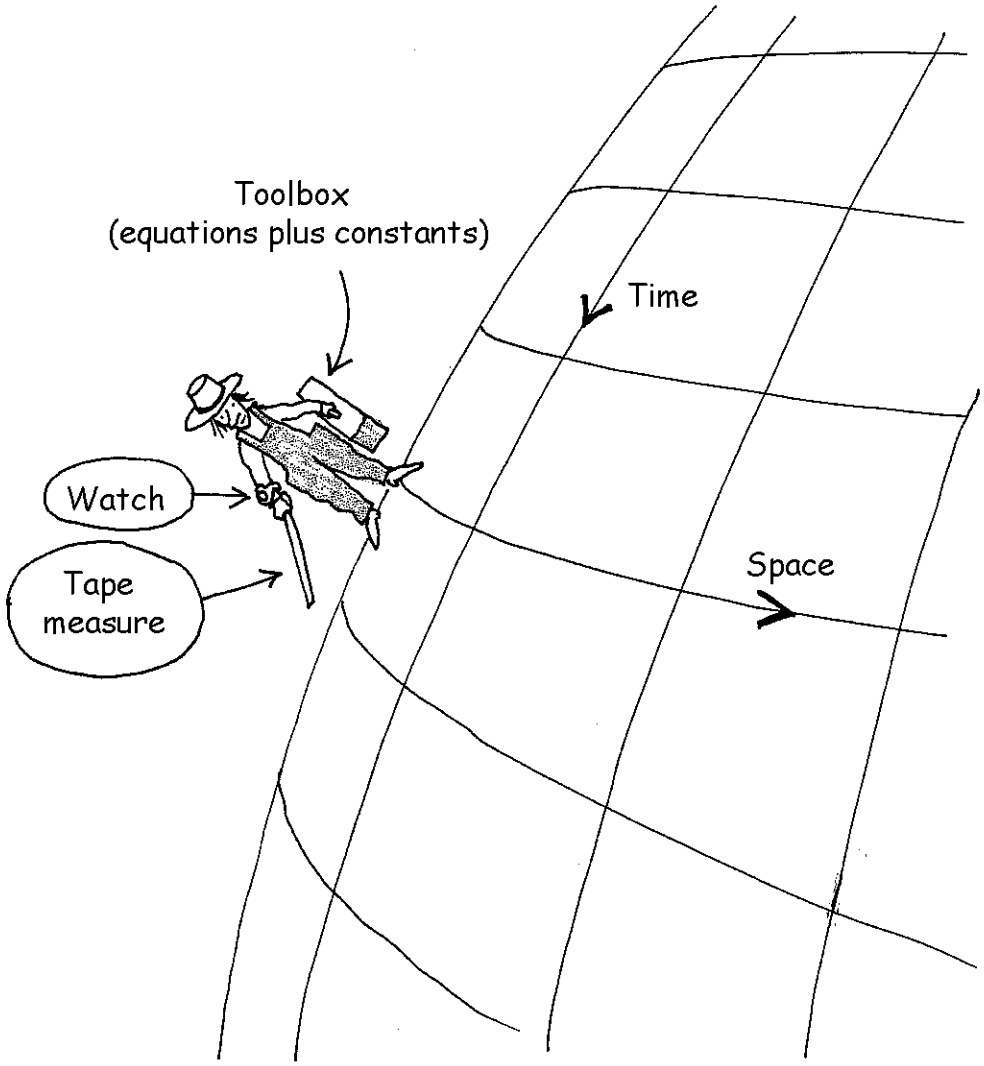
Seen along the axis





DRAW ME A SHEEP (*)

One of the major paradigm changes to have taken place at the start of the century was the consideration that we do not live in a **3d SPACE TIME** but in a 4d **HYPERSURFACE**. During the same period new equations completed those we already possessed, such as the equation of Maxwell, of electromagnetism. **NEW PHENOMENA** but a new collection of observables, such as the electric charge. The physicist had got himself a "toolkit" made up of a set of interdependent equations in which figure "constants"



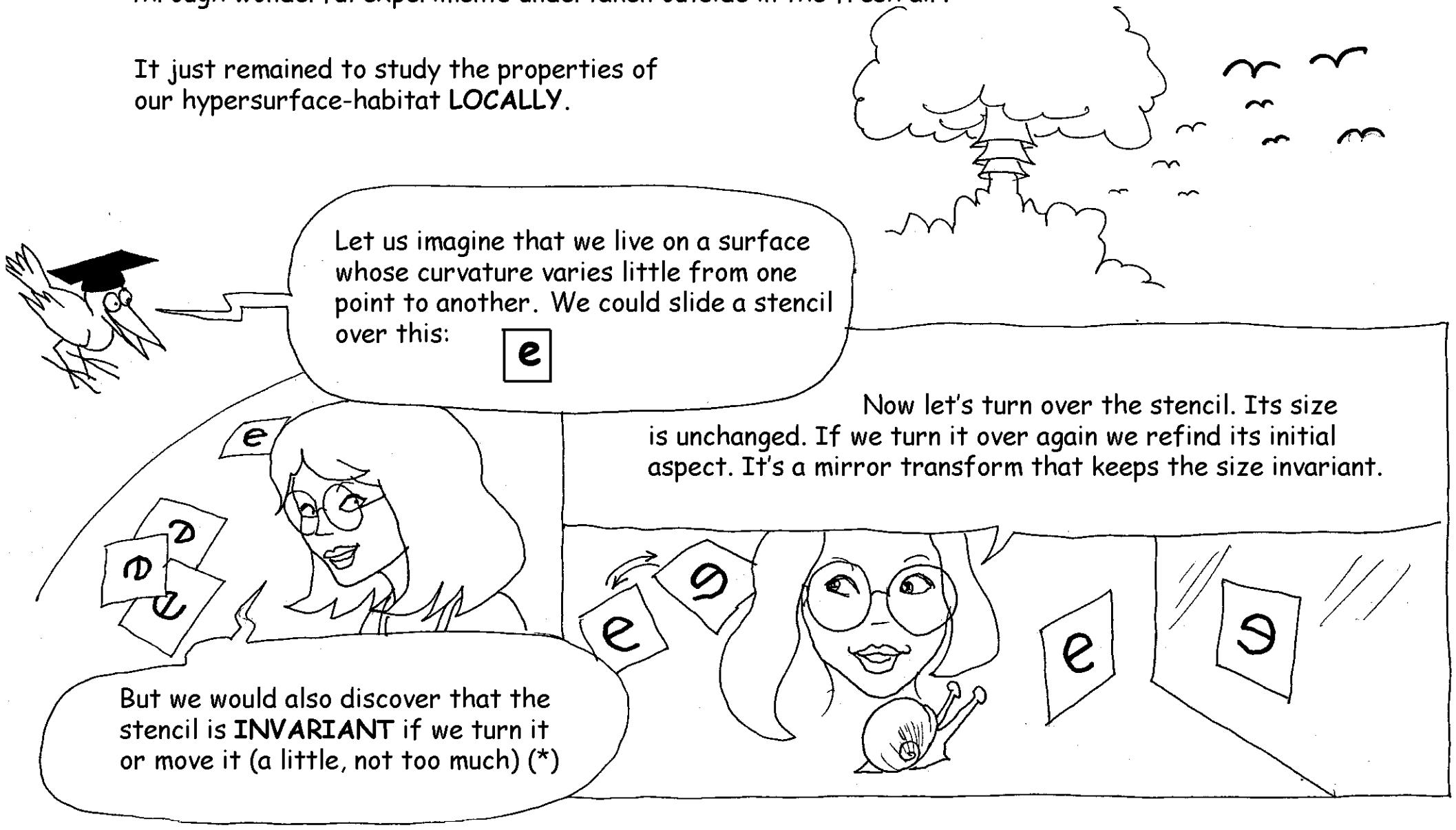
G: Gravitational constant
c: Speed of light
m: elementary masses (nucleons, electrons)
h: Planck's constant
e: elementary electric charge
μ : "magnetic permeability of the void"
α : Fine constant structure (atom geometry)

We discovered that there were the same atoms everywhere in the universe, that they evolved, had a past and a future, and that we live in a minuscule portion of space-time.

(*) " Le Petit Prince "
d'Antoine de Saint-Exupéry
France

We discovered that **RADIATION** and **MATTER** were simply two manifestations of the same entity, **ENERGY-MATTER**, according to the famous law of balance $E=mc^2$, and people quickly began to check through wonderful experiments undertaken outside in the fresh air.

It just remained to study the properties of our hypersurface-habitat **LOCALLY**.



(*) We could say that this space is locally invariant by GROUPS of ROTATIONS and TRANSLATIONS

My dear Tiresias, did you know that your shell is not identical to its mirror image? Are you a "left" or a "right" snail?

!!!

In fact, do such populations actually exist in nature?

We don't discuss politics in these comic books !

This symmetry brings to mind the **MATTER-ANTIMATTER DUALITY** (*), which inverses, in particular, the electric charge.

$$\ominus = -e$$

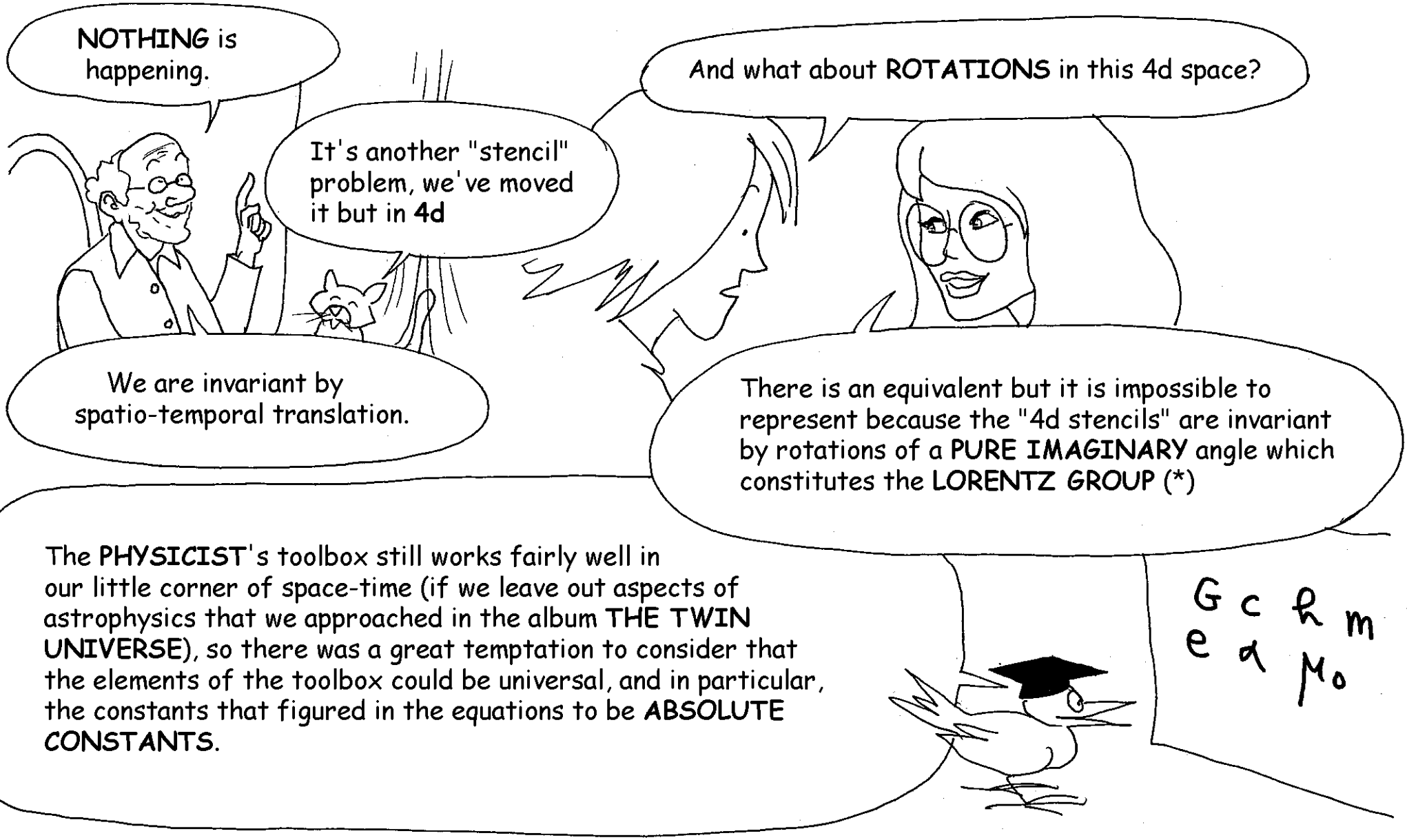
The fact that the character's size hasn't changed illustrates the fact that the mass of an antimatter particle is the same as that of the particle for which it constitutes its symmetric.

$$m = m$$

All particles: neutrons, mesons, quarks etc., possess their antiparticles, except the **PHOTON** which is its own antiparticle.

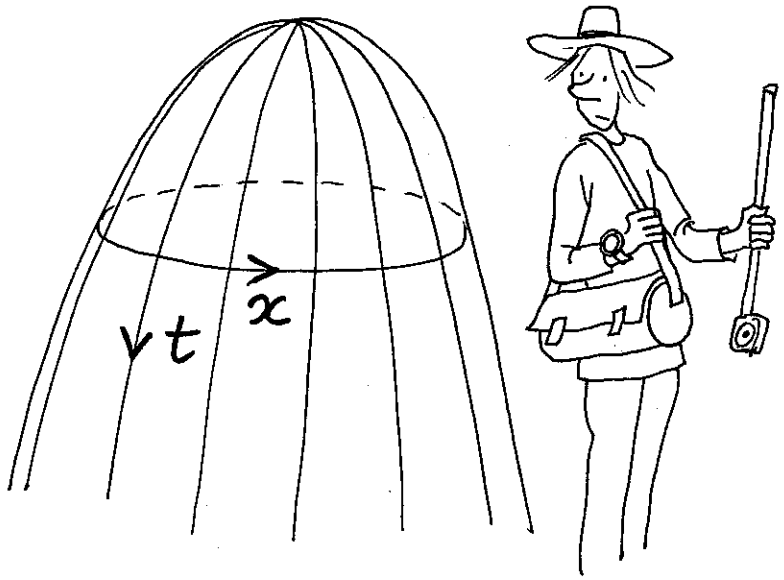
Now let's come to our space-time. I suggest that you do a very simple experiment. Go to a different room in your home, pull the curtains and wait (*)

(*) Experiment imagined by the French mathematician Jean-Marie Souriau.

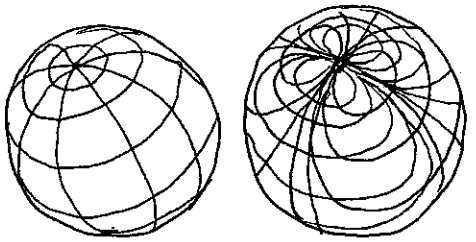


(*) By itself this property of "Lorentzian invariance by rotations» sums up all the very disconcerting aspects of the theory of SPECIAL RELATIVITY

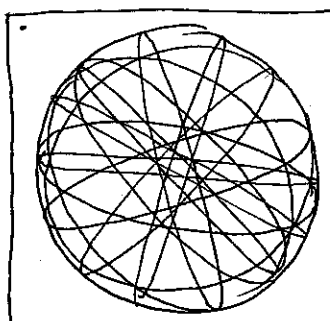
BIG BANG



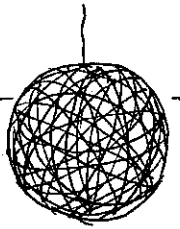
In the hypersurface that constitutes the solution to EINSTEIN'S equation there are particular curves which remain the same no matter what system of coordinates is chosen, they are **GEODESICS**. The same infinity of geodesics that can be inscribed on a sphere is independent if the coordinate system used to mark them on a surface.



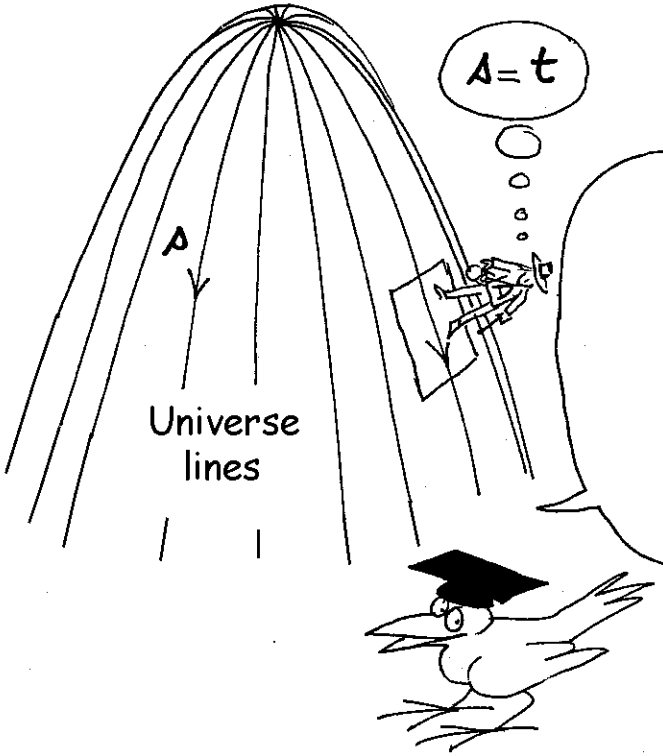
Groups of coordinates



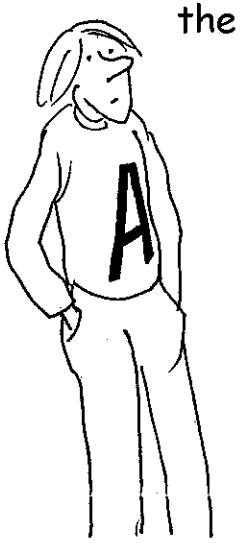
Geodesics:
The infinity of **Great Circles** of the sphere.



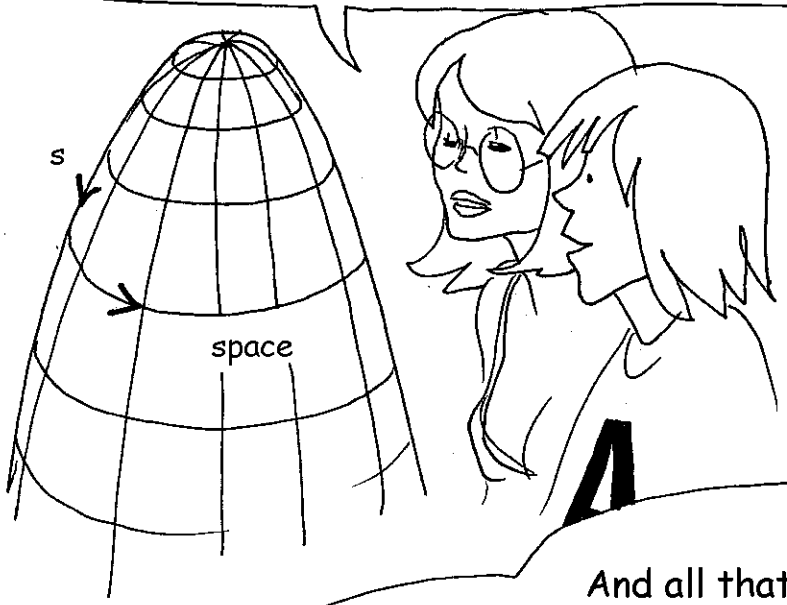
Luster created by the geodesics

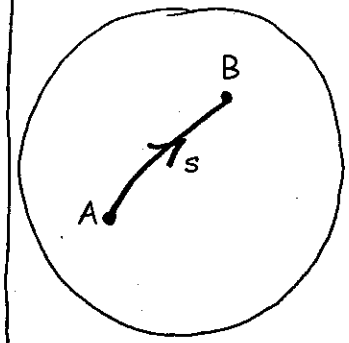


A family of geodesics in the hypersurface is chosen, converging towards a point. We decided to identify the curved abscissa **s**, measured along the curves and re baptised **UNIVERSE LINES**, will be identified as a **COSMIC TIME t**.



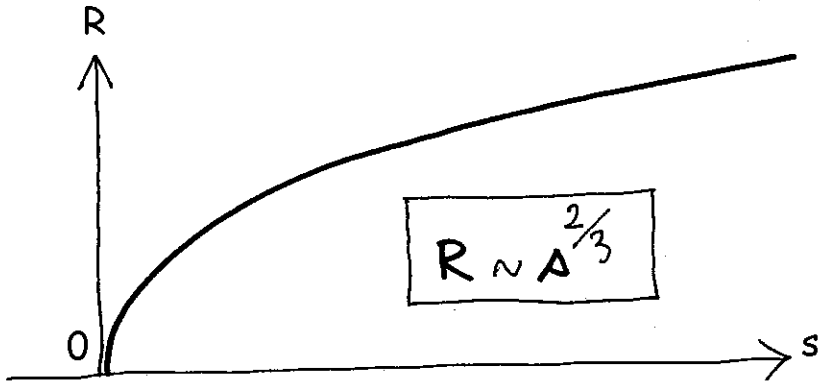
Perpendicular to these lines there is a three dimensional hypersurface, constituted by points situated at the same **EPOCH** s that we identify as PHYSICAL space.
2d image opposite.





The quantity s has an **INTRINSIC CHARACTER**. Over any trajectory AB drawn on the sphere, the distance covered is **s**.

The cosmological model, also called the **STANDARD MODEL** is a solution

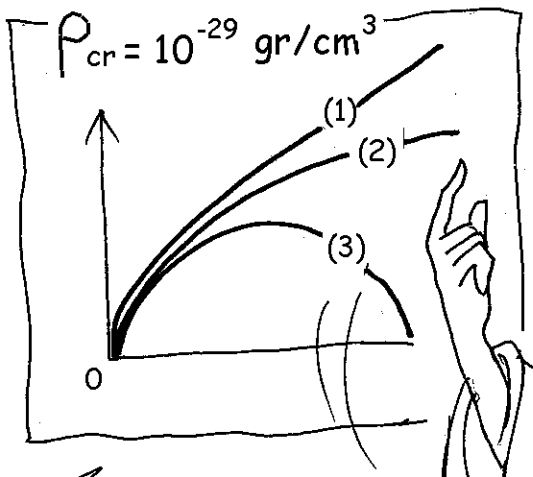


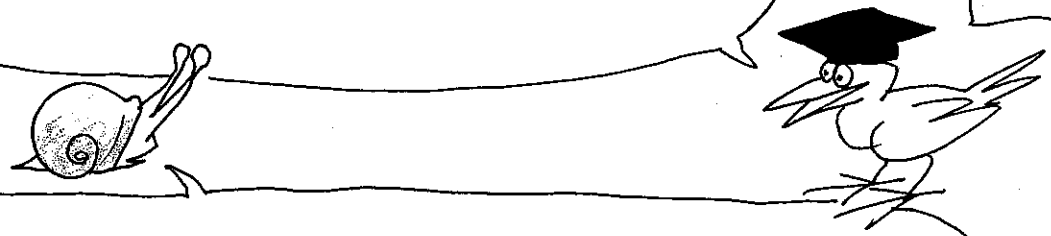
And all that with a set of equations populated with values of G, c, m, e, α, μ_0, considered to be **ABSOLUTE CONSTANTS**. The identification of s with time worked just as well. This idea led to the **BIG BANG** model.

And so?

(*) This choice is also called that of GAUSSIAN COORDINATES

This **Standard Model** had its moment of glory, its supporters, and its high priests. It was even calculated that the distant future of the Universe depended on its current density and according to whether it was superior, equal, or inferior to 10^{-29} gr/cm (*). The discovery that on the contrary the Universe was accelerating, was the death knell for this model (see The Twin Universe).





So people looked towards the past.

QUANTUM MECHANICS declares itself incapable of describing the phenomena taking place in time inferior to:

$$\text{Planck's time } tp = \sqrt{\frac{hG}{C^3}} = 10^{-43} \text{ sec}$$

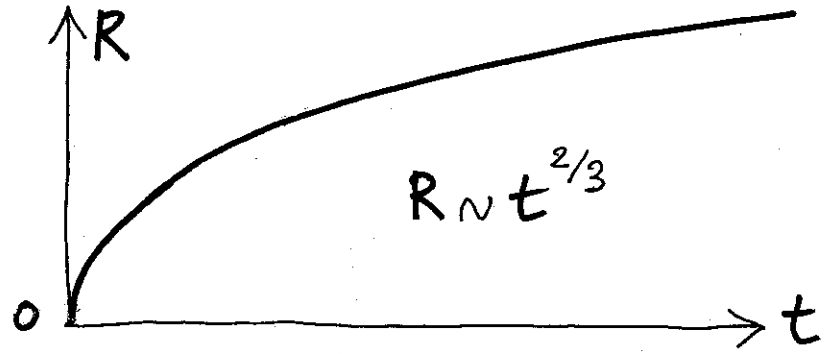
Or on distance inferior to :

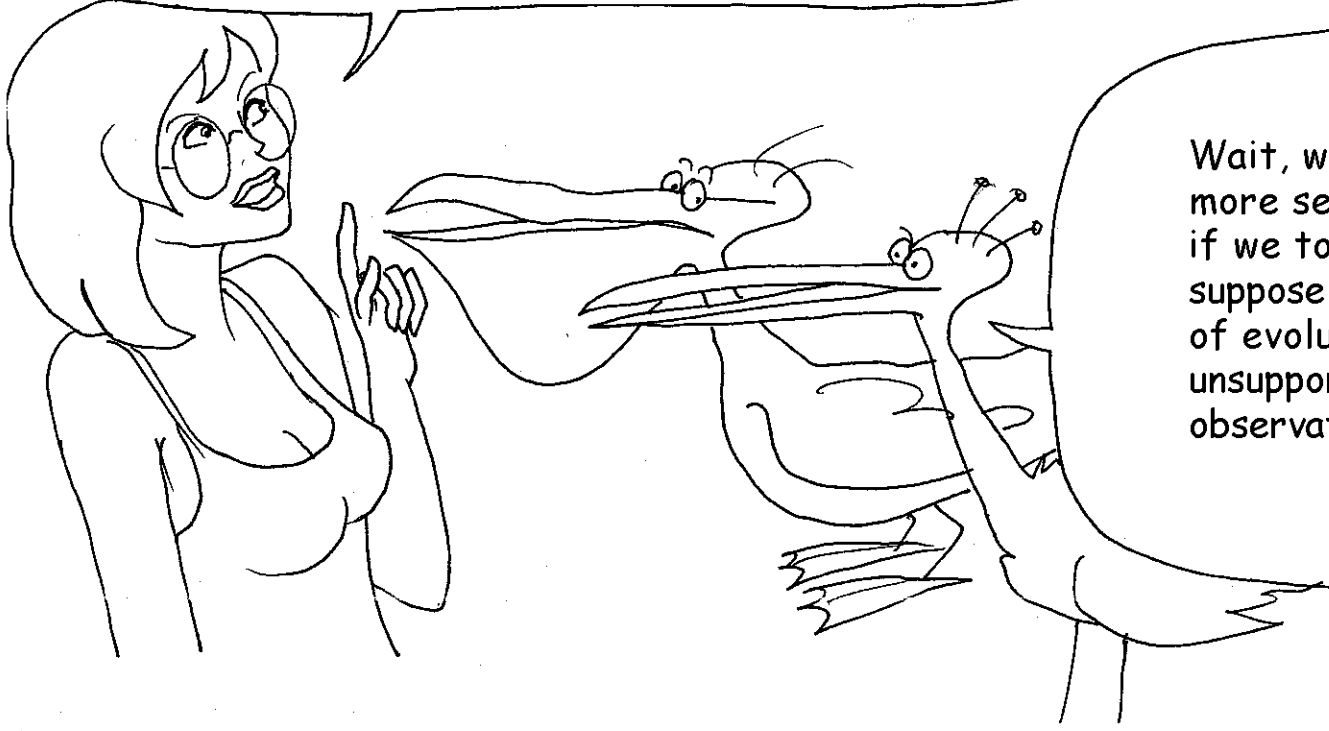
$$\text{Planck's length } Lp = \sqrt{\frac{hG}{C^5}} = 10^{-33} \text{ cm}$$

(*) See the final pages of the Geometricon (1980)

PLANCK'S WALL

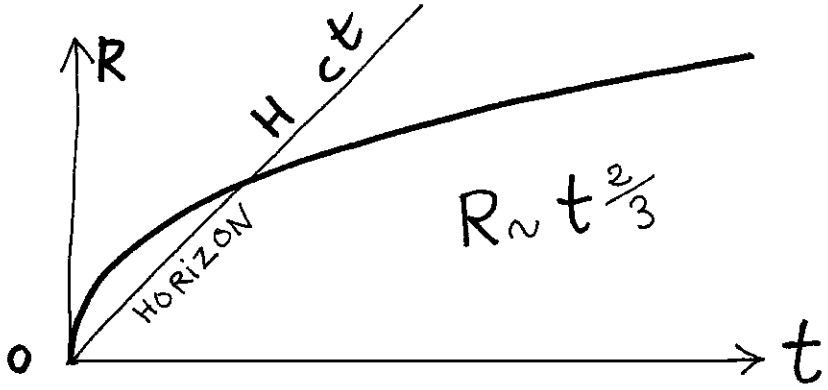
As no one doubted that what worked today would have had the same validity in the distant past, there was much speculation on the possible state of the Universe when t was inferior to Planck's length, without taking into account for a second that this fundamentally rested on the hypothesis that **G**, **h** and **c** are **ABSOLUTE CONSTANTS** unaffected by cosmic evolution.





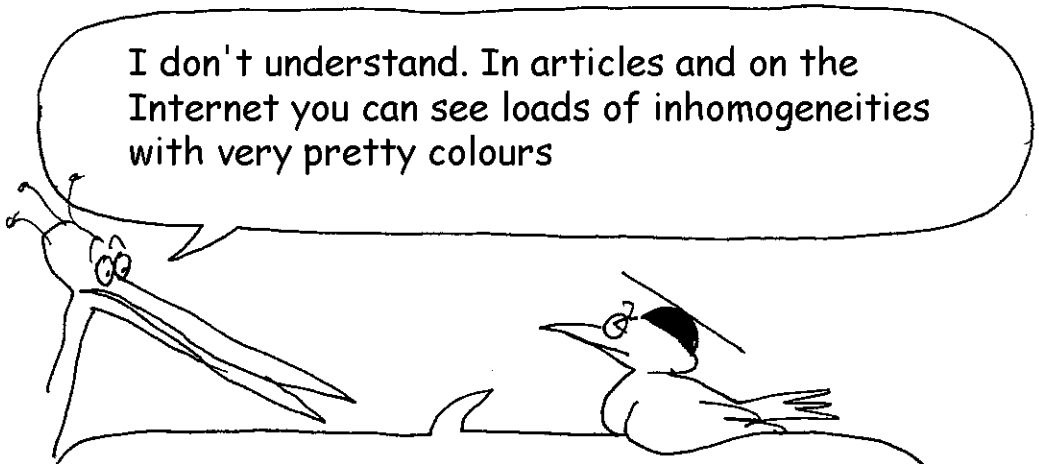
Wait, wait! I can cite lots of articles by more serious people who have shown that if we touch one of these constants, if we suppose the least variation during the course of evolution then that will bring about unsupportable contradictions concerning our observations!

MOVE ALONG PLEASE ! THERE'S NOTHING TO SEE.



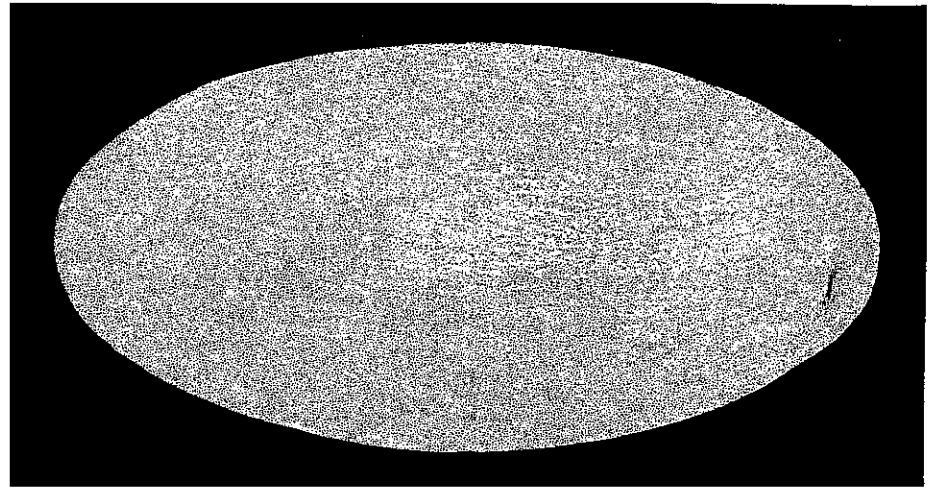
In 1992 the satellite COBE undertook the first precise measurements of the primordial radiation, the CMB, which gave an image of the universe during its first moments and showed that it was homogenous, give or take a hundred millionth.

Exclusive: the primitive Universe



I don't understand. In articles and on the Internet you can see loads of inhomogeneities with very pretty colours

That's because they increase the contrast with the computer. Otherwise the true picture would be like that on the side.



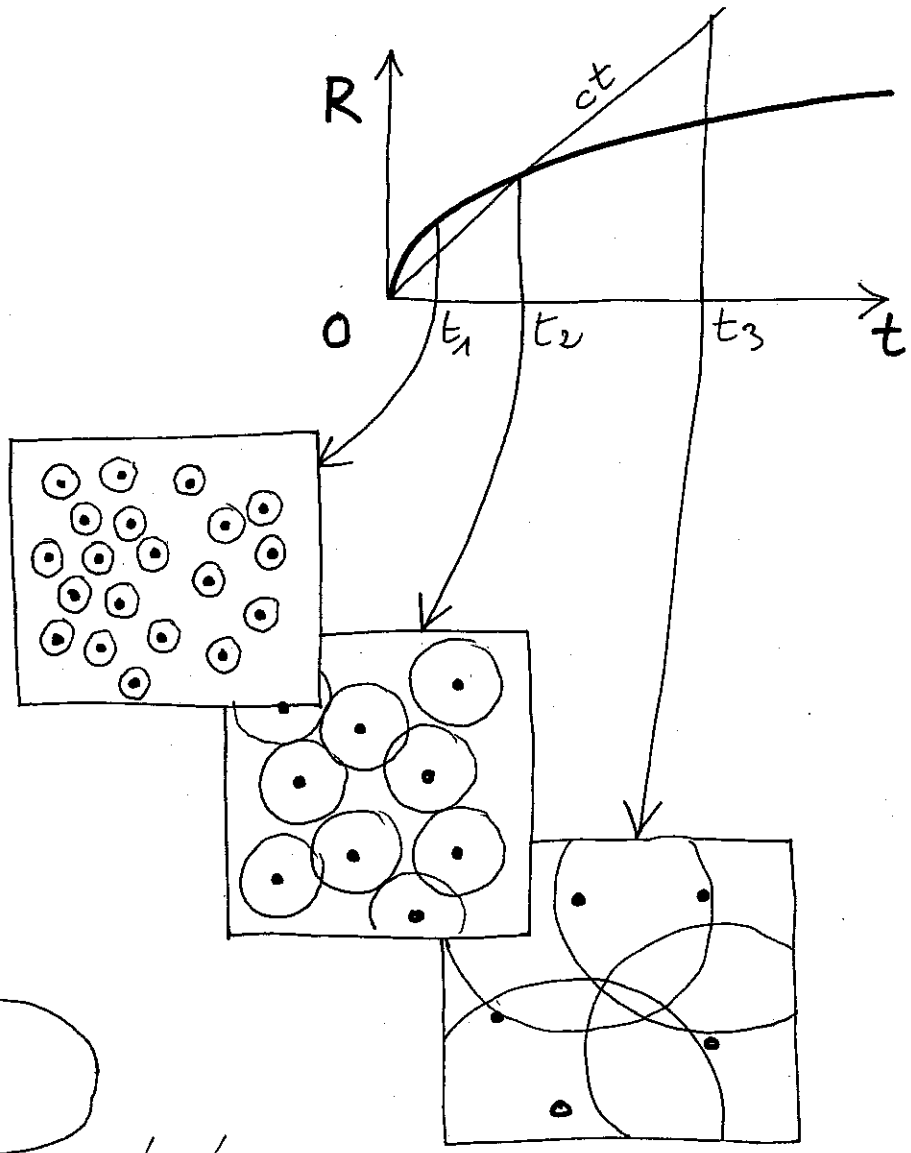
As it really is!

(*) Cosmic microwave Background

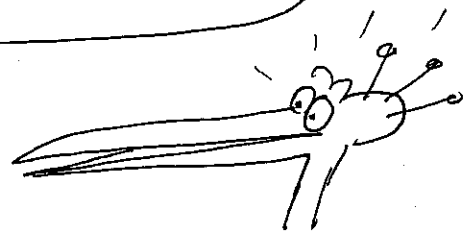
This fantastic homogeneity is an unavoidable paradox. If the speed of light is constant then an electromagnetic wave (*) emitted at an instant zero, will propagate in a bubble of radius ct, that we'll call the COSMOLOGICAL HORIZON. But, looking at the curve on the preceding page, the distance between particles becomes greater at a speed higher than c. They aren't aware of each other at all. It's an autistic universe. How do you explain that under these conditions a universe whose particles have never interacted with each other presents such a degree of homogeneity?

The Management

(*) Displacement at speed c

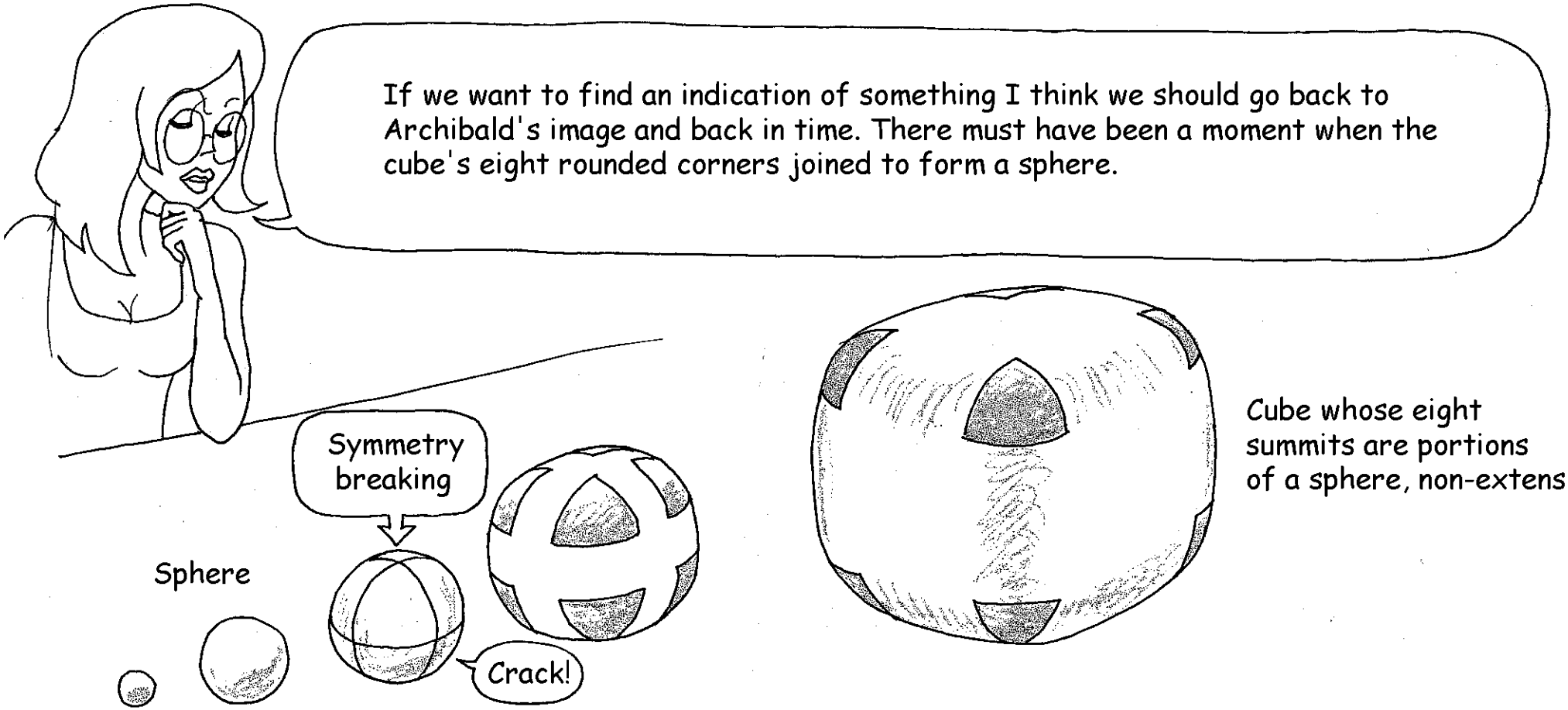


There could be a solution: that the speed of light was greater in the past (**)



(**) : An idea developed for the first time by the author in 1988, "An interpretation of cosmological model with variable light velocity" Modern Phy. Lett. A Vol3 n°16 Page1527

SYMMETRY BREAKING

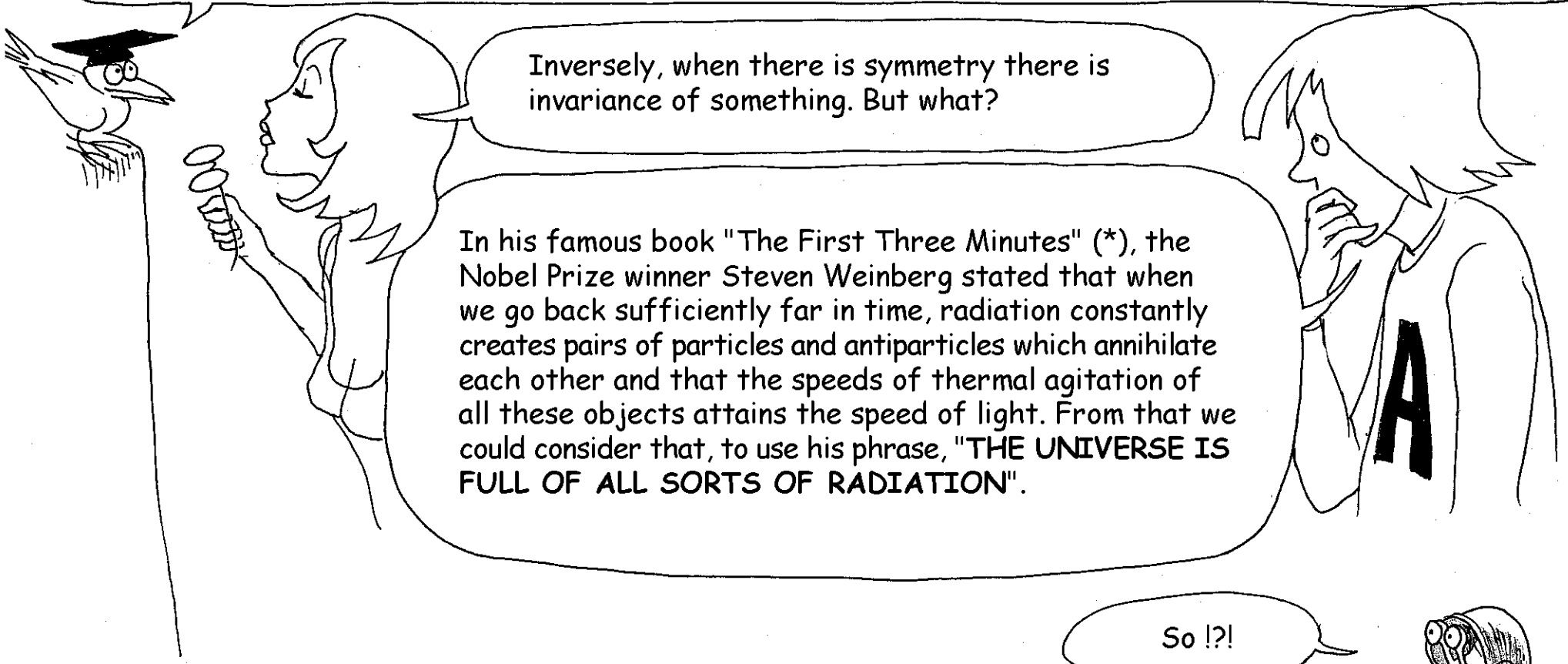


Cube whose eight summits are portions of a sphere, non-extensible.

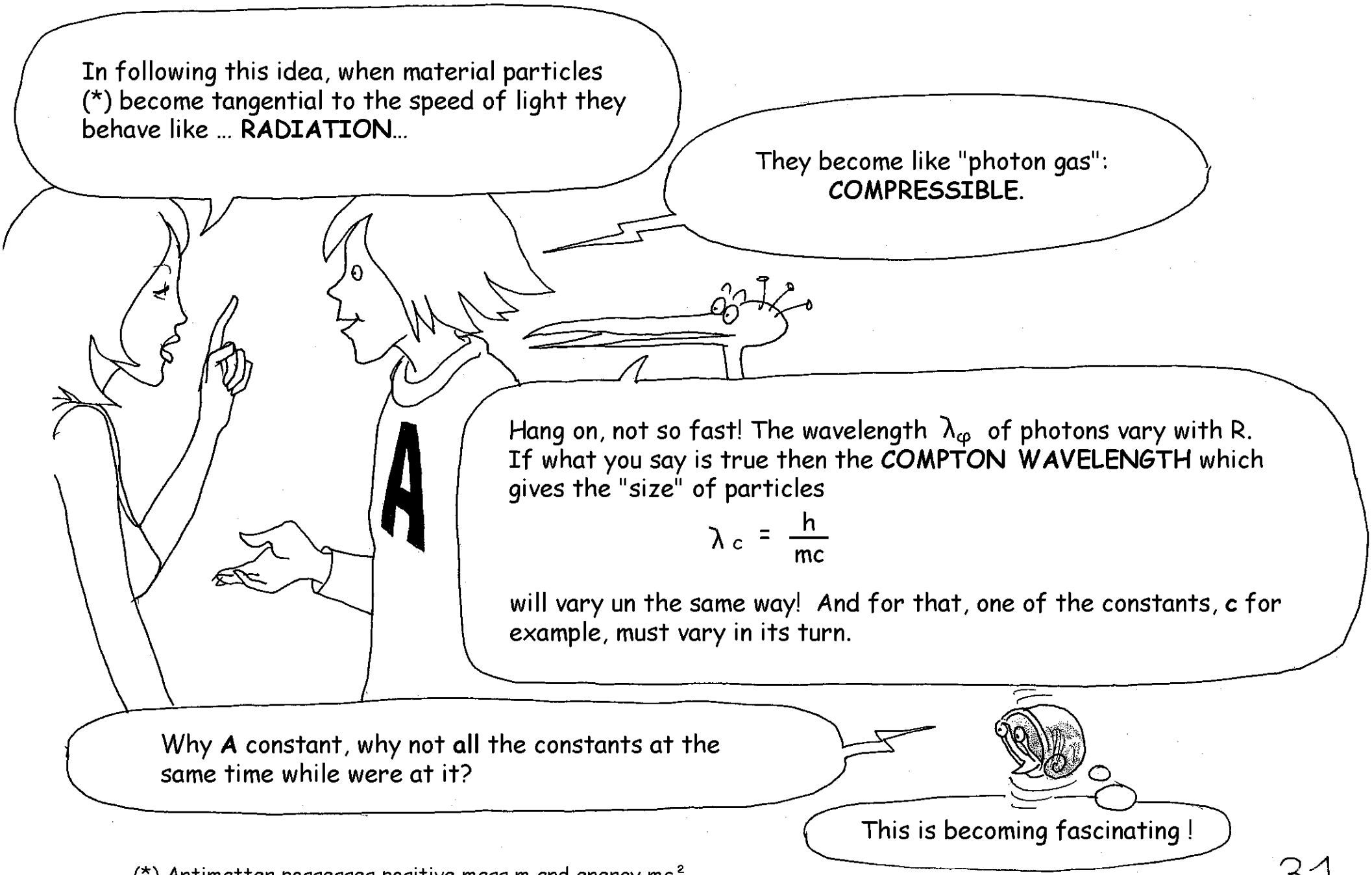
An object with the symmetry of the cube possesses a certain number of planes of symmetry and axes of discreet rotation symmetry of $\pi/2$, π, $3\pi/2$. A sphere has a degree of symmetry immeasurably higher (*) because every plane passing through its centre is a plane of symmetry and that the sphere remains invariant by rotation at an angle around any axis that also passes through its centre.

(*) O(2) symmetry.

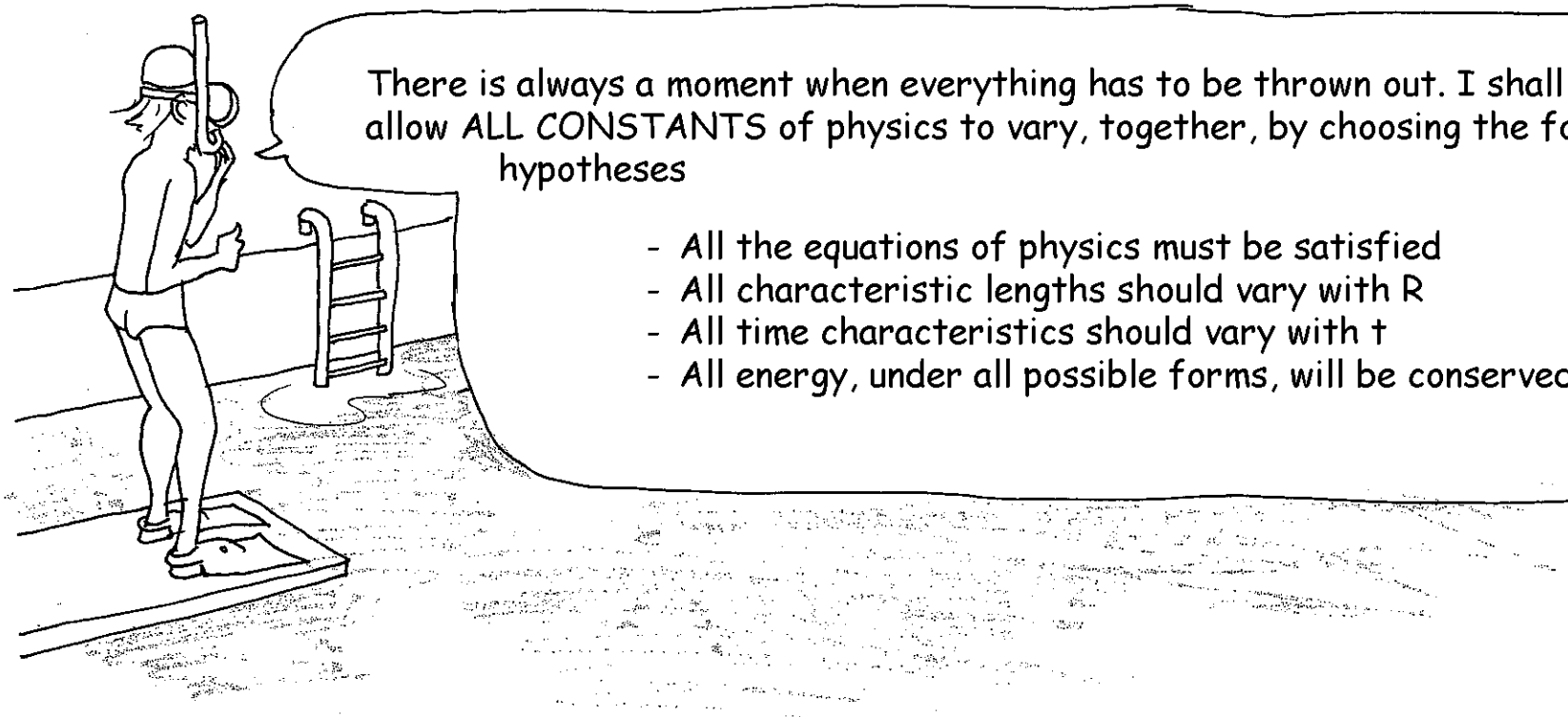
But the cube with blunted corners wasn't there to concentrate minds, give an image of a universe containing eight "matter clusters" and arranged as a regular polyhedron. Still, in two dimensions we could imagine a sphere which breaks into a great number of rigid fragments linked by extensible Euclidian surface elements. It thus completely loses its initial symmetry and what we call a **SYMMETRY BREAKING** will occur. But in physics such an event is synonymous with major changes, for example the way that expansion of the Universe operates.



(*) Which the author drew upon when writing BIG BANG in 1982



(*) Antimatter possesses positive mass m and energy mc^2.



There is always a moment when everything has to be thrown out. I shall therefore allow ALL CONSTANTS of physics to vary, together, by choosing the following four hypotheses

- All the equations of physics must be satisfied
- All characteristic lengths should vary with R
- All time characteristics should vary with t
- All energy, under all possible forms, will be conserved.

In GENERAL RELATIVITY we find a characteristic length which is the SCHWARTZCHILD RADIUS Rs

$L_S = \frac{2Gm}{c^2}$ So let's go for $\frac{Gm}{c} \sim R$ (*)

G is the "gravitational constant"

Still in the field of General Relativity, the famous equation of Einstein is written

$$S = -\frac{8\pi G}{c^2} T$$

Where the fraction represents EINSTEIN'S CONSTANT (*). For mathematical reasons it has to be invariant, which gives me:

$$G \sim c^2$$

I combine them and I get the first law:

$$m \sim R$$

Mass **m** increases with the characteristic dimension R of the Universe. Indeed, why not, Let us combine it with my hypothesis of the conservation of energy mc^2 = constant

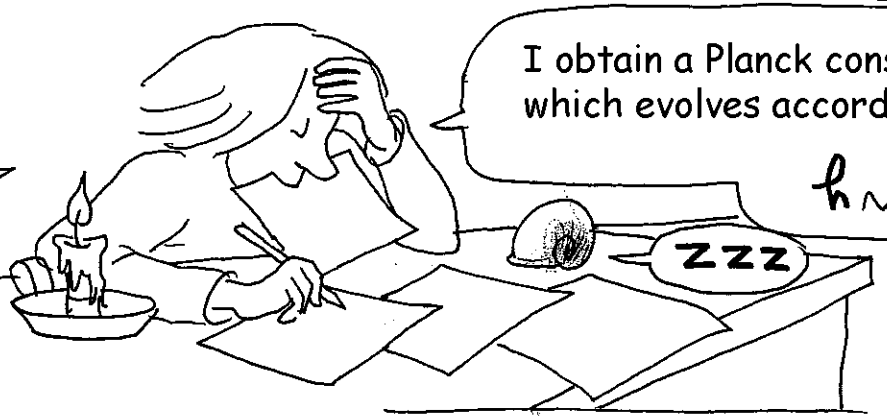
$$c \sim \frac{1}{\sqrt{R}}$$

In passing that gives me gravitation constant which varies according to

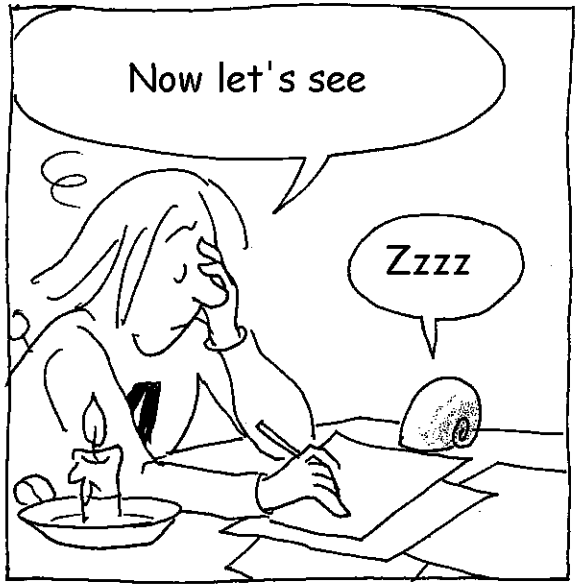
$$G \sim \frac{1}{R}$$

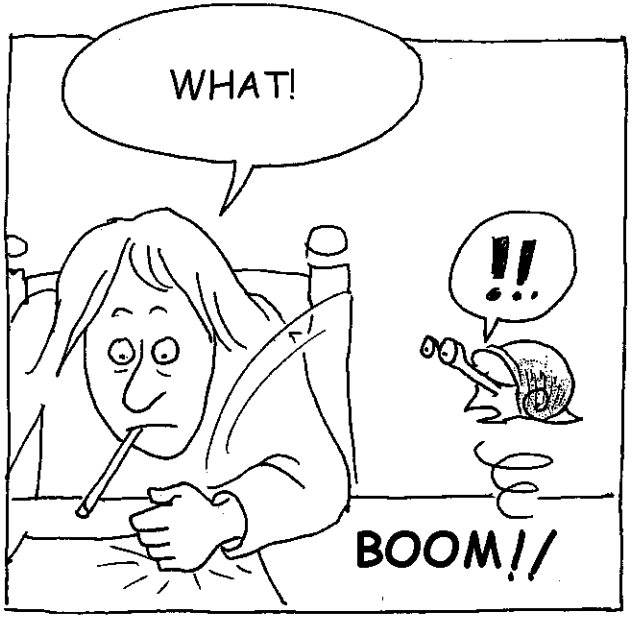
Now I add to the pot the fact that particles are compressible, that is to say

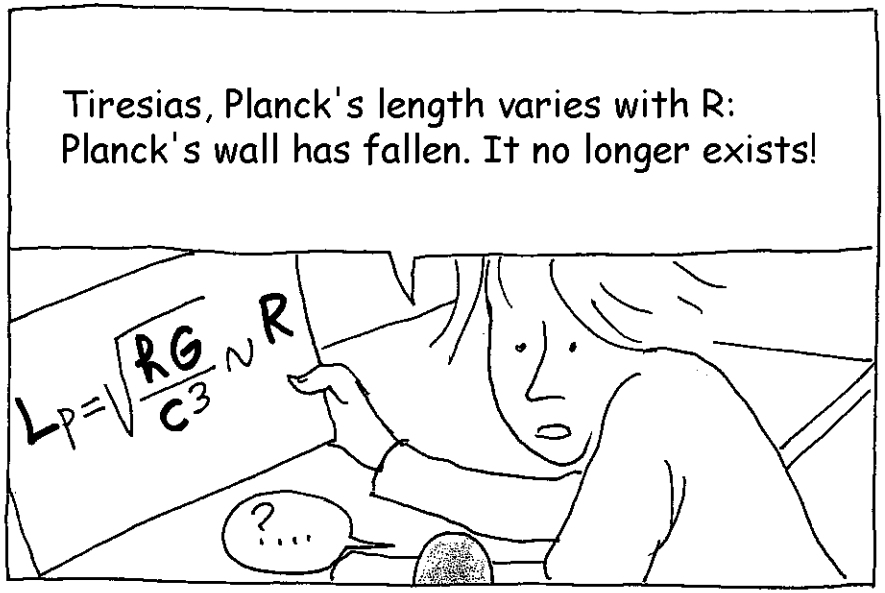
$$\lambda_c = \frac{h}{mc} \sim R$$

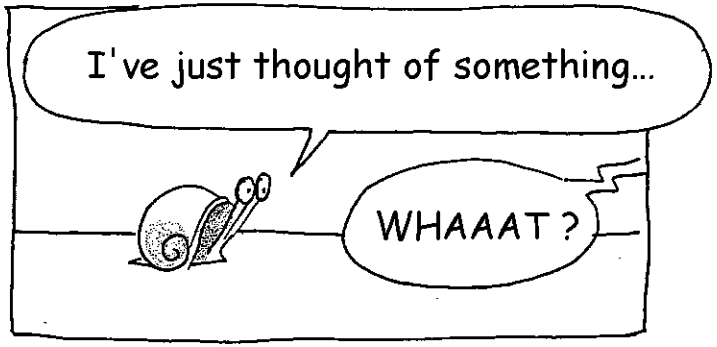


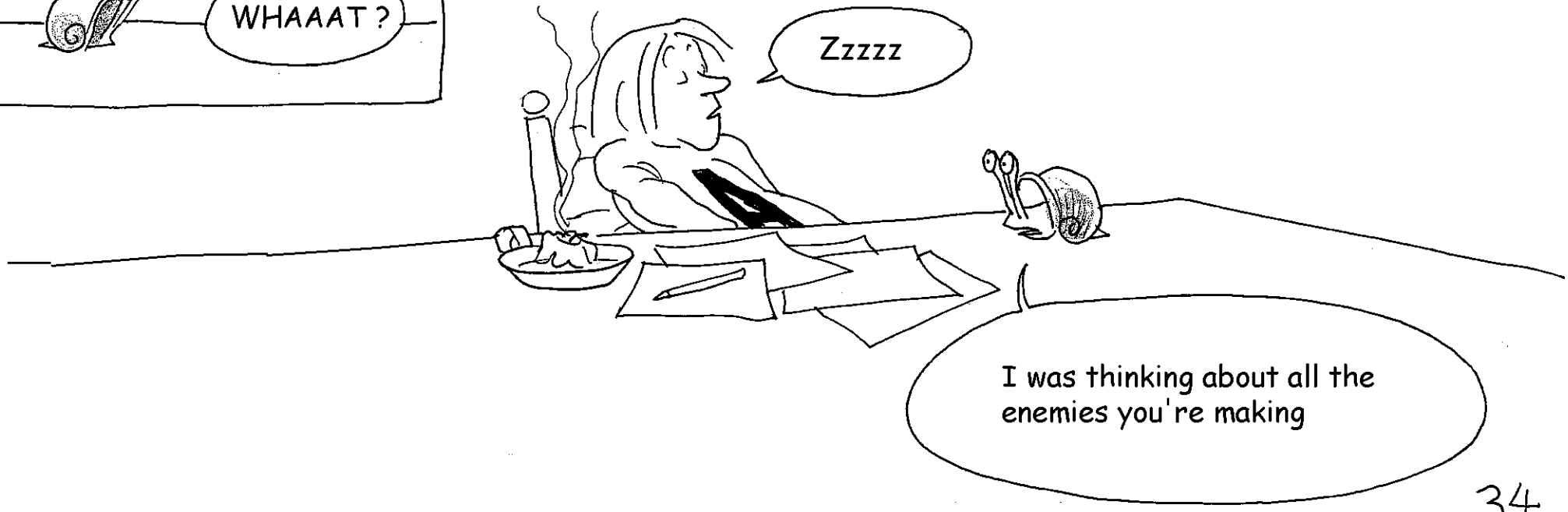
(*) Written in recent works as $\chi = -\frac{8\pi G}{c^4}$ but this difference results from the way the terms of the tensor T are written.


Now let's see
Zzzz


WHAT!
!!
BOOM!!


Tiresias, Planck's length varies with R:
Planck's wall has fallen. It no longer exists!
$L_P = \sqrt{\frac{RG}{c^3}} \sim R$
?...

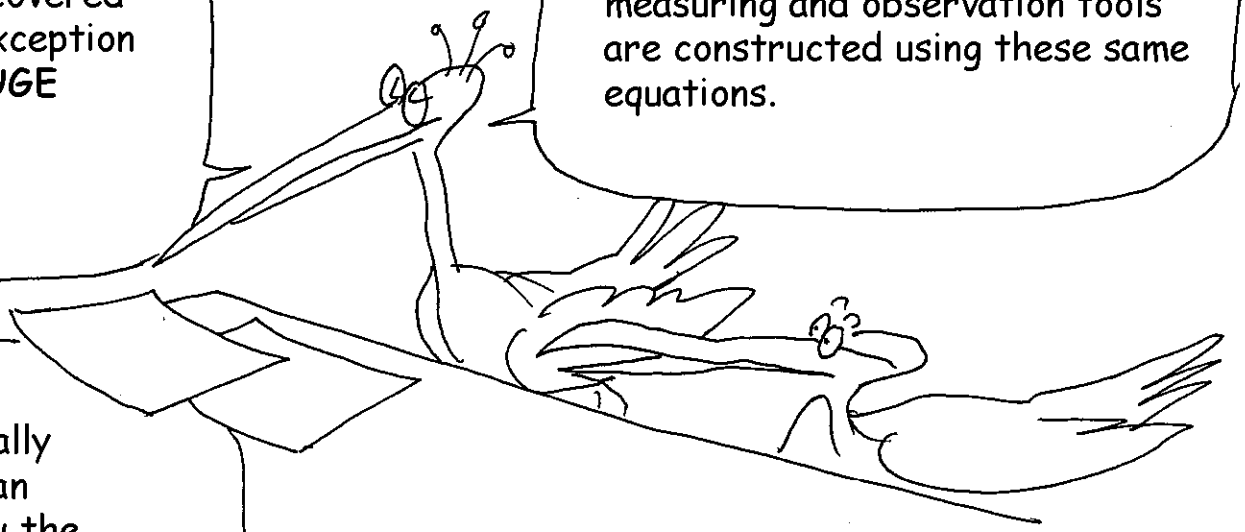

I've just thought of something...
WHAAAT ?


Zzzzz
I was thinking about all the enemies you're making

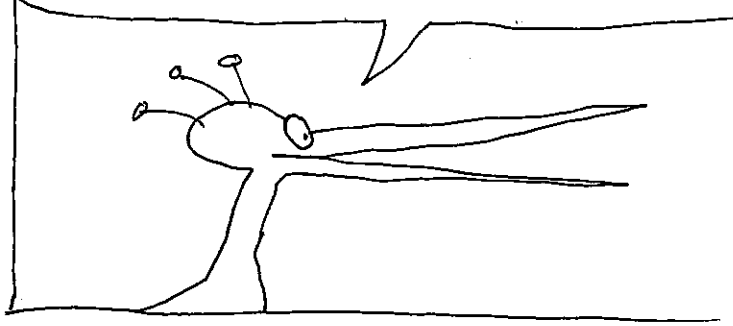
THE FOLLOWING MORNING

All that is very nice but I would simply say: what use is it? Archibald has merely discovered that the equations of physics, without exception (*), were invariant by what we call a **GAUGE TRANSFORMATION**

But remember one thing: measuring and observation tools are constructed using these same equations.



Conclusion: with this system it is essentially impossible to design an experiment or an observation instrument which would allow the least **VARIATION** to be shown as these measuring and observation tools "drift in parallel" with the quantities they are supposed to be measuring.



So all that I've done is useless?

(*) For the invariance of the equations of Maxwell, Schrödinger etc, see the ANNEX

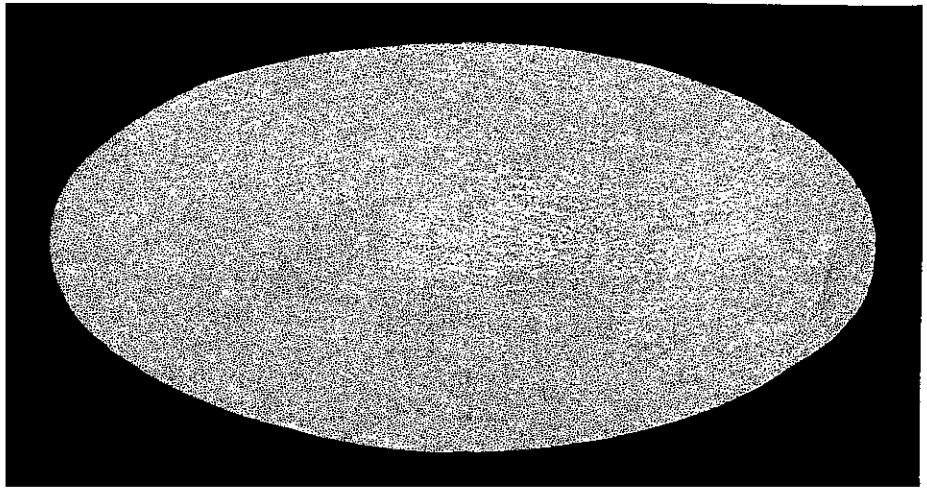
It's very pretty as a mathematical exercise but what is the interest if you can't measure anything? It's like trying to show evidence of the increase in temperature in a room by measuring the dilation of an iron table using a ruler made of the same metal.

Ha, ha!

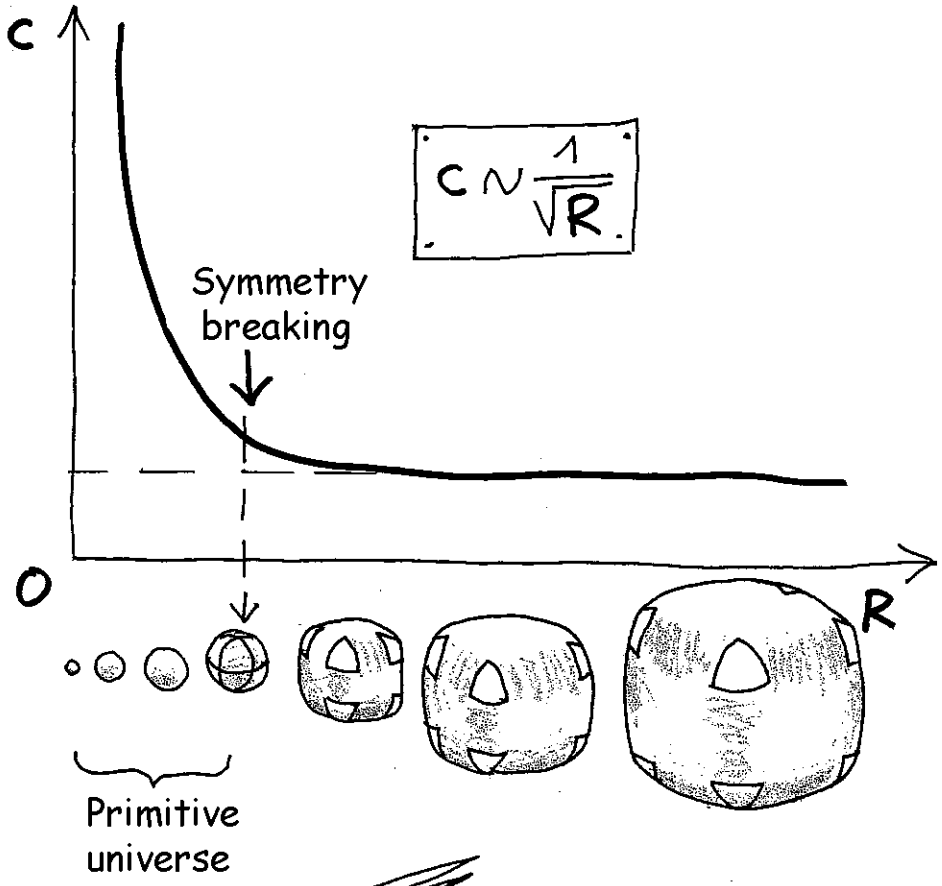
Wait, wait, there is something that we **OBSERVE** and that the model might be able to explain

Really? What?

That!



Primitive universe



$c \sim \frac{1}{\sqrt{R}}$ $G \sim \frac{1}{R}$ $\rho \sim R^{3/2}$

$m \sim R$ $e \sim \sqrt{R}$ $\varepsilon_0 = Cst$

$\alpha = Cst$ $\mu_0 \sim R$ (*)

(see Annex)

In Archibald's model (*) the speed of light was variable when the universe was in its primitive state, before **SYMMETRY BREAKING**. Then the **COSMOLOGICAL HORIZON** is no longer ct, with c constant, but is calculated using an **INTEGRAL** (see Annex). We then find that this horizon ... varies with R, which accounts for the **HOMOGENEITY** of the universe during those far distant epochs

Heavens!

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Don't let your SUPERSTRINGS trail like that, you'll trip over them.

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(*) Published by the author in scientific reviews with a referee system in 1988_1989_1995, 2001 to complete indifference.

END

ANNEX

First let us calculate the **COSMOLOGICAL HORIZON**

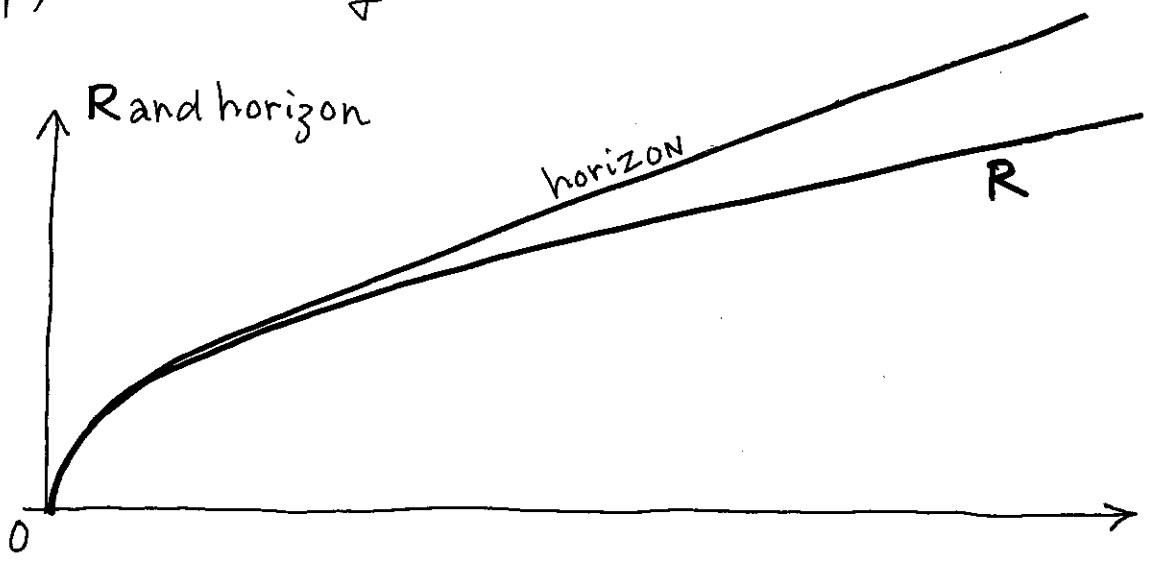
when the speed of light can be considered as an absolute constant : horizon $= ct$

In the early universe $c \sim \frac{1}{\sqrt{R}}$ so that horizon $= \int_0^{t(\text{present})} c(t)\,dt \sim \int_0^{t(\text{present})} \frac{dt}{\sqrt{R}}$

but $t \sim R^{3/2} \Rightarrow dt \sim \sqrt{R}\,dR \Rightarrow$ horizon $\sim \int_0^{R(\text{present})} dR = R$

$$\boxed{\text{horizon} \sim R}$$

To sum up, schematically :



FUNDAMENTAL GAUGE RELATIONSHIP

As an example, consider the Maxwell equations

$$\nabla \times B = -\frac{1}{c^2}\frac{\partial E}{\partial t} \qquad \nabla \times E = -\frac{\partial B}{\partial t} \qquad \nabla \cdot B = 0 \qquad \nabla \cdot E = \frac{\rho_e}{\varepsilon_0}$$

Consider the two first equations. Put it in a generalized adimensional form.

$$B = \mathbf{B}\,\beta \;;\; E = \mathbf{E}\,\varepsilon \;;\; c = \mathbf{c}\,\xi \;;\; t = \mathbf{t}\,\tau \;;\; \frac{\partial}{\partial t} = \frac{1}{\mathbf{t}}\frac{\partial}{\partial \tau}$$

$$\nabla = \begin{cases} \dfrac{\partial}{\partial x_1} = \dfrac{1}{\mathbf{R}}\dfrac{\partial}{\partial \varsigma_1} \\ \dfrac{\partial}{\partial x_2} = \dfrac{1}{\mathbf{R}}\dfrac{\partial}{\partial \varsigma_2} \\ \dfrac{\partial}{\partial x_3} = \dfrac{1}{\mathbf{R}}\dfrac{\partial}{\partial \varsigma_3} \end{cases} \quad \text{write } \delta \begin{cases} \dfrac{\partial}{\partial \varsigma_1} \\ \dfrac{\partial}{\partial \varsigma_2} \\ \dfrac{\partial}{\partial \varsigma_3} \end{cases}$$

$$\frac{\mathbf{B}}{\mathbf{R}}\,\delta \times \beta = -\frac{\mathbf{E}}{\mathbf{c^2 t}}\,\frac{\partial \varepsilon}{\xi^2 \partial \tau}$$

$$\frac{\mathbf{E}}{\mathbf{R}}\,\delta \times \varepsilon = -\frac{\mathbf{B}}{\mathbf{t}}\,\frac{\partial \beta}{\partial \tau}$$

combinning the two $\Rightarrow$ $\boxed{\mathbf{R} = \mathbf{c}\,\mathbf{t}}$ which fits the former calculations

Introduce Bohr 'radius :

$$R_b = \frac{\hbar^2}{m_e e^2} \sim R \; ; \; m_e \sim m \sim R \; ; \; e \sim \frac{\hbar}{R} \; ; \; \hbar \sim R^{3/2} \rightarrow \boxed{e \sim \sqrt{R}}$$

The fine structure constant α rules the geometry of the atoms.
If we choose to keep it constant we get :

$$\alpha = \frac{e}{\varepsilon_0 \hbar c} = Cst \Rightarrow \boxed{\varepsilon_0 = \text{Constant}}$$

ε_0 and μ_0 are linked through $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ whence $\boxed{\mu_0 \sim R}$

We assumed that all kinds of energies are conserved. The pressure is a density of energy so that :

$$E_{magnet} = R^3 \frac{B^2}{2\mu_0} = Cst \Rightarrow \boxed{B \sim \frac{1}{R}}$$

$$E_{electr} = R^3 \varepsilon_0 E^2 = Cst \Rightarrow \boxed{E \sim \frac{1}{R^{3/2}}}$$

$$\Rightarrow \frac{E}{B} = \frac{1}{\sqrt{R}}$$

From Maxwell equations we got : $\frac{E}{B} \sim \frac{R}{t} \sim \frac{1}{\sqrt{R}}$ OK

Thermal velocity V

The kinetic energy is $\frac{1}{2} m V^2$. If conserved $\boxed{V \sim \frac{1}{\sqrt{R}} \sim c}$

Mass density

$\rho = n\, m$ Assume the conservation of the number of species $n R^3 = cst$

$\boxed{\rho \sim \frac{1}{R^2}}$ Have a look to the Jeans length $L_J = \frac{V}{\sqrt{4\pi G \rho m}}$

We find $L_J \sim R$

Similarly t_J (Jeans time) $= \frac{1}{\sqrt{4\pi G \rho}} \sim t$

Everywhere the gauge transform hypothesis is consistent to our results in various fields

We can check it for a lot of things, like cross sections $\sim R^2$

Debye length $\sim R$, and so on.

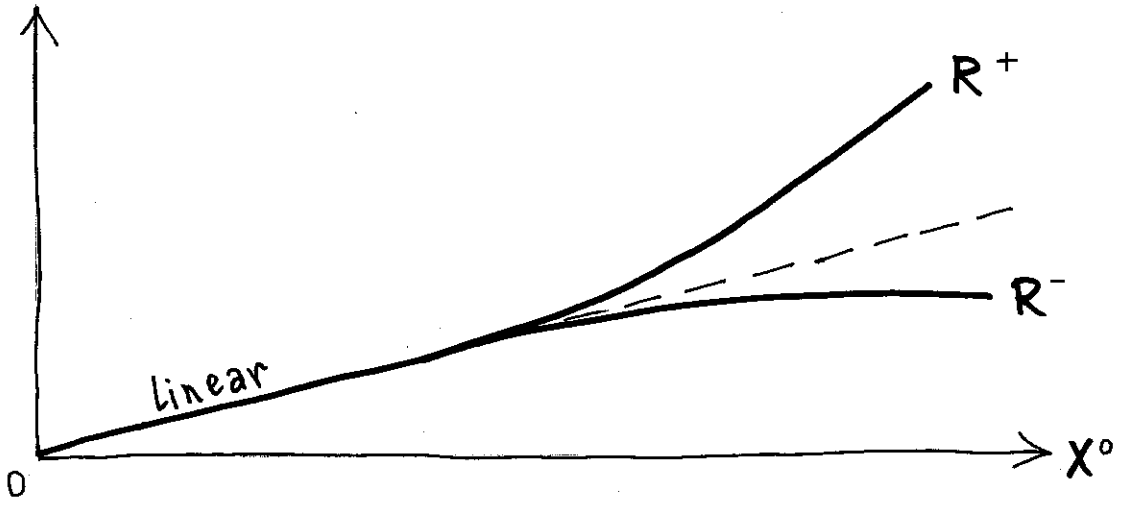
To finish the job we have to examine the link with our bimetric model

(See THE TWIN UNIVERSE)

In this model we have two space scale factor R^{+} and R^{-}. The solution of the coupled field equations provided the coupled differential equation system =

$$\begin{cases} R^{+''} = \dfrac{1}{R^{+2}}\left[\dfrac{R^{+3}}{R^{-3}} - 1\right] \\ \\ R^{-''} = \dfrac{1}{R^{-2}}\left[\dfrac{R^{-3}}{R^{+3}} - 1\right] \end{cases}$$

that explained the "black energy" effect =



LORENTZ iNVARiANCE

In the early time the solution is linear $R^+ = R^- \sim x^0$

As pointed out in **THE TWIN UNIVERSE** this cosmological solution is based on homogeneity and isotropy, plus flatness (curvature index $k=0$) so that the metrics are Robertson Walker metrics.

$$ds^2 = dx^{0^2} - R^2\left[du^2 + u^2 d\theta^2 + \sin^2\theta\, d\varphi^2\right]$$

Back to carterian coordinates: $ds^2 = dx^{0^2} - dx^2 - dy^2 - dz^2$

this space-time is locally **LORENTZ iNVARiANT**

To make the link wi our variable speed of light model we write =

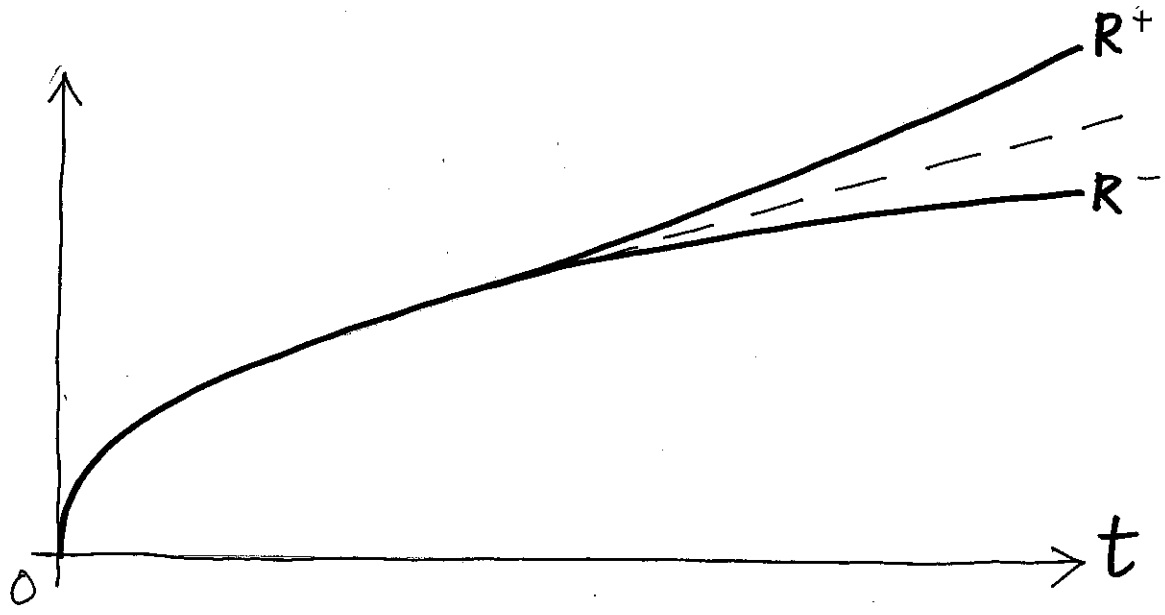
$$x^0 \sim R \;;\; dx^0 \sim dR \sim t^{-\frac{1}{3}} dt \sim \frac{dt}{\sqrt{R}} \sim c(t)\,dt$$

This links with the classical identification $x^0 = ct$ when c becomes constant

Before the symmetry breaking = $dx^0 \sim t^{-\frac{1}{3}} dt \Rightarrow x^0 \sim t^{\frac{2}{3}}$

EVOLUTiON

We can draw the evolution versus the physical time t, as defined above



ZENO'S PARADOX

Consider a "clock" composed by two masses orbiting around their common center of gravity

The period is $\tau = \frac{2\pi r^{3/2}}{Gm}$ $\quad Gm = Cst \quad r \sim R \quad \tau \sim t \sim R^{3/2}$

Calculate the number of turns N of this clock since the time $t = 0$ to the present time

$$N = \int_0^{R_0} \frac{dR}{R^{3/2}} = \left[\frac{1}{\sqrt{R}}\right]_0^{R_0} = \text{infinite!}$$