PATHS IN THE COSMOS

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- Matter Aggregation.
- Modification of Navier Stokes equations.
- Applications.

ABSTRACT

All the matter in the Universe behaves in the same way: its dynamics is based on the same laws, whatever the scale. If it want to explain how the Universe-cosmos works, it is necessary (Job of the Physicists and Mathematicians):

- To detect patterns between numeric models that describe the events.
- To detect patterns between events.

It will finds similarities between phenomenon's and numeric models. These are the mains goals.

It tries to create a theory for explaining the distribution and evolution of matter in the Universe in large scale, galaxies dynamic, Universe expansion, Dark matter and dark energy, etc, but also it is possible to apply this model-theory, in others fields as economy, human’s relations, people flocks, stock market, human feelings, etc.... It tries to explain a “general” behavior in future, not a particular one.

A particle, it experiences and feels, a single force pushing him in one direction. This force is the result of several forces (friction, magnetic, pressure, Coriolis, etc), which, acts on the particle. It is incredible, but this occurs in each of the particles of a fluid, and each of them, completely unaware of the forces and directions of other particles. This mutual ignorance perhaps is the main reason in the generation of precious figures or geometry and global structures.

When the following image appears in this Article, it means that at that moment, you need to research, advance, create a model, look for examples or whatever, to finish the point. It is a point that is not finished yet and needs to be developed. In fact, it will mean that with that Research and Development, it will be possible to write a complete Article:

→ “I would like again, to work in a University, in this field so exciting for me. I miss sharing ideas and research with other teachers. I just need time and place to do research. I can give training in CFD simulation at the university: sharing knowledge and science advances the world. My English is not good at all, but I speak Spanish and French.”

Cosmos (Carl Sagan): “Cosmos is all in the past, present and future.”

1. INTRODUCTION

The main goal for any mathematician is create numeric models about nature phenomenon. For that, is necessary discovery
(or create artificially) patterns, and if it is possible lineally, but that, is not easy, and normally not real.

As a writer, a mathematician thinks with a languages and as all language have their rules, their pretty rules....

It is very nice is front a white paper and write ideas and translating dreams....

The fact of call one event as unpredictable is to assume ignorance. The goal so, is know the evolution (temporal or spatial) of any object or event, from similarities.

In the nature, there are a lot of think very weird, about patterns and data series:

- Benford law, applied for example, in distances of galaxies from earth (Timoteo Briet Blanes – 2017): (brown=Benford law, yellow=data 4.000 galaxies data founds from Internet):

- Generation on Lissajous curves from different cases: for example in lift against position in a vibrating wing, etc... (Timoteo Briet Blanes – Book: “How to design a Race Car, Step by Step” – Amazon):

- Even, Vortex Street is sometimes formed when the wind from a star flows past a neutron star companion.... And also, Vortex Karman street, in different scales as a turbulences in cylinders, atmosphercials events, tail in striped galaxies, etc....:

- Is possible to see the vortices-disturbances created from the Kelvin-Helmholtz effect, also in different scales: clouds, Orion Nebula:
Many times, it is not easy to observe a well-defined or clear pattern. It is therefore necessary to analyze data or geometries, perhaps indirect to the phenomenon, which may give rise to a possible pattern.

For example, in a Meteorites rain (Quadrantides - temporal data from J. M. Trigo - January 1992), is possible to create a graphic in 2D, with “$d_i$” the detection instant of meteorite “$i$”:

$$d_i - d_{i-1}$$

It’s possible detect and analyze one geometry multifractal (may be because there is a random variable...) (“Structure multifractal in the galaxies distribution”: Vicent Martínez García - University Valencia - Spain) on this graphic (Timoteo Briet Blanes - 1993).

And more: is possible to see some phenomenon or properties as a fluid, in objects or particles dynamic.

For example, Bernouilli principle in accumulation-aggregation or exit of people from sport stadium, also sheep out of a stable, even it is possible apply fluids theories in vehicles traffic in cities, etc...

About the phenomenon prediction, if there are few laws which define him, it will be more complicated to know the evolution (chaos essence).

From all that is necessary to ask us, if there some think common for all these cases, some law able to means these examples.

That is the main goal for me and this article: know how the nature think and decides, and create language or concept mathematics, pretty and simple, in order to explain any event, as a fluid.

For example, get a fluid with density “$\rho$” constant; get a space in 2D and get $U_{i,j}$ velocity horizontal in point $(i,j)$ and $V_{i,j}$ vertical velocity in the same point:

$$A = U_{i+1,j} - U_{i,j} + V_{i,j+1} - V_{i,j}$$

So $A=0$, if the variation of the mass, is zero also. That is:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

Continuity equation or divergence zero; that is, with mathematic language is possible explain the nature.

To know the evolution of any event means the introduction may be of a probability of to be or not to be (Multifractal geometry in meteorites rain). That is very important.

Can you fight the flow of a brave river trying to reach the edge? Surely it will be useless, but you can try.... Every person has his own will and is able to choose his destiny or displacement as a decision or choice, but the group dilutes that will; It might even alter your environment, but only the environment ...

A person solitary, is unlikely to originate or produce a “different” evolution of the
whole; but it will be able to do so, only in the case of being able to generate a great impact that affects many people: the union, it makes force.

When one speaks of "power," power is the ability to influence large numbers of people. The birds, don't know what is the geometry of a flock, but hi flights and moves....

Who, when a very dear one has died, has not thought that the world is going to stop, that the sun will not come out any more, or that everything will change, or that he will telephone on your birthday to congratulate you. Really the sun does not come out the same way and with the same beauty, but the world follows, and despite what happened, everything remains the same.... and never phone....

I need understand the cosmos, but I and my actions, are very and quite insignificants....

There is a special relation between sloth or minimum energy principle and fluid dynamics. If I must to go from here to there, yes; I will go. But, with the minimum energy....

If it ask question about universe, it would be able to understand it....

1.1. EVENT

Any concept, dependent of time.

Any event in space or time; that is:

- Any event or phenomenon, which manifests against the time, such as the price of oil, the temperature of an object, stock market values, etc...

- Any event or phenomenon that manifests in the space, such as the position of an aircraft, the speed or position of a bird, etc...

Event, Phenomenon, Particle, Success, are the same concept.

1.2. EVENTS RELATIONS AND REPRESENTATION

A group of events can be represented by their relations between them, in the following ways:

- Through springs, dampers, shock absorbers and fix bars:
  - Fixed bar (positive or negative): one event moves in the same proportion as another to the same direction.
  - Spring: it is defined analogously to the bar, but with a force of repulsion or attraction, as a spring.
  - Damper: it is a displacement damper, applicable to bars and springs. Is a try to enter the variable "time" and velocity.
  - Inerter. Is a try also "time" and acceleration.
  - Etc....

It is possible to apply "mass" (size) to the event, in the form of "importance" or "transcendence", and others systems or properties combination as damper inerter:
The options, therefore, of connections between events, are endless. All these relationships can work under linear and non-linear functions.

- An event is represented according to different "Coordinates", which are the variables on which the Event depends. The "Dimension" of the event is defined as the number of variables on which it is possible to represent it:

Be 2 events; it is assumed that one of them varies and it is observed that the other event also varies or responds to the variation of the first. Are both events therefore dependents?

One could say yes, as long as these mutual variations are known over a suitably long time, since, perhaps, the second event varies "coincidentally"....

The glass is a material called "Amorphous":

This material has the property of not transmitting normally, a vibration. In fact, is possible think about the glass, as a material with a viscosity very high.

Given a dice, there is the same probability that any number from 1 to 6?

No. Each number is defined on each face, with hemispherical holes or part of hemispheres. These holes remove material from the dice, so that the face of number 6, for example, weighs less than the face of number 1 or any other...

1.3. DEPENDENCE OR NOT, BETWEEN EVENTS

A coin is thrown: what is the probability that it comes out face? The answer seems pretty obvious. But, and if it is known that previously the same coin has been launched 50 times and has always has face? The answer is no longer so simple, besides that there are some explanations mathematically (Markov chain, etc...). Also analyze Bayes, Pascal and Anchenwall.

Does it therefore influence what is known a priori of an event in order to predict it? Does knowledge influence? Yes that influences, indeed: if you ask us if it's going to rain an hour, just look at the sky and know if there are many clouds....

It would be the same with the lottery balls, since each number is marked with paint, which, makes the more paint, the more aerodynamic drag the ball? I'm very sure of that... I test in CFD that...
1.4. SOME COMMENTS, IDEAS, HYPOTHESIS
1.4.1. CONSIDERATIONS ON THE WORLD CRISIS

In the face of the evolution of an economic crisis, it always asks ourselves: "Until when?"

It do not know at all, when it will stop downloading, or when it will stop uploading in your case; but one thing is clear: at some point it will stop going down.

There is nothing that goes up or down forever; like a diver, no matter how deep the waters you dive, "always" there will be a time when you touch the bottom or reach your maximum depth.

To say that the economy rises and falls alternately, like a saw tooth, is to admit our ignorance of how it evolves; Besides, if he did not do it, it would be absolutely incredible to go up or down constantly ... Sure it would be surprised.

And another question:

Is there any merit in "leaving" that some stones, thrown into the sea, reach the bottom, is there merit in saying that they will reach the bottom?

Imagine a pool like an ocean; if we open the drain, sooner or later, it will empty...

The question always arises: "What to do?"

All governments "try" to mitigate the effects of the crisis, "doing things" under the options and criteria, more or less successful, that mark or govern their ideologies.

But also, we can all verify that these actions either have no appreciable effect, or are slightly appreciable in the very long term. If indeed it can see some effect, it is simply because the previous diver was already close to the bottom....

The world economy or global dynamics is the one that always prevails; it's like wanting to empty the sea, from glass to glass.

It is true that before a small action, as it is to cover the drain of the ocean, we make it never empty; but we will know that it is not going to be emptied, in a very long time. It is more: there are actions that do not affect "absolutely" in anything; therefore, it has 3 possibilities:

1. Do something and see its possible consequences in many many years.
2. Do something that does not affect anything (and people see that something is done).
3. Let the global dynamics prevail and flow...

What is the best choice? The 3; At least, let's dedicate ourselves to enjoyment and that other rights are not affected.

Sup "A" fixed; then if "C" moves, "B" will move; but the greater "b" and the smaller "c", keeping "a" constant, the displacement of "B" will be less.
It is an example to observe that although we have 3 dependent events, certain displacements of one of them may have very little importance on the others. Any government that takes credit for taking a country out of a crisis lies: it simply has been lucky to be at the right time.

1.4.2. TIME: COMMENTS ABOUT

It can define "being alive" to that substance that is able to have notion or consciousness of the passage of time. It is possible to perceive time in a different way; in fact, when it is sleeping or when it is older, it does so. Is time the necessary variable for there to be a dynamic? If everything were causal, the existence of time would not be necessary, since "everything" would already be defined and marked until eternity. It is also true that, as we have already seen, in the dynamics of a set of phenomena, only one of them lacks the power to modify fully; it is the randomness that marks this effect or influence.

Randomness is necessary in the universe, for whatever reason, but it is necessary.

In fact, let’s think of 2 different phenomena (water flow and galaxy formation): time scales and time are different. It is as if the dynamics of the universe invite us or force us to standardize time and its scale, in order to be able to compare.

In general, Density is defined as the quotient between the number of particles enclosed in a ball of determined radius “R” and center of particle, and the volume of the ball.

This definition is extended to “n” dimensions, defining the volume of a ball of “n” dimensions as:

\[
\frac{\pi^{n/2} R^n}{\Gamma(n/2 + 1)}
\]

“z” is an integer and “Γ” being the Gamma function:

\[
\Gamma(z) = \int_0^\infty t^{z-1} e^{-t} dt
\]

If it work with events, it is possible to define also the phenomenon density "pE": “tfull" time total or End Time, “Et" the event in “t" instant, (t1,...,tn) temporal interval; this definition is a frequency:

\[
\rho E = \frac{\sum_{i=1}^{n} E_n}{t_{full}}
\]

1.5. DEFINITIONS

1.5.1. DENSITY “ρ”

Density "ρ" is defined as the number of particles per unit volume or time interval.

1.5.2. PRESSURE “P”

It is a concept, very similar to Density, or better, is a consequence of her. Obviously, if the pressure is greater, the density also.

First, it can think about pressure as a definition in Kinetic theory of gasses (proportional to “m” total mass particles, “1/Vol” volume and “u” average velocity of particles, impulse (m*u) and “N” number particles); “p” is a local value, that is: around a point, “cte” is a constant):
In fact, it is common work with the Lift Force in Aerodynamics, as (‘A’ area and ‘C’ a coefficient); very similar to (pressure = Force / Surface, “cte” is a constant):

\[
\text{Force(lift)} = F = \rho \text{ } u^2 \frac{1}{2} AC \rightarrow \frac{F}{A} = P = \text{cte} \rho \text{ } u^2 \propto \rho \text{ } u^2
\]

This concept is very important in galaxies formation and evolution or in general in cosmology. In this case, “P” is called “Ram Pressure”, and very similarly, to Einstein equation (simplified) \( E = mc^2 \). In fact, the Pressure is the Energy; this concept of Pressure as Energy, is essential in order to define a new procedure for creating a CFD code; for a “Vol” (Volume) fix:

\[
E = m c^2 = \frac{m}{vol} c^2 Vol \propto \rho \text{ } Vol
\]

\[
E \propto P \text{ } Vol
\]

It can have a fluid with compressibility but is necessary to know the velocity for this compression or expansion. This value is the divergence of velocity; that is: the variation of volume, and may be positive (universe in expansion) or negative (universe in compression). It suppose that events group, may be different pressure against the time or other variable. That is: 2 events in a fluid (as a particles set) non incompressible:

The 2 events cannot be less than a distance “a” or more than a distance “b”. In case of being more than “b”, the events can be considered independent, in the first phase. These distances “a” and “b” are different depending on temperature, pressure and density, for the same fluid-group of events. The speed of compression and dilatation (“a” and “b”, is function of spring-damper system, or other combination between forces, velocity, acceleration, etc…). The density of a fluid formed by particles depends directly on the compressibility and vice versa; compressibility is defined as the force applied to 2 particles to bring them closer together. Be a closed box full of billiard balls; if you try to move the balls, it will be absolutely impossible:

![Image of billiard balls](image_url)

From this reasoning, one can perfectly understand Pascal’s principle, or the transfer of forces between communicating vessels:
If a particle "A" at the top of the cylinder is pushed, this force is distributed to all the particles around it, reaching the top of the other cylinder:

![Diagram](image)

Note: about refraction light:

It knows the blending of light in Relativity:

![Diagram](image)

But, it is possible to explain the curvature of light by the effect of gravity (not Newtonian concept), through the concept of refraction: light curves the more the density energy increases.

The refractive index of a medium is a measure of the speed of light in that medium.

The higher the refractive index, the slower the light. ... The higher the density of the air, the more molecules there are per volume, and the more light is being obstructed. Therefore the refractive index also increases.

Energy density is a measure of the energy stored in the field per unit volume of space. ... Let us use the similarity between the gravitational and electric fields to construct a gravitational energy density term.

Light bends, due to the existence of an energy density variation; that is: the energy density, it bends the space-time and so, the paths.

The energy density, have 3 contributions:

- Electric density: J/m³:
  \[ w_E = \frac{1}{2} E^2 \cdot \varepsilon_0 \]
  
  Vacuum permittivity:
  \[ \varepsilon_0 = 8.854 \cdot 10^{-12} \text{ As/Vm} \]

  field strength \( E = 1 \text{kV/mm} = 1 \text{ MV/m} \)

- Magnetic density: J/m³:
  \[ w_B = \frac{1}{2} B^2 / \mu_0 \]
  
  “B” units in “T”.
Vacuum permeability:

\[ \mu_0 = 4\pi \cdot 10^{-7} \text{ V s/Am} \]

For earth: \( B = 45 \, \mu \text{T} \)

- Gravitational energy: “g” gravity acceleration: \( \text{J/m}^2 \):

\[ \omega_G = \frac{g^2}{8\pi G} \]

For calculating the bend angle of light, when pass close to mass:

- “m” (“G” gravitational constant, “r” distance light to mass center, “c” light speed); in radians; applying Buckingham-Pl theorem:

\[ \theta = \frac{4Gm}{rc^2} \]

- By Newton theory, also is possible to calculate the same value, applying (Kinetic minus potential energy):

\[ \frac{1}{2} m V^2 - \sum_{i=1}^{n} \frac{GM m_i}{r} \rightarrow \text{minimum} \]

The bend, it blends by gravity (and others forces) action, creating a big big ellipse.

Also, applying Newton theory:

\[ F_1 = F_2 = G \frac{m_1 m_2}{r^2} \]

This value is half part of “real” result.

\[ \Delta V = g \Delta t = \frac{Gm}{R^2} \frac{3R}{c} = \frac{2mG}{Rc} \]

\[ \Delta V = \frac{2mG}{Rc} \rightarrow \alpha = \frac{2mG}{Rc^2} \]

\[ \Rightarrow \text{ In other way: It needs now:} \]

- Energy density. With Vacuum and not vacuum energy, “is possible may be”, calculate the refraction index and so, the speed light variation or other object in movement.

- The curvature of space-time, against energy density, or how is the light diffraction trough space with density energy.

- Vacuum energy.

In the space curve, the path of light or any object is a geodesic.
1.5.3. TEMPERATURE “T”

In the expression for pressure, calculate it for a 1 mole; then \(\text{\textit{N}}_A\) is Avogadro number, “M” molecular mass, “cte” is a constant, “R” is universal constant of gases):

\[
P \ast \text{Vol} = \text{m} \ast \text{u}^2 \ast \text{N}_A = \text{R} \ast \text{T}
\]

\[
T = \text{cte} \ast \text{M} \ast \text{u}^2 \sim \text{u}^2
\]

From these equations:

\[P \sim \rho \text{T} \]

It is always said that the displacement of the particles or molecules of a fluid is something unpredictable.

In the Brownian displacement, the particles vibrating (Temperature), produce a variation of position, and this position unpredictable, produce an evolution unpredictable.

Refractive index values are usually determined at standard temperature. A lower temperature means the liquid becomes denser and has a higher viscosity, causing light to travel slower in the medium. This results in a larger value for the refractive index due to a larger ratio.

1.5.4. VISCOSITY “\(\mu\)”

When starting a car when the traffic lights turn green, it does so after some time after the car that precedes it moves (delay time or “\(T_d\)”). It also happens when the price of oil changes due to the index variation of the New York Stock Exchange-Market; it does not do it immediately. “Viscosity= \(\mu =1/T_d\).”

If \(\mu = \infty\), if and only if, \(\rho = \text{Constant}\).

It can see the same delay or gap time, in a typical prey-predator numeric model, between input and output (excitation and response - pick to pick):

Viscosity = 1 / delay time between molecules in a fluid, in order to transmit the sound It is a way to classify different fluids.

Viscosity, as reaction time or gap time, brings together the reaction times of all the forces involved in the displacement of a particle: the force or gravitational field, induces a reaction time, the same as the magnetic field, pressure and others; the "final" viscosity, is the reaction time of a particle, before all the force fields that work or act on the particle (adding all times).

Calculate now, the reaction time between 2 particles of a fluid, for transmit a sound wave: “\(C\)” is the speed of sound (wave shock) in a fluid, “\(R\)” is the fluid constant, “\(x\)” is the average displacement of particles (as a Brownian movement), “\(t\)” is time and “\(N_m\)” the number particles in 1 lineal meter:
\[ T_d = \frac{1/C}{N_m} = \frac{1}{C^3 \sqrt{P/RT} N_A} = \frac{1}{C^3/\rho N_A} \]

Einstein viscosity value is:

\[ \mu_E = \frac{RT}{N_A} \frac{1}{6\pi Dr} \propto Dt \]

“D” is Diffusivity and “r” radio molecules or particles. So:

\[ T_d = \sqrt[3]{\mu_E 6\pi Dr/P C^3} \]

Is possible, so, in this moment, to do a fluids classification against “Td”. For that, is necessary calculate all with the same pressure and temperature. The sound speed “C”, for every fluid, depends of variation of pressure, against density; that is:

\[ C \propto \sqrt[3]{\frac{\partial P}{\partial \rho}} \]

This expression is equivalent to: the sound speed, depend of temperature “T”. That is very important:

\[ C \propto T \]

From another point of view, it has a particles group and between them, there is a spring between particles (or full fluid volume) with a constant “K”; from Hookes law, it is (“x” displacement, “u” velocity, “t” time):

\[ F = Kx = m\frac{u}{t} \]

\[ K = \frac{mC^2}{N_A \mu_G} \propto \frac{m}{\mu_G} \]

This “delay time” or “delay phase” (between input and output signal), can produce Lissajous curves: for example, in a flapping wing case, show a position against lift generate by wing, for a one frequency; show “input” and “output” and delay time between them; other sample about: incubation time for coronavirus or Covi-19:

⇒ This Viscosity, seem the “Friction”, which in my opinion, is the mother of all properties.

If there is a delay time between displacement molecules, smaller, the viscosity is bigger; that is the case for Lava, as a flow:

In the end of this “front”, it can see a parabolic velocity profile...It can see this "parabolic" velocity profile, in a people group walking in street (there are boundary layer in lateral walls):
Other effect very important about the Viscosity, is that:

It is possible to see “filaments” or “fingers” in the front of fluid flow:

The Dark Matter can be taken as a fluid of different Viscosity from the fluid that surrounds this Dark Matter and through which it moves. This difference in Viscosity and Density, as it has already seen, produces a peculiar and special distribution, producing “fingers”, voids, accumulations, groups, etc...

The same thing happens on the inside surface of a glass wet with a drink:

The same occur in enormous blobs deep inside the Earth. It can just barely detect them using seismic imaging or Tomography, and it really don't know what they are:

Other example: In the case of a surface with hot liquid, it is observed that instead of the liquid ascending uniformly, some “fingers” are formed:
As a sample and similarity with the reality (fingers), it shows a supernova explosion; it is possible to see the alterations in border:

Why? The viscosity is very important, also, in this geometrical phenomenon. Some samples about:

In the Article: "Tuning Contact Line Dynamics and Deposition Patterns in Volatile Liquid Mixtures": Asher P. Mouat, Clay E. Wood, Justin E. Pye, and Justin C. Burton; Phys. Rev. Lett. 124, 064502 – Published 14 February 2020, it is possible see the same effect, in a border of fluid in expansion:

Another example can be seen on a wet solid disc, in rotation. Perhaps the logical thing would be the water covering the surface should be diffused outwards in molecules. But the density is finite... this makes that because of the viscosity and in this case the surface tension, the water groups in point and from these points, the water escapes:
This is the same reason why "pearls" are formed in a supernova explosion so.

The particles of a fluid with a higher viscosity will respond more quickly to the changes in the surrounding particles; therefore, when there are small fluctuations or instabilities, they drag particles.

But, there are, for example, Bubbles nebulae. Why is it possible?

As said before, a fluid in the form of a sheet, when expanded, groups together.

But we know, for example, bubble nebulae or soap bubbles: these keep the surface, until a certain moment. This fact has limitations or conditions.

The formation of clusters when expanding depends on several factors:

- Viscosity.
- Density.
- Surface tension.
- Size.
- Speed of expansion
- Others like temperature, pressure, etc...

Why does this effect occur?

What is the Diffusivity “D” as a fluid property? Is the tendency to fade. If it have a spherical particles group ("r" radio particle, “cte” is a constant). When the viscosity and radio particle is greater, the diffusivity is less, if “T” (temperature) is greater the diffusivity also; that is:

\[ D = cte \times \frac{T}{\mu r} \]
Comparing this, with the Einstein relation for diffusivity ("$K_B$" is a Boltzmann constant) (very similar):

$$D = \frac{K_B T}{6\pi \mu r}$$

Any "displacement", is caused by the viscosity (high or low); Folds in Jupiter atmosphere and mountain (similar geometry...):

When it speaks of Viscosity in this Article, we speak of the union of different types of Viscosity: Viscosity of Baryonic matter and Dark Matter, Gravitational Viscosity, Magnetic Viscosity, and even, attraction by low pressure.

1.6. PHENOMENON NUMBER

In order to be able to compare phenomena with each other or simply to know limit or transition values between different dynamic states, a value is needed, which can have units. This value is denoted as "$R_P$":

$$R_P = \rho L V T_d$$

Being "L" the characteristic length of the phenomenon, "$T_d$" delay time, "$\rho$" density and "$V$" its speed.

This value defined in this way applies to fluids.

For example, in evacuation systems pedestrians, is possible to define other phenomenon number:

"$V$" velocity of pedestrian, "A" length of door, "$\rho$" density of pedestrian group, "$T_d$" delay time or reaction time between pedestrians:
For calculating the gap time: given a group of people, we push or move one of them; the time it takes (on average) for the people around it, will be the gap time \( T_d \); this test, in the same density conditions, as the problem to solve. In short, it is a problem of calculating the speed of transmission of a pressure wave.

\[
R_p = \frac{\rho V}{A T_d}
\]

Brownian and not Brownian motion (very sensible to random motion limits); is practically impossible, to have a Brownian fully random; for example: initial particle point \( = (0,0) \):

\[
x_1 := 0 \quad y_1 := 0 \quad i := 1 \ldots 100000
\]

\[
\text{alea}_i = \text{if}(\text{md}(1) < 0.5, -0.1, 0.1)
\]

\[
x_{i+1} := x_i + \text{alea}_i
\]

\[
y_{i+1} := y_i + \text{alea}_2
\]

Brownian and not Brownian motion (very sensible to random motion limits); is practically impossible, to have a Brownian fully random; for example: initial particle point \( = (0,0) \):

What is this factor—attraction between particles? The Viscosity, the gravity, etc. That is the same applied to humans and feelings. Also, a flock birds formation, is a particular case of DLA. It will see that.
Brownian displacement conditioned (only 0.5%). Very good “filament”...:

\[
x_1 := 0 \quad y_1 := 0 \quad i := 1..100000
\]
\[
\text{alea}_1 := \text{if}(\text{md}(1) < 0.505, -0.1, 0.1)
\]
\[
\text{alea}_2 := \text{if}(\text{md}(1) < 0.505, -0.1, 0.1)
\]
\[
x_{i+1} := x_i + \text{alea}_1
\]
\[
y_{i+1} := y_i + \text{alea}_2
\]

The Brownian displacement “full random” is less likely.

This is the easiest method to decide: do not worry about the decisions of your environment.

Decide for yourself, with or without weights in some decisions. The path produced by this displacement, is a tube of low pressure (see formation Galaxy point), so the matter, tend to aggregate in this zone-tube.

1.7.2. CLUSTER MATTER AND MATTER AGGREGATION BY VISCOSITY

It can see the accumulation of dust and lint at home, in a dispersion of tree leaf by the wind, in an accumulation of drop water in a flat plate, in clouds or plastics in sea:
The friction between particles is the responsible of these accumulations: that is: the Viscosity.

The same occur in “flock’s ice” in sea, petroleum filaments in leaks or water in cascades:

A case very interesting for me, is the Article, write by: Computer simulation of the collision of two GAS CLOUDS. Filamentary structures forming at the same time after the collision. This simulation was performed by Tsuyoshi Inoue, with the ATERUI supercomputer operated by the @prcnaoj_en: Tsuyoshi Inoue (Nagoya University).

→ It was a prediction mine....:

It can be observed that the seeds (yellow) accumulate in groups. This is due to the friction between them (viscosity). If these seeds are in a garden with grass, the accumulation in groups does may be not occur: the distribution may be is uniform.
This is because the grass has a higher friction (or viscosity) or in general, different friction; this fact, have consequences (it will see these):

The environmental have the conditions ideals for accumulations of people; may be that this accumulation is due to the same feelings (to be in beach...):

A lightning, is a trajectory that could be considered as a conditioned Brownian displacement. In the following image, it can see the influence of the rainwater (environmental) cascade on the path of the lightning, which follows the path of the water:

The particles with the same or similar viscosity, tend to join (that occur also in humans....).

In the case of flock’s birds, the friction force or Viscosity, work as feelings:

The governing equations or relations, between birds, in order to create the flocks:

- There is a “bird boss”, which do the way.
- There is a cohesion or density/pressure between birds.
- The direction of displacement is “@Pressure/density (acceleration).

In the other hand, for example, in a discotheque (or beach before), the people is there because they to have a good time, and the place, is the right one for it. Is possible show the next images, about interfaces between fluids of different viscosity (sea water), creating filaments, accumulations or aggregations; this densities and viscosities different, may be produced by different temperature, salinity, etc....:
1.7.3. AGGREGATION BY LOW PRESSURE

A zone with low pressure (in relation to another zone near), attract particles or matter. The case of a zone with high pressure, repelled or push a particle:

A particular case is depression tube and vortices.

When a particle move (also galaxy for example), his path is a depression zone; this zone is an attractor for any particle around; this depression tubes, create vortices around:

This low pressure, is present also around each particle in displacement, so, others particles are attracted. There is an Article about (December 2019): https://www.nature.com/articles/s41467-019-13643-y: A first-principle mechanism for particulate aggregation and self-assembly in stratified fluids; Roberto Camassa, Daniel M.
1.7.4. AGGREGATION BY INSTABILITIES: KEVIN–HELMHOLTZ INSTABILITY

The concept of instability is analogous to the concept of non-homogeneity. Non-homogeneity is needed for dynamics to exist, just as instabilities are needed for particular and special geometries to be formed and transformed into dynamics. If not, all is the same.

Is a case particular of DLA displacement.

Instabilities there are a lot types; this instability is typical, but not alone. For example, vortices or turbulences, also there are a lot types, but the Karman vortex, have a special geometry and dimensions, and is periodic.

The Kelvin–Helmholtz effect, cause a little variation between different layers of fluid; these variations change in time, producing turbulences.

The variation may be caused by gravity or random displacement of molecules (Brownian displacement of molecules). On a moving surface, the boundary interface produces a fluid brake, because there are different velocities and may be densities and/or viscosities.

The origin of these geometries is simple: start from a little perturbation; dynamic process:

Also, is possible that from these specials geometries create the galaxies arms....

So if that disturbance does not exist, it is necessary that the 2 bands circulate fully parallel. But it is more likely that not circulate parallel. In this way, disturbance occurs.

If two fluids bands are different density or/and viscosities and velocities will be a disturbance: the fluid with more velocity, tend to fill the low pressure in a fluid with less velocity.

This low pressure zone is originated by:

- Gap time of reaction between molecules; that is: different viscosity.
- Different velocity (simple, but real).
- Density different.
- Gravity, if exist.
- Rayleigh–Taylor:
This last effect, occur when a fluid with more density, interaction with other fluid:

For example, on earth, not only are there air flows or circulations in the atmosphere tangential to the surface, but also from top to bottom and vice versa:

Considering the origin of turbulence in terms of small initial disturbances, one case where we can see and observe the creation of turbulences is the curtains of most rural houses. We all have seen these curtains which are placed on the door to prevent the entry of mosquitoes. If it’s windy, we will see that the curtain starts to ripple. Originally, the curtain doesn’t move, but with a slight alteration, the wave starts:

Perturbation of Kelvin–Helmholtz also in other’s structures bigger, as Orion Nebula or even in the Sun:

The same occur in a recipient with boiling water:

These perturbations or disturbances also can be the origin of galaxy arms... These perturbation of Kelvin–Helmholtz, are very spectacular; we can think about this disturbance, as a brake wave, more or less:
As a Viscosity before, there are time gap between 2 particles. This gap can produce vortex as geometry: 1 particle want follow other particle with different directions; the geometry path, can be a Vortex or turbulence:

Is possible to see these specials geometries in stones (flow sand, etc); the origin, is the same: little disturbance, and density-viscosity differences; Kelvin-Helmholtz disturbances in stones or mountains:

1.8. MATTER DISTRIBUTION IN THE UNIVERSE

1.8.1. SPYDER WEB CREATION AS A UNIVERSE

The Background Microwave Cosmic (BMC), is a map of temperature variation in a distribution of mass in early universe (colors scale blue-red: low-high density or temperature):

Why this distribution? This special distribution of zones with more and less density is normal in the nature. All explosions for example, not have an equal matter in any direction or point, fragments distribution,
density or temperature (sun surface, supernovas, atomic bomb, nebulae, etc....):

The same occur in temperature in earth surface: there are little’s variations:

2 ways or numeric models, for explaining this special structure:

⇒ First way: it supposes that the Universe work as a fluid with viscosity:

These densities–viscosities variations (CMB), origin in the future, the different galaxies cluster and matter distribution in large scale. In fact, from this BMC as a boundary condition, is possible simulate the evolution of universe: the result is very similar to universe observable today:

The formation and evolution of a galaxy and galaxies can be simulated, assuming that we are working with a fluid with certain density and viscosity conditions.

At this point, the processes and phenomena that occur in a fluid are analyzed, to dynamically form galaxies.

⇒ There are other way for creating the universe in high scale:

For the formation of the web spyder or large scale structure of the universe, in a numerical modeling can be applied, Navier Stokes: with these equations, incorporating viscosity and external forces (such as gravity, magnetism, etc), it is possible to simulate the large-scale structure of the universe.

The speed of light, like the speed of gravitational attraction in the universe, depends on the environment. The speed varies depending on the density, viscosity, magnetism, etc.... This difference of "action" between particles, called now, Viscosity or difference of reaction time, is what produces the aggregation of matter-particles, forming the cosmic web.

The current structure of the Universe is generated from various forces:

- Gravity.
- Electromagnetism.
- Relativity.
- Others...
Is possible so, to apply the Navier Stokes equations, with magnetic force, etc….


From the actual Universe in high scale, through “reverse engineering”, is possible create the early structure and mass distribution.

The formation of filaments is completely logical and normal. If a group of mass particles starts with a constant density and all of them with the same mass, no filaments will be formed, but that (initial distribution “constant and uniform” is impossible (→ BMC):

There’s a particular structure, called Laniakea:

The yellow surface represents dust (latest data from Rosine Lallement and her team), and the purple surface represents hot star concentrations (and traces the outline of the Local Bubble). No dark matter though.

In the particular case of the Laniakea, “attractors” are observed that are accumulations of matter, which produce a lot of gravitational attraction; on the other hand, there are “repulsors” or dipole repeller, which are the opposite (zones of low density of matter). Therefore, it is necessary to simulate gravity, to have a good numerical model of the evolution of the Universe on a large scale; “?” is a dipole repeller point or zone:
The translation speed of galaxies today is not only explained by the existence of an attractor: a repulsive dipole is needed...

The velocities of a galaxy can be calculated using gravitational fields. But we have to work with the possibility that the galaxies, in their paths, have been helped by the gravities of other galaxies or galaxy paths (gravitational aid). That is why the calculations, without working with this possibility, are incorrect.

It is necessary, therefore, that repellent dipole, but it is simply that it has less force of gravity or attraction, because it has less mass or density.

It is all a question of mass distribution and therefore of gravity: always attractive, never repulsive.

For example, in the case of a pipe, the fluid is expelled because there is a pressure difference: the fluid flow has a direction towards the low pressure. But this does not mean that at the other end, there is a "repeller" that pushes the fluid...

Knowing a priori if it is going to rain in the next few minutes, while it is raining cats and dogs while having this desire is not something too difficult. However, knowing if it will rain in 46 and half days is not difficult at all. To know, for example, if tomorrow will be the day before, is easy, but it is not easy to know where a stone thrown with all the strength will fall.

In the determination or knowledge a priori of something, there are basically two aspects involved:

- The nature of the phenomenon itself.
- The time series we are using.

The essence of chaos is the scarcity and simplicity of laws that govern evolution; thus, it is easier to determine the evolution of the stock market than how a football will move; on the other hand, the more data we have about the evolution we want to simulate, the easier it will be for us and above all, the more reliable it will be.

In every chaotic process, there is a certain geometrical structure that is either visible or not observable: Fractal structure or geometry is the science that studies the representation of chaotic dynamics; we find fractal geometries in nature itself:

- Contours or borders of countries and coasts.
- The structure of a tree.
- The network of a person's blood circulation.

But also in representations of certain phenomena:

- The classic problem or simulation of a pendulum and 3 magnets of different colors.
- Etc....

One of the objectives that could be achieved by determining whether or not certain geometry is multifractal is to differentiate or classify phenomena according to their distribution of fractal dimensions.

Abstract:

Predicting what is going to happen is very tempting, and it is something that everyone would like to be able to do, in an easy and above all reliable way.
Chaos:

The essence of the so-called "chaos" and of fractal and multifractal geometry, is precisely the scarcity and simplicity of laws: simple and scarce laws, originate structures of all kinds extremely complex and unpredictable; we only have to think that only one force, perfectly quantifiable, is responsible for the structure of the universe, with its galaxies and groups of galaxies, planets and planetary systems, etc. The fewer and simpler the primary forces that manage or describe a phenomenon, the more disorder and chaos there will be with respect to time and also space: for example, it is easier to predict the evolution of the stock market, than the evolution or dynamics of a fluid, the variations of a pendulum or simply where a stone thrown by us might fall. But also: the easier a problem seems to us, the more difficult it will be to find its foundation, laws and interdependence between factors, and the more difficult it will be to simulate its evolution in time.

Without chaos, there is no evolution, life or change of any kind.

This leads us to the statement of a new vision of chaos: the more unpredictable and the more difficult it is to solve a problem or a phenomenon, the simpler and more straightforward will be its foundations and the laws that govern it.

There is a very widespread concept or idea, which is directly or indirectly related to the concept of chaos or disorder; such idea is the so-called "butterfly effect". This idea is basically false or at least erroneous in its traditional concept; 2 events, causes or effects, are not necessarily united nor is it necessary for them to be dependent, even though it is said that they are in a very distant time or that their effects or inter-effects are appreciable in an infinitely small measure; it is essentially and conceptually false and erroneous. It becomes necessary, therefore, to define related and unrelated events.

How does the science of chaos help to explain such complex and different processes?

In recent times, the idea has been emerging that introduces the notion of chaos as a central element in research and in almost any scientific explanation or response. The idea of chaos and apparent disorder is a tool, which helps to understand certain phenomena that so far are almost inscrutable.

"The cosmos par excellence is the world, the absolute whole that contains all the partial alls," says Marcel Conche in "The Notion of Order," and disorder, adds Georges Balandier, "cannot appear except as a rupture of unity, of general harmony, and as an obscuring of purpose.

Chaos and disorder, as challenges to scientific thought, invite us to find the regularities of the irregular, the determinations of the indeterminate, the order of disorder.

Incongruent perhaps? We do not believe so. In recent times, this science that studies the relationship between chaos and the perceptible and non-perceptible world has been identified as "chaology". For Balandier, in his book: "The disorder", the chaology "seems to be concerned, at first, only in the curiosities or the deviations of the illusion in benefit of a science that has become strange. For her, triviality becomes mystery. The leaking tap is no longer a small domestic matter and a source of irritation, but the occasion for an erudite observation, made over the years, that makes this anomaly a kind of paradigm of chaos. The water of a waterfall, with its fall in layers, its dispersion in a multitude of droplets and its subsequent circulation towards the errant current, manifests a higher level of this complexity with a disorderly rhythm. Cigarette smoke, the companion to the wanderings of the spirit, which first rises in a straight line and suddenly twists and composes moving figures, suggests the presence of a similar
phenomenon. Above, very high up, the marvellous clouds run, they construct celestial landscapes, mobile and always changing, chaos with which dreams are linked; but the new discipline wants to force its mystery, to find the answer that will make the forecast of the time beyond the immediate less fallible.

Chance is a determining factor in the manifestation of diverse phenomena and processes of the universe, and yet these are not as random as they appear or simulate:

Mitchell J. Feigembaum, states that "we are full of chaos", beauty is "essentially chaotic", the shape of the clouds is also chaotic. The science of chaos is for him "the study of disorder, of the irregular behavior of deterministic things, those that you know how they behave from one instant to another, and yet their displacements become irregular, erratic, and give the sensation that they are produced at random. And in reality, what happens is that they don't happen by chance.

Julie Fierro, comments that "in particular the transitions of the particles can be studied more adequately by resorting to chaos theory.

Thus, it is possible to conceive of other universes, parallel to ours and totally incommunicado, each with its very peculiar physics determined by chaos.... Thus the universe possesses order and disorder, cosmoses that form and expand and can give origin to symmetrical bodies like the galaxies with stars, ringed planets and life. The presence of chaos at all scales of the universe implies a great diversity of possibilities and, therefore, one or several universes with enormous potential to create diversity". In biology and medicine, chaos offers answers to problems such as issues related to blood circulation: turbulence breaks up circulatory and cardiac regularity. In the treatment of epilepsy, the creation of electrical turbulence in certain areas of the brain may be able to block or mitigate the attacks or convulsions caused by this disease or disorder. The applications that chaos can offer are immense: economy, stock market, political transitions, evolution of social conflicts, human relations, negotiations, etc...

Self-similarity:

One of the best-known geometries, perhaps because of its beauty and transcendence, is turbulence itself. Leonardo da Vinci (1500 A.D.), already described, in a truly masterful way, as it could not be less, which is the structure of a turbulence: "the small eddies are almost numberless, and large things are rotated only by large eddies and not by small ones, and small things are turned by both small eddies and large".

Who has not experienced, tested and observed the existence of personal problems, among the members of a group or team, and likewise, other types of problems in a subgroup of the main group, and so on? We have all dreamed at some time, that our society and ourselves, we are not more than integral part of another humanity or society formed by giants, as they are for example, the bacteria for us.

Something similar thought the ancients, when they said that the Milky Way in the night sky seen from the earth, was a trail of milk from the giants or gods; hence the name "Milky Way".

In fact, all fractals have the characteristic of self-similarity: any part is equal to the whole. We do not intend to make a course on fractals, since there are already articles and works on this subject. We simply wanted to offer this particularity that all fractals have.

The most usual representation of a turbulence is a spiral (everything depends on the parameterization that can be made of a phenomenon); it is as if the particles were attracted by a point (attractor), analogous to what happens in a sink, or as if the current
lines are curled up on themselves around a point.

Every dynamic system has attractor points, understood as the points, states or times to which it is directed and evolves. If we parameterize a dynamic phenomenon in order to observe the current lines, the existence of a spiral (not zero rotational of the velocity field) will indicate the existence of turbulence. Under certain conditions, which are very easy to achieve, all dynamic phenomena governed by few simple laws, can cause turbulence; that is: under a potential context of chaos, it is easy to have turbulence or sudden alterations.

A few weeks ago, we found a series of photographs, specifically 4, in which the captions were wrong; the truth is that it was quite difficult for us to assign the captions to each one of them:
- Image from space taken to the vortexes created by the Island of Guadalupe.
- A Karman vortex channel created by a soccer ball with D=100.
- The distribution of galaxies within a cluster or group of galaxies and the distribution of stars within a given galaxy.

There are, and we are aware of this, many other phenomena, in principle different from all points of view, which are enormously similar in terms of their structure, representation or evolutionary dynamics. We find this structure or phenomenon, in situations so different, in scale, type or context, as: car wakes, sudden and chaotic alterations of the stock market or economy, turbulences in biological groups and information networks, internet, blocking of knots, politics, human relations, historical periods, medicine, psychology, meteorology, fluid dynamics, etc.

In short, turbulence is nothing more than "alterations or variations" with respect to, let’s say, the "normal" of any type of dynamics; apparently, turbulence "twists" with respect to time (or to the chosen parameterization or representation); that is the essence of turbulence. This same "strange" or "abnormal" structure can also be found in other types of phenomena, not necessarily relative to the dynamics of a fluid.

An abrupt alteration of the stock exchange, for example, is nothing more than a turbulence caused by a series of initial and boundary conditions, which applied to a series of simple laws, originate a chaotic dynamic with respect to time. On countless occasions, after a bus has passed, we have related the turbulence it leaves behind to the results or alterations that certain economic policies, for example, leave in society.

The characteristic of self-similarity is shared by all dynamic phenomena, whatever their context.

Turbulent displacements are very common, both in nature (atmospheric flows, rivers,...) and in different applications of technological interest (flows in ducts, turbomachinery, boilers, combustion chambers, heat exchange equipment, vehicle aerodynamics,...), to the extent that most of the flows of interest, from almost any medium-serious or applicable point of view, are turbulent. The existence of turbulence alters various physical parameters of the fluid itself, as well as the flow itself.

For this reason, it is necessary to understand and comprehend its origin in order to be able to analyze and predict it.

The two scientific theories or methods could be said to be the most important and the most established, and par excellence, are radically different and propose extreme things:
- The existence of universal laws, which govern everything: a reductionist approach to science.
- The previous theory is not enough; to explain the world much more is required; from any level or scale, new phenomena appear, rich and varied, with elements absent in the previous, simpler level; new symmetries are
generated and new forms of organization emerge; hence the need to generate theories for each phenomenon or even for each scale.

What is the real one? Perhaps, as is always the case in science and in knowledge in general, it is a mixture of booths.

Sir Horace Lamb (1849-1934), in an international tribute given to him on his eightieth birthday, in 1929, said: "When I die, I hope to go to heaven. There, I hope to be enlightened about the solution of two problems, quantum electrodynamics and turbulence. On the first, I am very optimistic...

The first was solved by Richard P. Feynman (1918-1988), for which he was awarded the Nobel Prize in 1965. Feynman: "turbulence is the last major unsolved problem in classical physics".

The problem arises when the set "A" to be studied is formed by points; it is true that we can also join these points by means of lines, and thus obtain a figure; but we do not intend to do this; we want to be able to study the discrete set of points, without having to generate another geometric figure from it. To do this, we need a series of concepts.

Let "A" be a set of points belonging to $\mathbb{R}^n$, $A={X_i}$ / $i=1,...,n$. Let's give this set "A", a measure of probability. We will count for each $X_i$ the number of points of the set that we find inside a sphere of $\mathbb{R}^n$ of radius $\epsilon$, with the center said "$X_i". I will call $n_i (\epsilon)$, to this value. The probability that we will associate to each point of "A", will be the following one: $p_i (\epsilon) = n_i (\epsilon)/N$. In order that it is really a

$$S_\alpha (A) = 0 \quad \alpha > DH$$

The topological dimension of a set is defined as the number of coordinates needed to express a point belonging to that set. We can remember that a fractal is that geometric structure whose Hausdorff dimension is strictly greater than its topological dimension; given a fractal structure, we obtain from it a unique Hausdorff dimension. There are several definitions of Hausdorff's dimension applied to certain geometry; the most used method to calculate the "DH" is the box-counting method; this value, although it does not coincide exactly with the Hausdorff's dimension, coincides in the most interesting cases. The method consists of the following:

We place on the figure to be studied, in 2 or 3 dimensions, a rectangular grid with an epsilon "$\epsilon$" amplitude; I count the number of cells in which the figure enters some box and I call it "$N(\epsilon)$". We repeat the experience for various values of reticular amplitude, and we place on a 2-dimensional graph, the values of $"\log(N(\epsilon))"$ and $"-\log(\epsilon)"$; if we find the slope of the regression line that joins all the points found, we will have the dimension sought.

$$S_\alpha (A) = 0 \quad \alpha > DH$$

For every "A" set, there is only one number "DH ", named dimension Haussdorf of "A", DH(A), for which the following is verified:

$$S_\alpha (A) = 0 \quad \alpha < DH$$

We define external measurement $\alpha$-dimensional of set "A", as that.

$$B_A = \{ B_i / i = 1,...,\infty / A \subseteq \bigcup_i B_i / \epsilon_i \leq \epsilon / \forall i \}$$

$$S_\alpha,\epsilon = \lim_{\epsilon \to 0} \inf \sum_i \epsilon_i^\alpha$$

For every "A" set, there is only one number "DH ", named dimension Haussdorf of "A", DH(A), for which the following is verified:
measurement of probability, we will impose the following condition:

\[ \sum_{i=1}^{N} p_i(\varepsilon) = 1 \]

By Jensen et.al.1985, we have that the probabilities are related to the radius of the sphere, through a law of powers:

\[ p_i \approx \varepsilon^{\alpha_i} \]

The exponents \( \alpha_i \), will be the characteristic exponents of the set "A". We can therefore consider the application that associates each point with its exponent:

\[ \forall x \rightarrow \alpha_i \]

by studying how these values are distributed, will give us a lot of interesting information when it comes to characterizing set "A", with respect to dimensionality. A multifractal, is a fractal that has a distribution of characteristic exponents, instead of a single exponent. That is: there are different zones with different fractal structures.

For each "\( B_i \)" covering of the "A" set, of epsilon amplitude, we can consider the following partition function:

\[ \Gamma_1(q, \tau, \{ B_i \}, \varepsilon) = \sum_i \frac{p_i^q}{\varepsilon_i^\tau} \]

"\( P_i \)" is a measure of the "\( B_i \)" set. To eliminate the dependence with "\( B_i \)" we make the limit of \( \Gamma_1 \) for "\( q \)" and "\( \tau \" less or equal to 0; if we call \( \Gamma_2 \) to this limit, we can define the partition function, as follows:

\[ \Gamma(q, \tau) = \lim_{\varepsilon \to 0} \Gamma_2(q, \tau, \varepsilon) \]

Define \( \Gamma(q, \tau) = \infty \) if \( \tau > \tau(q) \)

\[ = 0 \] if \( \tau < \tau(q) \)

Define function: \( \delta q = (q-1) - 1 \tau(q) \)

One of the reasons why this last definition is important, is \( \delta 0 = DH \).

\[ \Gamma(0, \tau) = \lim_{\varepsilon \to 0} \inf \frac{\varepsilon_i-\tau}{\varepsilon} = 0 \quad \tau \leq 0 \]

If it change "\( \alpha = -\tau \), it have:

\[ \Gamma(0, \tau) = \lim_{\varepsilon \to 0} \inf \sum_{i=1}^{N} \varepsilon_i^\alpha = S_\alpha(A) \]

Since Haussdorf's dimension is unique, it follows that \( \delta 0 = DH \).

The generalised dimensions of Rènyi are defined as follows: Grassberger, 1983:

\[ D_q(\varepsilon) = \lim_{\varepsilon \to 0} \left( \frac{1}{q} \right) \frac{\log \sum_{i=1}^{N} (p_i(\varepsilon))q}{\log(1/\varepsilon)} \]

These types of dimensions were introduced in 1983 by Hentschell and Procacia, as an attempt to define dimensions that were easier to establish relationships between them. With the appearance of these dimensions, not only was this achieved, but also the dimensions used until then were defined, based on the generalized ones; dimension or capacity of Kolmogorov "DK" The following dimensions are available: the information dimension "DI" and the correlation dimension "DC".

<table>
<thead>
<tr>
<th>( DK )</th>
<th>( D_I )</th>
<th>( DC )</th>
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<tbody>
<tr>
<td>( \lim_{q \to 0} D_q )</td>
<td>( \lim_{q \to 1} D_q )</td>
<td>( \lim_{q \to 2} D_q )</td>
</tr>
</tbody>
</table>
The number of times \( \alpha \) takes a value within the closed interval \( (\alpha', \alpha' + d\alpha') \), can be expressed as follows:

\[
n(\alpha')d\alpha' = \varepsilon^{-f(\alpha)}d\alpha'
\]

\( f(\alpha) \), is the fractal dimension of the subset of \( A \) that have the same characteristic exponent \( \alpha \); that is: \( \forall -1(\alpha) \) where \( \alpha \in (\alpha', \alpha' + d\alpha') \).

To draw the function \( f(\alpha) \), we'll draw the envelope to the straights \( y=qx-\tau(q) \), varying \( q \) from \( -\infty \) to \( +\infty \), (V. Martínez 1988). The curve thus drawn has a single maximum and the value that the function takes at that point is the Hausdorff dimension of the set.

Very interesting things can be found in the works of P. Martien, S. Pope, P. L. Scott and R. S. Shaw on the time intervals between drops on a dripping tap in 1985, or the works of A. Provenzale, R. Vio and S. Cristiani on the variations of luminosity of quasar 3C-345 in 1993.

From an apparently chaotic phenomenon in terms of its high unpredictability, we obtain a defined geometry, on which we define and calculate its multifractal dimensions.

This characterization from the point of view of fractal geometry is applicable to other types of phenomena or time series.

The fractal dimension of a random distribution of galaxies is \( D = 3 \); the fractal dimension of galaxies located on the walls of low-pressure zones is \( D = 2 \); \( D = 1 \) on the walls, and \( D = 0 \), in galaxy clusters; in fact: \( D(r) \) with distance \( r \) (Mpc/h):

\[
\begin{align*}
D(0) &\approx 1.5 \\
D(0.8) &\approx 0 \\
D(3) &\approx 2 \\
D(100) &\approx 3
\end{align*}
\]

I have made an application – software in Mathcad, in order to apply it to dates (spatial coordinates, temporal series, etc...), and analyze the multifractal geometry characteristic (based in mathematic theory expose before):

\[
h(n,j) := [ (x_j - px_n)^2 + (y_j - py_n)^2 \times \varepsilon^2, 1, 0 ]
\]

\[
R_n = \sum_j h(n,j) - 1
\]

\[
p_i = \frac{R_i}{N}
\]

\[


\frac{\log(p_i)}{\log(\varepsilon)}
\]

In this moment, it applies this procedure, in a Meteorites rain. That is: as a first sample:

It have a table with dates, each corresponding to the instant of sighting a Quadrantides (meteorites rain in 1992); the accuracy of the shots is the maximum achievable from the combination of the human eye, the brain, a paper and a pencil; the format of these shots is as follows:

- The first two decimal places correspond to the hour in universal time, the next two to the minutes and the last two to the seconds.

The table is composed of 303 time dates, and may be sufficient to obtain some information. For example: 0.015038.

In order to observe, analyze and draw some kind of conclusion about the moments of sighting, it is convenient to normalize them by converting them into Julian time of day.

For this, assuming that in the data file, we have the moments already mentioned, and
knowing that "a" is the year, "m" the month
and "d" the day:

\[
\begin{align*}
C:\ldots\text{datos.txt} \\
i &:= 2..\text{length}(t) - 1
\end{align*}
\]

\[
a_i &= 1992 \quad m_i = 1 \quad d_{i1} = 3
\]

\[
f_{d1_i} := \text{floor}(t_i \cdot 100) \cdot 6060
\]

\[
f_{d2_i} := \text{floor}(t_i \cdot 100) - \text{floor}(t_i \cdot 100) \cdot 100 \cdot 60
\]

\[
f_{d3_i} := \text{floor}(t_i - 10000) - \text{floor}(t_i - 10000) \cdot 100
\]

\[
f_{d4_i} := f_{d1_i} + f_{d2_i} + f_{d3_i}
\]

\[
d_i := f_{d4_i} \frac{10}{246060} + d_{i1}
\]

\[
d_i, \text{is Julian day.}
\]

\[
d_{j1} := \text{floor}(365.25 a_i) + \text{floor}(30.6001 (m_i + 1)) + d_i - \\
+ \left[ 2 - \text{floor} \left( \frac{a_i}{100} \right) - \text{floor} \left( \frac{\text{floor} \left( \frac{a_i}{100} \right)}{4} \right) \right]
\]

In this way, we can already work with this data, since it is already standardized and unified.

The geometric representation of the data we have is basic for a good analysis; and not only that: from certain geometry.

It will only be possible to extract certain information and not another one. It sees the different representations.

Let's see how the time intervals between each sighting evolve:

If it calculate the differences of a higher order and represent the evolution, it will obtain:

\[
d_{j1} := d_{j} - d_{j-1}
\]

The areas with the largest peaks correspond to the time intervals of least activity and vice versa.

This representation does not tell us much, except for what has already been
mentioned; let's take the following representation:

\[ j = 3 \cdot \text{length}(t) - 1 \]

This geometry tells us the rate of growth of the time intervals between sightings; that is: as time goes by, the frequency of appearance of a Quadrantides decreases.

Let us now take the n-order differences:

We have represented the differences of different orders, from consecutive values; we obtain analogous geometries, for non-consecutive values.

In this last representation-geometry, it applies the Multifractal theory.

Obviously, we could generate many more geometries, starting, for example, by substituting division, multiplication or whatever.

Another very useful representation is the three-dimensional one (even 4, etc...):

1.8.2. GALAXIES

The formation and evolution of a galaxy and galaxies can be simulated, assuming that we are working with a fluid with certain density and viscosity conditions.

At this point, the processes and phenomena that occur in a fluid are analyzed, to dynamically form galaxies.

1.8.2.1. ORIGIN

When a particle move, his path is a depression path; all particles behind or
around her, rotate around the depression tube, producing vortices:

These “paths” of low pressure or density, can help matter particles, to aggregate each and other, producing, in the future, stars, black holes, etc. That is: the galaxy seed. Also, these paths allow and help other’s galaxies behind to follow the first galaxy.

It’s been barely 15 minutes since I got up from walking my dogs and, being in a square, I started laughing (and also now....) when I found some piles of seeds on the grass:

When I saw them, I wondered if the 4 accumulations I saw and their relative position had anything to do with:

- The size of the seeds.
- The friction between them.
- The size of the clumps.
- Etc...

No. It has nothing to do with that.

At first, the seeds are rolling on the grass, and at a certain moment, for a reason that is difficult to know...., one of them stops and drags more and more seeds to adhere to it, forming an accumulation or group.

The old galaxies, are very irregulars:

13-8 billion years old this galaxy-s light comes to us from when the Univers:

1.8.2.2. GALAXIES CREATION AND ROTATION

a) A Galaxy rotates, because the black hole or condensed matter in its center is most likely to rotate. This turn "drags" more and more matter, also making it rotate: for example, in the case of a sump, the water starts to rotate because it is most likely (it is very difficult not to rotate....). This rotation makes more and more water turn.

The same explanation it has for a water sink: the rotation direction (without Coriolis and more), is random:
b) Initial aggregation of matter, creating the galaxy. May be, sure..., in the galaxy center, it creates a black hole. Around depression tube? may be... Or from initial disturbance. Why rotate in this case? because there are a rotational moment, for every star which is pull.

The rotation of black hole, help galaxy in its evolution (also bend the light...).

The aggregation start of matter may be also created by Globular aggrupation (may be from an only one star...) or dust cloud (also by dark matter aggregation ??¿¿). Others initial seed: Globular aggregation and Dust cloud:

Can be the globular cluster, the origin of every galaxy?: a globular cluster, have rotation (also, is the most likely...). Rotation velocity stars in globular cluster, with the rotation axis:
1.8.2.3. VELOCITY PROFILE

ROTATION

The velocity radial in a galaxy is different if it supposes the rotation with the Kepler laws; the velocity “real” is greater. Solid line is a velocity by Kepler rules, and star line, velocity “real”:

![Velocity plot](image)

In order to create a model for galaxy matter, which its velocity profile is the correct, is possible change galaxy density and/or viscosity.

- Density (that is: considering as a only fluid, a galaxy):

  The existence of dark matter becomes necessary:

  The velocity \( V \) in a point with \( r \) distance to galaxy center is \((G\) gravitational constant, \( m \) mass of particle-point):

  \[
  V = \frac{Gm}{r}
  \]

  The variation of velocity “real” with the Kepler hypothesis, is suppose that \( m/r \), change in a special form (constant); so: (“cte” is more or less constant: is possible calculate a Density in every point, or full galaxy):

  \[
  \frac{m}{r} = cte
  \]

  \[
  2V\partial V \frac{r^2}{G} = G(r\partial m - m\partial r)
  \]

Adding this “new” matter to galaxy is possible obtains the good velocity profile; that is: increasing the density. The density value for that is approximately \( 1.38 \times 10^{-17} \) Kg/m³. In our solar system, there is Dark Matter, yes. The amount in our solar system (we suppose a sphere of solar system diameter) is more or less the mass of Pluto \((1.5 \times 10^{22} \) Kg):

![Pluto](image)

Problem: We not know the size of particle dark matter: May be Pluto size or less...

- Viscosity (that is: considering as a only fluid, a galaxy):

  In a galaxy, “a” star radio, “r” distance star to galaxy center, “m” the galaxy mass (inner part) and “\( \mu \)” the viscosity: the velocity \( V \) is proportional to “a” and “r” and proportional to “1/m”; “\( \mu \)” is the proportional constant (more or less: is possible calculate a Viscosity in every point, or full galaxy) or factor:

  \[
  V = \mu \frac{ar}{m}
  \]

  \[
  \mu_1 = \mu 6\pi
  \]

  Is possible so, to know the viscosity, for having a velocity.

- Density and viscosity (working together):

  Combining and substituting the mass for density*Volume (Vol), is possible change density and viscosity, in order to have the profile velocity “real” (“Vol” is the galaxy...
volume inner part, "K" constant more or less): is possible calculate a Density and Viscosity in every point or full galaxy): (the Viscosity is more important than Density):

\[
\sqrt{\frac{Gm}{r}} = 6\pi \frac{a}{m} \mu r \\
m = \rho \cdot Vol \\
\rightarrow \frac{\rho^{1/2}}{\mu} \approx K
\]

In the 3 cases, is possible create the real profile. Solid line is a velocity by Kepler rules, and star line, velocity "real":

The existence of dark matter is "not necessary" for Mond. Perhaps, the expression of the gravitational force is erroneous at great distances, and the transmission of these forces, is appreciable far from the source.

For this, in the expression of Newton's gravitational force, we can include a factor that depends on the distance, but that, like the Lorentz equations, is maintained along an infinite distance, but at a short distance, as it is the case of our solar system, the "new" force and the Newton, are practically the same. Only depend of the acceleration.

In fact, in our solar system, the acceleration is practically zero. It supposes the existence of Dark Matter.

In the early universe, there was less dark matter than today. From theories MOND or Verlinde types, the dark matter is "created" by baryonic matter: Speed rotation in galaxies in early universe:

- Existence of lot Neutrinos.
- Machos.
- Wimp.
- Etc...

None more comments about these "news" theories... (As Richard Feynman say: "if there are not evidences in reality, are wrongs iii").
Other think is a Velocity initial for every galaxy. This velocity final, obviously depend of the initial velocity. This initial velocity, depend of:

- Mass in general.
- Instability initial.
- Mass introduction and its velocity vector.
- Velocity initial of black hoe if exist.
- Etc.

1.8.2.4. ARMS FORMATION

First of all, and obviously, is possible appreciate the similarity with any real galaxy (geometry pattern – typical in mathematical or physical models). Typical galaxy in spiral:

Is possible so, apply fluids theory to galaxy formation, evolution and interaction? May be....

Other explanation, is more accurate and “real”, but complementary to these before: around a galaxy, there are a lot matter in different forms (in fact, the galaxies, swim in Dark Matter): traditional or visible, dark matter, may be etc.... that is: the density and also the viscosity, around and into a galaxy, is big.

Imagine now, that it has a cloth and a cylinder placed in the central part which rotates, creating a special pattern (A rotating fluids set with different viscosities and densities, can generate arms, as a density contours). Zones of creation of galaxy arms; the same phenomenon in whirl water. Also is possible generate these "arms" in chocolate rotating:
These waves are zones low pressure and other’s high pressure. In the zones of high pressure, so with high density, it creates the stars, so the arms (with the help, as always, of the gravity):

At certain heights in the atmosphere, there are different layers of air at different temperatures and therefore densities and viscosities. At that time, the interface, works like the free surface of the sea; waves with different frequencies and amplitudes are produced, producing different cloud geometries:
These waves are density waves. Why a lot are shapes types of galaxies? Depend of initial matter distribution, including amount, velocity rotation black hole, dimensions of black hole or disturbance zone, etc....

The stars matter may be composed by baryonic matter but also may be, by Dark Matter transformed in baryonic matter.... (Mond theory ????)....

Is possible see the arms, through a density map or viscosity map-field generation (café or chocolate for example – is very complicate to see these densities variation or height variation – waves).

First, it analyzes the next test:

- Wing in order to generate a vortex.
- Visualize the vortex, behind wing.

First image: blue-red → low-high pressure. Rest images: red-blue → high-low vorticity.

As a first test, good attempt....

Is necessary so, more, in order to create and visualize better the arms.

1.8.2.5. PHENOMENONS, PROPERTIES, RELATIONS, INTERACTIONS, GEOMETRIES, SIMILARITIES
All my life I have worked on aerodynamics applied especially to race cars. For this reason, I have deeply studied the creation of vortices and the interaction between them. The main objective is to apply this knowledge directly to the formation, evolution and interaction of galaxies. From this deep knowledge about vortices and turbulences in general, it is possible to know phenomena that will occur in galaxies, because they occur in vortices: formation, evolution and interaction. Next, there are several phenomena that occur in vortices and that although they have not yet been observed in galaxies, surely they will occur. It is a matter of investigating such phenomena, and for that, I need time and means to do it.

a) LUMINOSITY / ROTATION VELOCITY

The galaxy matter in rotation, interaction with other matter, producing big greater densities zones. So, is possible to think, that if a galaxy have a greater rotation velocity, the interaction with the matter, also is bigger, so more stars zones formation. So finally, if a galaxy have a greater rotation velocity, its luminosity will may be bigger. And that is true. Classification galaxies luminosity, against rotation velocity; Rubin in 1983:

b) LUMINOSITY / TYPE

A galaxy has more luminosity, will must to be more arms. Classification galaxies Sa, Sb and Sc:

c) GALAXIES TAIL

When talking about the Tail produced by a Galaxy on its way through the Universe, there are 2 types of Tails:

- The one produced by the Stripper of the matter of the galaxy caused by Ram Pressure: high pressure.

- The galaxy, in its path, "cleans" the path, capturing matter and leaving a trace of low density: low pressure.

In one case, the Tail acts by repelling matter, and the second case, by attracting matter.
d) **GALAXIES WITH LESS DARK MATTER**

If there is little dark matter, the galaxy has fewer arms.

---

Stripped galaxy and their CFD simulation:

The same occur in Mallorca Island (tail sand formation) in storm:

---

*e) OLD GALAXIES AGAINST LUMINOSITY AND ROTATION VELOCITY*

In the past (more density - far), a galaxy have more luminosity with less rotation velocity than today.

---

*f) VELOCITY ROTATION AGAINST DISTANCE*

Rotation velocity against distance:

<table>
<thead>
<tr>
<th>Galaxy</th>
<th>RA (decimal)</th>
<th>Dec (decimal)</th>
<th>PA (degrees)</th>
<th>d (Mpc)</th>
<th>Hubble Type</th>
<th>$\sigma_{rot}$</th>
<th>$\log D_{25}$</th>
<th>$\log r_{25}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGC 522</td>
<td>00 21 43.33</td>
<td>+02 49 40.3</td>
<td>351</td>
<td>3.1</td>
<td>Sa</td>
<td>9030</td>
<td>1.5</td>
<td>0.6</td>
</tr>
<tr>
<td>NGC 244</td>
<td>01 50 14.00</td>
<td>+27 38 42.2</td>
<td>86.6</td>
<td>5.8</td>
<td>Sa</td>
<td>2186</td>
<td>1.63</td>
<td>0.96</td>
</tr>
<tr>
<td>NGC 994</td>
<td>02 40 09.92</td>
<td>12 39 21.3</td>
<td>13.0</td>
<td>9.6</td>
<td>Sb</td>
<td>-29.17</td>
<td>1.10</td>
<td>0.10</td>
</tr>
<tr>
<td>NGC 504</td>
<td>08 49 11.9</td>
<td>60 13 15.9</td>
<td>65.0</td>
<td>19.2</td>
<td>Sb</td>
<td>-29.09</td>
<td>1.62</td>
<td>2.205</td>
</tr>
<tr>
<td>LGC 4906</td>
<td>00 17 38.09</td>
<td>52 58 56.3</td>
<td>49.6</td>
<td>35.6</td>
<td>Sk</td>
<td>-20.29</td>
<td>1.30</td>
<td>2.238</td>
</tr>
<tr>
<td>NGC 2682</td>
<td>09 21 55.10</td>
<td>20 46 29.0</td>
<td>114.0</td>
<td>56.5</td>
<td>Sb</td>
<td>-21.44</td>
<td>1.41</td>
<td>2.484</td>
</tr>
<tr>
<td>NGC 3577</td>
<td>10 54 42.52</td>
<td>17 59 37.0</td>
<td>122.0</td>
<td>19.9</td>
<td>Sc</td>
<td>-19.05</td>
<td>1.54</td>
<td>2.147</td>
</tr>
<tr>
<td>NGC 3511</td>
<td>11 02 47.25</td>
<td>17 59 22.6</td>
<td>26.0</td>
<td>16.2</td>
<td>Sc</td>
<td>-19.05</td>
<td>1.54</td>
<td>2.147</td>
</tr>
<tr>
<td>NGC 4031</td>
<td>11 32 58.69</td>
<td>00 23 50.9</td>
<td>130.6</td>
<td>16.1</td>
<td>Sc</td>
<td>-20.61</td>
<td>1.43</td>
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</tr>
<tr>
<td>NGC 6635</td>
<td>19 54 33.09</td>
<td>-12 56 42.5</td>
<td>72.6</td>
<td>23.0</td>
<td>Sc</td>
<td>-19.55</td>
<td>1.38</td>
<td>1.803</td>
</tr>
</tbody>
</table>
Analyze now, “D” and “V” relation.
Relation between Rotation velocity against distance:

There is a relation lineal. Ok….………..

g) VELOCITY ROTATION AGAINST MASS

Velocity rotation, against galaxy mass:

That is “normal” because if it is older, have more time to “work” with the environmental. A young galaxy, has less arms, is irregular and diffuse:

<table>
<thead>
<tr>
<th>D</th>
<th>Type</th>
<th>m abs</th>
<th>log D 25</th>
<th>log v m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mpc</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
</tr>
<tr>
<td>39.0</td>
<td>Sbc</td>
<td>-20.53</td>
<td>1.44</td>
<td>2.252</td>
</tr>
<tr>
<td>50.4</td>
<td>Sb</td>
<td>-21.53</td>
<td>1.53</td>
<td>2.368</td>
</tr>
<tr>
<td>71.5</td>
<td>Sc</td>
<td>-21.77</td>
<td>1.47</td>
<td>2.410</td>
</tr>
<tr>
<td>49.8</td>
<td>Sab</td>
<td>-20.87</td>
<td>1.18</td>
<td></td>
</tr>
<tr>
<td>19.2</td>
<td>SBab</td>
<td>-20.09</td>
<td>1.62</td>
<td>2.295</td>
</tr>
<tr>
<td>32.6</td>
<td>Sa</td>
<td>-20.26</td>
<td>1.30</td>
<td>2.228</td>
</tr>
<tr>
<td>58.5</td>
<td>SBbc</td>
<td>-21.44</td>
<td>1.41</td>
<td>2.464</td>
</tr>
<tr>
<td>19.9</td>
<td>Scd</td>
<td>-19.27</td>
<td>1.44</td>
<td>2.208</td>
</tr>
<tr>
<td>16.2</td>
<td>Sc</td>
<td>-19.05</td>
<td>1.54</td>
<td>2.147</td>
</tr>
<tr>
<td>36.1</td>
<td>Sc</td>
<td>-20.61</td>
<td>1.43</td>
<td>2.424</td>
</tr>
<tr>
<td>23.0</td>
<td>SBA</td>
<td>-19.55</td>
<td>1.38</td>
<td>1.803</td>
</tr>
</tbody>
</table>

h) AGE AGAINST ARMS

There are a relation between galaxy age and arms (number arms, luminosity and rotation speed). That is: if the galaxy is older, the galaxy has more arms (also in general, obviously): Triangulum 2.38 to 3.07 Mly, Pinwheel 20.9 ± 1.8 Mly, M51 37 Mly:
i) INTERACTION BETWEEN

A) INTERACTION AS A VORTICES WITHOUT GRAVITY

In the sky, is possible to see, a lot samples of collisions:

When two galaxies collide, collide also the dark matter.

Is possible to see the same between hurricanes (analogy with fluid theory or geometries patterns):

So, it can think about (evolution and combination), as an interaction between fluids vortex.

The interaction between vortices is some think very important and complicate:

These unions or alteration, depending of intensity (vorticity) of vortex; if there is one vortex, bigger than other vortex (red and green), can produce that: (each horizontal line correspond one context or size):
Also depend of densities, viscosities, temperatures, rotation direction, velocity rotation, size, etc... and other's paths as a way of other galaxies (depression tubes).

The study of these interactions between vortices, is typical in aerodynamic work about Race Cars; is important create vortices, but is more important, their interactions. Vortices in front wing race car Formula 1:

In this typical case, there are lot samples of interaction between vortices with the same or different turn sense, sizes, velocity, etc... (the same in galaxies).

It could simplify the problem of the interaction of 2 or more galaxies, assuming it work in 2 dimensions, but this is not real. Galaxies are 3-dimensional and so is their location. Interactions are not executed in a plane. Galaxies, interact with each other, giving rise to many different geometric shapes, depending on several factors:

- speed of rotation.
- size.
- quantity of mass.
- 3D location.
- direction of rotation.
- direction translation.
- Etc.....
On the other hand, it is possible perfectly, to simulate the interactions between galaxies and also the formation of galaxies, by CFD Simulation:

B) SENSE ROTATION – 1, INTERACTION


The sense of rotation of a galaxy is influenced by the displacement of its companions, even the farthest. This is revealed by the CALIFA galactic survey data used by a group of astronomers to carry out the study.

In principle, distant companions, located millions of light years away, should show little influence on the shape and rotation of the central galaxy, but a recent study indicates that the direction of rotation of a given galaxy depends, in effect, on the average displacement of its neighbors, including those located at long distances."

→ It was a prediction mine....:

It can see another very illustrative effect of the importance of the density and viscosity and this last Article.

Let's think of a submerged pendulum. It makes it swing.
It will be able to see that the pendulum will stop oscillating almost immediately. This is due to the opposition of the water molecules which act on it. In fact, the more density/viscosity the fluid has (less compressibility), the less time the initial oscillation will take to stop.

Now, let's think of two identical pendulums immersed in a fluid and with opposed oscillations.

After a short time, both pendulums will oscillate in the same direction and with the same frequency!!!

Why does this fact happen?

Because the density/viscosity of the fluid, because its variations and the forces transmission trough the particles. On the moon, this wouldn't happen, due to the air absence.

This morning, walking with my mother, she said to me: we're going with the wrong step. In other words, we don't have the same footprint in the same instant. This makes the walk "unstable" and unpleasant....

C) SENSE ROTATION – 2, AS A GEARS

For 2 nearby galaxies (can also occur in more distant galaxies), they rotate in opposite directions. This is because, in their rotation, each galaxy drags its companion, like 2 gears:

D) RESONANT ORBITS IN GALAXIES

Article: Francesca Fragkoudi: orbits of stars in a Milky Way-like barred spiral galaxy; these are resonant orbits extracted directly from one of the Auriga cosmological simulations, and shown in an inertial and rotating frame of reference:
E) GALAXIES: FULL INTERACTION

Each galaxy or group of galaxies, like a tail, leaves a path altered in density or pressure. These "virtual" pathways are there and exist, but they are very difficult to locate and know but they are there, and they determine and modify the path of other galaxies that approach these pathways.

Galaxy tails (high or low density), also evolve, move and change. The reason is that the environment affects them: other tails, zones of low and high density, etc....

The evolution of galaxies is based in:
- Viscosity.
- Interaction between Tails.
- Gravity.
- Others forces....

Is possible to know what is the path or direction of displacement of each galaxy, studying the star bridges, tails, etc....

About this last affirmation or possible research, there is an Article very recent:

“The Orbital Histories of Magellanic Satellites Using Gaia DR2 Proper Motions”, by Ekta Patel and other’s.: “With the release of Gaia DR2, it is now possible to measure the proper motions (PMs) of the lowest mass, ultra-faint satellites in the Milky Way’s (MW) halo for the first time. Many of these faint satellites are posited to have been accreted as satellites of the Magellanic Clouds (MCs)”

From this Article, it has a table of position and velocities of galaxies set, in order to analyze the interactions or paths between:

Here, an image very important: Star bridge in Magellanic clouds:
2. NAVIER STOKES EQUATIONS

ABSTRACT

Is necessary to detect patterns in numeric models that describe the events, and then, it will be easier to detect patterns between events:

I find similarities between phenomenon's and numeric models.

It try to create a theory for explaining the distribution and evolution of matter in the Universe in large scale, galaxies dynamic, Universe expansion, Dark matter and dark energy, etc.

But also is possible to apply this theory, in others fields as economy, human's relations, people flocks, stock market, feelings human, etc.…

It tries to explain a general behavior in future, not a particular. All dynamic event in the cosmos, are a wave…. And as a wave, is necessary to study it.

Richard Feynman:

- "MATHEMATICS. To those who do not know mathematics it is difficult to get across a real feeling as to the beauty, the deepest beauty, of nature. If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks in."

- "A theory for a scientist, even it is your most desired wish, even if you have invested a lot of time, even if you have married, if not explain the reality, the theory is wrong".

Albert Einstein:

- "Look deep into nature, and then you will understand everything better."

A perfect and full description and analysis of Navier Stokes equations, is essential and necessary so.

2.1. INTRODUCTION

Is possible and necessary, create a new Navier Stokes equations, as a little variation of original equations in order to explain better and easier the phenomenon in the Nature? Yes. I will try to do that.

2.2. GEOMETRIES SIMILARS IN THE NATURE

Some similarities between fluids and others phenomenon's in the nature:

2.2.1. COANDA EFFECT / VISCOITY / BOUNDARY LAYER

Street laterals (less velocity), people manifestation:

2.2.2. BERNOUILLI EFFECT

Sheeps:
This geometry is very similar to nozzle exhaust; and not only the geometry, also the density or pressure field:

\[
\begin{align*}
\frac{dx}{dt} &= ax - bxy \\
\frac{dy}{dt} &= -cy + dxy
\end{align*}
\]

Is a model very simple with "x" and "y" initials, and point fix (a/b, c/d):

\[
\begin{align*}
\frac{dy}{dx} &= \frac{y}{x} \frac{dx - c}{by - a}
\end{align*}
\]

Phase space:

\[
V = dx - c \cdot \ln(x) + by - a \cdot \ln(y)
\]

Some images with different "x" and "y" initials, and "a", "b", "c" and "d":
In the last images, they are the representations of pressure lines in a cavity with a fluid in displacement.

Geometries very similar, numeric model, so, must to be also similar....

In these representations of space phases, is possible to change the orientation and scale, of axis. In the next image, we can see the displacement of a flock-group of sheep, in particular, in corner left down (and the zoom of this zone):

Is possible to know the vortex center in these models? yes. When the variation of each variable (axis) is zero.

2.3.2. ROMEO AND JULIET MODEL

The same happens in love equations between two peoples (Romeo “R” and Juliet “J” model):

\[
\frac{dR(t)}{dt} = aR(t) + bJ(t)
\]
\[
\frac{dJ(t)}{dt} = cR(t) + dJ(t)
\]

Second order derivatives can be added that specify functions that act as catalysts by accelerating or decelerating sentiment, such as economic stability, gender and family opposition, and include partial derivatives so that R and J do not depend only on “t”.

I love more a girl (H) if the girl (M) love me:

\[
\frac{dH(t)}{dt} = aM(t)
\]
\[
\frac{dM(t)}{dt} = -bH(t)
\]

That is: the variation of my love to you, depend of your love to me.

There are other’s equations of love, one bit more complicate (Hannah Fry), but basically, are the same:
2.3.3. LANCHESTER MODELS

And finally, in the Second World War, the Lanchester equations, for predicting an air combat (“A” and “B”, number aircraft:

\[
\frac{dA(t)}{dt} = -bB(t)
\]
\[
\frac{dB(t)}{dt} = -aA(t)
\]

So, are the Prey and Lanchester equations, some similarities as a phenomenon? Are the Prey, Lanchester and Love, events similar? There are also, equations for war “guerrillas”:

\[
\frac{dA(t)}{dt} = -bA(t)B(t)
\]
\[
\frac{dB(t)}{dt} = -aA(t)B(t)
\]

If the phenomenon is the “same”, the numeric model also, but vice versa, is not necessary...

- In the Lanchester case eat aircrafts, and in the Prey case, eat animals, and if one go up, the other go down, with a gap or delay time.

- Basically, prey model and Lanchester model, are the same. It can transform:

\[
ax - bxy \rightarrow x(a - by)
\]

2.3.4. KORTEWEG DE VRIES MODEL

Is the evolution wave numeric model. The expression general is for a 1 dimension “x” and “t” time (“u” is the velocity):

\[
u_t + \alpha uu_x + \beta u_{xxx} = 0
\]

Is an expression one bit special. The discretization is (one of them):

2.3.5. MAXWELL EQUATIONS

The solutions of these important equations, are wave equations:

\[
\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}
\]
\[
\nabla \times \vec{B} = \mu \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}
\]

With solutions:

\[
\mu_0 \epsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2} = \nabla^2 \vec{E}
\]
\[
\mu_0 \epsilon_0 \frac{\partial^2 \vec{B}}{\partial t^2} = \nabla^2 \vec{B}
\]

2.4. NAVIER STOKES EQUATIONS

The “traditional” Navier Stokes equations, are:
It was shown before, that ("P" for pressure, "\(\rho\)" for density and "V" for velocity):

\[ P = \rho V^2 \]

So, supposing Density constant (in 1 Dimension):

\[ \frac{\partial P}{\partial x} = \rho 2u \frac{\partial u}{\partial x} \]

The acceleration is (\(\text{t}^\text{st}\) time):

\[ \text{acceleration} = \frac{\partial u}{\partial t} \]

Also, the units of next expression are acceleration:

\[ \frac{\partial P}{\partial x} \]

\[ \rho \]

So finally (for simplifying: "g" as gravity acceleration, is null now):

\[ \frac{\partial P}{\partial t} = -\frac{\partial x}{\rho} - u \frac{\partial u}{\partial x} + F(\text{viscous}) \]

Obviously, in right terms, is necessary adding the External forces as a electromagnetism, Coriolis effect, gravity, etc....

\[ F(\text{viscous}) = \frac{\mu \partial^2 u}{\rho \partial x^2} \]

The Laplacian (in this case of "u" in 1 Dimension "x"), measures what you could call the « curvature » or stress of the field. It tells you how much the value of the field differs from its average value taken over the surrounding points.

The Laplacian \(\Delta f(p)\) of a function \(f\) at a point \(p\), up to a constant depending on the dimension, is the rate at which the average value of \(f\) over spheres centered at \(p\) deviates from \(f(p)\) as the radius of the sphere grows.

That is, if the Laplacian is positive at a given point, then the average value of the function over a very small sphere centered around that point will be larger than the value of the function at the point. If it's negative, the average will be smaller. If it's zero, the average will be equal. For a harmonic function (everywhere vanishing Laplacian), the function's value always equals the average value over a sphere of any size centered around the point.

If on average over small spheres around is hotter than in then in the next second the temperature in will increase.

\[ \text{This tells it that the exchange rate of over time is given by the average rate of change of in space. If it interpret as the temperature (and therefore } \frac{\partial u}{\partial t}, \text{ is the rate of change of temperature), then it can see that there is more heat exchange in regions where the temperature is very variable, and less heat exchange when the temperature varies slightly.} \]
Discretizing the Laplacian expression:

\[ u_{i}^{n+1} = u_{i}^{n} + \frac{\Delta t}{\Delta x^2} \left( u_{i+1}^{n} - 2u_{i}^{n} + u_{i-1}^{n} \right) \]

**Case 1:**

"T_{dx}^\text{viscous}", gap time as a Viscosity:

\[ F(\text{viscous}) = \frac{u}{T_{dx}} \]

1D:

\[ \frac{\partial u}{\partial t} + u \left( \frac{\partial u}{\partial x} - \frac{1}{T_{dx}} \right) = -\frac{\partial P}{\partial x} + g \]

2D:

\[ \frac{\partial u}{\partial t} + u \left( \frac{\partial u}{\partial x} - \frac{1}{T_{dx}} - \frac{1}{T_{dy}} \right) + v \frac{\partial v}{\partial y} = -\frac{\partial P}{\partial x} + g_x \]

\[ \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \left( \frac{\partial v}{\partial y} - \frac{1}{T_{dx}} - \frac{1}{T_{dy}} \right) = -\frac{\partial P}{\partial y} + g_y \]

**Notation and conditions:**

Delay times, gravity acceleration and density, in each axis \((x, y)\). \((u,v)\) velocity in each axis.

In 1D: let "u\_x" the velocity in point or position "x" (with "h"=1):

\[ \frac{\mu}{\rho} \frac{\partial u_x^2}{\partial x^2} = \frac{\mu}{\rho} \left( \frac{u_{x+h} - 2u_x + u_{x-h}}{h^2} \right) = \frac{u}{T_{dx}} \]

\[ T_{dx} = \frac{\rho u_x}{(u_{x+1} - 2u_x + u_{x-1})\mu} \]

**C-2A+B:**
- C-2A+B = 0, if the A,B,C in progression lineal (Arithmetic progression).
- >0 if is crescent and <0 in other case.
- Will be a magnitude bigger, when the variation is bigger.
- The lower the "nu", the less heat transfer.
- C-2A+B=(B-A)-(A-C) : that is: variation average between distances in A, B and C.

Sample:
\( (C,A,B)=(2,8,48) \)
2 by 4 = 8
8 by 6 = 48
A-C+6 / B-A=40
(B-A)-(A-C) = 34

Is possible substituting the "F(viscous)" ?? May be….
More, “T” depends also of Pressure and Density. That is very important. Even, the density can depend of “x” and “t”.

b) Case 2:

2.5. PHENOMENONS WHERE APPLY NAVIER STOKES EQUATIONS MODELS

2.5.1. PEDESTRIANS / BIRDS FLOCK

About the displacement of pedestrian, the dynamic equation-model, is simple (expression for acceleration):

There are 2 models; it has doubt about which the correct model is:

\[ a_x = \frac{-\partial P_x}{\rho_x} + \frac{u_x}{T_{dx}} + \frac{u_x}{T_{dy}} \]
\[ a_y = \frac{-\partial P_y}{\rho_y} + \frac{u_y}{T_{dx}} + \frac{u_y}{T_{dy}} \]

Or:

\[ u_x \frac{\partial u_x}{\partial x} + u_y \frac{\partial u_x}{\partial y} = \frac{-\partial P_x}{\rho_x} + \frac{u_x}{T_{dx}} + \frac{u_x}{T_{dy}} \]
\[ u_x \frac{\partial u_y}{\partial x} + u_y \frac{\partial u_y}{\partial y} = \frac{-\partial P_y}{\rho_y} + \frac{u_y}{T_{dx}} + \frac{u_y}{T_{dy}} \]

(x,y) coordinates in 2D, (u,v) velocity in 2D, “a” acceleration. These expressions are a simplification of Navier Stokes equations. “T” (time) depend also of pressure and density.

Even: is possible to resolve this problem, with Navier Stokes equations for fluids, with some variations? may be...

Is possible to calculate the pressure “P” (in order to know, what this pressure is) (variation) from 1 real test; from this test, it know the density and the acceleration.

In Research Article, Modelling Adopter Behaviour Based on the Navier Stokes Equation, Kazunori Shinohara and Serban Georgescu, simulate the paths of a crown people in an aquarium.

As a viscosity, work, in this Article, as an attractive force (not separation) between people.
Is possible to create a simulation CFD, in order to generate the solution of the same problem (Tokio Tower Aquarium):

Practically, the same solution (velocity field).

Another example of the design of evacuation of pedestrians or people from an enclosure (study made by Arcadia.org, with team members: Mrk Clayton, Wei Yan): Given a corridor where people walk, at the end of which, there is an opening or a door. In the first image, you can see the accumulation at the exit increasing (in red) the pressure or density. By placing small circles along the corridor, the density is reduced:

In the example I have made, you can observe exactly the same, before and after the placement of "obstacles", with the same objective: Reduce pressure or density and improve the flow rate in outlet:

The zones "dark", show the zones with low pressure or density, attracting peoples....

It is also possible to simulate the movement of pedestrians, by assuming that each person is a particle with certain characteristics of compressibility, comfort area, etc:
From the Brownian displacement in which the particles move without restriction, passing through aggregates of limited diffusion (DLA) where there is only one restriction or condition of displacement, following the displacement of planets, all the dynamics obey rules of displacement between the particles that they make up the group, extremely simple and easy: flocks of birds or pedestrians, are clear examples of this fact:

By Craig Reynolds:

**"In 1986, I made a computer model of coordinated animal motion such as bird flocks and fish schools. It was based on three dimensional computational geometry of the sort normally used in computer animation or computer aided design. I called the generic simulated flocking creatures boids. The basic flocking model consists of three simple steering behaviors which describe how an individual boid maneuvers based on the positions and velocities its nearby flockmates:**
Alignment: steer towards the average heading of local flockmates

Cohesion: steer to move toward the average position of local flockmates

Each boid has direct access to the whole scene's geometric description, but flocking requires that it reacts only to flockmates within a certain small neighborhood around itself. The neighborhood is characterized by a distance (measured from the center of the boid) and an angle, measured from the boid's direction of flight. Flockmates outside this local neighborhood are ignored. The neighborhood could be considered a model of limited perception (as by fish in murky water) but it is probably more correct to think of it as defining the region in which flockmates influence a boids steering:

There are lot theories about this special dynamics phenomenon. For example, other theory or numerical model:

The path of one particle is the path with the minimum pressure. Also, the pressure work as a density; one particle will be where there is less density. So is possible create algorithms in order to create the path for any particle. Give a particle and give "sectors" in a sphere with center the particle:

\[ u^{n+1} = u^n - \frac{1}{\rho} \nabla p \]

The particle will move toward the half angle line of sector, with the least density (pressure); this displacement, with a delay time (viscosity) (step by step).

\[ \vec{V}_1 = \frac{\vec{V}_2 + \vec{V}_3 + \vec{V}_4}{3} \]

2.5.2. **BLACK-SCHOLES MODEL**

Is a model for analyze the behavior of Stock Market (sell and call), and predict some prices in the future. The expression is very similar to Navier Stokes equations:
Other expression for Navier Stokes equations:

\[ \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} - f v = -\frac{1}{\rho} \frac{\partial p}{\partial x} + K \frac{\partial^2 u}{\partial x^2} \]

And its similarity with Balck-Scholes:

1. \[ \frac{\partial V}{\partial t} \sim \frac{\partial u}{\partial x} \]
2. \[ \frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} \sim K \frac{\partial^2 u}{\partial x^2} \]
3. \[ rS \frac{\partial V}{\partial S} \sim u \frac{\partial u}{\partial x} \]
4. \[ -rV \sim -fv + \frac{1}{\rho} \frac{\partial p}{\partial x} \]

2.5.3. **SCHRÖDERINGER EQUATION**

\[ i\hbar \frac{\partial}{\partial t} \psi(r,t) = -\frac{\hbar^2}{2m} \nabla^2 \psi(r,t) + V(r,t)\psi(r,t) \]

It can work so or considerer as a wave (there is a wave expression in Schroeringer equation), all event in the universe.

\[ \Psi(x,t) = Ae^{i(kx-\omega t)} = A[\cos(kx-\omega t) + i\sin(kx-\omega t)] \]

2.5.4. **ALAN TURING BIOLOGY EVOLUTION**

Is a numeric model in order to predict the formation of patterns in the Nature ((there is a wave expression in equations model):

\[ \frac{\partial u}{\partial t} = D_u \frac{\partial^2 u}{\partial x^2} + f(u,v) \]
\[ \frac{\partial v}{\partial t} = D_v \frac{\partial^2 v}{\partial x^2} + g(u,v) \]

“u” and “v” are the concentrations of 2 axis. “D_u” and “D_v” are the coefficients of diffusion of “u” and “v”, and “f” and “g” the reaction between.

We can see perfectly, the heat equation (diffusion), into Alan Turing equations.

We can see also this evolution is Voronoi schemes (the evolution of “point”, may be a reaction in function of time and also metric-distance):
2.5.5. HEAT CONVECTION

"T" is the temperature, "V" the velocity vector, "a" the acceleration vector and "x" and "y", the coordinates in 2D:

\[ \mathbf{V} = (u, v) \]

\[ a = \frac{D\mathbf{V}}{Dt} = \frac{\partial \mathbf{V}}{\partial t} + \frac{\partial \mathbf{V}}{\partial x} \frac{\partial x}{\partial t} + \frac{\partial \mathbf{V}}{\partial y} \frac{\partial y}{\partial t} \]

\[ \frac{\partial T}{\partial t} + U \frac{\partial T}{\partial x} + V \frac{\partial T}{\partial y} = a \frac{\partial^2 T}{\partial y^2} \]

2.5.6. SOME CONCLUSION ABOUT THESE MODELS

In these models before, the numerical models are very similar, so the phenomenon must to be also (may be...). 

??¿¿ Schröeringer , Black-Scholes, Alan Turing:

In these 3 equations, we can see the diffusion equation (heat equation). This diffusion part also is in Navier Stokes equations. If in Navier Stokes equations, the extern forces are zero, is possible create and apply the Alan Turing model.

\[ \text{Is possible so, apply Schröeringer equation, to Stock Market evolution...} \]

2.6. NAVIER STOKES EQUATIONS

ANALYSIS

a) ADVECTION LINEAL EQUATION IN 1-D

(TRANSPORT WITH VELOCITY "c")

\[ \frac{\partial u}{\partial t} + c \frac{\partial u}{\partial x} = 0 \]

\[ u_{i}^{n+1} = u_{i}^{n} - c \frac{\Delta t}{\Delta x} \left( u_{i}^{n} - u_{i-1}^{n} \right) \]

Time (n)

\begin{array}{ccc}
\text{Position (x)} \\
\hline
i-1 & & i \\
\hline
n+1 & \text{X} & \\
n & \text{B} & \text{A} \\
\end{array}

\[ X = A - c \frac{\Delta t}{\Delta x} (A - B) \]

- If A>B, then x<A, independently of what scheme work for finites differences (forward, backward, central, etc...).
- X is "A" plus a value, function of a variation (plus or minus).
- If Δt is bigger, the variation is more important (more incorrect) (bigger). That is the basic concept for a inter and extrapolation.
- If Δx is bigger, the variation is smaller.
- “c” is the “risk factor”; if “c” is smaller, the variation is smaller.

Sample (money invests for a “i” and “i-1” people):

<table>
<thead>
<tr>
<th>Year</th>
<th>i-1</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>55</td>
<td>50</td>
</tr>
</tbody>
</table>

\[ x = 50 - \frac{1}{10} (50 - 55) = 55 \]
\[ x = 50 - \frac{1}{10} (50 - 55) = 50 \]

\( c = 0.1 \)

In the first case, “x-1” is a good friend of “x”(\( \Delta x = 1 \)). In the second case, is a friend not close (\( \Delta x = 5 \)).

b) Advection Lineal Equation in 2-D

\[ \frac{\partial u}{\partial t} + c \frac{\partial u}{\partial x} + c \frac{\partial u}{\partial y} = 0 \]

\[ u^{n+1}_{i,j} = u^n_{i,j} - c \frac{\Delta t}{\Delta x} (u^n_{i+1,j} - u^n_{i-1,j}) - c \frac{\Delta t}{\Delta y} (u^n_{i,j+1} - u^n_{i,j-1}) \]

c) Advection Non Lineal Equation in 1-D (Transport with velocity “u”) → Turbulence Formation (Non-linear Equation)

\[ \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} = 0 \]

\[ u^n_{x+1} = u^n_{x} + u^n \frac{\Delta t}{\Delta x} (u^n - u^n_{x-1}) \]

This model, allow the turbulence or non-linearity:

Matlab code and sample, Flow Diffusion using Crank Nicholson:

```matlab
clc
clear
M=100;
```
N=10;
LX=1;
LY=1;
TIME0=0;
TIME=1;
tt=1000;
Dt=(TIME-TIME0)/tt;
D=12e-4;
DX=LX/M;
DY=LY/N;
mu=D*Dt/(DX)^2;

%Initialization Matrix
for t=1:1;
    for i=2:M-1;
        U(i,t)=10*rand(1,1);
    end
end
%Boundary Conditions
for t=1:1;
    U(1,t)=0;
    U(M,t)=0;
end
for t=1:1;
    for i=1:1;
        d(i,t)=mu*U(i+1,t)+(1-2*mu)*U(i,t);
    end
end
for t=1:1;
    for i=M:M;
        d(i,t)=(1-2*mu)*U(i,t)+mu*U(i-1,t);
    end
end
%Constructing the Diagonal Matrix
a=ones(M-1,1)
b=ones(M,1)
g=(1+2*mu)*diag(b)-mu*diag(a,-1)-mu*diag(a,1)
gg=g^-1
for t=1:1;
    U(:,t)=gg*d(:,t)
end
for t=1:tt;
    for i=1:1;
        d(i,t)=mu*U(i+1,t)+(1-2*mu)*U(i,t);
    end
end
for t=1:tt;
    plot(U(:,t),'-*')
grid on
pause(0.4)
close
end

Give a function, to apply the Diffusion equations:

d(i,t)=(1-2*mu)*U(i,t)+mu*U(i-1,t);  
end
U(:,t+1)=gg*d(:,t)
end
for t=1:tt;
    plot(U(:,t),'-*')
grid on
pause(0.4)
close
end

d) ADVECTION NON LINEAL EQUATION IN 2-D

$$
\begin{align*}
\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} &= 0 \\
\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} &= 0 
\end{align*}
$$
\[
\begin{align*}
\eta_{i,j}^{n+1} &= u_{i,j}^n - \frac{\Delta t}{\Delta x} \left( u_{i,j}^n - u_{i,j-1}^n \right) - \frac{\Delta t}{\Delta y} \left( u_{i,j}^n - u_{i-1,j}^n \right) = 0 \\
\eta_{i,j}^{n+1} &= v_{i,j}^n - \frac{\Delta t}{\Delta x} \left( v_{i,j}^n - v_{i,j-1}^n \right) - \frac{\Delta t}{\Delta y} \left( v_{i,j}^n - v_{i-1,j}^n \right) = 0
\end{align*}
\]

Time \(\rightarrow\) \(n+1\)

<table>
<thead>
<tr>
<th>(i-1)</th>
<th>(i)</th>
<th>(i+1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(j)</td>
<td>(xu, xv)</td>
<td></td>
</tr>
</tbody>
</table>

Evolution of a wave, to brake:

\[
xu = Au - \frac{\Delta t}{\Delta x} Au (Au - Bu) - \frac{\Delta t}{\Delta y} Av (Au - Bu)
\]

\[
xx = Au - \frac{\Delta t}{\Delta x} Au (Av - Bv) - \frac{\Delta t}{\Delta y} Av (Av - Bv)
\]

First, one particle, tend to go where the Pressure is less (without external forces and viscosity). But the direction and acceleration or velocity, may be also depend of other’s forces as gravity ("g") (external force): if the gravity pull more than pressure, the particle, change its direction. So one particle, tend to go with the direction of the next value (acceleration):

\[
\frac{\partial P}{\partial t} + \frac{\partial u}{\partial x} = \nu \frac{\partial^2 u}{\partial x^2}
\]

May be, as external forces: g+ others as a magnetism, etc...

2.7. PATHS IN THE UNIVERSE

a) Different methods or ways, for generating paths and so, structures:
   - **LOW PRESSURE TUBE AND VISCOSITY.**
   - **LOW-HIGH PRESSURE.**

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....
Is incredible, but this expression and concept, is the origin of Navier-Stokes equations.

A system of particles tends to disorder, because it is simply the most likely: a book is thrown in the air completely undone in individual sheets: it will reach the floor in the form of a book completely ordered page by page?: it is not likely ....

It needs an energy definition. It can define this Energy, as a Pressure:

\[ E = E_K - E_P \]

In the particular case "Newtonian" (non with Relativity), about a particle in orbit with "n" masses: ("V" velocity, "M" and "m" masses, "G" constant gravitation, "r" vector between the 2 masses):

\[ \frac{1}{2} m V^2 - \sum_{i=1}^{n} \frac{GM}{r_i} \rightarrow \text{minimum} \]

In this case, the metric is the Euclidean. But there are more cases, for example with relativity or high mass and velocity:

Schwarzschild metric:

\[ ds^2 = \left(1 - \frac{2GM}{c^2 r} \right) \left(1 + \frac{2GM}{c^2 r} \right)^{-1} \]

In these equations, is possible to substituting in "r", the distance in every space-metric, in order to calculate geodesics (minimum distance) (changing also "m", etc....): for example: distances for Taxis in Manhattan: distance or metric, is equal to "d" or "Manhattan metric":

\[ x = (x_1, x_2) \]
\[ y = (y_1, y_2) \]
\[ d(x, y) = |x_1 - y_1| + |x_2 - y_2| + \ldots \]

With this metric, a sample of the Voronoi mesh is:

But, the gravitation action (potential energy) is not an action with velocity infinite: the speed of gravitation is the speed of light (this force, change depending of density for
example). This value is the "gap time action" (viscosity).

In this Potential Energy, in order to have more accuracy (real so), is necessary to add the Viscosity force (as a magnetic force or similar) and other’s forces.

c) NAVIER STOKES: TRADITIONALS AND WITH MODIFICATIONS

It was see these equations before.

2.8. APPLICATIONS AND SAMPLES
2.8.1. PEDESTRIAN, BIRDS, FLOCKS, CROWDS, ETC - SIMILARITIES

Is possible to simulate a people or pedestrian concentration, and also birds flock creation and evolution; it was see that before.

Are similar these cases and much others. For that, is possible to assign to every particle-bird-people, a few conditions for its displacement (forces form springs and dampers);

➔ It tries to assign a particle: Feelings….
- Propulsion force.
- Social force or comfort zone.
- Contact force.
- Force of compression (with max and min distance).
- Etc…

In an exit door (evacuation system), is very important to know what’s the limit for a "blockage" ("Reynolds number...."): suppose an administrative procedure consisting of generating a series of documents whose term is opened for a very short time. If there are many people doing these procedures, there may be a moment that collapses (blockage).

2.8.2. GOVERN MEASURES - SOFT MEASURES

Front bulb in ship:

Nowadays, big ships and also small ones, have the lower part that is submerged, a bulb in the front. The function of this bulb is to create a series of waves or turbulence, which when joined with the waves generated by the boat itself, are annulled or at least almost eliminated. In this way, they greatly reduce the drag of the boat.

This front bulb, is placed in front of the boat, as a kind of advance, as opening the way, as smoothing the way of the boat that comes behind.

In real life, as for example in the implementation of an economic or political measure in any country, it is necessary to carry out a series of smaller measures before the main measure. In this way, the harmful effects are softened or mitigated.

2.8.3. DYNAMIC SLOTH

The universe cools; less energy and more laziness; despite this principle the galaxies are moving away from each other, and increasingly faster ....
Suppose a spiral pipe; at the extreme, the fluid will leave with a tendency to follow a spiral path; but, the fluid, "hardly" will take anything to follow a straight path.

To the dynamics of the fluid, it does not cost him anything to become dissatisfied with a certain dynamic that "forces" him to "something".

An economic measure will remain in time (its effects), if the means are put periodically, so that it lasts or remains.

If it wants to divert a flow of fluid to a very "far" point, we have to place several "corrective" devices or adapters "along the trajectory, to reach our final objective, not just a device (or corrector) initially.

2.8.4. MEASURES FROM COUNTRY GOVERN - AGGREGATION

The government of a country can to make political, economic or social measures, which allows the non-creation of groups of people who share the same hobby, or who belong to the same religion, or who share ideals of many kinds. This can be applied to combat terrorism or to provide measures that help the group. Not aggregation seeds, in grass:

2.8.5. BERNOULLI EFFECT

Look a point before.

2.8.6. BOUNDARY LAYER

Look a point before.

2.9. NUMERICAL MODELIZATION (FEELINGS MODELIZATION)

Very important this point.

→ It tries to assign a particle: Feelings….

2.10. SOFTWARE TOOL CREATION

It needs 2 software’s:

- CFD "traditional" or Commercial: in this case: Star CCM+ of Siemens.
- CFD made by me: the characteristics of this new CFD, are:

First of all, it needs a little application in Matlab for example, in order to solve Navier Stokes equations, in a simple case.

Navier Stokes equations (traditional) with discretization in 2 dimensiones (traditional nomenclature):

$$\frac{\partial \vec{v}}{\partial t} + (\vec{v} \cdot \nabla)\vec{v} = -\frac{1}{\rho} \nabla p + \nu \nabla^2 \vec{v}$$
Navier Stokes (Gibbs expression plus Poisson equation):

\[
\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = -\frac{1}{\rho} \frac{\partial p}{\partial x} + \nu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right)
\]

\[
\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} = -\frac{1}{\rho} \frac{\partial p}{\partial y} + \nu \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right)
\]

\[
\frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial y^2} = -\rho \left( \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} \right)
\]

\[
\frac{u^{n+1}_{i,j} - u^n_{i,j}}{\Delta t} + u^n_{i,j} \frac{x_{i+1,j} - x_{i-1,j}}{2\Delta x} + v^n_{i,j} \frac{y_{i,j+1} - y_{i,j-1}}{2\Delta y} = -\frac{1}{\Delta x} \left( n_{i+1,j} - n_{i,j} \right) + \nu \left( \frac{u^n_{i+1,j} - 2u^n_{i,j} + u^n_{i-1,j}}{\Delta x^2} + \frac{v^n_{i,j+1} - 2v^n_{i,j} + v^n_{i,j-1}}{\Delta y^2} \right)
\]

\[
\frac{v^{n+1}_{i,j} - v^n_{i,j}}{\Delta t} + u^n_{i,j} \frac{y_{i,j+1} - y_{i,j-1}}{2\Delta y} + v^n_{i,j} \frac{x_{i+1,j} - x_{i-1,j}}{2\Delta x} = -\frac{1}{\Delta y} \left( n_{i,j+1} - n_{i,j} \right) + \nu \left( \frac{u^n_{i,j+1} - 2u^n_{i,j} + u^n_{i,j-1}}{\Delta x^2} + \frac{v^n_{i+1,j} - 2v^n_{i,j} + v^n_{i-1,j}}{\Delta y^2} \right)
\]

\[
\frac{n^{n+1}_{i,j} - n^n_{i,j}}{\Delta t} = \frac{1}{\Delta x} \left( n_{i+1,j} - n_{i,j} \right) - \nu \left( \frac{u^{n+1}_{i,j} - 2u^n_{i,j} + u^n_{i,j+1}}{\Delta x^2} + \frac{v^n_{i,j+1} - 2v^n_{i,j} + v^n_{i,j-1}}{\Delta y^2} \right)
\]

\[
\frac{n^n_{i,j} - n^n_{i,j}}{\Delta t} = \frac{1}{\Delta y} \left( n_{i,j+1} - n_{i,j} \right) - \nu \left( \frac{u^n_{i,j} - 2u^n_{i,j} + u^n_{i,j+1}}{\Delta x^2} + \frac{v^{n+1}_{i,j} - 2v^n_{i,j} + v^n_{i,j-1}}{\Delta y^2} \right)
\]

2 particulars cases; the main goal is to compare results with traditional Navier Stokes equations, against New Navier Stokes equations:

Cavity problem:

The initial condition is \(w, v, p = 0\) everywhere, and the boundary conditions are:

\(w \equiv 1\) at \(y = 0\) (the lid):

\(\frac{\partial w}{\partial y} = 0\) on the other boundaries:

\(\frac{\partial p}{\partial y} = 0\) at \(y = 0, 2\)

\(\frac{\partial v}{\partial x} = 0\) at \(x = 0, 2\)

Boundary layer problem:

The initial condition is \(w, v, p = 0\) everywhere, and the boundary conditions are:

\(w, v, p\) are periodic on \(x = 0, 2\)

\(\frac{\partial w}{\partial x} = 0\) at \(x = 0, 2\)

\(\frac{\partial v}{\partial y} = 0\) at \(y = 0, 2\)

\(p = 1\) everywhere.

\[\Rightarrow\] Cavity problem:

clear all

\(n=41; n=41; n=100; n=50;\)

\(x=0; x=2;\)

\(y=0; y=2;\)

\(d \times (x=0; x=2)/((n=1)-1);\)

\(d \times (x=0; x=2)/((n=1)-1);\)

\(x=0, 2;\)

\(y=0, 2;\)

\(x=0, 2;\)

\(y=0, 2;\)

\(Y, X=\text{meshgrid}(y, x);\)

\(\text{rho}=1;\)

\(h \times 0.001;\)

\(\% \text{Init}\)

\(u=\text{zeros}(ny, nx);\)

\(v=\text{zeros}(ny, nx);\)

\(p=\text{zeros}(ny, nx);\)

\(b=\text{zeros}(ny, nx);\)

\(\% \text{Pressure Field}\)

\(\% \text{Square Brackets of Poissons Equation}\)
Boundary layer problem:

```matlab
clear all
nx=21; ny=21; nt=50; nit=50;
xmin=0; xmax=2;
ymin=0; ymax=2;
dx = (xmax-xmin)/(nx-1);
dy=(ymax-ymin)/(ny-1);
x=linspace(0.2,nx);
y=linspace(0.2,ny);
[Y,X]=meshgrid(y,x);
rho=1;
nu=0.1;
F=1;
dt=0.01;

for it = 1:nt+1
    for i=2:(nx-1)
        for j=2:(ny-1)
            b(i,j)=rho*(1/dt*((u(i+1,j)-u(i-1,j))/(2*dx)+(v(i,j+1)-v(i,j-1))/(2*dy))-
                        ((u(i+1,j)-u(i-1,j))/(2*dx))^2-
                        2*((u(i,j+1)-u(i,j-1))/(2*dy)*(v(i+1,j)-v(i,j-1))/(2*dx))-
                        ((v(i,j+1)-v(i,j-1))/(2*dy))^2);  
        end
    end
    for iit=1:nit+1
        pn=p;
        for i=2:(nx-1)
            for j=2:(ny-1)
                p(i,j)=(pn(i+1,j)+pn(i-1,j)+pn(i,j+1)+pn(i,j-1)-
                        dx^2*dy^2/(2*(dx^2+dy^2))*b(i,j);  
            end
        end
        p(:,ny-1) =p(:,ny-1); %%dp/dy = 0 at y = 2
        p(1,:)=p(2,:);            %%dp/dy = 0 at y = 0
        p(:,1)=p(:,2);          %%dp/dx = 0 at x = 0
        p(:,ny)=0;                %%dp = 0 at y = 2
    end
    un = u;
    vn = v;
    for j=2:ny-1
        for i=2:nx-1
            %Velocity Field
            u(i,j) = un(i,j)-un(i,j)*dt/dx*(un(i,j)-un(i-1,j))+
                        vn(i,j)*dt/dy*(vn(i,j)-vn(i,j-1))-
                        dt/(2*rho*dx)*p(i+1,j)+p(i-1,j)+
                        (dt/dy^2*(vn(i,j)+vn(i,j-1)+vn(i,j-1)+
                        (dt/dy^2*(vn(i,j)+vn(i,j-1)+vn(i,j-1))));
            v(i,j) = vn(i,j)-vn(i,j)*dt/dx*(vn(i,j)-vn(i,j-1))-dt/(2*rho*dx)*p(i,j+1)+p(i,j-1)+
                        (dt/dy^2*(vn(i,j)+vn(i,j-1)-2*vn(i,j)+vn(i,j-1)));  
        end
    end
    u(1,:)=0;
    u(nx,:)=0;
    u(:,1)=1;
    v(1,:)=0;
    v(ny,:)=0;
    v(:,1)=0;
    v(nx,:)=0;
    contourf(x,y,p.,'linewidth',0)
    hold on
    quiver(x,y,u.,v.);2
    xlabel('x')
    ylabel('y')
```

for i=2:(nx-1)
  for j=2:(ny-1)
    p(i,j)=((pn(i+1,j)+pn(i-1,j))*dy^2+(pn(i,j+1)+pn(i,j-1))*dx^2)/(2*(dx^2+dy^2))
    dx^2*dy^2/(2*(dx^2+dy^2))*b(i,j);
  end
  %Periodischer Term für x=0
  for j=2:(ny-1)
    p(1,j)=((pn(2,j)+pn(nx,j))*dy^2+(pn(1,j+1)+pn(1,j-1))*dx^2)/(2*(dx^2+dy^2))
    dx^2*dy^2/(2*(dx^2+dy^2))*b(i,j);
  end
  %Periodischer Term für x=2
  for j=2:(ny-1)
    p(nx,j)=((pn(1,j)+pn(nx-1,j))*dy^2+(pn(nx,j+1)+pn(nx,j-1))*dx^2)/(2*(dx^2+dy^2))
    dx^2*dy^2/(2*(dx^2+dy^2))*b(i,j);
  end
end

%Wall BC: u,v = 0 @ y = 0,2
u(:,ny)=0;
u(:,1)=0;
v(:,ny)=0;
v(:,1)=0;
udiff = (sum(sum(u)) - sum(sum(un)))/sum(sum(u))
stepcount=stepcount+1;
quiver(x,y,u.',v.');
pause(0.01)
end
xlabel('x')
ylabel('y')
colorbar

title(['stepcount = ', num2str(stepcount)])

My special software application; objectives:
- Basically, new expression for Navier Stokes, with variations.
- To can change differs expression or terms of new Navier Stokes equations and analyze the results.
- To compare these results, with results working with traditional Navier Stokes equations.
- This software, is useful in order to simulate, pedestrians. Very important also that.

Analyze in CFD, show samples, Create Mathematics expressions or numeric models, Test, Development, etc....
3. NEW EXPANSION UNIVERSE MODELS

ABSTRACT

There are several numerical models, to explain how is the expansion dynamics, like the equations of Friedmann-Lemaître-Robertson-Walker. But it is a model that is very simple to explain, for example, the variation of pressure or density, and other important values, and more: is only possible an acceleration negative. In this article new concepts and new procedures are defined, to obtain a more useful numerical models that are able to describe the dynamics of the Expansion of the Universe (positive or negative), as well as the evolution of diverse variables that participate in the phenomenon, as a variation density and pressure, and even the acceleration. In these new created numerical models, expressions are established to calculate certain values of the intergalactic medium (such as density, viscosity, pressure, force), considering it as a fluid, which will be very useful in later articles, to know the evolution and interaction of matter in the Universe. And other think more important: is possible other vision about Dark Energy, as force, not as a matter or particle. It describe expansion Universe model as a spring damper set, as energy from vacuum or low pressure and also and finally, from Navier Stokes equations.

3.1. INTRODUCTION

If you look at the distances that separate us from the galaxies that are not in our local group, you will see that they are moving away from us. That is to say: the Universe is expanding. Edwin Hubble already validated this fact experimentally by measuring the distances and speeds of many galaxies, and created a numerical model that expressed the linearity between distance and speed, whose constant is called the Hubble constant. Recent observations have shown that this relationship is not linear, and some more important: the Universe is expanding with acceleration (H=H(t)). Why is it expanding and how? This expansion, will be end? They are 3 very important questions that currently, do not have totally satisfactory or real answer. All explanations are hypothesis, which as such, must be demonstrated, and explain the reality. One of the most accepted but not validate, is that there is a kind of dark energy, which works as the opposite of gravity, that is: repelling instead of attracting. In fact, the evolution of length parameter (“a”) in axis vertical, from big bang, against universe time in axis horizontal, from now: is possible see that from end inflation period to more or less 7500 million years, there are an acceleration negative, because the density was bigger than expansion force. From this date to actuality, surprise and Nobel prize so, there are acceleration positive (the gravity force was less than “dark force-energy”):

H is not constant in Time:

“a” scale universe factor (traditional nomenclature):
Depending these values, it have one or other universe evolution, so is necessary know its:

$$H_0 = 67.3 \text{ km s}^{-1} \text{ Mpc}^{-1},$$
$$\Omega_{R,0} = 9.24 \times 10^{-5},$$
$$\Omega_{M,0} = 0.315,$$
$$\Omega_{\Lambda,0} = 0.685,$$
$$\Omega_{K,0} = 0$$

If $$\Omega_{M,0} = 0.01$$:

Is possible interpolate these lines, in this case, first sample and values:

$$a(t) \approx c_1 t^{2/3} + c_2 (e^{t/c_3} - 1)$$

$$c_1 = 0.822,$$
$$c_2 = 0.0623,$$
$$c_3 = 0.645$$

How to do the Excel sheet?
3.2. HYPOTHESIS

Hypothesis 1: Non Homogeneous Universe.

Hypothesis 2: Non Isotropic Universe.

3.3. VELOCITY AGAINST DISTANCE EXPANSION MODEL (3 MODELS)

In city traffic, when the speed of cars is bigger, the separation between the, also in bigger:

Today, we know that in Hubble expression (V=Hx), (wrong may be??), H=H(t); is possible so, the expansion of Universe ? yes, but depend of a lot of things.

But, the “Expansion Velocity” may be, depend of Pressure and Density also (”x” space length), (“a” and “b” > 0):

\[ V_E = \text{function}(x, P, \rho) \]

\[ V_E \propto \frac{1}{\rho^a P^b} \]

\[ V_E = H(t) \frac{1}{\rho(x)^a P(x)^b} \]

And more: is possible, a little variation of Hubble law:

\[ V = H x^{1+e} / e \neq 0 \]

And other model yet:

\[ H = H(x) \]

This last equation-relation, is created by:

3.4. VACUUM ACCELERATION EXPANSION

Between 2 zones with different pressure, there is pressure difference which produces acceleration “a” (high to low pressure): pulling with acceleration “a” (From Navier Stokes equations):
\[ a = \frac{1}{\rho} \frac{\partial P}{\partial x} \]

What is the origin of this Acceleration - Suction, as a Dark Energy action? It know perfectly, that the Bing Bang, is not an explosion or blast (is a space expansion). But, is perfectly possible to assign it an analogy with a wave-shock. In any wave shock produce by a blast (big bang for example), there are a zone of high pressure (wave front) and after, other wave or zone of low pressure. This zone, produce (without any drag) one acceleration: next images about wave explosion propagation with simulation CFD techniques (test made with Star CCM+ as a CFD code: simulation in 3D (cut plane view), 10 km diameter sphere, 14.5 million mesh cells, explosion of dynamite into air dry, K-epsilon turbulence model):

The front-shock wave, have only 2 brakes (drag): viscosity and mass (gravity).

The pressure profile in any blast wave is (the wave may to be oscillations (positives and negatives) in time). Friedlander waveform sample for any explosion:

\[ P = P_0 e^{\left(\frac{\gamma-1}{2}\right)\left(1-\frac{t}{t^*}\right)} \]

In this example, \( P_0 = 70 \text{ kPa} \) \( t^* = 100 \text{ ms} \)

The zone or zones, with negative pressure, the "dark energy", work (the dark energy change in time), producing acceleration-suction (with positive pressure, work but pushing).

Even, combining some hypothesis is possible that in the future, there are variations positives and negatives in dark energy:

This evolution in waves or not, depend of densities in the universe (baryonic matter, radiation, dark energy, dark matter, electromagnetic).
3.5. NAVIER STOKES MODEL

This model of expansion of the Universe has been realized in 1 dimension, assuming that the whole Universe expands equally in any direction. But I don't think this is the case; there have been observations in various directions in the Universe, which show that it is not uniform in all directions (or equal); although there is little data from which to draw final conclusions, I think it is. For this reason, the expansion of the Universe will depend on pressure and density, so in each direction, the expansion will be different.

\[ \mu V = \mu H \chi^{1+\varepsilon} \]

The next term in Navier Stokes, is the most important:

\[ \frac{P_x}{\rho} \]

\[ \rho_{\text{vac}} = \frac{\Lambda c^2}{8\pi G} \]

\[ P_{\text{vac}} = -\rho_{\text{vac}} c^2 \]

\[ \Lambda = \frac{3H^2}{c^2} \Omega_\Lambda \]

\[ P = -\frac{c^4}{8\pi G} \frac{3H^2}{c^2} \Omega_\Lambda = -\frac{3H^2 c^2}{8\pi G} \Omega_\Lambda \]

2 results for "P":

\[ P_x = \int \frac{3V^2 c^2}{8\pi G} \chi^{1+\varepsilon} d\chi = -\frac{3V^2 c^2}{\varepsilon 8\pi G} \chi^{-\varepsilon} \]

\[ \text{Also: } H=H(x) \text{, from:} \]

From Navier Stokes, directly:

Sup: \( V=\text{H}x \)

\[ g = \frac{Gm}{x^2} = \frac{4\pi G\rho x}{3} \]
\[
\frac{P_x}{\rho} + g = \frac{P_x}{\rho} + \frac{4\pi G \rho x}{3} = H^2 x
\]

\[
P_x = (H^2 - \frac{4\pi G \rho}{3}) \rho x
\]

Is easy calculating that, with other 2 models for "H".

Is very interesting, the next expression:

\[
P = \frac{1}{2} \rho V^2
\]

→ From this special equation, and very common; it has a Navier Stokes equations part:

\[
\frac{\partial P}{\partial x} = \rho V \frac{\partial V}{\partial x}
\]

If the density is not constant:

\[
\frac{\partial P}{\partial x} = \frac{1}{2} \frac{\partial \rho}{\partial x} V^2 + \rho V \frac{\partial V}{\partial x}
\]

There is another problem, very important:

If the density is not the same in any direction or there are different densities in some places, if it calculates (from supernovas, or galaxies cluster or individual galaxies) the "$H_0$" Hubble constant, the results can will be different. That is very important, in the famous "Hubble Tension" problem.

\[
\left(\frac{\dot{R}}{R}\right)^2 - \frac{8}{3} \pi G \rho - \frac{1}{3} \Lambda = -\frac{k c^2}{R^2}
\]

\[
H^2(t) = \frac{8\pi G \epsilon(t)}{3} \frac{c^2}{R_0^2} - \frac{k c^2}{R_0^2} \frac{1}{a^2(t)}
\]

that space is flat ($k = 0$) if the mean

\[
\rho_c(t) = \frac{\epsilon_c(t)}{c^2} = \frac{3H^2(t)}{8\pi G}
\]

Sup: $V = Hx^{1+\epsilon}$

\[
E = T + V = cte = \frac{1}{2} m H(t)^2 x^{2(1+\epsilon)} - \frac{G M m}{x}
\]

\[
H(t)^2 = \frac{2 cte + 8\pi G \rho x^2}{m} \frac{3}{x^{2(1+\epsilon)}}
\]

\[
\rho(t, x) = \rho = \frac{\left(H(t)^2 x^{2(1+\epsilon)} - \frac{2 cte}{m}\right)^3}{8\pi G x^2}
\]

if $\epsilon = 0.01$, then \((10^{26} \text{ meters} = \text{ radio universe})$:

\[
if \rightarrow x = 10^{26} \text{ meters}
\]

\[
\chi^{2\epsilon} \approx 1.8(\text{error})
\]

3.6. MODEL 4: FRIEDMANN EQUATIONS

Kinetic energy + Potential energy = constant, so:

3.7. SPRING - DAMPER EXPANSION MODEL
Considering that the viscosity of universe works as a damper; also, the mass (gravity) and density so, work as a spring. So (“KS” is a value of spring constant, and “KD” diffusivity of Damper) (is possible that “KS” and “KD” non-constants) (Vacuum(Force)=Fv):

\[ F_v - K_s x - K_D \frac{\partial x}{\partial t} = ma \]

About the constants (in general form):

\[ K_s = function(mass,x) = f(m,x) \]
\[ K_D = function(viscosity,x) = g(\mu,x) \]

Is possible suppose that (reasonable option), is one option:

\[ K_s = \chi \]
\[ K_D = Velocity = V \]

Kinetic energy + Potential energy is constant “\( K \)”: \[
V^2 - \frac{2Gm}{x} = K1 * \frac{2}{m} = \frac{K}{m}
\]
\[ m = \rho \frac{4}{3} \pi \chi^3 \]

So, the critical density is:

\[ \rho = \frac{3H^2}{8\pi G} \chi^{2\varepsilon} \]

Finally:

\[ K_D \frac{\partial x}{\partial t} = K_D V = F_{viscous} \]
\[ K_S x = Force(Gravitational) \]

3.8. ANALYSIS NUMERICALLY: MODELS VALIDATION

3.9. CONCLUSIONS

I'd like my death to be my epitaph:

…He dedicated his life to trying to understand how the cosmos works….
I just need time, place and teachers/students to share.

I stopped teaching at the University (a few years ago) to focus on this Research. I need to go back to a University to advance and share knowledge and ideas.