



## COSMOS PATHS

**Timoteo Briet Blanes**

Twitter: @TimoteoBriet

Mail: [racecarsengineering@gmail.com](mailto:racecarsengineering@gmail.com)

LinkedIn: [www.linkedin.com/in/timoteobriet](http://www.linkedin.com/in/timoteobriet)

### INDEX

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

### MOTIVATIONS, FUTUR AND WISHES

All my life I have worked giving classes during 5 years in Universities of Spain and South America, and also I have worked in Formula 1 teams and in general, vehicles. Mainly I have worked in Aerodynamics and CFD Simulation. I have edited 18 books with ISBN and hundreds of conferences in Universities, Articles, etc....

5 years ago, I decided to leave the University and all my work in Formula 1, to devote myself to research on topics that I had been working for many years but did not dedicate much time. I left teaching at the University, because with so much bureaucracy, I had very little time to research and try to write Articles and do experiments; in Spain, to research, is very complicate.

Basically I investigate about the use of Aerodynamics and CFD Simulation, to solve Cosmological and Astrophysics problems. In the last years, I have proposed a series of phenomena for example in galaxies, which have been validated by some Articles that have appeared. I should have been the author of these Articles, but for that, I needed time and dedication, which I have not had. I need time to dedicate myself to my research and I am sure that I can achieve great results and I am sure that I can solve many questions in Cosmology and Astrophysics.

I love life, nature, the universe, the cosmos and I don't like the Astrology and to make animals suffer: I hate the so-called bloody spectacle of the bulls, the fights or races with animals, etc..., but what I love most is research:

Any future for a Society is based on Science and Research. There is no other way to progress and well-being.

I have never liked crowds of people, nor that they look at me or feel that they are talking about me (Asperger's ?...). But I feel good to be looked at and talked about when I am teaching.

As you can see in this paper, there are many things that I describe and predict, but I don't have the time, I don't have the money, and I don't have the means to investigate and confirm or validate these assumptions. I don't know how to speak and understand (listen) much English, this is a serious problem for me, although I understand it perfectly read (also, I speak perfectly French).

Every time that appear the image in orange, means that here, is possible to create an research Article jiji:

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc...

For this, I need:

- Time for research.
- Create, may be, a research group.
- Students who want to collaborate in this great study and writing Articles.

One of my dreams would be to work investigating and giving classes, again in a University, surrounded by passionate people like me in these subjects, to speak continuously, to dream together with people like me, to enjoy the joint and shared knowledge. I deeply love research and I want, at my age of 52 years, to devote myself completely to this subject, with which. I have been more than 30 years, researching personally, without pause. I not find money, just enough to live on.



As a summary of my objectives with this Article-Work: I am looking for a University where I can have time for my research, have colleagues to exchange knowledge and ideas and material or tools to carry out quality studies.

For my part, I could teach Aerodynamics and CFD Simulation, in any area of engineering.

"It has been said that astronomy is a humbling and character-building experience. There is perhaps no better demonstration of the folly of human conceits than this distant image of our tiny world. To me, it underscores our responsibility to deal more kindly with one another, and to preserve and cherish the pale blue dot, the only home we've ever known." - Carl Sagan.

Here at the head of this Article. You have my LinkedIn and Twitter address, so you can know more about me and my activities.

## **ABSTRACT**

All the matter of the cosmos behaves in the same way: its dynamism is based on the same laws everywhere, and under almost all scales of size. If you want to explain how the Universe-cosmos works, 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 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 is possible to apply this model-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 (particle) in the cosmos, are a wave.... And as a wave, is necessary to study it.

A particle, he experiences and feels, a single force pushing him in one direction. This force is the result of several forces (friction, magnetic, 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 and structures.

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

## **1. INTRODUCTION**

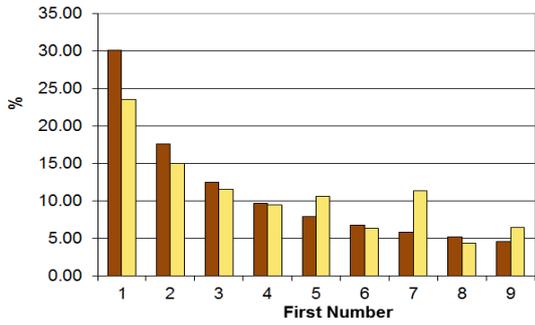
The main goal for any mathematician is create numeric models about nature phenomenon. For that, is necessary discovery (or create) patterns, and if it is possible lineally, but that, is not easy, and normally not real. May be, that the phenomenon witch is studied (numeric model), have more laws or different laws or even more or less laws, but our numeric model, explain the phenomenon; a typical case of atoms and electrons in circulars orbits.

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

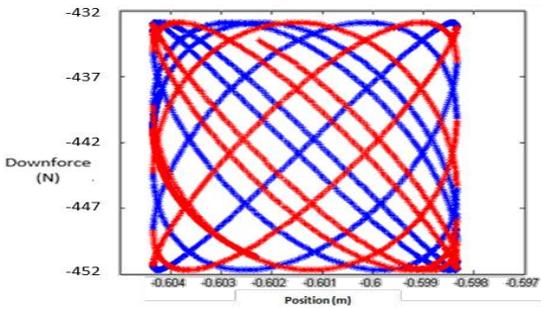
Is very nice is front a white paper and write ideas and translating dreams....

The fact of call one event as unpredictable is to assume ignorance. Our 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 estranges, about patterns:

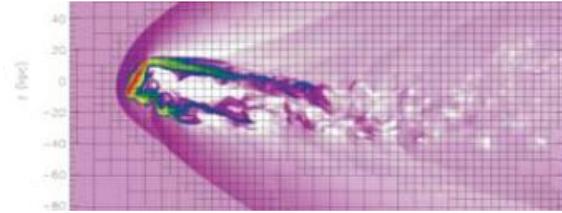
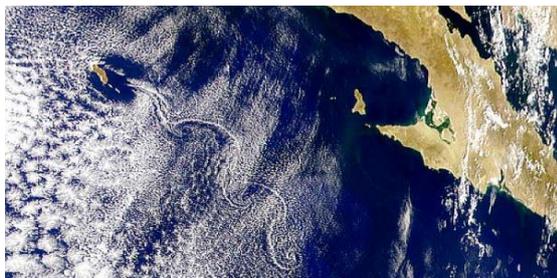
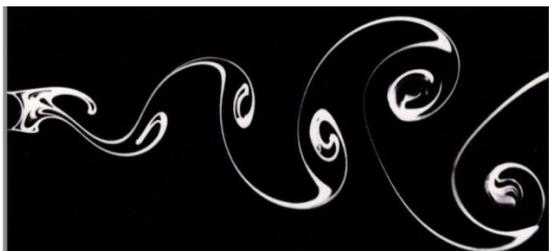
- Benford law, applied for example, in distances of galaxies from earth (Timoteo Briet Blanes – 2017): (brown=Benford law, yellow=data 4.000 galaxies data founds from Internet):



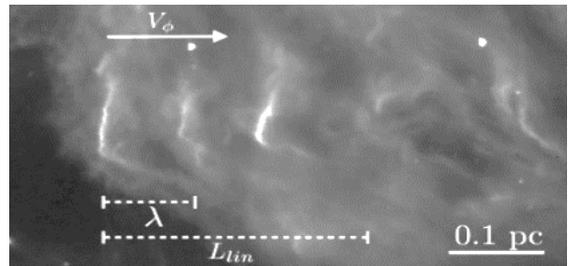
Generation on Lissajous curves from different cases: electronic control, lift or downforce against position in a vibrating wing, etc... (Timoteo Briet Blanes – Book “Aero Post Rig Analysis”):



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, atmospheric 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:



Also, in a lot cases, is not possible to see some pattern or some think as that, but is possible analyze the phenomenon in order to find a pattern.

For example, in a Meteorites rain (Quadrantides – temporal data from Josep Maria Trigo - January 1992), is possible to create a graphic, with “d<sub>i</sub>” the detection instant of meteorite “i”, d<sub>i</sub> – d<sub>i-1</sub> against d<sub>i-1</sub> – d<sub>i-2</sub>. Is possible detect and analyze one geometry multifractal (may be because there is a random variable....) (Vicent Martínez García - University Valencia - Spain) on this graphic (Timoteo Briet Blanes - 1993).

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

For example, Bernoulli principle in accumulation or exit of people from sport stadium, also sheep out of a stable, even 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 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 mathematics, pretty and simple, in order to explain any event, as a fluid. For example, get a fluid with density "ρ" constant; get a space in 2D and get  $u_{ij}$  velocity horizontal in point (i,j) and  $v_{ij}$  vertical velocity in the same point:

$$A = u_{i+1,j} - u_{ij} + v_{i,j+1} - v_{ij}$$

So  $A=0$ , or the same: variation zero of the mass:

$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$  : Continuity equation or divergence zero; that is, with language mathematic 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 movement 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; that is: dynamic. For example: ball position, aircraft velocity, economics values, temperature, petroleum price, etc.... Any idea or concept, for Carl Sagan, in its definition of Cosmos. Event, Phenomenon, Particle, Success, are the same concept. Fluid is a set of particles.

### 1.2. EVENTS REPRESENTATION

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

- Through springs, dampers or shock absorbers and 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".

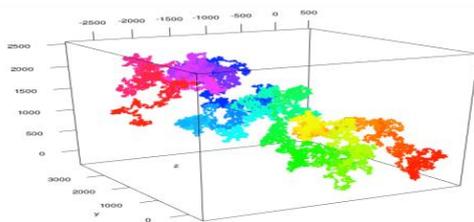


- Inerter. Is a try also, to enter the variable "time", so also velocity, acceleration, etc.
- Etc....

It is possible to apply "mass" to the event, in the form of "importance" or "transcendence", and others systems as damper inerter. Also others options or conditions.

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:



### 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.

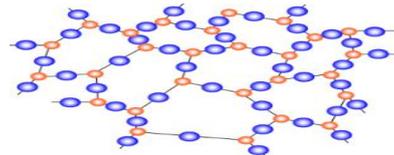
Does it therefore influence what is known a priori of an event in order to predict it? Does knowledge influence? Yes that influences, indeed: if you ask us if it's going to rain an hour, just look at the sky and know if there are many clouds....

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

→ Here, is necessary create relations representation and more about.

Given a die, 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 die, so that the face of number 6, for example, weighs less than the face of number 1 or any other...



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...





Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

**1.4. SOME COMMENTS, IDEAS,  
HYPOTHESIS**

**1.4.1. CONSIDERATIONS ON THE  
WORLD CRISES**

In the face of the evolution of an economic crisis, it always asks ourselves: "Even 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

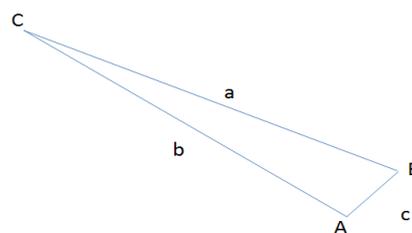
slightly appreciable in the very long term. If indeed it can see some effect, it is simply because the previous diver was already close to the bottom....

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 movement of "B" will be less.



It is an example to observe that although we have 3 dependent events, certain movements 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.

### 1.5. DEFINITIONS

#### 1.5.1. DENSITY "ρ"

Density "ρ" is defined as the number of particles per unit volume or time interval. 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 "ρE": "t<sub>full</sub>" time, "E<sub>t</sub>" the event in "t" instant, (t<sub>1</sub>,...,t<sub>n</sub>) temporal interval; this definition is a frequency:

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

#### 1.5.2. PRESSURE "P"

Is a concept, very similar to Density, or better, is a consequence of her. Obviously, if the density is greater, the pressure also. First, it can think about pressure as a definition in Kinetic theory of gases (proportional to "m" total mass particles, "1/Vol" volume and "u" average velocity of particles, impulse (m\*u) and "N" number particles); "ρ" is a local value, that is: around a point, "cte" is a constant):

$$P = cte \frac{mN u^2}{Vol} = cte * \rho * u^2 * N \propto \rho u^2$$

In fact, is common work with the Lift Force in Aerodynamics, as ("A" area and "C" a coefficient); very similar to (Eq.3) (pressure = Force / Surface):

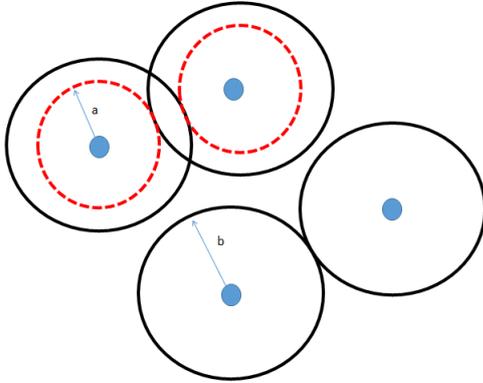
$$Force(lift) = \rho u^2 \frac{1}{2} AC$$

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 similar, to Einstein equation (simplified) E=mc<sup>2</sup>. In fact, the Pressure is the Energy; this concept of Pressure as Energy, is essential in order to define a new procedure for create a CFD code:

$$E = m C^2 = \frac{m}{vol} C^2 Vol \propto P * Vol$$

We 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).

We suppose that events group, may be different pressure against the time or other variable. That is: 2 events in a fluid 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. But if there is some kind of compressibility, the balls will tend to move and pass one another.... (Tennis ball, for example).

### 1.5.3. TEMPERATURE "T"

In the expression for pressure (Eq.4), we calculate it for a 1 mole; then ("N<sub>A</sub>" is Avogadro number, "M" molecular mass, "cte" is constant):

$$P * Vol = m u^2 N_A = R * T$$

$$T = cte * M * u^2 \propto u^2$$

From (Eq.4) and (Eq.6):

$$P \propto \rho T$$

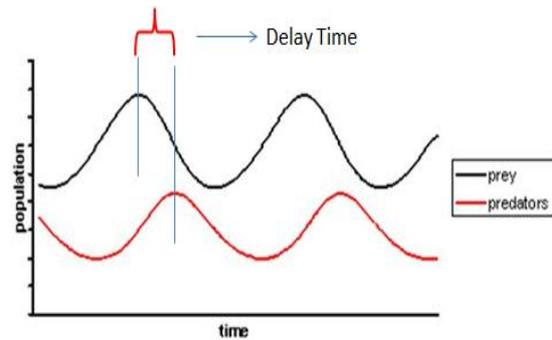
About the Brownian movement, the particles vibrating (Temperature), produce a variation of position, and this position unpredictable, produce an evolution unpredictable.

### 1.5.4. VISCOSITY "μ"

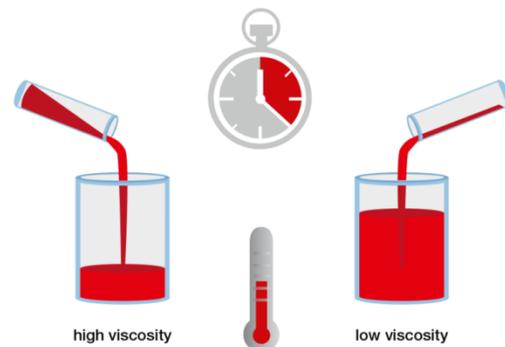
When starting a car when the traffic lights turn green, it does so after some time after the car that precedes it moves (delay time or "T<sub>d</sub>"). It also happens when the price of oil changes due to the index variation of the New York Stock Exchange-Market; it does not do it immediately. "Viscosity=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

If μ = ∞, if and only if, ρ = Constant.

We can see the same delay 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.





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, "t" is time and "N<sub>m</sub>" the number particles in 1 lineal meter:

$$T_d = \frac{1/C}{N_m} = \frac{1}{C^3 \sqrt{\frac{P}{RT} N_A}} = \frac{1}{C^3 \sqrt{\rho N_A}}$$

Einstein viscosity value is:

$$\mu_E = \frac{RT}{N_A} \frac{1}{6\pi D r} / \chi^2 \propto D t$$

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

$$T_d = \sqrt[3]{\frac{\mu_E 6\pi D r}{P C^3}}$$

Is possible so, in this moment, to do a fluids classification against "T<sub>d</sub>". For that, is necessary calculate all with the same pressure and temperature.

The sound speed "C", for-in each fluid, depend of variation of pressure, against density; that is:

$$C \propto \sqrt{\frac{\partial P}{\partial \rho}}$$

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

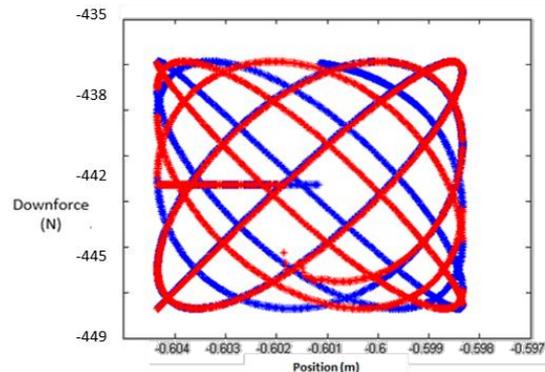
$$C \propto T$$

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

$$F = Kx = m \frac{u}{t}$$

$$K = \frac{m C^2}{N_A \mu_G} \propto \frac{m}{\mu_G}$$

This "delay time" or "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:



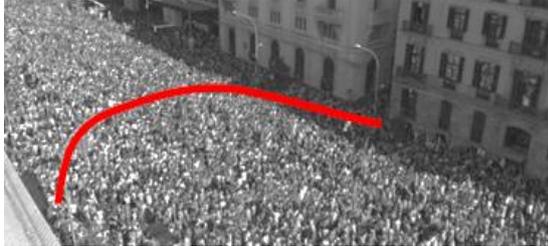
➔ This Viscosity, seem the "Friction", which in my opinion, is the mother of all properties.

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





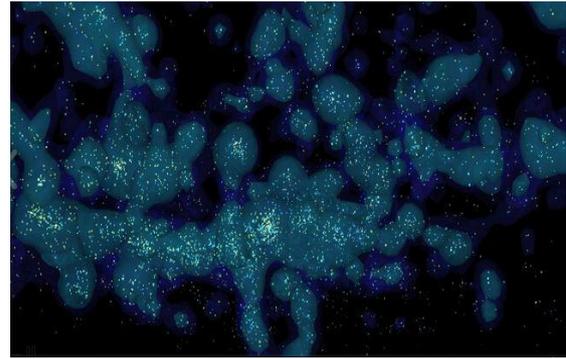
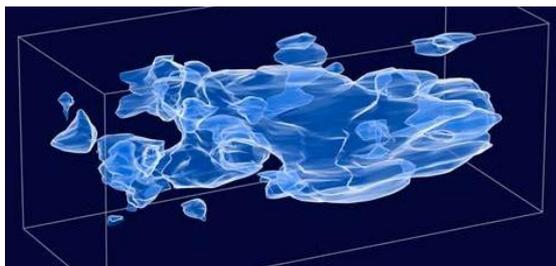
In the end of this "front", it can see a parabolic velocity profile...It can see this "parabolic" velocity profile, in a people group walking in street (there are boundary layer in lateral walls):



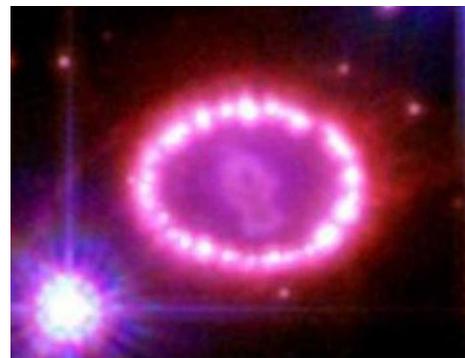
It is possible to see "filaments" or "fingers" in the front of fluid flow:



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, as we have already seen, produces a peculiar and special distribution, producing "fingers", voids, accumulations, etc...

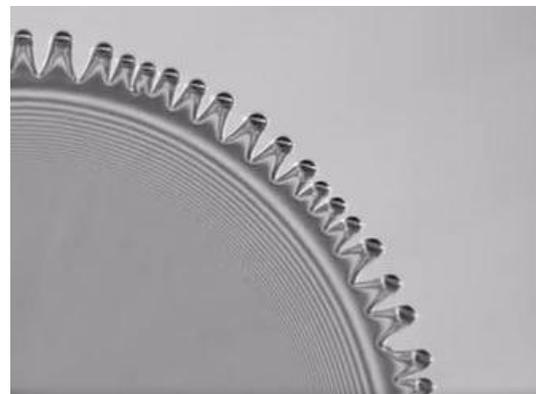


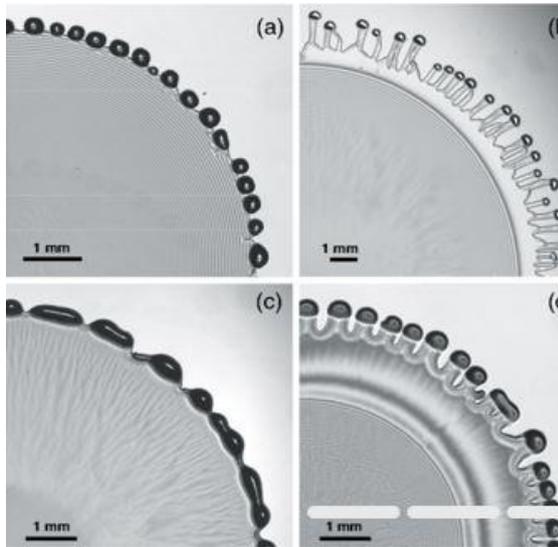
As a sample and similarity with the reality, it show a supernova explosion; it is possible to see the alterations in border:



Why? the viscosity is very important, also, in this geometrical phenomenon.

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:





It is possible to verify the effect of viscosity on the dynamics of a fluid:

If the viscosity of a fluid is higher, it will produce more "fingers" than another fluid with lower Viscosity.

In a experiment about 2 fluid shock: it can also see the formation of "pearls" in fluid shock:



Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

Why does this effect occur?

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.

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

$$D = cte * \frac{T}{\mu r}$$

Comparing this, with the Einstein relation for diffusivity ("K<sub>B</sub>" is a Boltzmann constant) (very similar):

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

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.

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





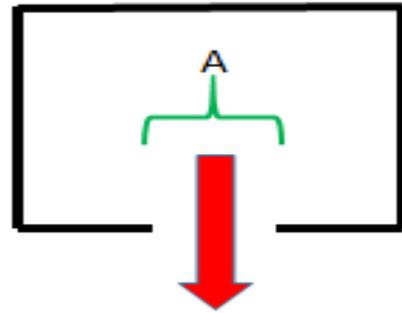
**1.6. PHENOMENON NUMBER**

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 "RP":

$$R_p = \rho L V T_d$$

Being "L" the characteristic length of the phenomenon and "V" its speed.

This value defined in this way applies to gaseous fluids. For example, in evacuation systems pedestrians, is possible to define other phenomenon number: Pedestrians groups and evacuation; representation and notation:



"V" velocity of pedestrian, "A" length of door, "ρ" density of pedestrian group, "Td" delay time or reaction time between pedestrians:

$$R_p = \frac{\rho V}{A T_d}$$

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

$$a_x = \frac{-\partial P_x}{\rho_x} + \frac{u_x}{T_{dx}} + \frac{u_x}{T_{dy}}$$

$$a_y = \frac{-\partial P_y}{\rho_y} + \frac{u_y}{T_{dx}} + \frac{u_y}{T_{dy}}$$

(x,y) coordinates in 2D, (u,v) velocity in 2D, "a" acceleration. This expression, is a simplification of Navier Stokes equations, that it will see. More, "T", depend also of pressure and density.

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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:

### 1.7. MATTER AGGREGATION

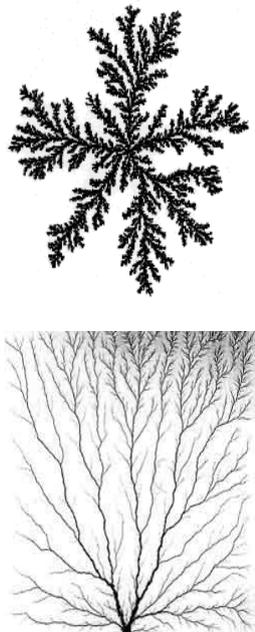
#### 1.7.1. BROWNIAN AND DLA MOVEMENT

If a set of particles possesses totally random movements, at a certain moment the positions of these particles will be distributed randomly and uniformly throughout the whole space.

In the case of not entirely random movements, the final positions will not be uniform and uniformly distributed.

In reality, there is no phenomenon that has complete randomness, so the final distribution of a group of particles will not be uniform: threads, groups, etc. will always be formed....

When a particle comes in contact with another particle, it remains attached to it. If the particles reach the seed particle describing random walks, it is called DLA or movement of aggregates by limited diffusion; for example: Ice and lightning geometry formation:



What is this factor-attraction between particles? The Viscosity, the gravity, etc. That is the same applied to humans and feelings. It will see that.

Brownian and not Brownian motion (very sensible to random motion limits); is practically impossible, to have a Brownian fully random.

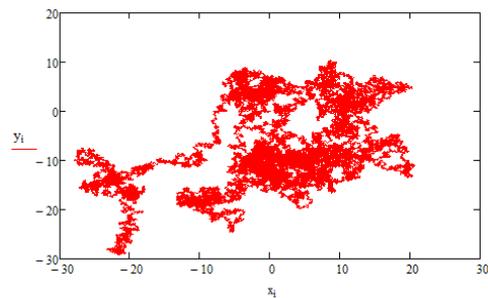
$$x_1 := 0 \quad y_1 := 0 \quad i := 1..100000$$

$$alea1_i := \text{if}(\text{rnd}(1) < 0.5, -0.1, 0.1)$$

$$alea2_i := \text{if}(\text{rnd}(1) < 0.5, -0.1, 0.1)$$

$$x_{i+1} := x_i + alea1_i$$

$$y_{i+1} := y_i + alea2_i$$



$$x_1 := 0 \quad y_1 := 0 \quad i := 1..100000$$

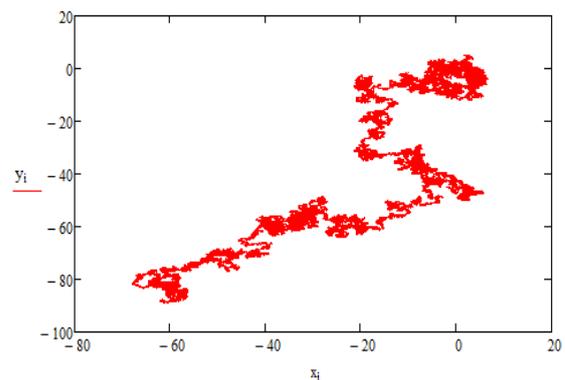
$$alea1_i := \text{if}(\text{rnd}(1) < 0.505, -0.1, 0.1)$$

$$alea2_i := \text{if}(\text{rnd}(1) < 0.505, -0.1, 0.1)$$

$$x_{i+1} := x_i + alea1_i$$

$$y_{i+1} := y_i + alea2_i$$

Brownian movement conditioned (only 0.5%). Very good "filament"....



The Brownian movement 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 movement, is a tube of low pressure (see formation Galaxy point), so the matter, tend to aggregate in this zone-tube.

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Development, etc....

### 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:



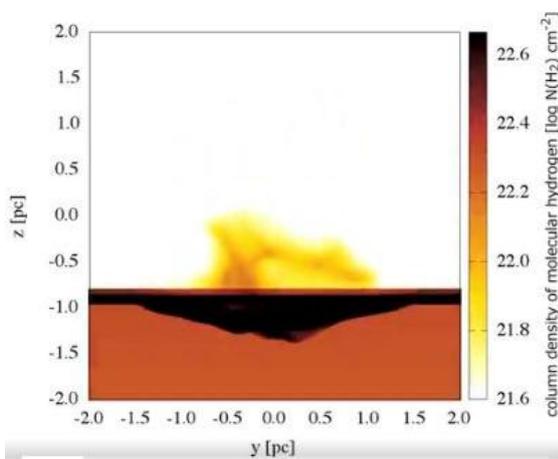
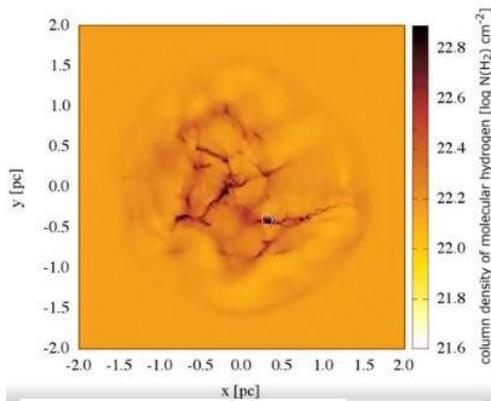
The friction between particles is the responsible of these accumulations: that is: the Viscosity.

The same occur in "flocks 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....:



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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 not occur: the distribution is uniform. This is because the grass has a higher friction (or viscosity); 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.

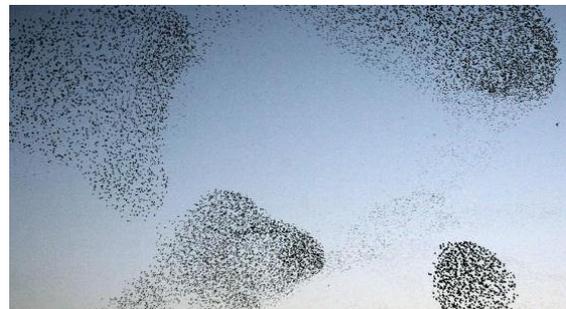


A lightning, is a trajectory that could be considered as a conditioned Brownian movement. In the following image, you can see the influence of the rainwater (environmental) cascade on the path of the lightning,, which follows the path of the water:



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 movement is "@Pressure/density.

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....:

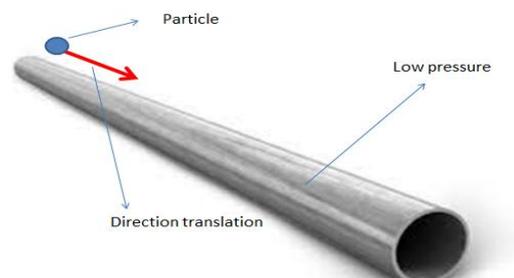


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### 1.7.3. AGGREGATION BY LOW PRESSURE

A zone with low pressure (in relation other zone near), attract particles or matter. 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; depression tubes and vortices around:



This low pressure, is present also around each particle in movement, 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. Harris, Robert Hunt, Zeliha Kilic & Richard M. McLaughlin.

→ It was a prediction mine....:

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**1.7.4. AGGREGATION BY INSTABILITIES: KEVIN-HELMHOLTZ INSTABILITY**

Is a case particular of DLA movement.

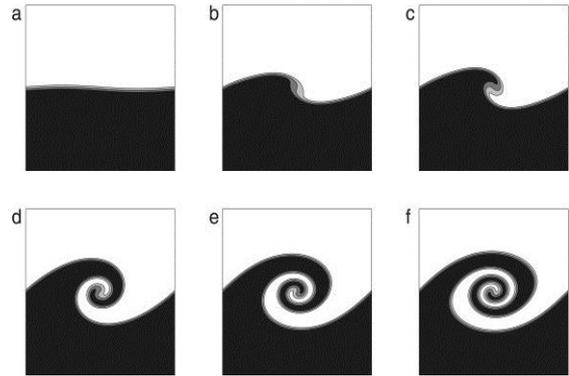
Instabilities there are a lot types; this instability is typical, but not alone. For example, vortices or turbulences, also there are a lot types, but the Karman vortex, have a special geometry and dimensions, and is periodic.

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 movement of molecules (Brownian movement 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:



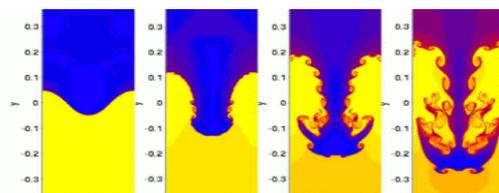
Also, is possible that from these specials geometries create the galaxies arms....

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.
- Density lower.
- Gravity, if exist.
- Rayleigh-Taylor:

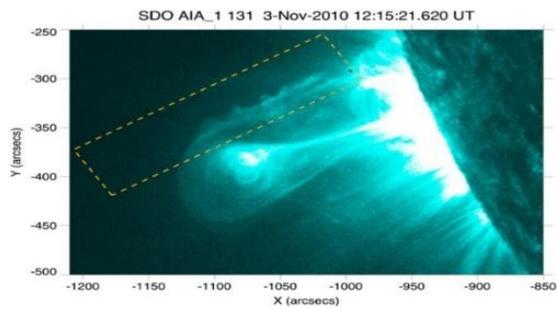
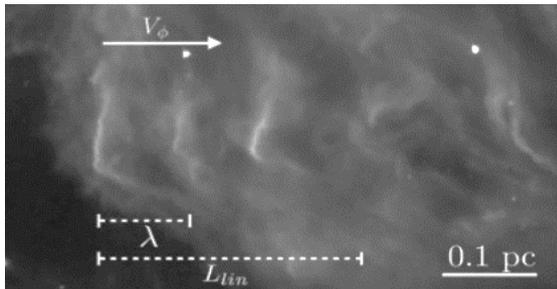
This last effect, occur when a fluid with more density, interaction with other fluid:



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:



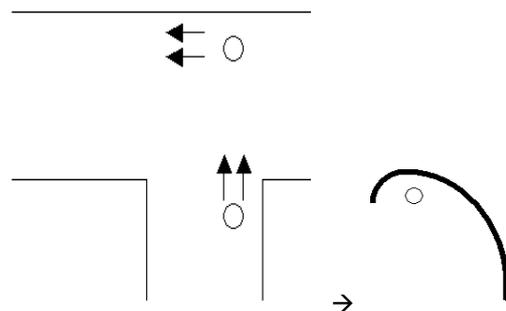
These perturbations or disturbances also can be the origin of galaxy arms.... This perturbation of Kelvin-Helmholtz, are very spectacular; we can think about this disturbance, as a brake wave, more or less:



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



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:

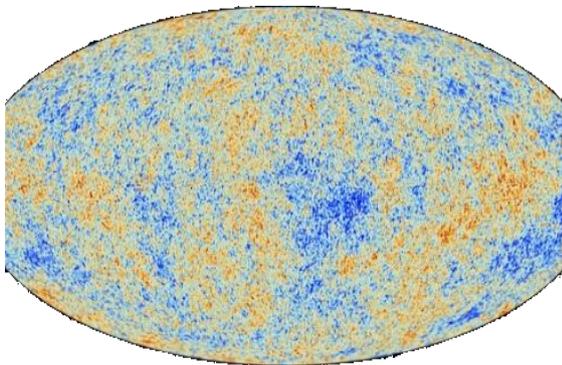


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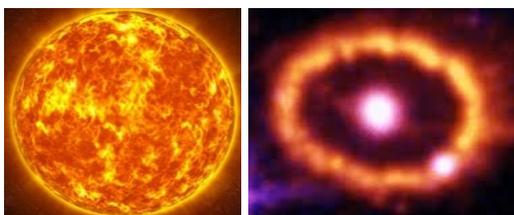
### 1.8. MATTER DISTRIBUTION IN THE UNIVERSE

#### 1.8.1. SPYDER WEB CREATION AS A UNIVERSE

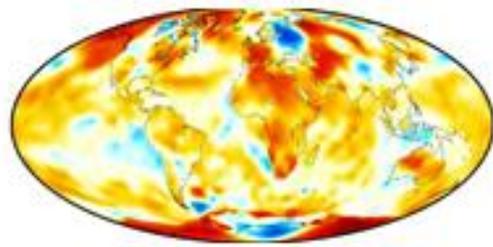
The Background Microwave Cosmic (BMC), is a map of density variation in a distribution of mass in early universe (colors scale blue-red: low-high density or temperature):



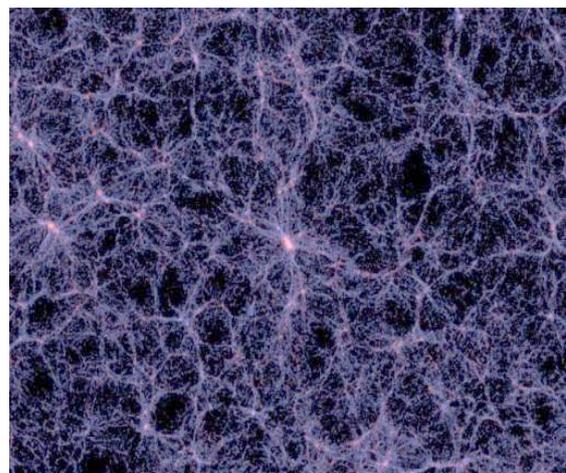
Why this distribution? This special distribution of zones with more and less density is normal in the nature. All explosions for example, not have an equal matter in any direction or point, fragments distribution, density or temperature (sun surface, supernovas, atomic bomb, nebulae, etc....):



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



These densities, viscosities and fields forces 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 gravity, dark matter, dust, density waves, magnetism, gravitational waves, etc..., are very important in order to create the actual and special matter distribution in the universe; but the Viscosity, as we will see in this article, is one of the major responsible for the matter is grouped and evolve, as it does. It is not the only property, of course, but it is one of the most important.

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

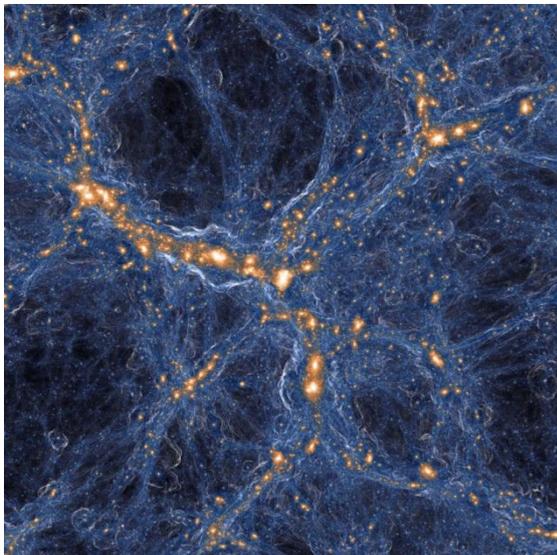


produces the aggregation of matter-particles, forming the cosmic web.

Therefore, the variation of viscosity causes the accumulation of matter in a non-uniform way. Then gravity continues to work.

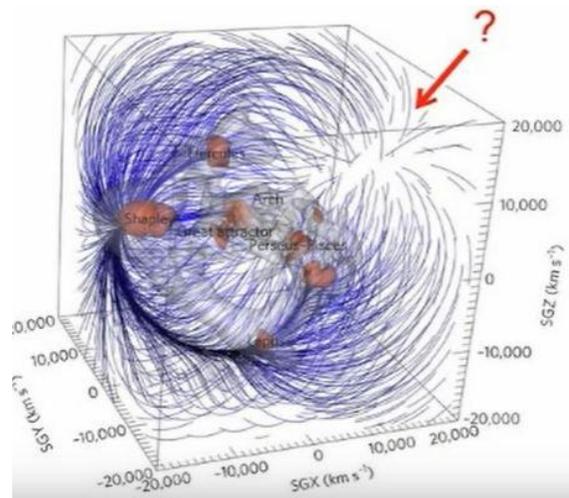
It has already been said that the current structure of the Universe is generated from various forces:

- Gravity.
- Electromagnetism.
- Viscosity.
- Others...

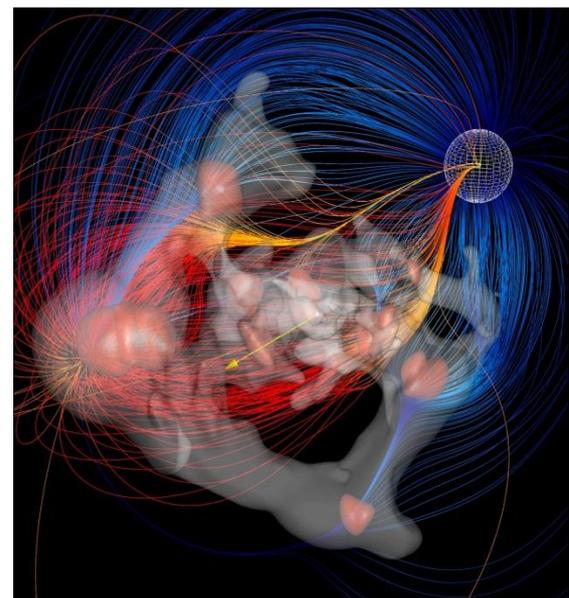
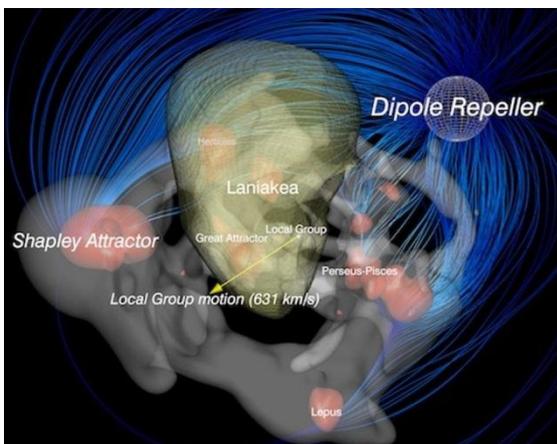


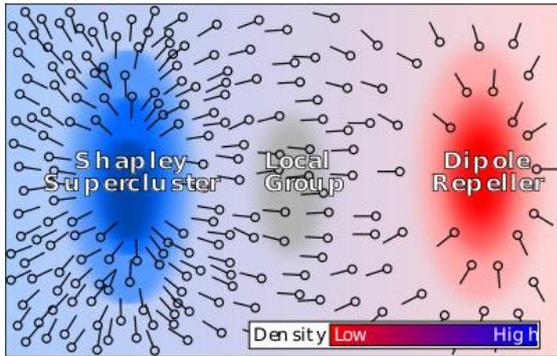
The yellow surface represents dust (latest data from Rosine Lallement and her team), and the purple surface represents hot star concentrations (and traces the outline of the Local Bubble). No dark matter though.

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:



There's a particular structure, called Laniakea:





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...



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→ Multifractals in Universe structure:

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.

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 a 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 a certain geometry is



multifractal is to differentiate or classify phenomena according to their distribution of fractal dimensions.

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, strings and superstrings, 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. Feigenbaum, 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 movements 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.

Julieta 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...

Selfsimilarity:

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 movements 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 the two.

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".

Numeric model for calculating fractals dimensions (in order to know if is fractal-multifractal):

Hausdorff's definition of dimension was introduced in 1918.

Let "A" a set of "Rn"; the external measurement is defined  $\alpha$ -dimensional of "A", as that: let "Bi" a coating of "A"; let " $\epsilon_i$ " the diameter of each coating and be an arbitrary epsilon.

$$B_A = \left\{ \left\{ B_i \right\} / i = 1, \dots, \infty / A \subset \cup_i B_i / \epsilon_i \leq \epsilon / \forall i \right\}$$

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

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

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

$$S_{\alpha}(A) = \infty \quad \alpha < DH$$

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

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 "ε" amplitude; I count the number of cells in which the figure enters some box and I call it "N(ε)". We repeat the experience for various values of reticular amplitude, and we place on a 2-dimensional graph, the values of "log(N(ε))" and "-log(ε)"; if we find the slope of the regression line that joins all the points found, we will have the dimension sought. 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  $\mathbb{R}^n$ .  $A = \{X_i\} / i=1, \dots, n$ . Let's give this set "A", a measure of probability. We will count for each "Xi" the number of points of the set that we find inside a sphere of  $\mathbb{R}^n$  of radius "ε", with the center said "Xi". I will call "ni (ε)", 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 measurement of probability, we will impose the following condition:

$$\sum_{i=1}^N p_i(\epsilon) = 1$$

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

$$p_i \approx \epsilon^{\alpha_i}$$

The exponents "αi ", will be the characteristic exponents of the set "A". We can therefore consider the application that associates each point with its exponent:  $V: X_i \rightarrow \alpha_i$ ; 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 "Bi" covering of the "A" set, of epsilon amplitude, we can consider the following partition function:

$$\Gamma_1(q, \tau, \{B_i\}, \epsilon) = \sum_i \frac{P_i^q}{\epsilon_i^\tau}$$

"Pi" is a measure of the "Bi" set. To eliminate the dependence with "Bi" , we make the limit of "Γ1" for "q" and "τ" less or equal to 0; if we call "Γ2" to this limit, we can define the partition function, as follows:

$$\Gamma(q, \tau) = \lim_{\epsilon \rightarrow 0} \Gamma_2(q, \tau, \epsilon)$$

$$\text{Define } \Gamma(q, \tau) = \begin{cases} \infty & \text{if } \tau > \tau(q) \\ 0 & \text{si } \tau < \tau(q) \end{cases}$$

$$\text{Define function: } \delta q: \delta q = (q-1) - 1\tau(q)$$

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

$$\Gamma(0, \tau) = \lim (\inf \epsilon^{i-\tau}) / \epsilon \rightarrow 0 \quad \tau \leq 0$$

If it change "α = -τ", it have:

$$\Gamma(0, \tau) = \liminf_{\epsilon \rightarrow 0} \sum_{i=1}^N \epsilon_i^\alpha = S_\alpha(A)$$

Since Hausdorff's dimension is unique, it follows that  $\delta 0 = DH$ . The generalised dimensions of Rényi are defined as follows: Grassberger, 1983:

$$\lim_{\epsilon \rightarrow 0} \frac{-\sum_{i=1}^N p_i(\epsilon) \log(p_i(\epsilon))}{\log(1/\epsilon)} = D_q(\epsilon)$$

$$D_q(\epsilon) = \lim_{\epsilon \rightarrow 0} (1-q)^{-1} \frac{\log \sum_{i=1}^N (P_i(\epsilon))^q}{\log(1/\epsilon)}$$



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".

$$DK = \lim_{q \rightarrow 0} Dq$$

$$DI = \lim_{q \rightarrow 1} Dq$$

$$DC = \lim_{q \rightarrow 2} Dq$$

The number of times "α" takes a value within the closed interval (α', α' + dα'), can be expressed as follows:

$$n(\alpha')d\alpha' = \mathcal{E}^{-f(\alpha)} d\alpha'$$

"f(α)", is the fractal dimension of the subset of "A" that have the same characteristic exponent "α"; that is: "V -1(α)" where α ∈ (α', α' + dα').

To draw the function "f(α)", we'll draw the envelope to the straights "y=qx-τ(q)", varying "q" from "-∞" to "+∞", (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):

- D(0) ≈ 1.5
- D(0.8) ≈ 0
- D(3) ≈ 2
- D(100) ≈ 3

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):

$$h(n,j) := \text{if} \left[ (x_j - px_n)^2 + (y_j - py_n)^2 < \varepsilon^2, 1, 0 \right]$$

$$R_n := \sum_j h(n,j) - 1$$

$$p1_i := \frac{R_i}{N}$$

$$v := \sum_i p1_i \quad p_i := \frac{p1_i}{v}$$

$$\alpha_1 := \frac{\log(p_i)}{\log(\varepsilon)}$$

In this moment, to apply this procedure or software, in a Meteorits rain. That is: as a first sample:

It have a table with dates, each corresponding to the instant of sighting a Quadrantides (meteorits 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:

```
:= 
C:\.\datos.txt
```

```
i := 2..length(t) - 1
```

```
a1 := 1992      m1 := 1      d1 := 3
```

```
fd1i := floor(ti·100)·60·60
fd2i := floor([(ti·100) - floor(ti·100)]·100)·60
```

```
fd3i := floor[(ti·10000 - floor(ti·10000))·100]
fd4i := fd1i + fd2i + fd3i
```

```
d1 := fd4i ·  $\frac{10}{24·60·60}$  + d1
```

d<sub>j</sub> is Julian day.

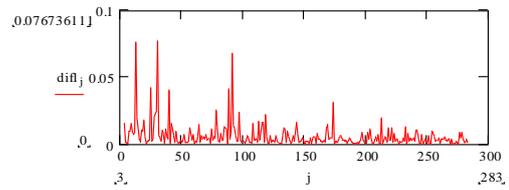
```
dji := floor(365.25a1) + floor[30·6001(m1 + 1)] + d1 +
+ [ 2 - floor( $\frac{a_1}{100}$ ) + floor( $\frac{\text{floor}(\frac{a_1}{100})}{4}$ ) ]
```

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 see the different representations.

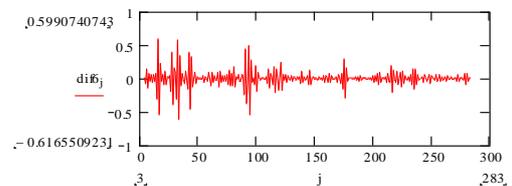
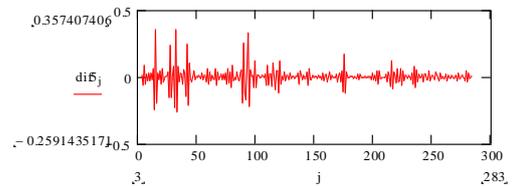
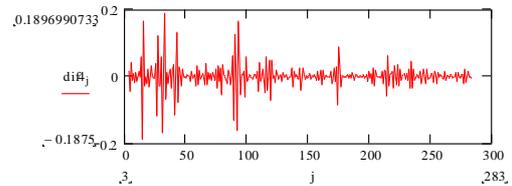
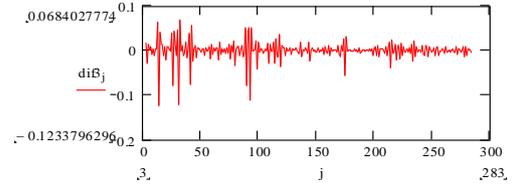
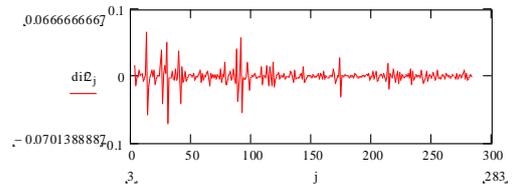
Let's see how the time intervals between each sighting evolve:

$$\text{difl}_j := d_j - d_{j-1}$$



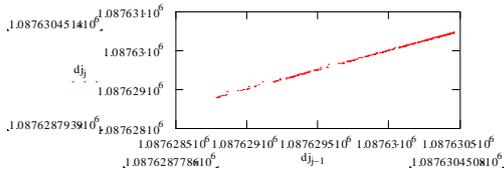
If it calculate the differences of a higher order and represent the evolution, it will obtain:

$$\text{dif2}_j := \text{dif1}_j - \text{dif1}_{j-1} \quad \text{dif3}_j := \text{dif2}_j - \text{dif2}_{j-1}, \text{etc.}$$



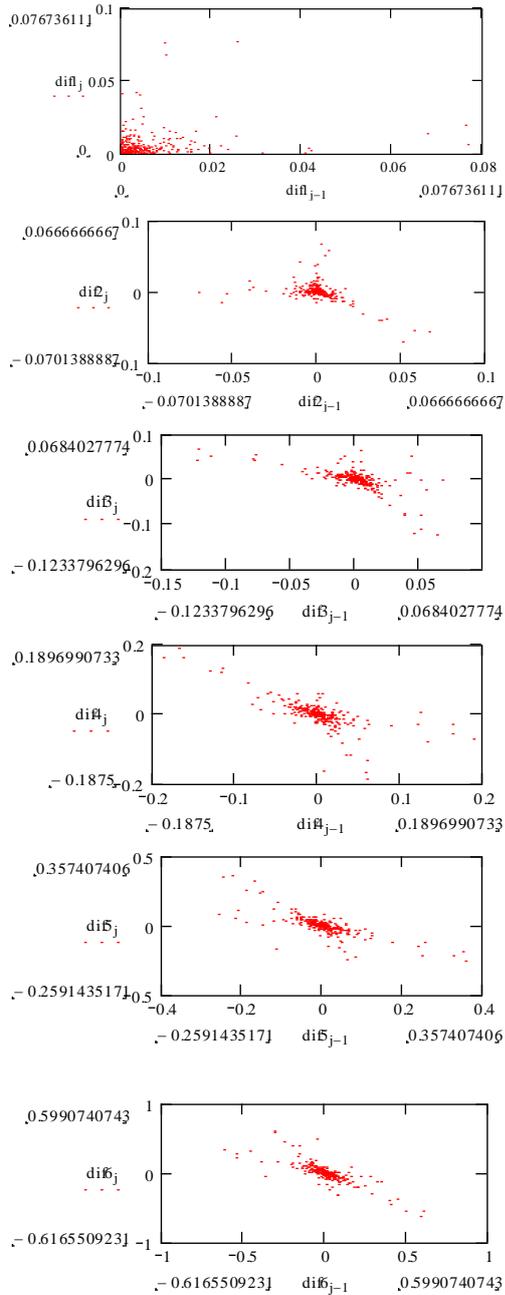
The areas with the largest peaks correspond to the time intervals of least activity and vice versa. This representation does not tell us much, except for what has already been mentioned; let's take the following representation:

$$j := 3..length(t) - 1$$



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 Quadrantid decreases.

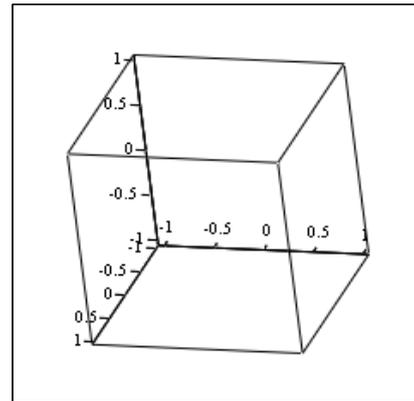
Let us now take the n-order differences:



We have represented the differences of different orders, from consecutive values; we obtain analogous geometries, for non-consecutive values. In these last representation-geometry, it apply 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....):

$$x(j) := dj_{j-1} \quad y(j) := dj_j \quad z(j) := dj_{j-2}$$

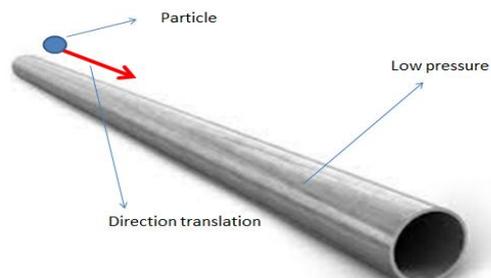


(x, y, z)

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

### 1.8.2. 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.

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

### 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 create 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.

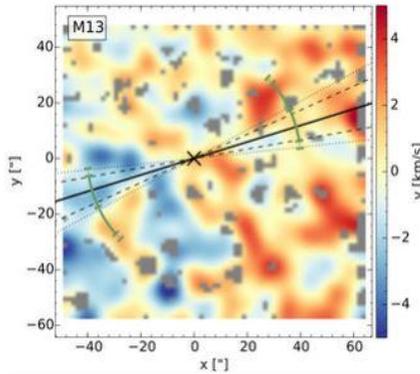
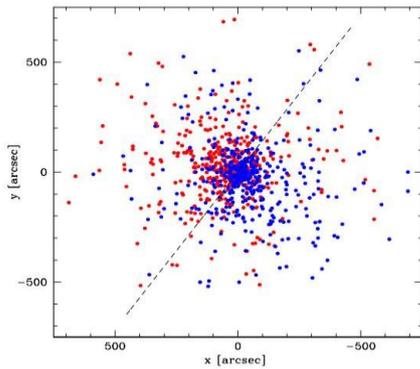


The rotation of black hole, help galaxy in its evolution (also bend the light...).

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



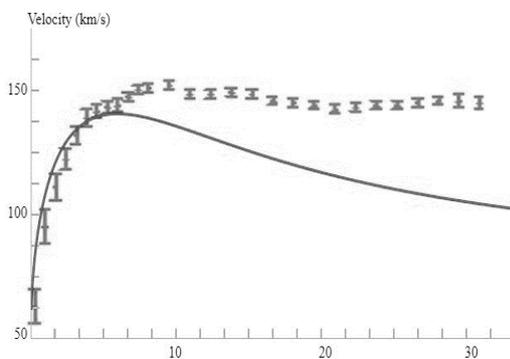
Can be the globular cluster, the origin of every galaxy?: a globular cluster, have rotation (also, is the most likely...). Rotation velocity stars in globular cluster, with the rotation axis.:



Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

### 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".:



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:

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):

$$V^2 = \frac{Gm}{r}$$

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):

$$\frac{m}{r} = cte$$

$$2V\partial V r^2 = G(r\partial m - m\partial r)$$

Adding this "new" matter to galaxy is possible obtain the good velocity profile; that is: increasing the density. The density value for that is approximately  $1.38 \cdot 10^{-17} \text{ Kg/m}^3$ . 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 ( $1.5 \cdot 10^{22} \text{ Kg}$ ):



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

- Viscosity:



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

$$V = \mu_1 \frac{ar}{m}$$

$$\mu_1 = \mu 6\pi$$

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

- Density and viscosity (working together):

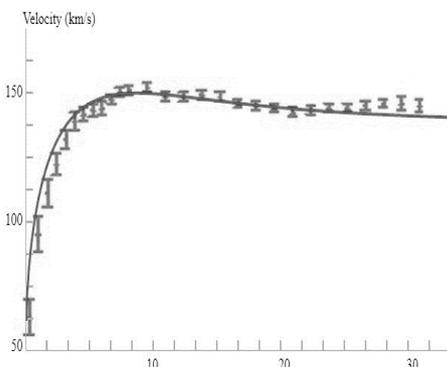
Combining and substituting the mass for density\*Volume (Vol), is possible change density and viscosity, in order to have the profile velocity "real" ("Vol" is the galaxy volume inner part, "K" constant more or less): is possible calculate a Density and Viscosity in every point or full galaxy): (the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

$$\sqrt{\frac{Gm}{r}} = 6\pi \frac{a}{m} \mu r$$

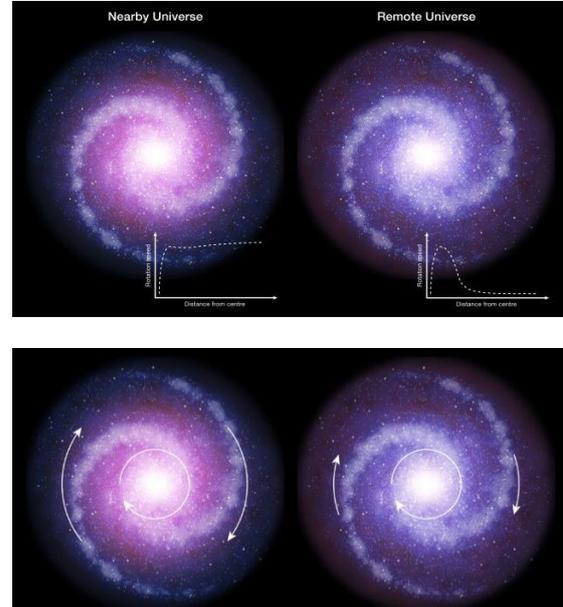
$$m = \rho * Vol$$

$$\rightarrow \frac{\rho^{1/2}}{\mu} \approx K$$

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



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.:



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.

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

### 1.8.2.4. ARMS FORMATION

First of all, and obviously, is possible appreciate the similarity with any real galaxy

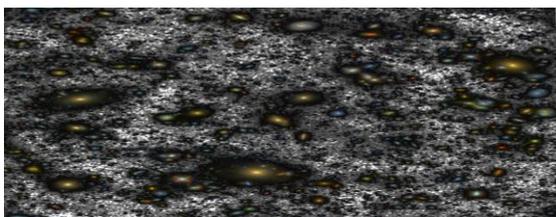


(geometry pattern – typical in mathematical or physical models). Typical galaxy in spiral.:



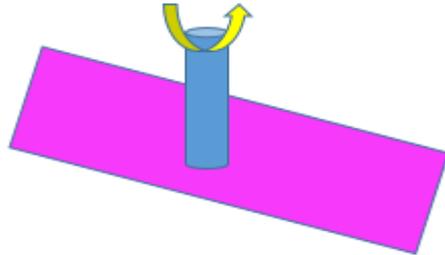
Is possible so, apply fluids theory to galaxy formation, evolution and interaction? May be...

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.

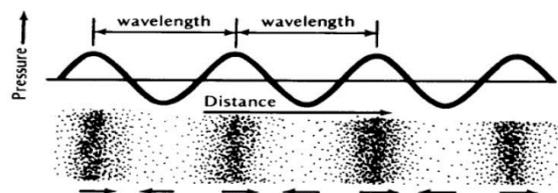


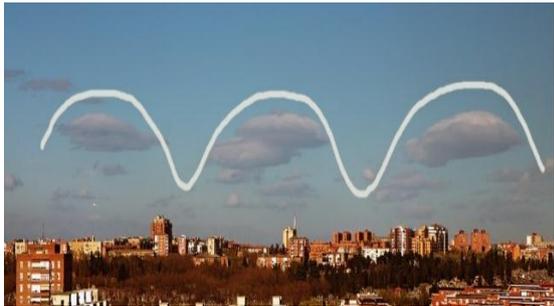
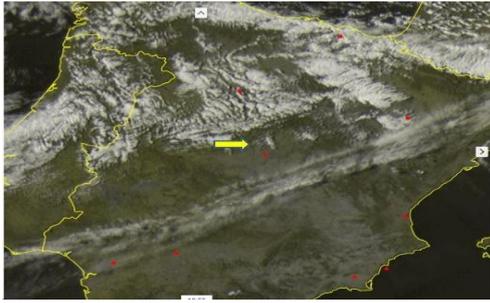
Imagine now, that it has a cloth and a cylinder placed in the central part which rotates, creating a special pattern (A rotating fluids set with different viscosities and densities, can generate arms, as a density contours). Zones of creation of

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):





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....

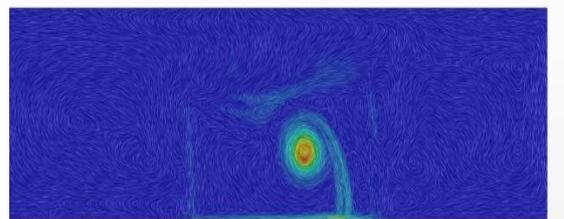
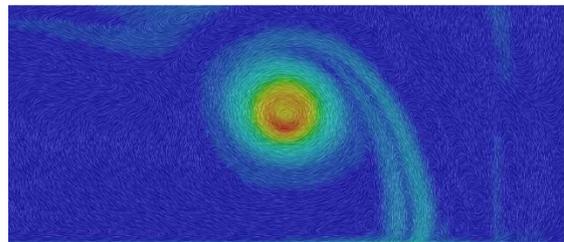
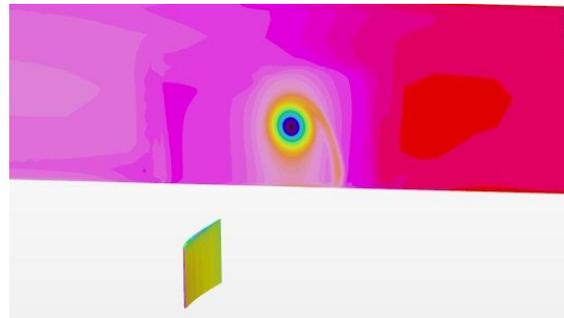
The stars matter may be composed by baryonic matter but also may be, by Dark Matter transformed in baryonic matter....

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).

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

First, it analyzes the next test:

- 1 Fluid.
- 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....

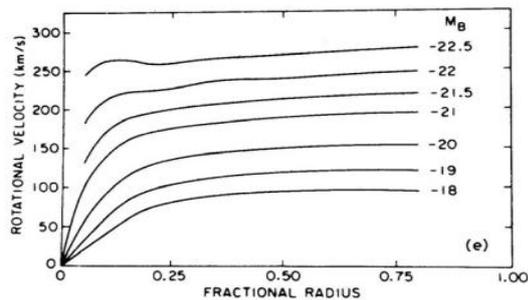
Is necessary so, more, in order to create and visualize the arms.

**1.8.2.5. PHENOMENONS, PROPERTIES, INTERACTIONS, SIMILARITIES, RELATIONS, GEOMETRIES,**

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.

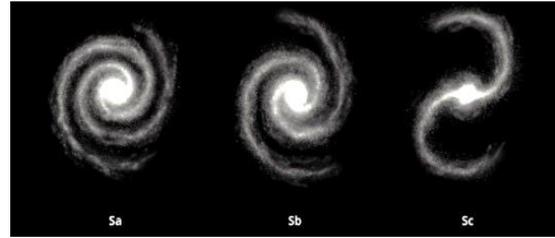
**a) LUMINOSITY / ROTATION VELOCITY**

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.:

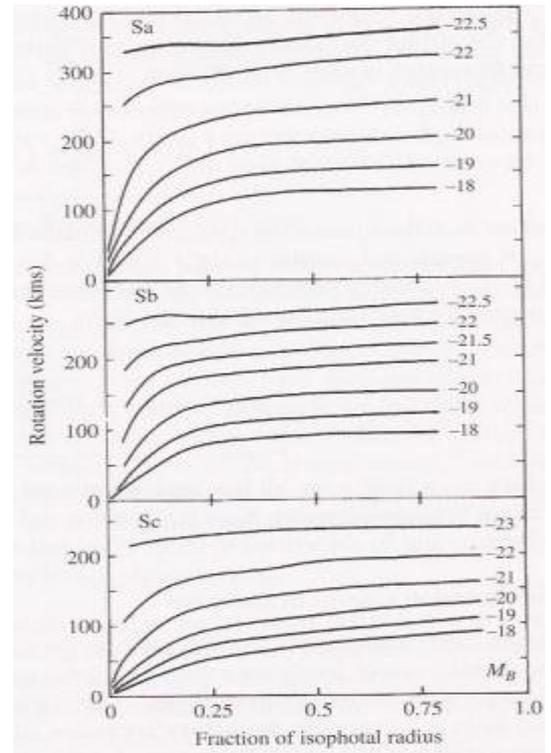


**b) LUMINOSITY / TYPE**

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



Rotation velocity Sa, Sb and Sc galaxies.

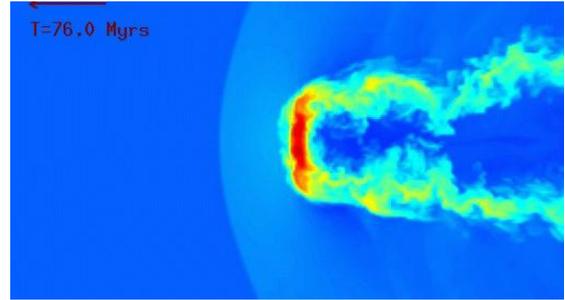
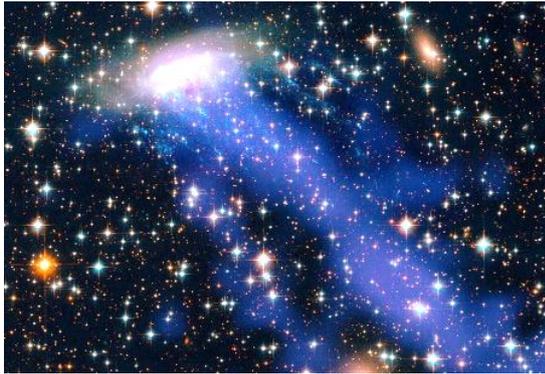


**c) GALAXIES TAIL**

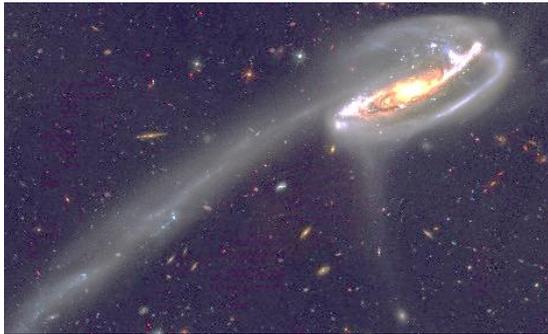
When talking about the Tail produced by a Galaxy on its way through the Universe, there are 2 types of Tails:

- 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.



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



Stripped galaxy and their CFD simulation:

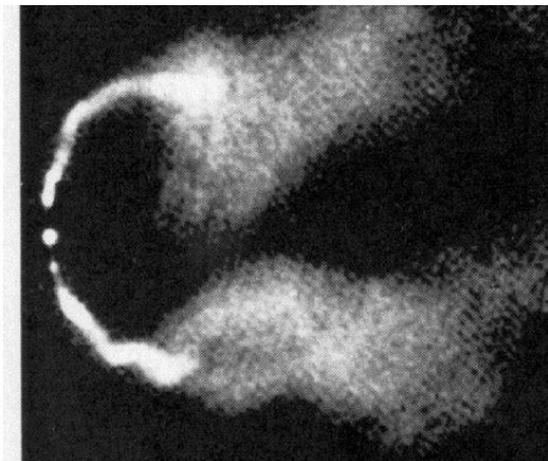
**d) GALAXIES WITH LESS DARK MATTER**

If there are few dark matter, the galaxy have less arms.

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

**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.



Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....



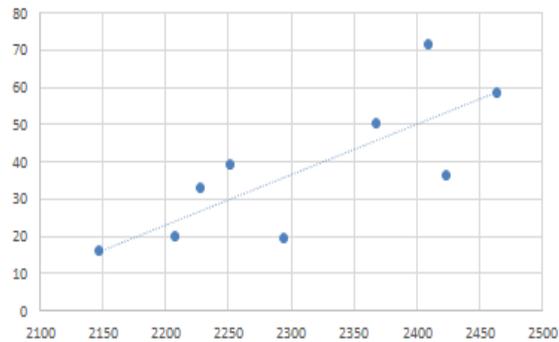
**f) VELOCITY ROTATION AGAINST DISTANCE**

Rotation velocity against distance:

Galaxy (1)	RA hh mm ss (2)	Dec dd mm ss (3)	PA d (4)	D Mpc (5)	Type (6)	$m_{abs}$ (7)	$\log D_{25}$ (8)	$\log v_{rot}$ (9)
NGC 522	01 24 45.91	09 59 40.5	33.3	39.0	Sbc	-20.53	1.44	2.252
NGC 684	01 50 14.03	27 38 44.2	88.8	50.4	Sb	-21.53	1.53	2.368
MCG-01-05-047	01 52 49.01	-03 26 51.2	161.4	71.5	Sc	-21.77	1.47	2.410
NGC 781	02 00 09.02	12 39 21.5	13.0	49.8	Sab	-20.87	1.18	
NGC 2654	08 49 11.91	60 13 13.9	65.0	19.2	SBab	-20.09	1.62	2.295
UGC 4906	09 17 39.94	52 59 34.3	49.0	32.6	Sa	-20.26	1.30	2.228
NGC 2862	09 24 55.10	26 46 29.0	114.0	58.5	SBbc	-21.44	1.41	2.464
NGC 3279	10 34 42.61	11 11 50.7	152.0	19.9	Scd	-19.27	1.44	2.208
NGC 3501	11 02 47.35	17 59 22.6	28.0	16.2	Sc	-19.05	1.54	2.147
NGC 5981	15 37 53.55	59 23 30.9	139.5	36.1	Sc	-20.61	1.43	2.424
NGC 6835	19 54 33.09	-12 34 02.5	72.0	23.0	SBa	-19.55	1.38	1.803

D Mpc (5)	Type (6)	$m_{abs}$ (7)	$\log D_{25}$ (8)	$\log v_m$ (9)
39.0	Sbc	-20.53	1.44	2.252
50.4	Sb	-21.53	1.53	2.368
71.5	Sc	-21.77	1.47	2.410
49.8	Sab	-20.87	1.18	
19.2	SBab	-20.09	1.62	2.295
32.6	Sa	-20.26	1.30	2.228
58.5	SBbc	-21.44	1.41	2.464
19.9	Scd	-19.27	1.44	2.208
16.2	Sc	-19.05	1.54	2.147
36.1	Sc	-20.61	1.43	2.424
23.0	SBa	-19.55	1.38	1.803

Analyze now, "D" and "V" relation. Relation between Rotation velocity against distance.:



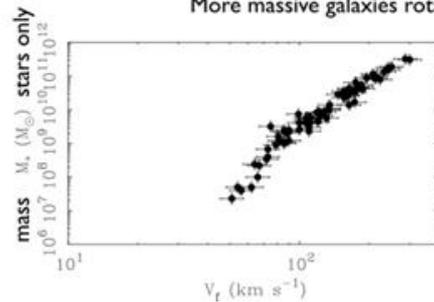
There is a relation lineal. Ok.....

**g) VELOCITY ROTATION AGAINST MASS**

Velocity rotation, against galaxy mass:

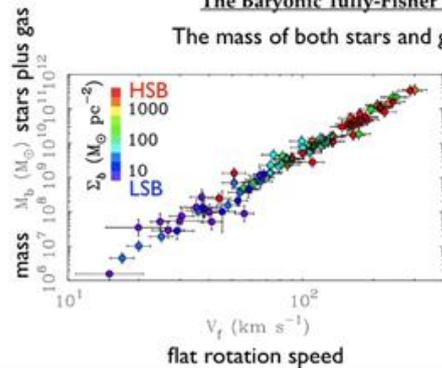
**The Tully-Fisher Relation**

More massive galaxies rotate faster



**The Baryonic Tully-Fisher Relation**

The mass of both stars and gas matters



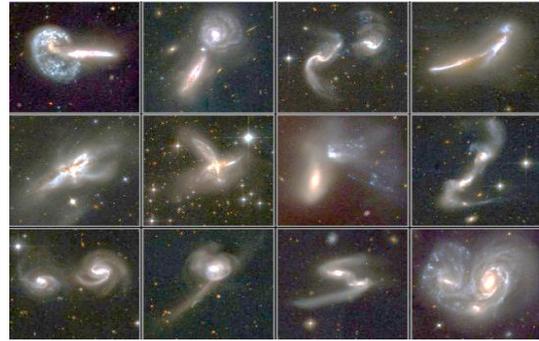
**h) AGE AGAINST ARMS**

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



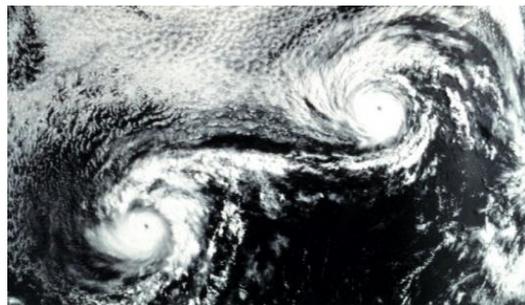
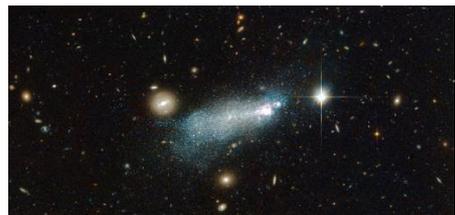


That is "normal" because if it is older, have more time to "work" with the environmental. A young galaxy, has less arms, is irregular and diffuse:



When two galaxies collide, collide also the dark matter.

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



**i) INTERACTION BETWEEN**

**A) INTERACTION AS A VORTICES WITHOUT GRAVITY**

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

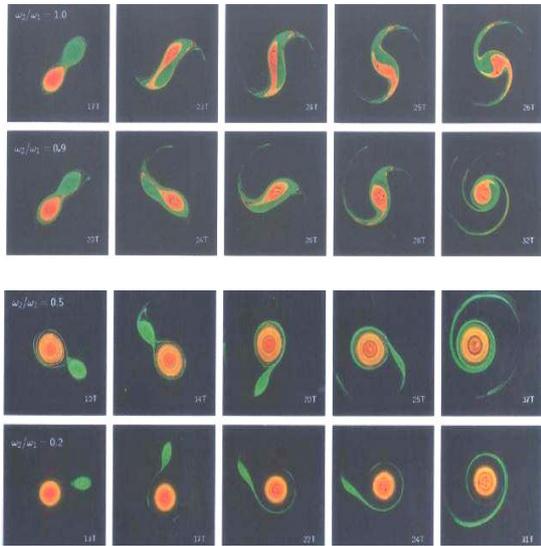
So, it can think about (evolution and combination), as an interaction between fluids vortex.

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

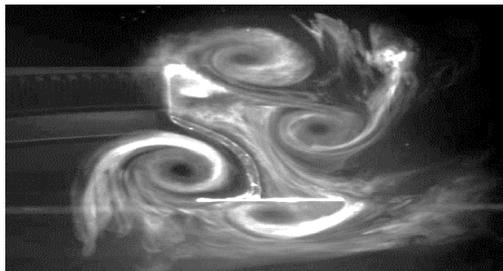


produce that: (each horizontal line correspond one context or size):



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.:

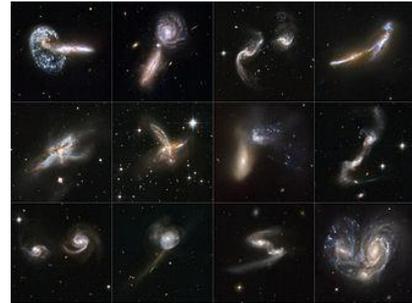


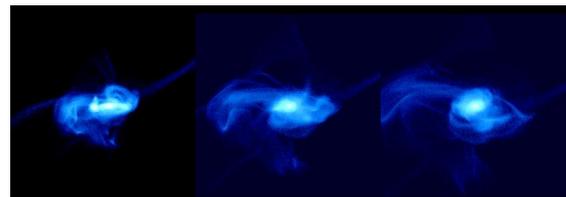
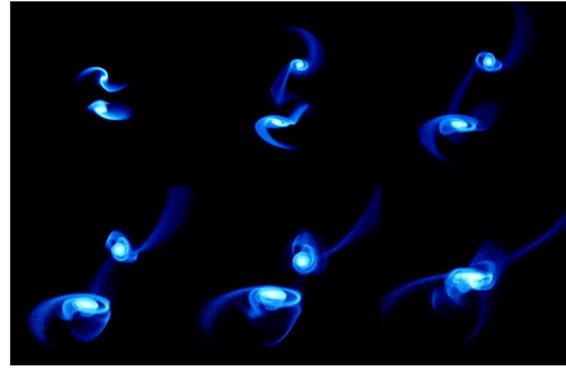
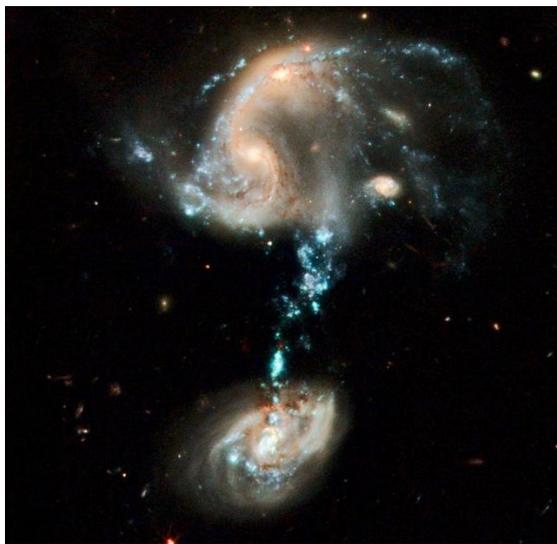
In this typical case, there are lot samples of interaction between vortices with the same or different turn sense, sizes, velocity, etc.... (the same in galaxies).

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:

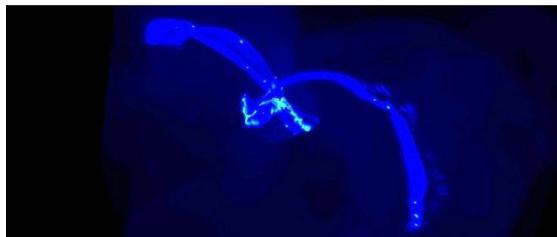
- speed of rotation.
- size.
- quantity of mass.
- 3D location.
- direction of rotation.
- direction translation.
- Etc.....





Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, 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**

Article: ""J. H. Lee et al. "Galaxy Rotation Coherent with the Motions of Neighbors: Discovery of Observational Evidence". The Astrophysical Journal, 2019:

The sense of rotation of a galaxy is influenced by the movement 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.

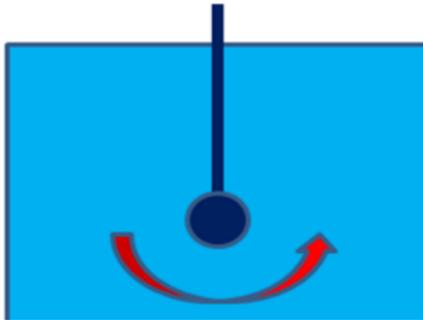
In principle, distant companions, located millions of light years away, should show little influence on the shape and rotation of the central galaxy, but a recent study indicates that the direction of rotation of a given galaxy depends, in

effect, on the average movement of its neighbors, including those located at long distances.”

→ It was a prediction mine....:

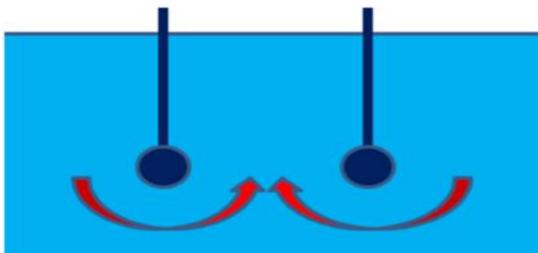
It can see another very illustrative effect of the importance of the density and viscosity and this last Article.

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?

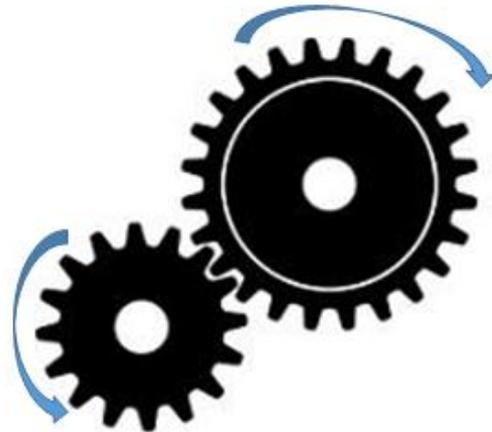
Because the density/viscosity of the fluid, because its variations and the forces transmission trough the particles. On the moon, this wouldn't happen, due to the air absence.

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....

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

### C) SENSE ROTATION – 2, AS A GEARS

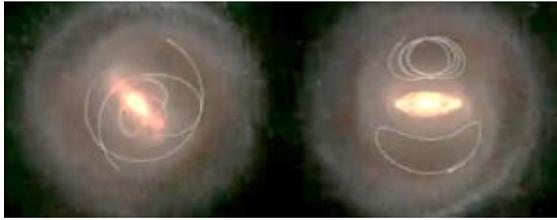
For 2 nearby galaxies (can also occur in more distant galaxies), they rotate in opposite directions. This is because, in their rotation, each galaxy drags its companion, like 2 gears:



Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

### 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:



Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

**E) GALAXIES: FULL INTERACTION**

Each galaxy or group of galaxies, like 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.



Here, an image very important: Star bridge in Magellanic clouds.:



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

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, 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:**

	X	Y	Z	V <sub>x</sub>	V <sub>y</sub>	V <sub>z</sub>
	[kpc]	[kpc]	[kpc]	[km s <sup>-1</sup> ]	[km s <sup>-1</sup> ]	[km s <sup>-1</sup> ]
Aqu2	28.71±1.23	53.16±1.77	-85.98±2.87	91.31±239.21	250.76±212.3	130.49±166.0
CanVen2	-16.37±0.22	18.58±0.51	158.67±4.32	-0.66±162.9	-203.05±150.42	-70.09±16.93
Car2	-8.3±0.0	-34.54±0.8	-10.65±0.25	134.12±11.0	-287.58±4.14	134.95±13.02
Car3	-8.29±0.0	-26.6±1.24	-8.06±0.37	-10.7±18.9	-151.85±8.41	356.05±25.9
Cra2	10.3±0.88	-81.23±3.86	75.13±3.57	-34.4±35.2	115.88±21.41	2.83±19.96
Dra2	-10.57±0.04	15.58±0.28	14.61±0.26	22.54±22.16	100.31±22.35	-341.04±25.48
Hor1	-7.16±0.1	-48.01±4.36	-67.91±6.16	-20.24±30.24	-150.18±45.34	152.34±32.09
Hyl1	1.87±0.19	-19.59±0.36	-16.48±0.3	-144.15±6.58	-178.7±8.73	288.26±8.57
Hya2	47.82±3.06	-117.14±6.39	76.34±4.17	-165.16±302.26	-92.01±257.22	208.27±275.52
Phx2	25.47±3.14	-24.81±2.31	-71.85±6.69	-67.68±48.82	-165.47±54.59	162.72±31.4
Ret2	-9.63±0.06	-20.38±0.96	-24.14±1.14	19.92±12.38	-96.74±17.42	218.24±14.63
Seg1	-19.38±0.98	-9.47±0.84	17.67±1.57	-98.19±18.34	-205.06±38.14	-35.49±22.9
Tuc3	0.79±0.41	-8.95±0.4	-19.03±0.85	23.48±5.94	146.27±8.05	185.68±5.69
Car1	-24.72±0.6	-94.62±3.48	-39.26±1.44	-36.84±18.42	-50.55±8.51	149.23±20.28
Dra1	-4.15±0.32	64.88±5.0	45.01±3.47	54.29±13.85	4.15±8.25	-151.78±11.73
Fnx1	-39.58±0.57	-48.15±0.87	-126.93±2.3	38.14±22.76	-107.56±21.25	76.0±9.72
Scu1	-5.22±0.19	-9.59±0.6	-84.12±5.26	16.93±12.7	175.89±16.04	-96.14±1.87
UMin1	-22.16±0.71	52.0±2.68	53.46±2.75	-4.26±10.75	46.77±10.69	-148.2±10.61
LMC	-1.06±0.33	-41.05±1.89	-27.83±1.28	-57.60 ±7.99	-225.96±12.60	221.16±16.68
SMC	15.05±1.07	-38.10±1.75	-44.18±2.03	17.66±3.84	-178.60±15.89	174.36 ±12.47

## 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 Feymann:

- "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:

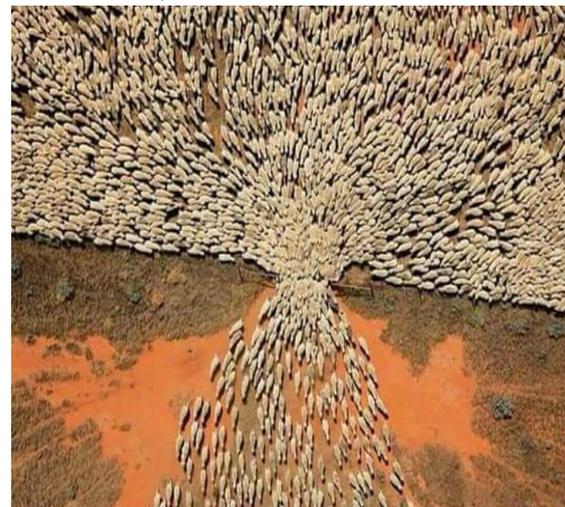
### 2.2.1. COANDA EFFECT / VISCOSITY / BOUNDARY LAYER

Street laterals (less velocity), people manifestation:

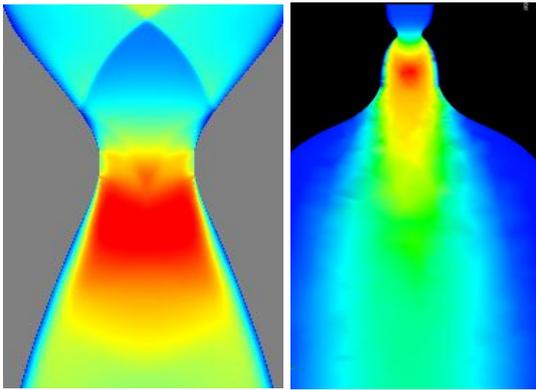


### 2.2.2. BERNOULLI EFFECT

Sheeps:

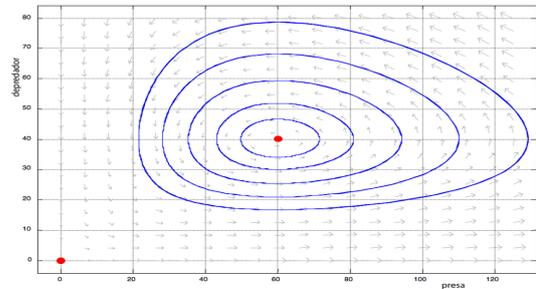
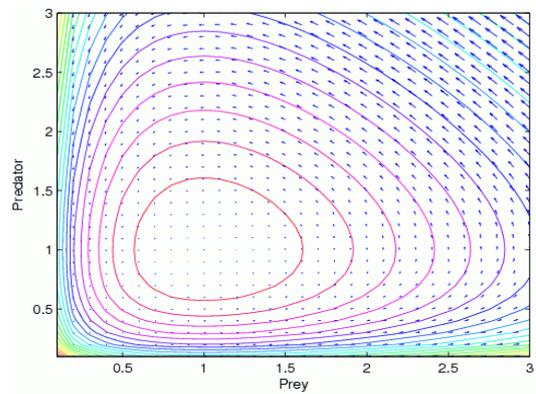
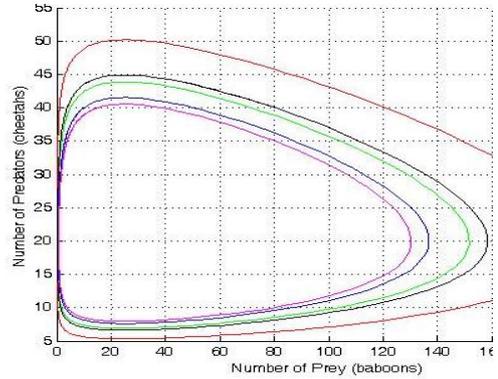


This geometry is very similar to nozzle exhaust; and not only the geometry, also the density or pressure field:



$$V = dx - c * \ln(x) + by - a * \ln(y)$$

Some images with different "x" and "y" initials, and "a", "b", "c" and "d":



### 2.3. NUMERICAL MODEL SIMILARS IN THE NATURE

#### 2.3.1. PREY AND DEPREDATOR NUMERIC MODEL

"x" number prey and "y" number predator:

$$\frac{dx}{dt} = ax - bxy$$

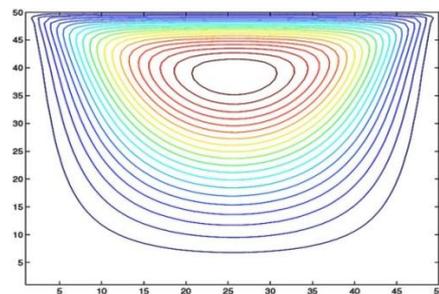
$$\frac{dy}{dt} = -cy + dx$$

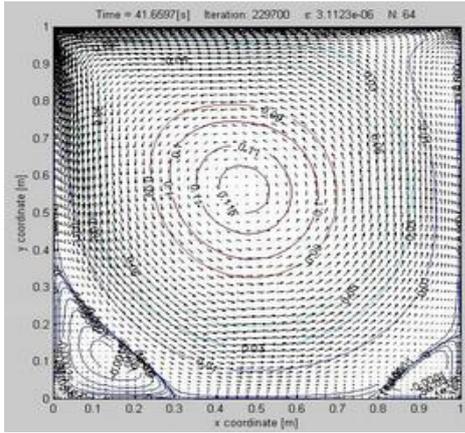
Is a model very simple with "x" and "y" initials, and point fix (a/b, c/d):

$$\frac{dy}{dx} = -\frac{y}{x} \frac{dx - c}{by - a}$$

Phase space:

This geometry concept is very similar to: Typical Cavity problem fluids.:





In the 2 last images, they are the representations of pressure lines in a cavity with a fluid in movement.

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

In these representation of space phases, is possible to change the orientation and scale, of axis. In the next image, we can see the movement 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**

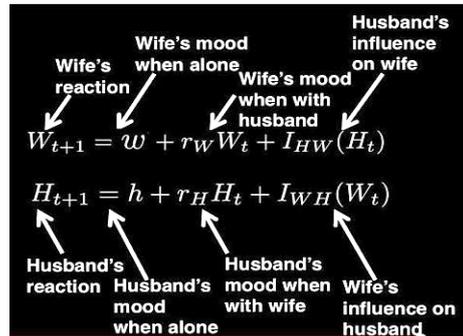
The same happens in a love equations between two peoples (Romeo and Juliet model); I love more a girl (H) if the girl (M) love me:

$$\frac{dH(t)}{dt} = aM(t)$$

$$\frac{dM(t)}{dt} = -bH(t)$$

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

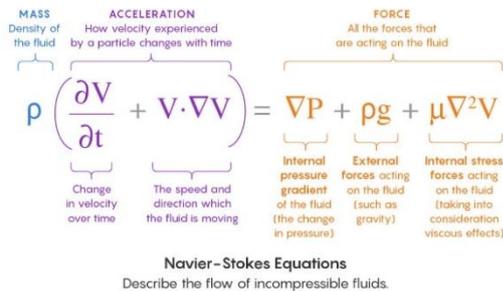
$$u_t + \alpha uu_x + \beta u_{xxx} = 0$$

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

$$\frac{u_n^{m+1} - u_n^{m-1}}{2h_t} = -\alpha \left( \frac{u_{n+1}^m + u_n^m + u_{n-1}^m}{3} \right) \left( \frac{u_{n+1}^m - u_{n-1}^m}{2h_x} \right) - \beta \left( \frac{u_{n+2}^m - 2u_{n+1}^m + 2u_{n-1}^m - u_{n-2}^m}{2h_x^2} \right)$$

**2.4. NAVIER STOKES EQUATIONS**

The "traditional" Navier Stokes equations, are:



In the last equation, the Pressure variation is negative and is necessary add, to right term, the external forces, as an electromagnetic force, Coriolis if is necessary, etc....

Introducing the Viscosity concept, as a Time from this Article, the new Navier Stokes is (without external forces):

1D:

$$\frac{\partial u}{\partial t} + u \left( \frac{\partial u}{\partial x} - \frac{1}{T_{dx}} \right) = \frac{-\partial P / \partial x}{\partial \rho / \partial x} + \mathbf{g}_x$$

2D:

$$\frac{\partial u}{\partial t} + u \left( \frac{\partial u}{\partial x} - \frac{1}{T_{dx}} - \frac{1}{T_{dy}} \right) + v \frac{\partial u}{\partial y} = \frac{-\partial P / \partial x}{\partial \rho / \partial x} + \mathbf{g}_x$$

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \left( \frac{\partial v}{\partial y} - \frac{1}{T_{dx}} - \frac{1}{T_{dy}} \right) = \frac{-\partial P / \partial y}{\partial \rho / \partial y} + \mathbf{g}_y$$

Notation and conditions:

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

In 1 D: let "u<sub>x</sub>" the velocity in point or position "x":

$$\frac{\mu}{\rho} \frac{\partial^2 u}{\partial x^2} = \frac{\mu}{\rho} (u_{x+1} - 2u_x - u_{x-1}) = \frac{u}{T_{dx}}$$

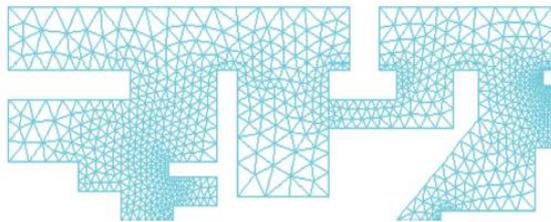
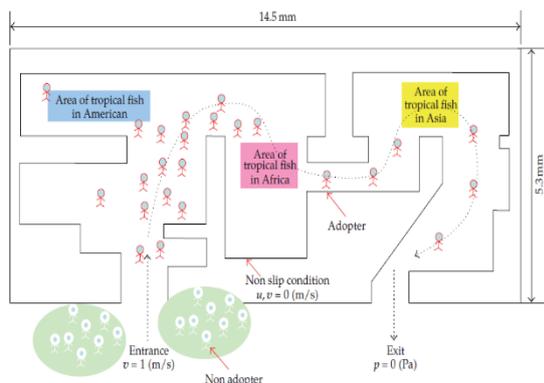
$$\rightarrow T_{dx} \propto \frac{u_x}{(u_{x+1} - 2u_x - u_{x-1})}$$

More, "T" depends also of Pressure and Density. That is very important.

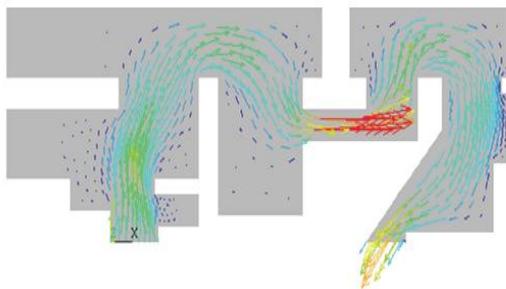
**2.5. PHENOMENONS WHERE APPLY NAVIER STOKES EQUATIONS MODELS**  
**2.5.1.**

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:



Mesh of Tokyo Tower Aquarium.



**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:

$$\frac{1}{2} \sigma^2 S^2 \frac{\partial^2 V}{\partial S^2} + rS \frac{\partial V}{\partial S} + \frac{\partial V}{\partial t} - rV = 0$$

Annotations for the Black-Scholes equation:  
 -  $\sigma^2$ : volatility  
 -  $S^2$ : price of commodity squared  
 -  $\frac{\partial^2 V}{\partial S^2}$ : rate of change of rate of change  
 -  $rS$ : price of financial derivative multiplied by price of commodity  
 -  $\frac{\partial V}{\partial S}$ : rate of change with respect to price of commodity  
 -  $\frac{\partial V}{\partial t}$ : rate of change with respect to time  
 -  $rV$ : risk-free interest rate multiplied by price of financial derivative

Even, from this special equation, is possible create a Heat equation expression:

$$\frac{\partial u}{\partial t} = \frac{1}{2} \sigma^2 \frac{\partial^2 u}{\partial x^2}$$

**2.5.3. TRAFFIC OF PEOPLE**

Is possible to simulate the car traffic or even the group or flocks of peoples in a city, working with fluids equations (streets as a tubes, semaphore as a valve, etc....).

From the Brownian movement in which the particles move without restriction, passing through aggregates of limited diffusion (DLA) where there is only one restriction or condition of movement, following the movement of planets, all the dynamics obey rules of movement between the particles that they make up the group, extremely simple and easy: flocks of birds or pedestrians, are clear examples of this fact:



Fig. 12: Bird flocks and peoples accumulation.

In both latter cases, the study of their dynamics allows the optimal design of evacuation systems for sports stadiums and risk protocols, for example.

**2.5.4. SCHRÖDINGER EQUATION**

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

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

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

**2.5.5. 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):



Fig. 13: Patterns in animal skin and evolution in chemical reactions:

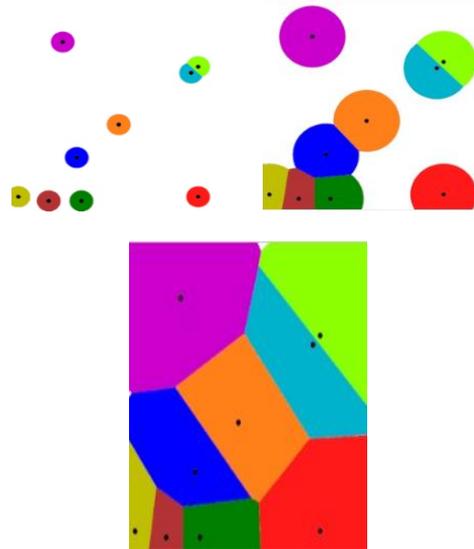
$$\frac{\partial u}{\partial t} = D_u \frac{\partial^2 u}{\partial x^2} + f(u, v)$$

$$\frac{\partial v}{\partial t} = D_v \frac{\partial^2 v}{\partial x^2} + g(u, v)$$

"u" and "v" are the concentrations of 2 axis. "D<sub>u</sub>" and "D<sub>v</sub>" 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):



**2.5.6. 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 the Alan Turing model.

→ Is possible so, apply Schröeringer equation, to Stock Market evolution....

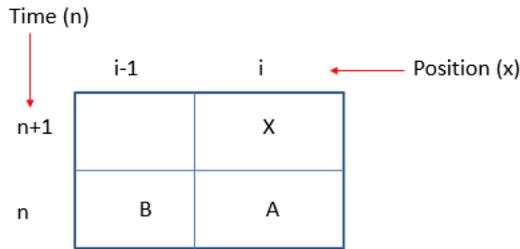
**2.6. NAVIER STOKES EQUATIONS ANALYSIS**  
**a) ADVECTION LINEAL EQUATION IN 1-D (TRANSPORT WITH VELOCITY "c")**

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

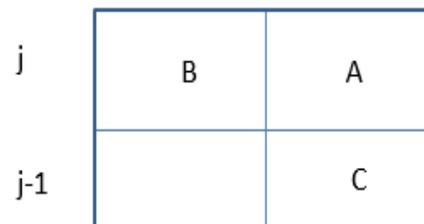
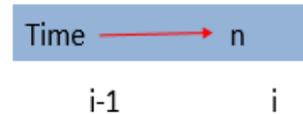
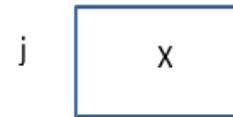
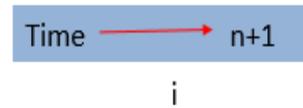


$$u_i^{n+1} = u_i^n - c \frac{\Delta t}{\Delta x} (u_i^n - u_{i-1}^n)$$

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



$$u_{i,j}^{n+1} = u_{i,j}^n - c \frac{\Delta t}{\Delta x} (u_{i,j}^n - u_{i-1,j}^n) - c \frac{\Delta t}{\Delta y} (u_{i,j}^n - u_{i,j-1}^n)$$

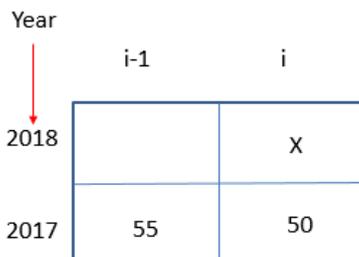


$$X = A - c \frac{\Delta t}{\Delta x} (A - B)$$

- 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  $\Delta t$  is bigger, the variation is more important (more incorrect) (bigger). That is the basic concept for a inter and extrapolation.
- If  $\Delta x$  is bigger, the variation is smaller.
- "c" is the "risc factor"; if "c" is smaller, the variation is smaller.

$$X = A - c \frac{\Delta t}{\Delta x} (A - B) - \frac{\Delta t}{\Delta x} (A - C)$$

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



$$X = 50 - \frac{1}{10} \frac{10}{1} (50 - 55) = 55$$

$$X = 50 - \frac{1}{10} \frac{10}{5} (50 - 55) = 50$$

c=0.1

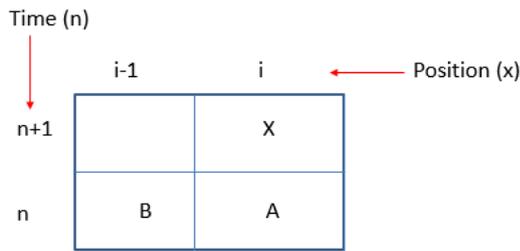
In the first case, "x-1" is a good friend of "x" ( $\Delta x=1$ ). In the second case, is a friend not close ( $\Delta x=5$ ).

**c) ADVECTION NON LINEAL EQUATION IN 1-D (TRANSPORT WITH VELOCITY "u" → TURBULENCE FORMATION (NONLINEAR EQUATION))**

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} = 0$$

$$u_x^{n+1} = u_x^n - u_i^n \frac{\Delta t}{\Delta x} (u_x^n - u_{x-1}^n)$$

**b) ADVECTION LINEAL EQUATION IN 2-D**



$$X = A - A \frac{\Delta t}{\Delta x} (A - B)$$

This model, allow the turbulence or non lineality:

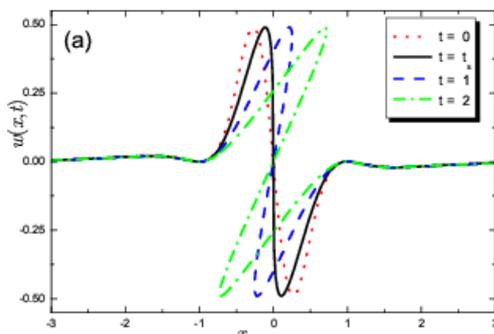


Fig. 14:

Matlab code and sample, Flow Diffusion using Crank Nicholson:

```

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;
%Initilization 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;

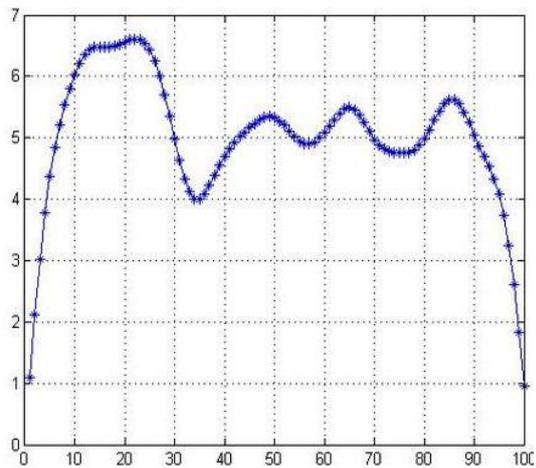
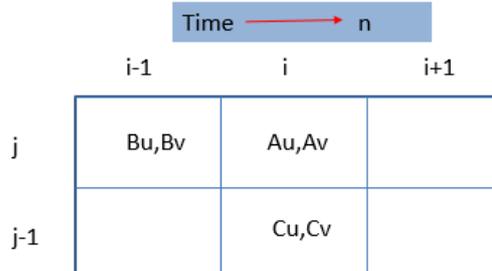
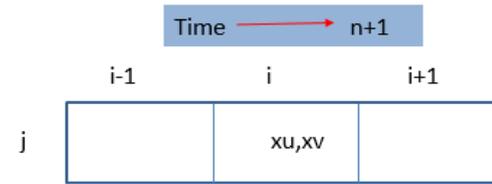
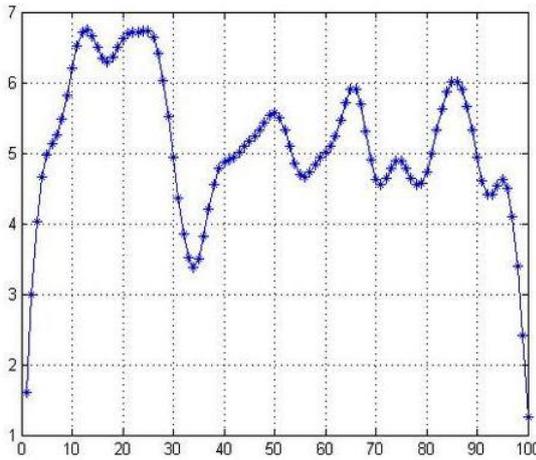
```

```

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=2:M-1;
        d(i,t)=mu*U(i+1,t)+(1-2*mu)*U(i,t)+mu*U(i-1,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
    for i=2:M-1;
        d(i,t)=mu*U(i+1,t)+(1-2*mu)*U(i,t)+mu*U(i-1,t);
    end
    for i=M:M;
        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)
end
close
end

```

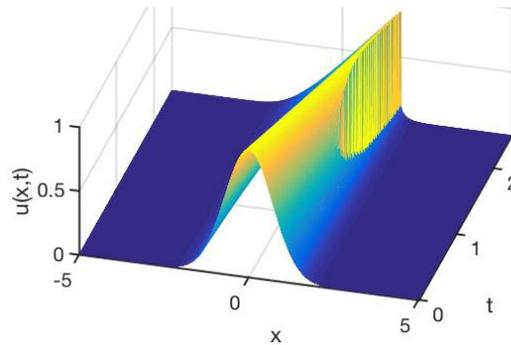
Give a function, to apply the Diffusion equations:



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

$$xv = Au - \frac{\Delta t}{\Delta x} Au(Av - Bv) - \frac{\Delta t}{\Delta y} Av(Av - Bv)$$

Evolution of a wave, to brake:



**d) ADVECTION NON LINEAL EQUATION IN 2-D**

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

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

$$u_{i,j}^{n+1} = u_{i,j}^n - \frac{\Delta t}{\Delta x} u_{i,j}^n (u_{i,j}^n - u_{i-1,j}^n) - \frac{\Delta t}{\Delta y} v_{i,j}^n (u_{i,j}^n - u_{i,j-1}^n) = 0$$

$$v_{i,j}^{n+1} = v_{i,j}^n - \frac{\Delta t}{\Delta x} u_{i,j}^n (v_{i,j}^n - v_{i-1,j}^n) - \frac{\Delta t}{\Delta y} v_{i,j}^n (v_{i,j}^n - v_{i,j-1}^n) = 0$$

**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.**

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):

$$\frac{\partial P}{\rho} + g$$

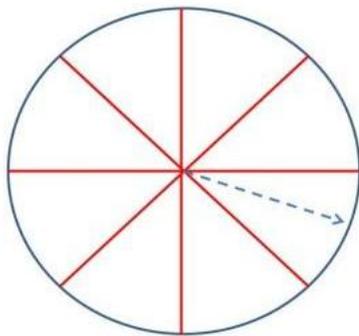
Is incredible, but this expression and concept, is the origin of Navier-Stokes equations.

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:

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:



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

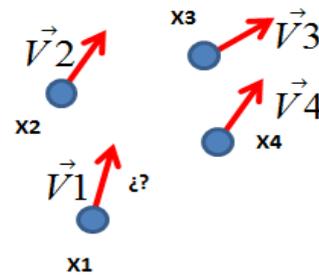
The particle will move toward the half angle line of sector, with the least density; this movement, with a delay time (viscosity) (step by step).

Let  $P = u^2 m$ ; "u" and "m" depend of 3 variables (x,y,z). But now, work only in "x" variable.

$$\begin{aligned} \frac{\partial P}{\partial x} &= 2u \frac{\partial u}{\partial x} + u^2 \frac{\partial m}{\partial x} \\ \frac{\partial P}{\partial x} &= 0 \rightarrow \frac{\partial u}{\partial x} = -\frac{u}{2} \frac{\partial m}{\partial x} \end{aligned} \quad \text{Eq. (20)}$$

So if velocity is greater, then the density is smaller.

It need to know what is the direction of particle movement "X1", if we know the direction of particles "X2", "X3" and "X4":



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

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

**b) MINIMUM ENERGY**

Any particle, tend to walk with the minimum energy "E" (Kinetic Energy (Ek), Potential Energy (EP)):

$$E = E_K - E_P$$

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

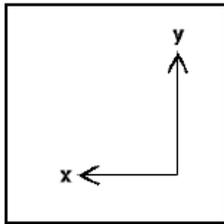
$$\frac{1}{2} m V^2 + \sum_{i=1}^n \frac{GM m_i}{r} \rightarrow \text{minimum}$$



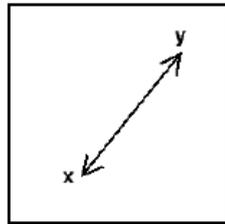
But, the gravitation action (potential energy) is not an action with velocity infinite: the speed of gravitation is the speed of light. This value is the "gap time action" (viscosity).

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.

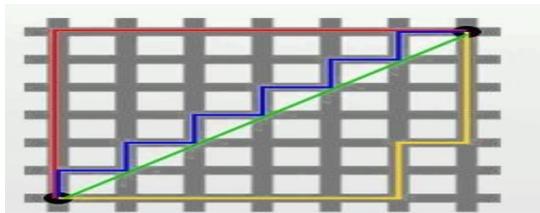
In this equation, is possible to substituting in "r", the distance in every space-metric, in order to calculate geodesics (minimum distance) (changing also "m", etc...): for example: distances for Taxis in Manhattan: distance or metric, is equal to "d" or "Manhattan metric":



Manhattan



Euclidean



$$x = (x1, x2)$$

$$y = (y1, y2)$$

$$d(x, y) = |x1 - y1| + |x2 - y2| + \dots$$

**c) NAVIER STOKES (MODIFICATION)**

The Navier Stokes equations, traditional, are:

$$\frac{\partial \vec{v}}{\partial t} + (\vec{v} \cdot \nabla) \vec{v} = -\frac{1}{\rho} \nabla p + \nu \nabla^2 \vec{v}$$

It want to substitute the last term by:

$$\frac{u}{T_d}$$

That is: a Velocity, divided by a Delay Time as a Viscosity.

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

**2.8. APPLICATIONS AND SAMPLES**

**2.8.1. PEDESTRIAN EVACUATION SYSTEMS - SIMILARITIES**

Is possible to simulate a people or pedestrian concentration, and also birds flock creation and evolution. Are similar these cases and much others. For that, is possible to assign to every particle-bird-people, a few conditions for its movement (forces form springs and dampers):

- Propulsion force.
- Social force or comfort zone.
- Contact force.
- Force of compression (with max and min distance).

In an exit door (evacuation system), is important reduce the pressure; this pressure is function of density and so, the compressibility. In fact, is better low exit velocity, for a better evacuation (more peoples).

In order to modeler numerically this phenomenon, and so, know from what values there are a blockage of exit, is necessary to create no dimensional number; that is: Reynolds number = Re ("V" velocity of peoples translation, "A" length parameter or exit door length, "ρ" density of people group, "μ" viscosity people group):

$$R_p = \frac{\rho V}{A T_d}$$

In this case, in order to calculate the Viscosity, it calculates the time of a Soliton wave for a people group; the viscosity is the 1/ time for a 1 meter, of contact people transmission in all axis or directions (average with more weight for the main direction). So, "RE" will be no dimensional.

The governing equations for this example are:

$$a_x = \frac{-\partial P_x}{\rho_x} + \frac{u_x}{T_{dx}} + \frac{u_x}{T_{dy}}$$

$$a_y = \frac{-\partial P_y}{\rho_y} + \frac{u_y}{T_{dx}} + \frac{u_y}{T_{dy}}$$

**SIMILARITIES**

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.:



- 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 dimensions (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):

$$\begin{aligned} \frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} &= -\frac{1}{\rho} \frac{\partial p}{\partial x} + \nu \left( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} \right) \\ \frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} &= -\frac{1}{\rho} \frac{\partial p}{\partial y} + \nu \left( \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} \right) \\ \frac{\partial^2 p}{\partial x^2} + \frac{\partial^2 p}{\partial y^2} &= -\rho \left( \frac{\partial u}{\partial x} \frac{\partial u}{\partial x} + 2 \frac{\partial u}{\partial y} \frac{\partial v}{\partial x} + \frac{\partial v}{\partial y} \frac{\partial v}{\partial y} \right) \end{aligned}$$

### 2.8.5. BERNOULLI EFFECT

Look a point before.

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

### 2.8.6. BOUNDARY LAYER

Look a point before.

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

## 2.9. NUMERICAL MODELIZATION

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

## 2.10. SOFTWARE TOOL CREATION

It need 2 software's:

- CFD "traditional" or Commercial: in this case: Star CCM+ of Siemens.

$$\begin{aligned} \frac{u_{i,j}^{n+1} - u_{i,j}^n}{\Delta t} + u_{i,j}^n \frac{u_{i,j}^n - u_{i-1,j}^n}{\Delta x} + v_{i,j}^n \frac{u_{i,j}^n - u_{i,j-1}^n}{\Delta y} &= \\ -\frac{1}{\rho} \frac{p_{i+1,j}^n - p_{i-1,j}^n}{2\Delta x} &+ \nu \left( \frac{u_{i+1,j}^n - 2u_{i,j}^n + u_{i-1,j}^n}{\Delta x^2} + \frac{u_{i,j+1}^n - 2u_{i,j}^n + u_{i,j-1}^n}{\Delta y^2} \right) \end{aligned}$$

$$\begin{aligned} \frac{v_{i,j}^{n+1} - v_{i,j}^n}{\Delta t} + u_{i,j}^n \frac{v_{i,j}^n - v_{i-1,j}^n}{\Delta x} + v_{i,j}^n \frac{v_{i,j}^n - v_{i,j-1}^n}{\Delta y} &= \\ -\frac{1}{\rho} \frac{p_{i,j+1}^n - p_{i,j-1}^n}{2\Delta y} + \nu \left( \frac{v_{i+1,j}^n - 2v_{i,j}^n + v_{i-1,j}^n}{\Delta x^2} + \frac{v_{i,j+1}^n - 2v_{i,j}^n + v_{i,j-1}^n}{\Delta y^2} \right) \end{aligned}$$

$$\begin{aligned} \frac{p_{i+1,j}^n - 2p_{i,j}^n + p_{i-1,j}^n}{\Delta x^2} + \frac{p_{i,j+1}^n - 2p_{i,j}^n + p_{i,j-1}^n}{\Delta y^2} &= \\ \rho \left[ \frac{1}{\Delta t} \left( \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} + \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \right) - \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} \right. & \\ \left. - 2 \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta y} \frac{v_{i+1,j} - v_{i-1,j}}{2\Delta x} - \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \right] \end{aligned}$$

$$\begin{aligned} u_{i,j}^{n+1} = u_{i,j}^n - u_{i,j}^n \frac{\Delta t}{\Delta x} (u_{i,j}^n - u_{i-1,j}^n) - v_{i,j}^n \frac{\Delta t}{\Delta y} (u_{i,j}^n - u_{i,j-1}^n) & \\ - \frac{\Delta t}{\rho 2\Delta x} (p_{i+1,j}^n - p_{i-1,j}^n) & \\ + \nu \left( \frac{\Delta t}{\Delta x^2} (u_{i+1,j}^n - 2u_{i,j}^n + u_{i-1,j}^n) + \frac{\Delta t}{\Delta y^2} (u_{i,j+1}^n - 2u_{i,j}^n + u_{i,j-1}^n) \right) \end{aligned}$$



$$v_{i,j}^{n+1} = v_{i,j}^n - u_{i,j}^n \frac{\Delta t}{\Delta x} (v_{i,j}^n - v_{i-1,j}^n) - v_{i,j}^n \frac{\Delta t}{\Delta y} (v_{i,j}^n - v_{i,j-1}^n) - \frac{\Delta t}{\rho 2 \Delta y} (p_{i,j+1}^n - p_{i,j-1}^n) + \nu \left( \frac{\Delta t}{\Delta x^2} (v_{i+1,j}^n - 2v_{i,j}^n + v_{i-1,j}^n) + \frac{\Delta t}{\Delta y^2} (v_{i,j+1}^n - 2v_{i,j}^n + v_{i,j-1}^n) \right)$$

$$p_{i,j}^n = \frac{(p_{i+1,j}^n + p_{i-1,j}^n) \Delta y^2 + (p_{i,j+1}^n + p_{i,j-1}^n) \Delta x^2}{2(\Delta x^2 + \Delta y^2)} - \frac{\rho \Delta x^2 \Delta y^2}{2(\Delta x^2 + \Delta y^2)} \times \left[ \frac{1}{\Delta t} \left( \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} + \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \right) - \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x} - 2 \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta y} \frac{v_{i+1,j} - v_{i-1,j}}{2\Delta x} - \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \frac{v_{i,j+1} - v_{i,j-1}}{2\Delta y} \right]$$

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

Cavity problem:

The initial condition is  $u, v, p = 0$  everywhere, and the boundary conditions are:

$u = 1$  at  $y = 2$  (the 'lid');

$u, v = 0$  on the other boundaries;

$\frac{\partial p}{\partial y} = 0$  at  $y = 0$ ;

$p = 0$  at  $y = 2$

$\frac{\partial p}{\partial x} = 0$  at  $x = 0, 2$

Boundary layer problem:

The initial condition is  $u, v, p = 0$  everywhere, and at the boundary conditions are:

$u, v, p$  are periodic on  $x = 0, 2$

$u, v = 0$  at  $y = 0, 2$

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

$F = 1$  everywhere.

➔ Cavity problem:

```
clear all
nx=41; ny=41; nt=100; 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;
dt=0.001;
% Init
u=zeros(ny,nx);
v=zeros(ny,nx);
p=zeros(ny,nx);
b=zeros(ny,nx);
%Pressure Field
%Square Brackets of Poissons Equation
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-1,j))/(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))*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
        end
        p(:,ny)=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:nx-1
        for i=2:ny-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*(un(i,j)-un(i,j-1))-dt/(2*rho*dx)*(p(i+1,j)-p(i-1,j))+nu*(dt/dx^2*(un(i+1,j)-2*un(i,j)+un(i-1,j)))+(dt/dy^2*(un(i,j+1)-2*un(i,j)+un(i,j-1))));
            v(i,j) = vn(i,j)-vn(i,j)*dt/dx*(vn(i,j)-vn(i-1,j))-vn(i,j)*dt/dy*(vn(i,j)-vn(i,j-1))-dt/(2*rho*dy)*(p(i,j+1)-p(i,j-1))+nu*(dt/dx^2*(vn(i+1,j)-2*vn(i,j)+vn(i-1,j)))+(dt/dy^2*(vn(i,j+1)-2*vn(i,j)+vn(i,j-1))));
        end
    end
    u(1,:)=0;
    u(:,1)=0;
    u(nx,:)=0;
    u(:,ny)=1;
    v(1,:)=0;
    v(ny,:)=0;
    v(:,1)=0;
```





```

end
%Periodischer Term für x=2
for j=2:ny-1
    u(nx,j) = un(nx,j)-un(nx,j)*dt/dx*(un(nx,j)-un(nx-1,j))-vn(nx,j)*dt/dy*(un(nx,j)-un(nx,j-1))-dt/(2*rho*dx)*(p(1,j)-p(nx-1,j))+nu*(dt/dx^2*(un(1,j)-2*un(nx,j)+un(nx-1,j))+(dt/dy^2*(un(nx,j+1)-2*un(nx,j)+un(nx,j-1))))+F*dt;
    v(nx,j) = vn(nx,j)-un(nx,j)*dt/dx*(vn(nx,j)-vn(nx-1,j))-vn(nx,j)*dt/dy*(vn(nx,j)-vn(nx,j-1))-dt/(2*rho*dy)*(p(nx,j+1)-p(nx,j-1))+nu*(dt/dx^2*(vn(1,j)-2*vn(nx,j)+vn(nx-1,j))+(dt/dy^2*(vn(nx,j+1)-2*vn(nx,j)+vn(nx,j-1)))));
end
%Wall BC: u,v = 0 @ y = 0,2
u(:,ny)=0;
u(:,1)=0;
v(:,1)=0;
v(:,ny)=0;
udiff = (sum(sum(u))-sum(sum(un)))/sum(sum(u))
stepcount=stepcount+1;
quiver(x,y,u.',v.',1)
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 differents 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, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

## 2.11. ANALYSIS AND RESULTS WITH MY SOFTWARE

Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

## 3. NEW EXPANSION UNIVERSE MODELS

### ABSTRACT

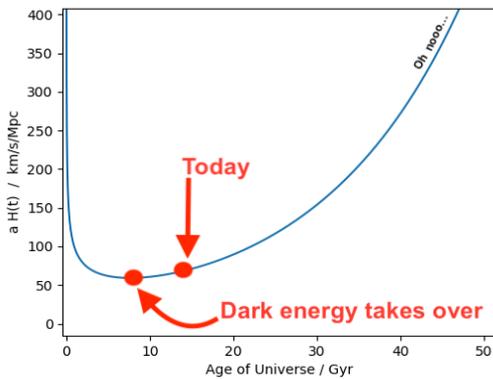
There are several numerical models, to explain how is the expansion dynamics, like the equations of Friedmann-Lemaître-Robertson-Walker. But it is a model that is very simple to explain, for example, the variation of pressure or density, and other important values, and more: is only possible an acceleration 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:

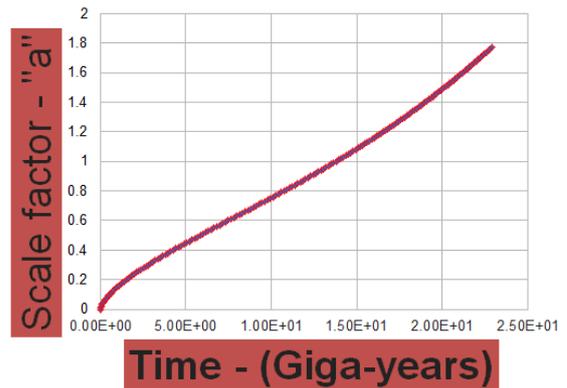
"a" scale universe factor (traditional nomenclature):

$$H(a) = H_0 \sqrt{\Omega_{R,0} a^{-4} + \Omega_{M,0} a^{-3} + \Omega_{K,0} a^{-2} + \Omega_{\Lambda,0}}$$

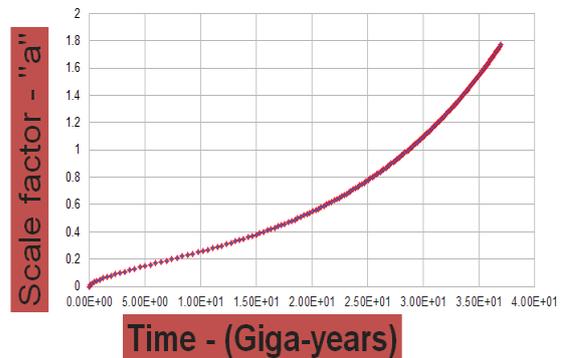
$$t(a) = \frac{1}{H_0} \int_0^a \frac{a' da'}{\sqrt{\Omega_{R,0} + \Omega_{M,0} a' + \Omega_{K,0} a'^2 + \Omega_{\Lambda,0} a'^4}}$$

Depending these values, it have one or other universe evolution, so is necessary know its....:

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



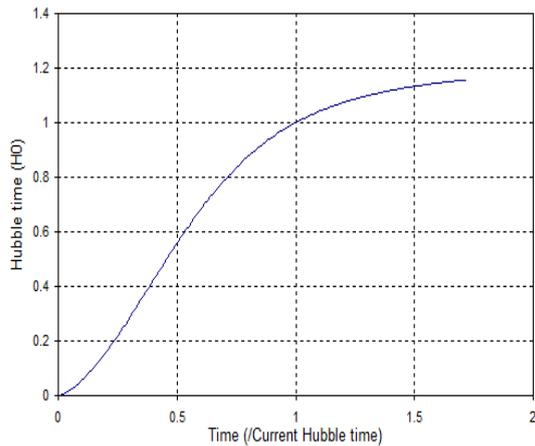
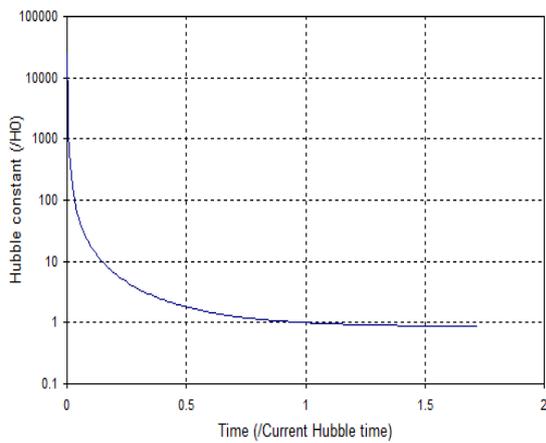
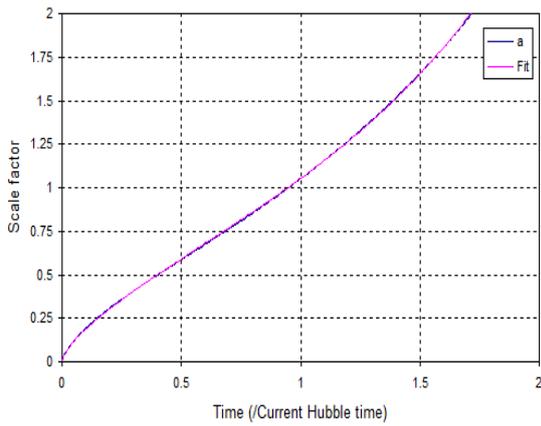
If  $\Omega_{M,0} = 0.01$ :



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

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

$$\begin{aligned} c_1 &= 0.822 \\ c_2 &= 0.0623 \\ c_3 &= 0.645 \end{aligned}$$



How to do the Excel sheet?

	A	B
1	<b>Scale Factor Calculation</b>	
2		
3		
4	<b>Constants</b>	
5	Omega R	9.24E-05
6	Omega M	0.01
7	Omega K	0
8	Omega D	0.99
9	H0	2.18E-18
10	Secs/gyr	3.16E+16
11		

	a'	f(a')	int(f(a'))	t	TIME	SCALE FACTOR
					t	a
21						
22						
23	0	0.720918704	0	0.00E+00	0.00E+00	0
24	0.01	0.720918704	0.003604594	1.65E+15	5.23E-01	0.01
25	0.02	1.169293969	0.019055657	5.99E+16	1.90E-01	0.02
26	0.03	1.512911245	0.026466683	1.21E+16	3.84E-01	0.03
27	0.04	1.797985443	0.043021166	1.97E+16	6.25E-01	0.04
28	0.05	2.043648414	0.062229336	2.85E+16	9.03E-01	0.05

$$0 = A23 / (\text{SQRT}(\$B\$5 + \$B\$6 * A23 + \$B\$7 * A23 * A23 + \$B\$8 * A23 * A23 * A23))$$

$$0.003604594 = C23 + (A24 - A23) * (B24 + B23) / 2$$

$$0.00E+00 = C23 / \$B\$9$$

$$0.00E+00 = D23 / \$B\$10$$

### 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):

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

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

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

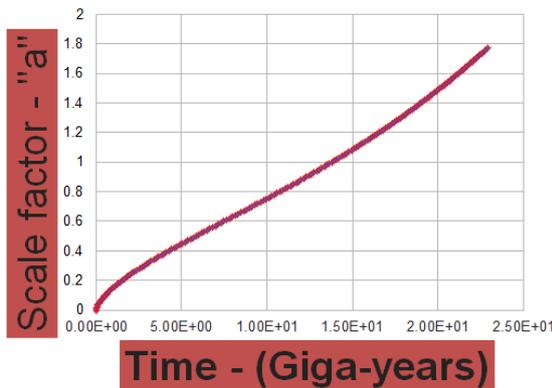
And more: is possible, a little variation of Hubble law:

$$V = H x^{1+\varepsilon} / \varepsilon \neq 0 \quad \text{Eq. (2)}$$

And other model yet:

$$H = H(x) \quad \text{Eq. (2)}$$

This last equation-relation, is created by:



Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

### 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):

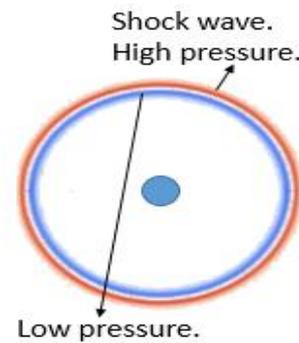
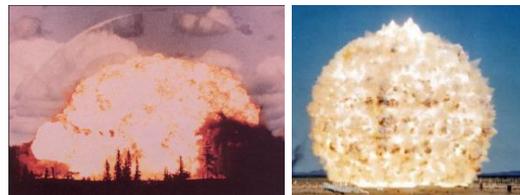
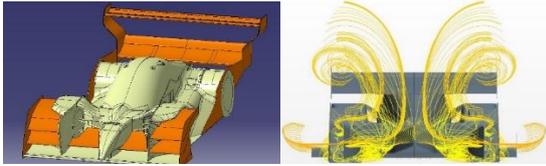


Figure 3: Pressure contour of wave blast.

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

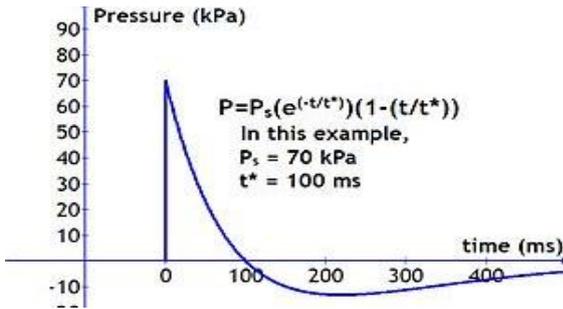


It can see the low pressure rear in any car (any wave shock) (simulation CFD techniques (test made with Star CCM+ as a CFD code: simulation in 3D about Pikes Peak race car, 11 million mesh cells, air dry, K-epsilon turbulence model, wheels and ground moving, 250 km/h speed):



Analyze in CFD, search samples, Create Mathematics expressions or numeric models, Test, Development, etc....

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



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:

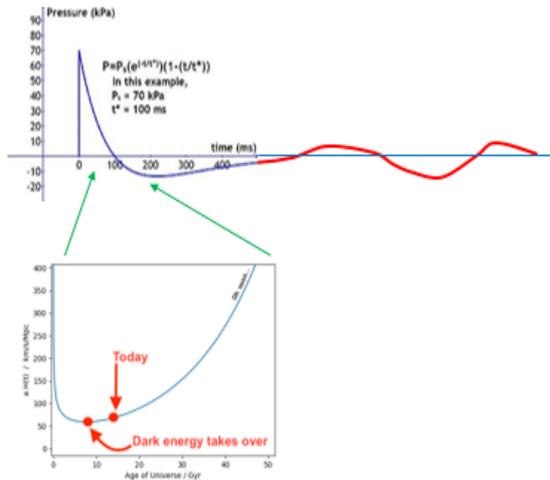
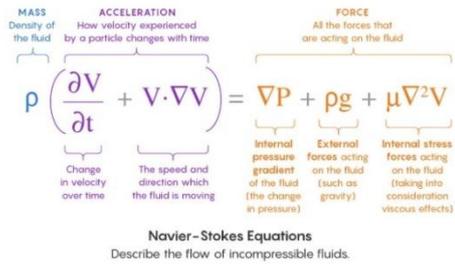


Figure 7: Evolution Dark Energy force.

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



$$P_x = \frac{\partial P}{\partial x}$$

Expressions for every part in Navier Stokes equations:

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

$$\frac{\partial v}{\partial t} = H^* x^{1+\epsilon} + H^2 (1 + \epsilon) x^{1+2\epsilon}$$

$$v \frac{\partial v}{\partial x} = H^2 x^{1+\epsilon}$$

$$g = \frac{Gm}{x^2} = \frac{4\pi G \rho x}{3}$$

$$\mu v = \mu H x^{1+\epsilon}$$

The next term, is the most important:

$$\frac{P_x}{\rho} \quad ??$$

$$\rho_{vac} = \frac{\Lambda c^2}{8\pi G}$$

$$P_{vac} = -\rho_{vac} c^2$$



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

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

$$= -\frac{3H^2 c^2}{8\pi G} \Omega_\Lambda$$

2 results:

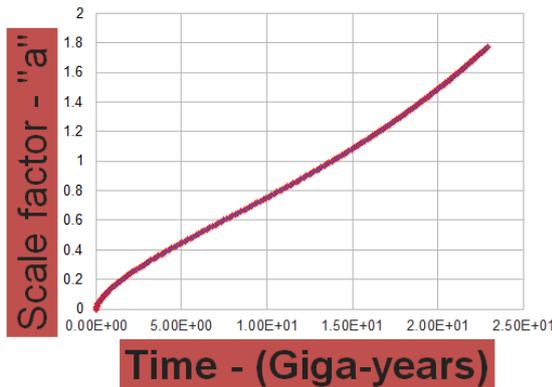
→

$$P_x = \int \frac{3v^2 c^2}{8\pi G x^{1+\epsilon}} dx = -\frac{3v^2 c^2}{\epsilon 8\pi G} x^{-\epsilon} \text{ Eq.}$$

(1)

→

Also: H=H(x), from:



From Navier Stokes, directly:

Sup: V=Hx

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

$$P_x = \left( H^2 - \frac{4\pi G \rho}{3} \right) \rho x$$

Is easy calculate that, with other 2 models for "H":

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

### 3.6. MODEL 4: FRIEDMANN EQUATIONS

Kinetic energy + Potential energy = constant,  
so:

$$\left( \frac{\dot{R}}{R} \right)^2 - \frac{8}{3} \pi G \rho - \frac{1}{3} \Lambda = -\frac{kc^2}{R^2}$$

$$H^2(t) = \frac{8\pi G \epsilon(t)}{3 c^2} - \frac{kc^2}{R_0^2 a^2(t)}$$

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

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

$$E = T + V = cte =$$

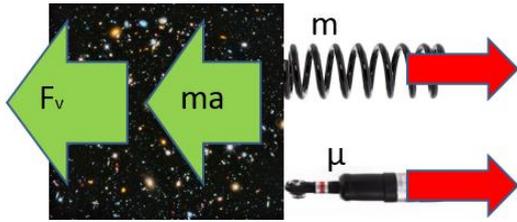
$$= \frac{1}{2} m H(t)^2 x^{2(1+\epsilon)} - \frac{GMm}{x}$$

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

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

### 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):

$$K_s = \text{function}(\text{mass}, x) = f(m, x)$$

$$K_D = \text{function}(\text{viscosity}, x) = g(\mu, x)$$

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

$$K_s = x$$

$$K_D = \text{Velocity} = V$$

Kinetic energy + Potential energy, is constant "K":

$$V^2 - \frac{2Gm}{x} = K1 * \frac{2}{m} = \frac{K}{m}$$

$$m = \rho \frac{4}{3} \pi x^3$$

Finally:

$$K_D \frac{\partial x}{\partial t} = K_D V = F_{\text{viscous}}$$

$$K_s x = \text{Force(Gravitational)}$$

### 3.8. ANALYSIS NUMERICALLY: MODELS VALIDATION

Analyze in CFD, search samples,  
Create Mathematics expressions or  
numeric models, Test,  
Development, etc....

### 3.9. CONCLUSIONS

I'd like my death to be my epitaph:

He dedicated his life to trying to understand how the cosmos works.