A Very Quick Fantasy of Starting a Cosmos

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Abstract- The present text shows a way to use the dialog structure present in philosophical studies (like Plato) and early scientific studies (like Galileo) in themes devoted to “quantification”. It represents a tentative approach of using tools more related to “human sciences” into “exact sciences”. It is part of the project “Humanization as a tool for increasing interest in exact sciences” being conducted by the author. The text considers a free introduction to nonlinear events using arguments that allow using hypothesis, external conditions, model concepts, when trying to quantify an “event”. In this dialog usual equations submitted to restrictive conditions and following some directed arguments allowed, then, attaining some conclusions like the constancy of the velocity of light, the eventual existence of barriers of energy, and also the particular equations used. However it is not intended to be a “quantification study” with “unsuspected conclusions”, although they may raise discussions, but an “exploratory didactic text”, which aims to raise the interest of students about nonlinear differential equations and physical events. Three interlocutors are present (following Galileo), indicated by signs “+”, “o”, and “-”.

Keywords: philosopohical dialog, didactic for exact sciences (light, differential equations).

I. INTRODUCTION

It happened!

On its turn, what did happen was not so sure to be explained.

- I think that this report could begin with: “In early times, when the Universe was young…”

+ Well, it still does not exist such thing that we can really call “time”…

- And does it exist something like a young “Universe”?

+ I have just begun with this story! Let’s go on!

Adjustments can be made further…

+ OK, then! Do your work.

- Now I have missed the point. But what I am trying to introduce here is a conception of how to conceive a cosmos, if someone eventually interests on such themes.

+ It would be difficult to find someone outside of a cosmos, I would say. But, anyway, let’s know your idea.

- Well, firstly it would be necessary to imagine something that does not vanish since the very first beginning, or to which we may impose this characteristic. Energy is the obvious choice…

+ May we firstly define “obvious” here?

- As I have already said, adjustments can be made further. I was then saying that, if the amount of energy does not change, it is necessary to show it in a comprehensive way, so that anyone can understand it. The best way is to introduce here a mathematical balance.

+ Which, on his hand, implies to have created mathematics before creating the cosmos.

- Or that mathematics creates the cosmos. I like this possibility. It is a good explanation for all the difficulties associated with a cosmos.

+ But we are talking about a beginning. The cosmos is still only a tiny infinitesimal size bigger than a singularity! There is no space for a smaller part…

- Don’t be so silly! If there is any space, smaller spaces can be used to fill it. Use your imagination! Continuing: …when thinking on a little part of it, it would be necessary to have a balance for the energy that passes through this little part. That is, the variation of energy must take into account the energy that enters, the energy that goes out and the energy created in this small part.

+ I agree! Some beautiful equations will, I hope, help me to understand this… somewhat unorthodox thinking.

- It’s OK for me. Let’s go to some equations.
II. THEORETICAL BACKGROUND

- The obvious equation, using a three-axis space system and one time axis is [1]:

$$\frac{\partial E}{\partial t} + u \frac{\partial E}{\partial x} + v \frac{\partial E}{\partial y} + w \frac{\partial E}{\partial z} = \frac{\partial}{\partial x} \left( D_x \frac{\partial E}{\partial x} \right) + \frac{\partial}{\partial y} \left( D_y \frac{\partial E}{\partial y} \right) + \frac{\partial}{\partial z} \left( D_z \frac{\partial E}{\partial z} \right) + G,$$

(1)

- I am not interested to explain details, but only main characteristics. So, let’s use the one-dimensional version:

$$\frac{\partial E}{\partial t} + u \frac{\partial E}{\partial x} = \frac{\partial}{\partial x} \left( D_x \frac{\partial E}{\partial x} \right) + G,$$

(2)

- See? You have here all terms I have mentioned. $E$ is obviously the energy, and the four parcels are, in the sequence, the time variation, the convective transport, the diffusive transport, and the generation.

- I think that you have made some big jumps here. It is OK that $E$ stands for energy, $t$ for time, $x$ for distance, and $G$ for generation, which, in this case, if an opinion is allowed, is also adequate for “God generation”. But what mean $u$ and $D_x$?

+ Yes! Note that when using this form, you are saying that a gradient principle applies for the energy, which was not explained at all...

- OK. Then I will explain it now. The variable $u$ in equation (2) only stands for a characteristic velocity in the $x$ direction. And yes, I am assuming a gradient principle that allows a diffusive transport of energy. In this case, the energy tends to diffuse from regions with higher concentration to regions with lower concentrations...

+ Concentrations of what?

- Concentrations of energy, of course, because this is all that we have!

+ But, what happened with the basic dimensions?

- They are corrected by the use of $D_x$, which is, as you already inferred, the diffusive coefficient of the energy.

- Is this a constant coefficient?

- I don’t know...

- YOU don’t know? In this case, who else will know anything?

- Look: I am thinking the complete thing, not the details. They don’t interest me in the present moment.

+ Wait, wait. Have you said that you are thinking the complete think? Is this right?

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III. FIRST RESULTS

- It would be interesting for me to see what kind of conclusions can you extract from such an equation like (4b).
  + If it is an equation for light, let’s see what happens with light in your cosmos.
    - I think that we can consider a volume of space in which we have only variation, convection and diffusion, but no energy generation. It is a first approximation, of course.
    + It seems reasonable, but talking about light, it would imply in a very dense environment, I suppose.
    - Why are you saying this?
    + I am not certain, but I suppose that diffusion, in the sense of a balance equation, would need strong interactions between the different mc² parts that were used to quantify energy.
    - You are perhaps right. But, as you know, I did not impose “conditions of use” in these first moments. They must be studied in a further occasion…
    + This guy is irritating me with all these “further steps”.
    - I was saying that the equation may be represented in the form:
      \[ c \frac{\partial c}{\partial t} + c^2 \frac{\partial c}{\partial x} = \frac{\partial}{\partial x} \left( D_v c \frac{\partial c}{\partial x} \right), \]  
      (5)
    + Nice! There is the immediate solution \( c=0 \).
    - Interesting. Would it imply that the cosmos which you are creating now would stop to grow, staying stationary? That is, with zero velocity no light and no energy would irradiate?
    - I think that it simply implies no energy at all, or no cosmos at all. And if there is no energy, then zero equals zero, or nothing equals anything. It is a right result, I suppose.
    + Why do you argument in such a way that all things always seem reasonable? I accept it, but I don’t want to believe it…
    - It is also interesting to verify that, whatever the behavior of \( D_v \), if the velocity of light is a constant, equation (5) also holds.
    + Oh! Let us explore this possibility. If it is right that diffusion implies in strong interactions, the absence of diffusion would represent something like “no interactions”, or, in the extreme case, only one “light element”. Is it OK?
    - I think so…
    + In this case, for \( D_v \to 0 \) do we have a constant \( c \) as solution of this equation?
    - Yes, we do.
    + There exists then the possibility that the velocity of light is constant for an “empty environment”. Is this a conclusion of this equation?
      - I’m afraid that this is the case.
      + Are there more results?
      - There are so many results you want. It is only necessary to verify if they are valid for your cosmos.

- My cosmos? I am not intending to create a cosmos. This is your problem.
  - Well, your suggestion leads to this equation, in the one-dimensional case:
    \[ \frac{\partial c}{\partial t} + c \frac{\partial c}{\partial x} = 0, \]  
    (6)
  - Considering an initial condition in the form
    \[ c(0, x) = h(x), \]  
    (6a)
  - equations (6) and (6a) have a general solution, using characteristics, in the form [3]:
    \[ c(t, x) = h[x - c(t, x) t] \]  
    (6b)
  + And?
    - Well, you can imagine any initial condition, and you will have a solution.
    + Yes, but if the characteristics overlap, we have a chock. And it implies impossibility… or not?
      - I am not so radical, because I think that we can extract some information from these “shocks”. But, if you consider that they represent impossibilities, remember that you have always the previous solution of a constant velocity. And it holds anyway.
    - Well, I am happy having at least one solution… I think that I will not discuss the overlapping points now. Let then your cosmos have a constant velocity for light. At least, for now.
      + I don’t know if I am making a fool commentary here, but, if I remember well, you were talking only about weak interactions, that is, no dense environments, or not?
    - Strictly speaking, yes. I was interested in this case.
      + And for the strong interactions case, does it happen anything different?
        - In essence, if you want to take the simpler solution, the constant velocity also holds here.
      + Thank you for confirming my previous statement! Then, independently of the value of \( c \) in different environments, it is constant.
        - At least one of the solutions is a constant value.
          + Are there more solutions also in this case?
            - Probably also as many as you want, I believe.
          + What means “I believe?” These are strange words in your mouth!
            - I am trying only to sketch the main idea. Things are going too fast to concentrate on details now. Somewhere, sometime, it will be necessary to have “something” thinking in order to describe the details of this thing.
              + I am not sure, but have you said “details of this think?”
            - This statement is also right, but nonlinear partial differential equations are somewhat cumbersome to be explained in few words, specially having now “something fast” occurring and trying to observe it.
+ OK. Then give me an example, in order to illustrate this possibility.
- We may consider, for example, an intermediary situation in which the parcel of equation (5) multiplied by $c^2$ is much bigger than the other parcel multiplied only by $c$. Considering that $D_s$ is also big, we have:
  \[
  c^2 \frac{dc}{dx} = \frac{\partial}{\partial x} \left( D_s c \frac{dc}{dx} \right),
  \]
  \(7\)
  + Well, this is a really stationary case…
  - But I’m not saying that it holds always, or that it holds at all. It “may” hold for a certain time range or for a special situation. The first integration would be:
  \[
  c \frac{dc}{dx} = \frac{1}{3} x + A,
  \]
  \(8\)
  - $A$, in this case, is an integration constant. Assuming a constant $D_s$, the second integration furnishes [4]:
  \[
  \frac{1}{6 \sqrt{3} D_s} \ln \frac{c^2 - \frac{2}{3} \sqrt{3} D_s c + \left( \frac{\sqrt{3} D_s}{2} \right)^2}{c + \frac{\sqrt{3} D_s}{2}} + \frac{2c - \frac{\sqrt{3} D_s}{2}}{\sqrt{3} D_s} = \frac{x}{3D_s} + B,
  \]
  \(9\)
  - $B$ is the second integration constant. Note that it is only an example and mainly a mathematical solution. Considering the trigonometric parcel, it implies that $c$ assumes alternate values for increasing $x$.
  + But it implies also that negative values may be attained. Intuitively $c$ is always positive. Your “recently” generated cosmos arrangement implies in light being irradiated from “the center” of it along the $x$ axis, pointing outside of the cosmos, if I can say so. Having now negative $c$ values, what is happening?
  - As I said before, this may be only a mathematical solution. It may have no physical sense…
  + Oh, oh! You will not escape so easily! At least one possibility must be furnished. As you have said before: “use your imagination”.
  - I don’t know. Something may be attracting radiation, however I would not bet my chips on this possibility, because we are not using a force concept, but only an energy concept. Another explanation could be a “glue effect” due to the strong interaction range in which you put us with your questions.
  + Me?!
  - Yes, you! This strong interaction discussion was induced by your questions. For the low interaction case it seems that the simple constant solution satisfied our colleague.
  + OK. I am not interested in this strong interaction question. But when you used the mass concept to quantify energy in equation (3), you have intrinsically used the force concept, I mean. So, radiation attraction could not be discarded so quickly…
  - I am tired. Do what you want…
  + OK. Don’t be angry or upset, please. I was only trying to explore some aspects of other solutions of $c$. This solution of a constant $c$ is so… limiting!
  - But it may work! Perhaps observing would be a better way to obtain an answer.

IV. DISCUSSION
  o From the previous application, does a negative value of $c$ mean that light is traveling in the opposite direction of $x$?
  + No, no! I don’t think so. But, who knows? I imagine that we are not talking, in this case, about an observable light velocity, but about an ideal light velocity needed to “pass” through that point along $x$. So, it may be only pointing to the mentioned glue effect. When squaring $c$ and obtaining the energy through equation (3), it only shows that the needed energy varies from zero to infinity in this strong interaction region, which probably implies in some impossibility of a mass singularity to cross certain “frontier” along $x$.
  o Now you are going too quick for me. Why would it limit the movement of a mass singularity?
  + Because to obtain an “infinite amount” of energy in a cosmos in which it was said that there is a “fixed amount” of energy is a contradiction.
  o Wow! Now we are talking philosophically! Finally! Yes, if a mass singularity is moving along $x$ with any $c$, it will not be possible to cross the points where $c \rightarrow \infty$ because it will not be possible to furnish an infinite $c$. It would imply in an infinite amount of energy, which is not available in this cosmos. Logic is sometimes better than mathematics.
  + I would say that both are complementary…
  o The glue effect would be, then, this barrier, and not necessarily an attractive force?
  + Seems so. Forces may even be strongly repulsive between singularities in this strong interaction environment, but they will not be able to furnish an infinite energy, because it does not exist in this cosmos.
  o Can you illustrate it, please?
  + There are many possibilities. In this figure $S$ represents a radiation source with the central singularity and an energy barrier. “a” shows two singularities which will stay connected, independently of the kind of forces acting between them, while “b” shows more singularities. If there are different sizes of barriers, a situation like “c” may emerge, in which the link is not strong as in “a” “d” shows this weaker link for more points.
Oh, thank you. I don’t need more. This sketch is sufficient.

- I am here trying to put ideas in order. You asked me too much and I need some rest. But I heard your comments. The cosmos is only beginning the time history. It is still not evidenced that something different will occur at any distance from a radiation source! If something occurs, I think that the one interested on such things will study and calculate it.

+ Only as a curiosity: what are you considering a “radiation source”?

- Now we have the starting singularity. But in a “future situation” I can suppose, as sources, some highly concentrated energy singularities, perhaps mass singularities, irradiating something that “will tend to” the constant velocity of light accepted for the lower interaction region…

+ Why are you using this “trending” statement?

- Because of the two environments considered: for strong or low interactions. If \( c \) constant is the “real” solution, then perhaps your discussion interpreting the “variations of \( c \) along \( x \)” in the strong interaction region as the energy needed for something to “be” at the points along \( x \) is acceptable, I mean. But I must think better about all your comments.

+ I was only saying that, if you need infinite energy to “be” at a point, the conditions of this cosmos impede you to “be” at that point. In other words, you will not cross it. That is, a mass singularity will not cross this point or any point having more energy than those existing in your cosmos.

+ But you are then putting mass singularities into cages. Would it be possible to have a cosmos in which, independently of force interactions, attractive or repulsive, big or small, the mass singularities would stay “stable” in positions or regions referenced to radiation sources only because the energy principle is imposing this?

- I really don’t know. I didn’t think about it. I was only starting a cosmos…

+ I am somewhat astonished! If you don’t know, who will know? How could you don’t know?

- Repeating: I was not thinking details. I was only intending to give some coherent start. But it seems that you are interested in details. Well, I suggest you to think this discussion in spherical coordinates. The solutions \( c=0 \) and \( c=\text{constant} \) still hold and you will be able to check all the things commented here. Equations (7) and (9) furnish then another dependences with \( x \), being \( x \) the radius in the spherical system.

+ Then, are you done? Have you finished your job?

- I need some more days doing simpler things. But it seems that some details of our talk are still hidden in our arguments.

+ What do you mean?

- When using a balance equation related to possible \( N \) components, my feeling is that we are looking in the direction of mean values of the desired variable. The generating or vanishing of energy may give a zero mean value for \( G \), but it does not mean that, for example, that mass singularities will be there continuously or will move continuously. They may appear and disappear…

+ My God…

- Yes…?

+ In this case, a mean operation for “to be” and “not to be” cases would perhaps be necessary.

+ That is, a “square wave” statistics, I suppose.

V. CONCLUSIONS

+ This statistics is useful, but it leads to highly intricate equations, which must be adequately interpreted [5]. I think that we have already a good view about regions of strong interactions and low interactions, about the possibility of constancy for the velocity of light, about the possibility of energy barriers in the strong interaction region, and some intermediary conclusions which may be resumed by the equations used and generated here…

- For me all these things, beginning with this “constancy of the velocity”, are still impregnated with a taste of incredulity…

+ I agree: constant light velocity implies adjusting dimensions in order to describe simple phenomena…

+ Like distorting time and space. I also don’t like it…

- But it may work… Let’s observe our cosmos evolving!

+ Correction! This is your cosmos! You imposed the conditions. Let’s observe your cosmos evolving.

- Yes, yes, my cosmos.

+ And why did you started this thing? What will be of all these conjectures and arguments if they show to be nonsense?

- I was trying to have fun. And it seems that we have attained some fun while sharing ideas. So, this “global” objective was attained. But now I am tired. I really need some rest after all these questions. I will do simpler things the next days. In, say, six or seven days we can meet to continue this discussion. I will then have finished the entire job.

+ OK. Let’s think a bit more about all these things

- Maybe we will need some other insights to attain the details with more precision…

+ We? This is your problem…

- I know, I know…

+ May I make a last question?

- Sure, but try to be brief.

+ We are talking here because we are the divine trinity that derives from the unity, that is, yourself. This condition is still unclear for me. Can you explain me how is it possible? In other words, can you perhaps shed some light also here?

- I will let this also for a further moment, OK? Let’s drink something…

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