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If you have these lines in front of you, it means that no one has done anything since January 1979, when the academician Thibault Damour, who is 'Mr Cosmology in France', posted the first of his headless articles on his page at the Institut des Hautes Etudes de Bures sur Yvette, to which he belongs.

Thibault Damour

What's at stake?

This is a major challenge. Cosmology and astrophysics have been in disarray for decades. As mentioned in the video, the General Relativity model, based on Einstein's equation:

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} = \chi\, T_{\mu\nu}$$

But this model can no longer account for the observations. I therefore propose to switch to a new model corresponding to a system made up of two field equations:

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} = \chi \left[T_{\mu\nu} + \sqrt{\frac{\overline{g}}{g}}\, t_{\mu\nu} \right]$$

$$\overline{R}_{\mu\nu} - \frac{1}{2} \overline{R}\, \overline{g}_{\mu\nu} = -\chi \left[\sqrt{\frac{g}{\overline{g}}}\, \overline{T}_{\mu\nu} + \overline{t}_{\mu\nu} \right]$$

In 2019 Damour reacted to this attempt to propose an extension of the cosmological model with an aggressive approach, including sending a registered letter with acknowledgement of receipt to my home address. For years, all attempts at a meeting and an explanation went unanswered.

Why?

In 2002, with another researcher, Ian Kogan, he published a 41-page article which was the first 'bimetric' model, with two types of material. He describes them as 'right' and 'left' and associates the metrics $g^{R}_{\mu\nu}$ and $g^{L}_{\mu\nu}$ with them. For the sake of clarity, when comparing the two approaches we will keep our notations $g_{\mu\nu}$ and $\overline{g}_{\mu\nu}$. Einstein's equation is the result of a variational calculation based on an action:

$$S = \int d^4x \sqrt{-g}\ (R - \chi L)$$

where R is the Ricci scalar derived from the metric, L is the Lagrangian of matter and χ the Einstein constant. The classic calculation of variations, which consists of varying the metric according $\delta g_{\mu\nu}$ to leads to :

$$\delta \int d^4x \sqrt{-g}\ R = \int d^4x \sqrt{-g}\ \delta g^{\mu\nu} (R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu})$$

et à :

$$\delta \int d^4x \sqrt{-g}\ R = \int d^4x \sqrt{-g}\ \delta g^{\mu\nu}\ T_{\mu\nu}$$

Hence Einstein's equation above.

What does Damour do in 2002 ?

He constructs an action, noting that this gesture is purely arbitrary and does not arise from physical constraints. Since he has two metrics $g_{\mu\nu}$ and $\overline{g}_{\mu\nu}$, he deduces two Ricci scalars R and $\overline{R}$ (which he assigns the indices R and L, 'right' and 'left'). Since he has two types of matter, he introduces two 'Lagrangians of matter' L and $\overline{L}$. He therefore proposes an action in the form :

$$S = \int d^4x \sqrt{-g}\, (R - \chi L) + \int d^4x \sqrt{-\overline{g}}\, (\overline{R} - \chi \overline{L}) - \mu^4 \int d^4x (g\overline{g})^{\frac{1}{4}} V(g,\overline{g})$$

When we construct the Einstein-Hilbert action, we use an elementary hypervolume $d^4x\sqrt{-g}$, or in fact $d^4x\sqrt{|g|}$. A formula that may seem strange. But let's consider the metric of the sphere S2 :

$$ds^2 = R^2\ (d\theta^2 + \sin^2\theta\, d\varphi^2)$$

The square root of the metric determinant is :

$$\sqrt{g} = R^2 \sin\theta$$

By integrating, we find the surface area of the sphere S2. In 4D the elementary volume $d^4x\sqrt{-g}$ is a 'space-time' elementary volume.

So what can we say about the term :

$$-\mu^4 \int d^4x (g\bar{g})^{1/4} V(g,\bar{g})$$

It does not derive from subtle considerations of differential geometry. It's a bricolage like any other, introducing a kind of four-dimensional hypervolume $d^4x(g\bar{g})^{1/4}$. The V function, which is just as heuristic, is supposed to handle the interaction between the two types of material (which in Damour and Kogan's approach are supposed to belong to 'branes'). The variations are calculated by considering the variations in the metrics $\delta g^{\mu\nu}$ and $\delta \bar{g}^{\mu\nu}$. Damour then arrives at equations :

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} = \chi \left[T_{\mu\nu} + t_{\mu\nu} \right]$$

$$\bar{R}_{\mu\nu} - \frac{1}{2} \bar{R}\, \bar{g}_{\mu\nu} = \chi \left[\bar{T}_{\mu\nu} + \bar{t}_{\mu\nu} \right]$$

Finally, at the end of a 40-page paper, Damour and Kogan produce no results whatsoever.

There is a great similarity with the equations of the Janus model. In his article, Damour makes no suggestion that this second matter could be made up of negative masses. Let's write his system of equations in Mixed notation:

$$R_\mu^\nu - \frac{1}{2} R\, \lambda_\mu^\nu = \chi \left[T_\mu^\nu + t_\mu^\nu \right]$$

$$\bar{R}_\mu^\nu - \frac{1}{2} \bar{R}\, \lambda_\mu^\nu = \chi \left[\bar{T}_\mu^\nu + \bar{t}_\mu^\nu \right]$$

The tensor of an 'ordinary' material can then be written as:

$$T_\mu^\nu = \begin{pmatrix} \rho c^2 & 0 & 0 & 0 \\ 0 & -p & 0 & 0 \\ 0 & 0 & -p & 0 \\ 0 & 0 & 0 & -p \end{pmatrix}$$

By analogy, we could write that:

$$\overline{T}_{\mu}^{\nu} = \begin{pmatrix} \overline{\rho}\overline{c}^2 & 0 & 0 & 0 \\ 0 & -\overline{p} & 0 & 0 \\ 0 & 0 & -\overline{p} & 0 \\ 0 & 0 & 0 & -\overline{p} \end{pmatrix}$$

sing the Newtonian approximation, the pressure terms could be neglected.

$$T_{\mu}^{\nu} \simeq \begin{pmatrix} \rho c^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix} \qquad \overline{T}_{\mu}^{\nu} \simeq \begin{pmatrix} \overline{\rho} c^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

From this system of two equations, disregarding the interaction terms t_{μ}^{ν} and $\overline{t}_{\mu}^{\nu}$ and if $\overline{\rho} \prec 0$ the second matter is made of negative mass, we would deduce that positive masses attract each other while negative masses repel each other.

But in the Janus model they attract each other.

How can we move to this configuration by following Damour's approach?

Nothing could be simpler. All you have to do is add a minus sign to the action (shown here in red):

$$S = \int d^4x \sqrt{-g}\,(R - \chi L) - \int d^4x \sqrt{-\overline{g}}\,(\overline{R} - \chi \overline{L}) - \mu^4 \int d^4x (g\overline{g})^{\frac{1}{4}} V(g,\overline{g})$$

And you have every right to do so. The system of equations would then become:

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} = \chi\left[T_{\mu\nu} + \text{interaction term}\right]$$

$$\overline{R}_{\mu\nu} - \frac{1}{2} \overline{R}\, \overline{g}_{\mu\nu} = \chi\left[-\overline{T}_{\mu\nu} + \text{interaction term}\right]$$

This is beginning to come close to the Janus equations. In the article published in November 2024 in the European Physical Journal, we find a derivation of the system of equations from another action, which has the virtue of ensuring the invariance of the equations by changing coordinates..

In fact, what was the guiding principle behind the Janus model?

Opting for a form of action that makes it possible to restore the action-reaction principle.

Simply.

And in this process, the minus sign is essential. It is the trick that serves as the pivot of the model. In what follows, i.e. in the two articles that T. Damour has posted on his IHES page, it is clear that he has understood nothing (or wanted to understand nothing) about the subtlety of this approach to finding physical coherence.

In his article of 12 December 2022 he insisted on the absurdity of the Janus model, claiming that negative masses attract 'when it is well known that they repel each other' (in the Einsteinian model). I immediately pointed out his error, which I should have avoided doing, as it would have shown that he hadn't actually read my papers. He rectified the error in a paper dated 28 December 2022, published online six days later.

Incidentally, in this second paper he showed that he had finally understood that the 'Bianchi conditions' were satisfied asymptotically, in the Newtonian approximation. He then mentions the case of neutron stars, forgetting that in this case, this request concerns the calculation of the geodesics followed by negative masses, which then escapes all observation.

For those who know how to read and see, his initial objections, in this paper dated 28 December 2022 , fall completely flat. But these are the only words that scientists, journalists and intellectuals (French and ... foreign!) will remember. In accordance with the rules of the scientific community, the exercise of a right of reply would be perfectly justified, and the best thing would be for it to be exercised within the Academy of Science itself, which would publish a final report.

If this text is still accessible, it will mean that this right of reply could not be exercised and that there remains on the IHES page a final article, that of 28 December, **the content of which contradicts its title.**

One final comment:

The decoding of gravitational signals recorded using the LIGO and VIRGO devices reveals 'black hole mergers' involving masses in excess of one hundred solar masses. All this is based (Damour was awarded the Balsan prize for his contribution to this work) on two things:

- The idea that the black hole model is mathematically and physically consistent

- That the signals can be interpreted as the result of gravitational waves as emanating from the general relativity model.

- In the Janus model, black holes become mathematical chimeras. The images recorded of hypermassive objects located within the M 87 galaxy and the Milky Way are ‘Schwarzschild bodies’ (where we are faced with a simple gravitational reshift effect corresponding to a wavelength ratio of 3).

- The theory of gravitational waves, within the framework of the Janus model, remains to be written, just as the result of mass mergers requires another scenario.

For these two reasons, I think that decoding the signals corresponding to gravitational waves leads to an overestimate of the masses.