GRAVITATION AND COGRAVITATION

Note de lecture

Gravitation and Cogravitation: Developing Newton's Theory of Gravitation to Its Physical and Mathematical Conclusion, Oleg D. Jefimenko, 367 pp. Electret Scientific Company, Star City, 2006. Hardcover. ISBN: 0-917406-00-1. Price: 22.00 dollars.

The author of this book, Oleg D. Jefimenko, is Professor Emeritus of the Department of Physics of the West Virginia University. During his scientific life he wrote many papers and books dealing with the foundations of gravitation and electromagnetism. For many years he worked experimentally and theoretically with electrets, with the electric field outside resistive wires carrying steady currents and with electrostatic motors. He has a very interesting book on this topic, [1].

The subject of the present book is an extension of Newton's law of gravity. In particular the author expresses the gravitational interaction in terms of fields. Moreover, he supposes not only the gravitational field which falls as the inverse square of the distance but also a new field which he calls "cogravitational field." This new field would be created only by moving masses and would act only upon moving masses. It would be analogous to the magnetic field generated by moving source charges and acting upon other moving test charges. In addition to all this, he works only with retarded fields. That is, the fields as detected at one point at a specific time would had originated elsewhere at an earlier or retarded time. The fields would propagate in space at a finite speed. He says that this velocity of propagation of the gravitational fields is not yet known, although he believes it to be equal to the velocity of light. Jefimenko quotes a paper of 1893 by Oliver Heaviside as being the first to propose the new gravitational field, [2].

These hypotheses lead to a greater complexity in force calculations as now some additional terms appear depending upon the velocities, accelerations and rotations of the interacting bodies. The main emphasis

of the book is to present detailed calculations of these new components
in a variety of situations (moving line masses, rotating spherical shells
etc.) The author claims that his generalized theory of gravitation is
compatible with the special theory of relativity. The same is not valid
as regards the general relativity theory, as the numerical values of some
gravitational effects predicted by both models disagree with one another.
There is a comparison of these theories along the book.

On page 24 the author presents a relevant comment that the cograv-
itational field has not yet been actually observed, but he expects it to
be detected by the *Gravity Probe B* launched in 2004 by NASA. What
this book presents is a whole series of calculations of possible new effects
which one day may be observed in space or detected in the laboratory.
As such it is a relevant book with a rich material for reflections.

Here we would like to discuss a few specific aspects. The author
defines on page 12 that "a cogravitational field is a region of space where
a mass experiences a cogravitational force." When Maxwell defined the
electromagnetic field he utilized similar words, [3, Vol. 1, paragraph 44,
p. 47]: "The Electric Field is the portion of space in the neighbouhood of
electrified bodies, considered with reference to electric phenomena." But
then we can ask: How can a region of space propagate in space? This
makes no sense. If the field is not a region of space, what definition should
we utilize? Based on the authority of whom? Jefimenko at least is aware
of this difficulty, although still far from a clear solution. On page 25
he mentioned: "Although we say that gravitational and cogravitational
fields 'propagate,' is is not entirely clear what physical entity actually
propagates, since by definition gravitational and cogravitational fields
are 'regions of space.' It is conceivable that what actually propagates is
some particles that somehow create the gravitational and cogravitational
fields." Let us consider the usual electromagnetic fields generated in an
antenna. Normally people consider that what creates these fields are
oscillating charges in the antenna. But these charges do not propagate
in space at light velocity. So the question remains, what is a reasonable
and clear definition of a field?

Other problems arise with Maxwell, Jefimenko and all others who
work with the field concept as represented by a vector. How can a region
of space have magnitude and direction? How can an abstract entity
as a portion of space act upon a material body? These difficulties are
rarely discussed. But they are not removed by introducing a complicated
mathematics.

On page 12 Jefimenko says: "Quantitatively, a cogravitational field is defined in terms of the field vector $\mathbf{K}$ by the equation $\mathbf{F} = m_t(\mathbf{v} \times \mathbf{K})$, where $\mathbf{F}$ is the force exerted by the cogravitational field on a test mass m_t moving with velocity $\mathbf{v}$." This is analogous to the magnetic component of Lorentz's force law, namely, $\mathbf{F} = q\mathbf{E} + q(\mathbf{v} \times \mathbf{B})$. As it happens with most textbooks on electromagnetism, Jefimenko did not specify the meaning of the velocity $\mathbf{v}$ which appears in his force law. Is it the velocity of the test particle relative to what? It is essential to clarify this question before going on with the calculations, after all velocity is not an intrinsic property of any body. It is always the velocity of the body relative to something else. As we discussed elsewhere, many different meanings have been given to this velocity along the years, see [4, Appendix A: The Origins and Meanings of the Magnetic Force] and [5, Section 7.2.5: Velocity in Lorentz's Force] for the relevant references. In 1881 J. J. Thomson arrived theoretically at half this magnetic expression, calling $\mathbf{v}$ the "actual velocity" of the charge. On page 248 of his paper he said: "It must be remarked that what we have for convenience called the actual velocity of the particle is, in fact, the velocity of the particle relative to the medium through which it is moving" (...), "medium whose magnetic permeability if μ." In 1889 Heaviside corrected the factor $1/2$ of Thomson's paper but still accepted the same meaning for this velocity, as is evident from the title of his paper: "On the electromagnetic effects due to the motion of electrification through a dielectric." In 1895 Lorentz obtained theoretically his force but utilized a different interpretation for the velocity. Now he considered it as the velocity of the test body relative to the ether, a very specific medium which he always considered in a state of rest relative to the frame of fixed stars. Einstein in his paper 1905 creating the special theory of relativity changed once more the meaning of this velocity. He considered it as the velocity of the test body relative to a frame of reference or to an observer. All of this has led to many confusions and misunderstandings in physics. Even when presenting a specific calculation, Mercury's perihelion precession, Jefimenko presented a force law including a velocity-dependent term and said (page 333): "where $\mathbf{v}$ is the velocity of the body." Once more we can ask, velocity of Mercury relative to what? Unfortunately we don't find an answer to this crucial question in the book.

As Jefimenko's force law depends upon the velocity and acceleration of the bodies, it predicts that in some situations a body can behave as having an apparent negative mass (pages 224, 327). In his model anti-

gravitational bodies can exist in the universe, although not yet detected with certainty. These are interesting possibilities which should be further investigated.

Despite the problems or limitations presented above, this is a very relevant book which should interest all scientists dealing with the foundations of physics. Beyond the theoretical calculations he presents some possible astrophysical applications as the differential rotation of the sun (page 250). He also discusses in Chapter 17 two classical tests of general relativity, the bending of light under the action of a gravitational field, and the gravitational shift of spectral lines, but now considered from the point of view of his new theory. Chapter 20 is devoted to a calculation of Mercury's residual precession and a comparison between Jefimenko's model and the generalized theory of gravitation.

There are references and remarks at the end of every Chapter. The book ends with an Appendix on vector identities and another discussing the dimensions of gravitational and cogravitational quantities. We recommend this book to all physicists and students who wish to open their minds to new possibilities in physics.

References

[1] O. D. Jefimenko. *Electrostatic Motors: Their History, Types, and Principles of Operation.* Electret Scientific, Star City, 1973.

[2] O. Heaviside. A gravitational and electromagnetic analogy. *The Electrician*, 31:281–282 and 359, 1893. Reproduced in O. D. Jefimenko, *Causality, Electromagnetic Induction and Gravitation*, 2nd ed., (Electret Scientific, Star City, 2000), pp. 189-202.

[3] J. C. Maxwell. *A Treatise on Electricity and Magnetism.* Dover, New York, 1954.

[4] A. K. T. Assis. *Weber's Electrodynamics.* Kluwer Academic Publishers, Dordrecht, 1994. ISBN: 0-7923-3137-0.

[5] A. K. T. Assis. *Relational Mechanics.* Apeiron, Montreal, 1999. ISBN: 0-9683689-2-1.

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