A new approach to Gravity

S. B. Faruque

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Department of Physics, Shahjalal University of Science and Technology, Sylhet, Sylhet 3114, Bangladesh

Abstract

Beginning with a decomposition of the Newtonian field of gravity, I show that four classical color fields can be associated with the gravitational field. The meaning of color here is that these fields do not add up to yield the Newtonian gravitational field, but the forces and potential energies associated with them add up to yield the Newtonian force and potential energy, respectively. These four color fields can have associated magnetic fields as in linearized gravity. Thus we envisage a theory where four sets of Maxwellian equations would prevail. A quantum gravity theory with four spin 1 fields can thus be envisaged.

1 Introduction

Gravitational force is attractive despite there is nothing opposite in the masses of the attracting bodies. Newtonian gravity is the low energy version of the general theory of relativity and linearized gravity stands in between them. In linearized gravity, attracting bodies, the source body and the test mass, are assumed to have opposite masses. In this theory, a gravitomagnetic charge is attributed to both the source and the test mass. Both gravitoelectric and gravitomagnetic charges of the test and source bodies are assumed to have opposite sign. This is seemingly justified, but conceptually unacceptable, because, there is so far no evidence of difference in what we call mass is found. Therefore, if the source is of positive gravitoelectric charge, then the test body should also have the same positivity. If the gravitomagnetic charge is negative in one, then it should be the same in the other. Beginning with this conceptual departure from linearized gravity, I formulate the Newtonian portion of gravity in a way that can be extended to a quantum theory. Here, I decompose the Newtonian field of gravity into four parts with which gravitoelectric and gravitomagnetic charges interact. The fields are not additive, but the forces and potential energies arising from the four fold interaction add up to yield the same force and potential energy that we find in Newtonian gravity. I present the fields and calculation of the forces and potential energies in this new approach to gravity in the next section.
2 Fields and forces of gravity

For slowly moving gravitational sources, the field equations of gravity resemble those of electrodynamics[1]. Hence, a formal theory called gravitoelectromagnetism has evolved in course of time. In this theory, the standard formulae of electrodynamics are applicable, except that for a source of inertial mass $M$, the gravitoelectric charge is $M$ and the gravitomagnetic charge is $2M$. On the other hand, for a test particle of mass $m$, the gravitoelectric charge is $-m$ and the gravitomagnetic charge is $-2m$. The source and the test particle have opposite charges to ensure that gravity is attractive [2-3]. But, as we know very well that there are no evidences in favor of difference between source and test bodies regarding their that property which is called mass, one feels uncomfortable with such a difference in signs of the charges of source and test bodies. To avoid the seemingly justified, but conceptually unbearable unparallel convention of source and test particle charges, we have come across a new way of making gravity attractive always without assigning charges to the sources and test particles that do not match.

In our formulation, we shall treat the source body of mass $M$ as possessing gravitoelectric charge $q_E = M$ and gravitomagnetic charge $q_B = -2M$. The same convention will be used for the test particle; so the test particle possesses gravitoelectric charge $q_E = m$ and gravitomagnetic charge $q_B = -2m$. The source body will be assumed to produce four fields that are associated with the gravitoelectric and gravitomagnetic charges. Both of these charges produce fields that act on the test particle charges depending on the nature of the charges. That means, if we call $\vec{E}_e$ the electric field due to gravitoelectric charge, then $\vec{E}_b$ is the electric field due to gravitomagnetic charge. $\vec{E}_e$ has to colors, one, $\vec{E}_{ee}$ acts only on electric charge, and the other, $\vec{E}_{eb}$ acts only on magnetic charge. In the same way, $\vec{E}_{be}$ acts only on electric charge and $\vec{E}_{bb}$ acts only on magnetic charge. Hence, we find four fields. We assume the expressions for these color fields, in some analogous way to ordinary gravity, as (G=1):

\begin{align*}
\vec{E}_{ee} &= \frac{M}{r^2} \hat{r}, \\
\vec{E}_{bb} &= -\frac{2M}{r^2} \hat{r}, \\
\vec{E}_{eb} &= \frac{3M}{2r^2} \hat{r}, \\
\vec{E}_{be} &= -\frac{3M}{r^2} \hat{r}, 
\end{align*}

where the source body of mass $M$ is assumed to be located at the origin of coordinate system and $r$ is the radial coordinate. The characteristics of these fields, as evident from the expressions, are that gravitoelectric charge produce diverging fields and gravitomagnetic charge produce converging fields. Also, the cross fields are $3/2$ times stronger than the direct fields.
The test particle of gravitoelectric charge $m$ and gravitomagnetic charge $(-2m)$ experience four forces given by the symmetric prescription,

$$\vec{F} = q\vec{E}$$

as given by the following expressions:

$$\vec{F}_1 = (m)\vec{E}_{ee} = \frac{Mm}{r^2} \hat{r},$$

$$\vec{F}_2 = (-2m)\vec{E}_{bb} = \frac{4Mm}{r^2} \hat{r},$$

$$\vec{F}_3 = (-2m)\vec{E}_{eb} = -\frac{3Mm}{r^2} \hat{r},$$

$$\vec{F}_4 = (m)\vec{E}_{be} = -\frac{3Mm}{r^2} \hat{r}.$$  

We note that

$$\vec{E}_{\text{resultant}} = \vec{E}_{ee} + \vec{E}_{bb} + \vec{E}_{eb} + \vec{E}_{be} = -\frac{5M}{2r^2} \hat{r} \neq \vec{E}_{\text{Newtonian}}.$$  

However,

$$\vec{F}_{\text{resultant}} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \vec{F}_4 = -\frac{Mm}{r^2} \hat{r} = \vec{F}_{\text{Newtonian}}.$$  

Hence, the fields $\vec{E}_{ee}$, $\vec{E}_{bb}$ etc. are colored; they do not add up to the Newtonian field, but the forces due to the four color fields on the gravitoelectric and gravitomagnetic charges of the test particle add up to the net force as equal to what we know as the Newtonian gravitational force.

The resulting potential energies of the test particle is given by the prescription $\vec{F} = -\nabla U$, $U$ being the potential energy, as

$$U_1 = \frac{Mm}{r},$$

$$U_2 = \frac{4Mm}{r},$$

$$U_3 = -\frac{3Mm}{r},$$

$$U_4 = -\frac{3Mm}{r},$$

and their sum

$$U_{\text{resultant}} = -\frac{Mm}{r} = U_{\text{Newtonian}}.$$  

Hence, like the force, the potential energy is colorless and add up to yield the correct resultant as given by the Newtonian potential energy. The four
potentials in which the test particle finds itself are given by $\Phi = \frac{U}{r}$, $q$ being either $q_E$ or $q_B$, as

$$\Phi_{ee} = \frac{M}{r}, \quad (17)$$

$$\Phi_{bb} = -\frac{2M}{r}, \quad (18)$$

$$\Phi_{eb} = \frac{3M}{2r}, \quad (19)$$

$$\Phi_{be} = -\frac{3M}{r}. \quad (20)$$

We note that

$$\Phi_{\text{resultant}} = -\frac{5}{2} \frac{M}{r} \neq \Phi_{\text{Newtonian}}. \quad (21)$$

Therefore, the effective force due to all the fields, experienced through the gravitoelectric and gravitomagnetic charges, on the test particle is exactly the same as the Newtonian force on the particle. The fields themselves do not superpose to yield a resultant equivalent to the Newtonian field. Hence, the fields are color-sensitive. At the end, we regain the same force and potential energy experienced by the test particle as if it has nothing extra of the Newtonian formulation. After all, Newtonian force and potential energy are the reality at the low energy scale. In this way, we have gained a compromise between linearized gravity’s two types of charges and Newtonian gravity’s attractive force, without giving up the parallel between source and test particle masses (charges).

3 Discussion

We have shown that the Newtonian gravitational force between two bodies can be obtained using linearized gravity’s two types of masses, namely, gravitoelectric and gravitomagnetic charges. In linearized gravity, conventionally the source body’s charges and test particle charges are opposite in sign. But, here we ascribe to the source body and test particle charges of the same sign. We then associate four color fields with the source mass and compute the individual forces experienced by the test particle due to its gravitoelectric and gravitomagnetic charges. The individual forces add up to exactly the Newtonian gravitational force. The potential energies also add up to the Newtonian potential energy. But, the fields and potentials do not superpose, i.e., they are colorfull. Thus, in this new approach to gravity, four color fields are responsible for the gravitational force. Hence, we can envisage that four sets of Maxwellian equations would prevail when the theory is extended using four magnetic fields ascribed with the four electric color fields. Finally, a quantum gravity theory with four spin 1 fields can be envisaged which would complete a theory of gravity.
References

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