Title: Gravitation, Force and Geometry

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Abstract

Gravitation is described as a uniquely geometric phenomenon, incompatible with the concepts of force and energy, and only analogically associable with non-geometric mathematical formalizations. In particular, the mathematical derivation of gravitational waves from the field equations is shown to be opportunistic and physically untenable.

The mathematics of relativistic gravitation theory is remarkable for its expansibility and physical ambiguity. To a large extent it applies equally well to an interpretation of gravitation as a force and as a geometric distortion of spacetime. But given the pre-relativistic association of gravitation with force, that ambiguity, fomented by the consolidation and predominance of mathematics in the interpretation of physical phenomena, has led to an overextension of the mathematics and resulted in theoretical misdirection.

Two principal analogies between the physical and mathematical can be identified in the development of the General Theory and implicated in its misdirection. One derives from Einstein's heuristic insight associating gravitation with geometry, apparently due to an idea suggested by his friend Paul Ehrenfest (who owed it to Max Born), that the ratio of circumference to diameter of a rotating disk will deviate from *pi* with relativistic accelerations at the radius. In Einstein's subsequent pursuit of a generalization of relativity, where he hypothesized the equivalence of inertial acceleration and gravitation, the similarity of the inertial effect on the rotating disk and the gravitational pressure we experience at the earth's surface suggested that gravitation might indeed be explicable as a fundamentally geometric principle. Experimentation has confirmed the validity of that seminal geometric insight and the service of the mathematical analogy. But in the kinematical similarity between objects on a rotating disk and in gravitational orbit there is a distinct dynamical difference: A test particle in a box that is fixed at the edge of a rotating disk presses against the radial wall of the box, manifesting a centrifugal "force", derivative of the actual force that is rotating the disk; in contrast, a test particle in a box orbiting a massive body floats freely, following its geodesic in spacetime in parallel with the box, and gives no indication of the presence of a force or acceleration. There is thus a mathematical analogy due to the similar kinetics of the rotating disk and the orbiting body, but not a physical equivalence.

The development of the Field Equations was based on another mathematical analogy, formalizing the behavior of bodies being accelerated or pressured toward an attractive or determinant center, as in a field of force or a collapsing, concentrating sphere. The analogy holds in this case because gravity, like a field of force, produces a typically concentric form to the motion of affected bodies. But again, the mathematical analogy is not a physical equivalence. A neutral test particle inside a charged box that is accelerating toward the vortex of a field of force presses against the wall of the box opposite the direction of force, and a non-neutral particle of different mass than the box accelerates at a different rate than the box, moving consequently toward one wall or its opposite; in contrast, a particle in a box falling or spiraling in a gravitational field floats freely, following its geodesic in spacetime in parallel with the box, and gives no indication of the presence of a force or acceleration.*

In each case - the rotating disk or orbiting body and the attractive or determinant field - there is a discernible difference in the *empirical* behavior of test particles being acted upon by a force and those moving in a gravitational field. The mathematical analogy between gravitation and force is limited to the description of the curvilinear trajectories of idealized, dimensionless particles.

Empirical gravitational phenomena derive from the distortion or compression of spacetime in the presence of mass, the relative curvature of geodesic motion in the presence of a gravitational distortion, and the static acceleration of bodies when their geodesics are *resisted* at the surfaces of large masses. In these descriptions there is no indication that gravitation might somehow produce a force-like and radiant energy.

When gravitation is isolated from circumstances where it is being resisted, there is only geodesic motion - curvilinear or straight, energetic or not, according to an observer's frame of reference. In the relative accelerations and decelerations of orbital dynamics, and in the perturbations of orbits due to external gravitational influences, there is no intrinsic indication of acceleration, there is only the *appearance* of acceleration from the perspective of other reference frames.

The most prominent (and now expensive) case of hypothetical gravitational energy radiation is the inspiraling binary star system, where there is evidently a loss of net relative (kinetic/potential) energy between the companions due to their orbital dynamics. But in terms of gravitation as a geometric phenomenon, the corresponding increase in extrinsic energy would be of purely relative (kinetic/potential) energy between a binary system and the rest of the universe due to the increasing concentration of the binary's gravitational field; any mathematical treatment of the conversion of relative orbital energy into radiant mass-energy could only approximate the phenomenon insofar as it is analogical.

In view of the direct empirical evidence of the purely geometrical nature of discrete gravitational phenomena it is incomprehensible how the predictions of energy-bearing *gravitational waves*, *gravitons*, and *gravitomagnetic effects* can be justified, as all are based on the supposition of a gravitational force and energy. They are mathematical extrapolations from the original Field Equations drawn opportunistically from electromagnetic analogies. It is here that the physical ambiguity and indifference of mathematics has been misleading gravitation theory, and consequently, it is here that the derivative predictions of General Relativity (of gravitational waves, gravitons, and gravitomagnetic effects) remain unconfirmed. In the absence of a coherent physical theory that could somehow link relative phenomena with the production of radiant energy there is no reason to expect such predictions can ever be confirmed.

It must be acknowledged that the energy disclosed by the continuous *resistance* to gravitation - the persistence of pressure of bodies against a massive surface - deserves investigation as-such. But *geometry is not dynamic*. If non-Euclidean geometry sometimes brings bodies into persistent conflict, pressure and resistence, the basis of that persistence has to be independent of the incidental conflict of geodesics. Its origin has remained unspecified and unexamined because of its association with gravitation where gravitation has been imputed with energetic properties. It remains an intriguing and unexplored phenomenon, but it is outside the focus of this discussion.

There is a positive and constructive aspect of the objection to an identification of gravitation with force and energy. The clarification of the distinction can be expected to lead to unencumbered advances in gravitation theory and to simplifications of problems in other field-theories by the elimination of a supposed force of gravity.

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* Note: There may be an appearance of force if the gradient of a gravitational field relative to a body's extension in the direction of the field is extreme enough to produce tidal stresses to the body's molecular binding energies. (The earth's ocean tides are a dramatic instance.) But this too is entirely geometric in its origin, and manifests only a local variation in the *resistance* to gravitation.