The nature and mechanism of gravity in terms of advanced classical dynamics

Call for quantitative confirmation

Michael Schmiechen, Berlin

Abstract

The following model of gravity is one of the by-products of a rational reconstruction of classical macroscopic dynamics to be published in due course. Classical dynamics is being conceived as an instance of an axiomatic theory of quantities proper, in the original sense of extensities, and the impact of modern physics on classical dynamics is being shown.

This conceptual background implies that body forces, gravitational in particular, are momentum productions in bodies and, 'consequently', that the constant of gravitation is a property of the nucleons, the 'reaction' constant relating the inertia specific production of momentum to its cause or driving 'force', the gradient of the inertia potential.

This short outline is a call for quantitative confirmation of the proposed model in terms of the standard model of particle physics. Further relativistic and quantum mechanical developments of the model are strongly suggested, but are not subject of the present investigation into the fundamentals of classical dynamics by a mechanical engineer.

> "*Die Erklärung der Schwere*, die Mutmaßung über die Entstehung der Kristalle pp habe ich wie die Offenbarung Johannis ans Ende gebracht, und *man kann davon glauben soviel man will oder kann*."
>
> Georg Christoph Lichtenberg: Sudelbücher. J (1789-1793) 1158.
>
> "*The explanation of gravity ... one may believe of it as much as one likes to or can*."
>
> *Italics and translation by the present author.*

Balance of extensity of motion: motus quantitas

The focal point of classical dynamics of non-polar continuous media in Euclidean space is Cauchy's universal equation of motion

$$d_t v_i \equiv \partial_t v_i + v_j \partial_j v_i = 1/\rho \, \partial_j \sigma_{ji} + f_i \, .$$

This equation is the *local mass or rather inertia specific balance of momentum* according to Newton's second law, which in turn is the *balance of the extensity of motion, motus quantitas* or for short *motus,* as Newton *correctly* called it, or *momentum*, as it is called in recent textbooks.

- Accordingly the *local inertia specific momentum* v is identical with the local intensity of motion, traditionally called the *local velocity of the continuous body of matter*.
- The *local density of the capacity of motion* ρ , the local density of inertia is traditionally called the *local density of mass*. The reason is that the mass or quantity of matter is being measured in terms of inertia.
- Further the *local density of the diffusive flow of momentum* σ , the local diffusive momentum flux is traditionally called the *local stress*.

- And the *local inertia specific production of momentum* f , the local inertia specific body force is traditionally called the local mass specific force or the *force field in the continuous body of matter*.

Body force fields: gravity in particular

As the fields of inertia density, velocity and acceleration, and stress the field of body force, gravity force in particular, 'takes place', *exists physically only in the continuous media*, not in the 'empty' spaces surrounding them. The *formal definition of gravity fields outside bodies of matter* is of course possible and is, and will continue to be, common practice *as a matter of convenient representation*.

But no operational interpretation of momentum production outside bodies of matter has ever been given. Even Einstein 'proves' the existence of 'gravity fields' with test bodies brought into gradients of inertia potentials, by the momentum productions in a bodies of matter. Evidently this 'proof' is circular, not only in the present context.

Since Newton's cautious statement "hypotheses non fingo" the 'nature' of body force fields, the gravity field in particular, has remained unexplained. Most textbooks do not even raise the question. Embedding dynamics into the theory of quantites proper reveals the nature of body forces as momentum productions. This question being answered axiomatically, the 'real' question to be answered in the following concerns the physical mechanism of momentum production.

Balance of capacity of motion: inertia

Cauchy's equation is being derived from Newton's second law observing the balance of inertia

$$d_t \rho \equiv \partial_t \rho + \partial_i (v_i \rho) = 0 + 0 ,$$

traditionally called the equation of continuity.

On the right hand side of this balance of the capacity of motion

- firstly the diffusive flux of inertia vanishes by definition. implying the definition of the local intensity of motion, the velocity, *falsely* called 'barycentric' velocity due to the *traditional confusion* of centre of inertia and the centre of gravity. And
- secondly the production of inertia vanishes as a matter of fact, the conservation of *mass measured in terms of inertia*.

Diffusive momentum flux: stress

The concept of continuous bodies of matter is a convenient mathematical abstraction, an aggregate description of physical bodies of matter. The latter are of molecular or, on a larger scale, maybe turbulent structures, the random motions in which determine the diffusive momentum fluxes caused or 'driven' by (functionals of) velocity gradients.

'Consequently' despite Cauchy's universal equation of motion a wide variety of motions of different bodies of matter is being observed corresponding to the large number of different materials and turbulent flows and a hierarchy of laws of diffusive momentum flux have been identified. On the molecular level *these stress laws are also called constitutive laws or laws of materials* (Stoffgesetze). Only in few simple cases these macroscopic law can be derived from molecular data.

According to Einstein's *principle of general relativity* the *universal local balances* of inertia and momentum, the equation of continuity and Cauchy's equation, *hold independent of the frame of observation*. Further the density of inertia and the diffusive flux of momentum are independent of the frame of observation according to the *principle of material invariance*.

Inertia specific momentum production: 'force field'

As a consequence two observations in different frames differ only in the values of the local inertia specific momentum production and of the local acceleration and the relation

$$\Delta f_i = \Delta d_t v_i$$

holds in continuous bodies of matter. This is the 'principle', in the present context the *theorem of local equivalence*, which is considered to be the starting point of Einstein's theory of general relativity. The theorem *looks like* a kinematical relationship and Einstein has shown that it can be treated that way in great generality.

More interesting in the present context of macroscopic classical dynamics is to ask for *the physical implications of Cauchy's equation*

$$d_t v_i - f_i = 1/\rho\, \partial_j \sigma_{ji} .$$

According to the material invariance of inertia density and stress it implies the material invariance of the difference of momentum storage and production and, 'consequently', *it implies a universal property of matter*. 'Evidently' this is the core of the present note.

In case of locally uniform conditions, uniform motion in particular, the stress tensor

$$\sigma_{ji} = -p\, \delta_{ji} + \tau_{ji}$$

reduces to the spherical pressure tensor and Cauchy's equation reduces to Euler's equation, at locally uniform density of inertia

$$d_t v_i - f_i = \partial_i e$$

with the inertia specific pressure or internal energy

$$e \equiv p / \rho .$$

Again this balance only *looks like* a purely kinematical relationship.

Low frequency asymptotic model of nucleons

In a 'universe' with uniform mass potential two particular frames of observation may be selected, one (1), moving with the body of matter, in which the acceleration vanishes

$$d_t v_i^{(1)} = 0_i .$$

and any other (0), traditionally called inertial, in which the local inertia specific momentum production vanishes

$$f_i^{(0)} = 0_i .$$

According to the theorem of local equivalence the inertia specific momentum production in the first observation space is

$$f_i^{(1)} = - d_t v_i^{(0)} .$$

According to Cauchy's equation this production of momentum is materially invariant, *it must be ascribed to some universal material mechanism of energy storage in matter.*

Due to the fact that 'nearly all' inertia is 'contained' in the nucleons, 'for that reason' also *falsely* called 'baryons', *the simplest 'low' frequency asymptotic model to be conceived is that of nucleons being containers in which their inertias are suspended in linear spring systems.* This model does not cover the dynamics encountered in particle collisions.

According to this model the inertial force, the storage of momentum, is balanced by the deformation of the spring system, the deformation being

$$d_i^{(1)} = - d_t v_i^{(0)} / \omega^2$$

and the crudest possible estimate of the natural circular frequency of the spring-mass system being

$\omega = 2*\pi*10^{9}$ 1/sec .

Momentum production proper: gravity

This model of nucleons permits to 'explain' gravity without resorting to the concept of 'gravitational mass' as distinct from 'inertial mass', still figuring prominently in all textbooks. While a whole hierarchy of stress laws is being identified only one 'universal' law of inertia specific production of momentum, independent of the medium under consideration, has been identified *until now* for matter in the state considered in classical dynamics.

In a physical universe containing matter *the only causes for the production proper of motion, are gradients of the inertia potential*. And in the simplest case the local inertia specific production of momentum in the body is proportional to the gradient of the inertia potential, the phenomenological constant being the production or 'reaction' constant G , traditionally called constant of gravitation.

According to Newton's law of gravitation the total production of momentum in the classical universe vanishes. The gradient of the inertia potential depends on the inertia distribution in the universe, but 'hardly at all' on the local inertia distribution.

Usually the gravity field, *falsely* called 'acceleration of gravity', the inertia specific momentum production

$$f_i^{(0)} = g_i = - G\, \partial_i\, U^{inert}$$

in bodies of matter is formally assumed to extend through 'empty' space filled with inertia potential

$$\partial_i\, \partial_i\, U^{inert} = - 4\, \pi\, \rho \quad .$$

In terms of the model of nucleons proposed gravity may be 'explained' by a deformation

$$d_i^{(0)} = - 1/\rho^{inert}\, \partial_i\, U^{inert}$$

of the spring system inside the nucleons due to the gradient of the inertia potential. Consequently the constant of gravitation is

$$G = \omega^2 / \rho^{inert}$$

and an estimate of the density in the singularities, in which alone gradients of the inertial potential cause momentum productions, corresponding to the estimate of the natural circular frequency, is

$$\rho^{inert} = 0.6*10^{30}\ kg/m^3 .$$

Action requirements

The conceptual framework of quantities proper provides not only for a solid foundation of classical dynamics and all its branches, the world we live in, but for direct links to the theories of general relativity, of molecular physics and of particle physics, *as it should be*. 'Inversely' this advanced conception of classical mechanics provides a model for the nature of gravity and, maybe, the clue for the final solution of the problem.

In advanced classical dynamics there is no need for the concepts of 'inertial and gravitational masses', but only for the inertia, the capacity of motion of bodies of matter, physically singularities suspended in the nucleons. Further there is no need for the *incredible* concept of gravity fields, inertia specific productions proper of momentum, outside bodies in 'empty' space 'filled' with the inertia potential.

The picture drawn looks pretty self-evident, maybe too 'evident'. Consequently the author firmly believes that it must have 'occurred' to others before and that it must have been described in the literature. But so far he has found neither expositions nor discussions, neither supporting nor refuting the ideas proposed.

Letters to various colleagues asking for serious discussion, to be found on the website of the author, remained mostly unanswered, otherwise without answer, except for ritual repetitions of textbook phrases. Classical mechanics is *not just a formal limit* of Einstein's theory of general relativity, but, as has been expected, the latter has a *dramatic physical impact* on advanced classical dynamics.

At this stage the model described is a suggestive draft, comparable to Lucretius' description of 'atoms' and their Brownian motion and to Bohr's model of atoms in its early days. In due course it will have to be refined as the latter has been. At least superficially it is in accordance with the standard model of particle physics, describing nucleons *containing* quarks, singularities of the mass potential, suspended in gluons.

Consequently the purpose of this short outline is to invite particle physicists to establish the quantitative correspondence. In the light of the present exposition this looks like a rather straightforward task. The 'real' problems are the stability of the nucleons and the interaction of the physical singularities of inertia with the inertia potential, solutions providing for the ultimate 'explanation' of inertia. As reader of the Scientific American the author 'feels' that the Higgs field must be just around the corner.

Contacts

m.schm@t-online.de

www.t-online.de/home/m.schm