Gravitational Interaction
A Conceptual Approach from Mechanics Perspective

Sorin Stefan RADNEF*

*Corresponding author
INCAS – National Institute for Aerospace Research "Elie Carafoli",
Bd. Iuliu Maniu 220, Bucharest 061136, Romania,
radnefss@yahoo.com

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Abstract: *The paper brings to attention the well-known interaction of gravity alongside the well-known property of inertia stated as in classical mechanical motion. The results are based on the general concept that all physical entities interact with each other and this natural interaction is balanced, i.e. there is a natural equilibrium of the interaction. Considering the first principle of mechanics and noting that inertia is actually a stability property and is the only mechanical property that this natural interaction manifests in the equilibrium state, the quantitative description of this interaction is approached, which actually becomes the gravitational interaction. This way we derived that gravity interaction is, in fact, an inertia interaction preserving and respecting the Newtonian mechanics principles.*

Key Words: *inertia, gravity interaction, principles of mechanics*

1. INTRODUCTION

Sir Isaac Newton deduced from Kepler's laws the algebraic structure of the force G_{12} which represents the gravity interaction between two rigid bodies, no matter how small, which we call "body-point" or "point body". Considering m_1 and m_2 their gravitational masses the well-known today expression of this force is:

$$G_{12} = f\frac{m_1 m_2}{d^2}$$

where $f = 6,67384 \times 10^{-11}$ [m^3/kg/s^2] is the universal constant of gravitational attraction and d is the rectilinear distance between the two geometrical points which represents the bodies, [1], [2]. The main goal of this work is to derive this algebraic formula using a rational model based on the property of inertia as an intrinsic physical property of the existence of any physical entity and on widely accepted concepts regarding the knowledge of physical phenomena.

Almost all treatises regarding the gravity interaction presented it from the gravity law just mentioned above [3], [4]. Even Ernest Mach who tried to link inertia with universal interactions, reduces the treatment of gravitational interaction to the law mentioned above, without a deduction starting from these interactions, [5].

2. BASIC CONSIDERATIONS

We will start from the concept that all physical entities exert mutual influences, by virtue of which phenomena and processes exist as we have observed from a physical point of view. These interactions are exercised continuously and are in a state of equilibrium so as to constitute the support of physical existence without affecting its constitutive structure. This natural interaction is between any structural components of a physical entity and between any components of two of these physical entities.

If we accept this point of view, it is necessary to analyze such an interaction for components no matter how small they may be, but preserving the property of inertia in the interaction process. This is an additional aspect, which supports the point-body concept used by the principles of mechanics.

Since physical entities and their existential interactions are without any mechanical alteration of their properties, so that it is possible to determine their properties with a high degree of invariance, we can deduce that these entities and their existential interactions have stable behavior.

From a strictly mechanical point of view, this physical state presents itself as a relative and continuous movement, during which each body (i.e. a physical entity in the form of substance) manifests opposition to other additional external interactions applied to it, actions that attempt to modify this natural relative movement. Such a property, which is actually one of stability of natural interactional equilibrium, is called “inertia”.

This property of interactional equilibrium is the only one that is emphasized and used from a mechanical point of view. Even though these interactions in equilibrium become increasingly weaker, the property of stability is preserved and at a limit state we can consider a body isolated from an interactional point of view, but with the property of maintaining its opposition to the actions applied to it, actions that attempt to modify this natural relative motion.

The first principle of Newtonian mechanics, [1], [2], state that such an “isolated body”, idealized as a body-point, has the rectilinear and uniform movement as its natural mechanical state revealed in a suitable frame of reference, from which it is isolated from mechanical viewpoint. On the other hand, considering this mechanical state as the reference one, any supplementary action applied to the body-point will produce a modification to this mechanical state, which constitutes the third principle of classical mechanics. Some years later, Euler states that the force, as the measure of the intensity of immediate interaction capacity acting on a body-point, is proportional to body’s inertia properties, measured by the physical quantity denoted as “mass”, and its acceleration:

$$\vec{F} \sim m \cdot \vec{a}$$

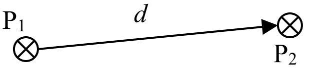
This formula has been validated over the following years up to the present day, from (almost) every physical and technical point of view. Following such a way of understanding, the natural interaction can be called “inertial interaction” and the only property that characterizes this interaction is inertia, measured by the physical quantity mass.

Following the first two principles of mechanics, [2], and based on physical and technical experience, the property of inertia highlighted by the (natural) interactional equilibrium for each body, which is part of the natural interaction, becomes a property attached to each body (and any of its components).

Thus, the property of inertia and its measure, the mass, become an intrinsic property of every physical entity made up of substance, that is of every body.

To find the structure of this (natural) equilibrium interaction, it is appropriate to deduce the mechanism of this interaction for only two point-body interactions, given this understanding of the interaction phenomenon.

For this purpose, it is necessary to conceive a reality modeled only for two bodies, placed in a homogeneous and isotropic "material" environment. We will consider two point-body P_1 and P_2, having m_1 and m_2 their mass property, placed at a distance denoted d and that this relative position and velocity underline aspects of the inertial interaction that can be analyzed separately, being causes that can eventually be linearly composed, with respect to an appropriate reference frame. So, the inertial interaction due to the relative position has the following scheme:



As a basic hypothesis, in accordance with the third principle of mechanics, [1], [2], we will consider that the intensity of the immediate interaction capacity, exerted between these two point-bodies, is divided into two components, one for each of these two bodies.

3. QUANTITATIVE REASONINGS

As mentioned above, the only property that characterizes natural existential interaction is inertia, measured by the physical quantity called "mass". The body P_1 has and manifests its intensity of interaction capacity identically at every geometric point of a spherical surface with the center in P_1, due to the properties of homogeneity and isentropy of the material environment.

Thus, denoting by CIn1 this intensity of the immediate capacity of interaction for P1 on a sphere of radius *r*, we may infer that:

$$CIn_1(r) \sim \frac{m_1 \boldsymbol{a}_1}{4\pi r^2} \tag{1}$$

where $\boldsymbol{a}_1$ represents the "*activity*" of the *material* environment in the interaction of P_1 and P_2 and ~ means the proportionality. For P_2 we have symmetrically:

$$CIn_2(r) \sim \frac{m_2 \boldsymbol{a}_2}{4\pi r^2} \tag{2}$$

Taking into account the "basic considerations", the intensity of action exerted by P_1 on P_2 must be proportional with:

a) $CIn_1(d)$

b) The *inertia* of P_2 expressed as dependence on m_2, denoted α_2, which is a continuous one and includes the interaction aspects ignored by considering the intensity of interaction capacity exerted between this two body-point as separated into two components, one for each of this two body; thus, its value is:

$$\alpha_2(m_2, \boldsymbol{a}_2) \tag{3}$$

This way, we derive that the force, F_{12}, applied to P_2 has the formula:

$$F_{12} \sim CIn_1 \cdot \alpha_2(m_2, \boldsymbol{a}_2) = \frac{m_1 \boldsymbol{a}_1}{4\pi d^2} \cdot \alpha_2(m_2, \boldsymbol{a}_2) \tag{4}$$

and for the force F_{21}, applied to P_1:

$$F_{21} \sim CIn_2 \cdot \alpha_1(m_1, \boldsymbol{a}_1) = \frac{m_2 \boldsymbol{a}_2}{4\pi d^2} \cdot \alpha_1(m_1, \boldsymbol{a}_1)$$

Using the third mechanics principle[1], that state $F_{12}=F_{21}$, we derive that:

$$\frac{m_1 \boldsymbol{a}_1}{4\pi d^2} \cdot \alpha_2(m_2, \boldsymbol{a}_2) = \frac{m_2 \boldsymbol{a}_2}{4\pi d^2} \cdot \alpha_1(m_1, \boldsymbol{a}_1) \tag{5}$$

or, in an equivalent algebraic form:

$$\frac{m_1 \boldsymbol{a}_1}{\alpha_1(m_1, \boldsymbol{a}_1)} = \frac{m_2 \boldsymbol{a}_2}{\alpha_2(m_2, \boldsymbol{a}_2)} \tag{6}$$

Following the same reasoning for the body-point P_1 and another one denoted generically P_k, arbitrary chosen from the set of the *cosmic bodies*, we arrived at the following sequence of equal ratios:

$$\frac{m_1 \boldsymbol{a}_1}{\alpha_1(m_1, \boldsymbol{a}_1)} = \frac{m_2 \boldsymbol{a}_2}{\alpha_2(m_2, \boldsymbol{a}_2)} = \ldots = \frac{m_k \boldsymbol{a}_k}{\alpha_k(m_k, \boldsymbol{a}_k)} = \ldots \overset{not}{=} E_g \tag{7}$$

denoting with E_g the common value of the ratios.

If we accept that the material environment is objective relative to its influence in the interactional process, then:

$$\boldsymbol{a}_1 \equiv \boldsymbol{a}_2 \equiv \cdots \equiv \boldsymbol{a}_k \overset{not}{=} \boldsymbol{a} \tag{8}$$

and, finally:

$$F_{12} = \frac{m_1 \boldsymbol{a}_1 \cdot m_2 \boldsymbol{a}_2}{4\pi d^2 \cdot E_g} = \frac{m_1 \cdot m_2}{4\pi d^2} \cdot \frac{\boldsymbol{a}_1 \boldsymbol{a}_2}{E_g} \tag{9}$$

Denoting by $\varepsilon_g = \frac{E_g}{\boldsymbol{a}^2}$ the physical quantity that represents the way the ***inertia*** and the properties of the ***material*** environment compete coherently in establishing the stability property of the natural existential interaction, which is the *inertial interaction*, we have the final formula for the inertial interaction between two body-points:

$$F_{12} = \frac{m_1 \cdot m_2}{4\pi \cdot \varepsilon_g} \cdot \frac{1}{d^2} \tag{10}$$

4. CONCLUSIONS

The conceptual approach of gravity interaction from the inertia property of the natural existential interaction, in equilibrium, between the physical entities (represented in the form of substance and considered as body-point), as presented in the above, does not state if the gravity force between two body-point is of attraction or repulsion type. If we accept that an equilibrium interaction *preserve the entity* of the entire set of entities that interact as a stable set, then we may infer that this force is of attraction type.

Comparing the formula (10) with the Newtonian formula for the gravity force we derive the value for ε_g; $\varepsilon_g=1/(4\pi \cdot f)=1{,}192379\times 10^9$[kg·s²/m³]

The formula (10) imply the "inertial mass" and thus the so-called "gravitational mass" becomes conceptually identical to it, from a conceptual viewpoint, being the same phenomena in fact.

In this paper, we have not discussed the reference frame problem related to the basic considerations, presented above. Thus, the whole conceptual approach is valid in a reference frame in which the principles of Newtonian mechanics are valid.

Based on the assumptions and ideas in the “basic considerations” it becomes possible to attempt to formulate the principles of mechanics in a more general manner.

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