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New Fundaments for Classical Mechanics

Ionel DINU, M.Sc.
NYSICS Central Co., Ltd., Bucharest 060403, Romania
E-mail: *nysics_central@yahoo.com*
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Abstract
It is widely known that the principles of classical mechanics as laid down by Isaac Newton have certain difficulties related especially to the physical interpretation of the notions of force and mass. Motivated by the arguments of a recent article showing that gravitation is an Archimedic force in the aether, the present work takes a fresh look at the ideas that constitute the fundaments of Newtonian mechanics. New interpretation of the crucial experiment of free fall of bodies points to the necessity of changing the views accepted today. The most significant conclusion is that classical mechanics, essentially a theory addressing the motion of solid bodies, must have its principles derived from those of fluid mechanics, more specifically from the behavior of the fluid aether.

Keywords: classical mechanics, mass, aether, inertia, gravitation

Introduction

The whole body of knowledge called classical mechanics rests on observations made on the movement of solid bodies. The two principal phenomena that were investigated in the past and whose interpretations form now the pillars of the science of mechanics were the movement of celestial bodies and the motion of bodies in free fall. In an epoch when the clock was an instrument made by the experimenter and the time was a notion yet to be conceptualized, it was still possible for Galileo Galilei (1564-1642) to find that the distance covered by a body falling from rest is proportional with the second power of the time and for Johannes Kepler (1571-1630) to reach the conclusion that the second power of the period of revolution of a

planet is proportional with the third power of the radius of its orbit. All these observations were necessarily of kinematical character and concerned phenomena of sufficient generality that the material properties of the bodies in motion needed not be taken into account.

Dynamics was initiated by Isaac Newton with his introduction of the notions of mass and of a constant force that gives rise to constant acceleration. They were invented for the sole purpose of giving an account of the movements of the planets around the Sun. However, insufficient understanding of the origin of the gravitational force, of the role of the aether and scarcity of information regarding the phenomenology peculiar to fluid motion, turned Newton's attempt into a half success. This can be seen, for example, in the fact that classical mechanics is to this day not able to explain the effect of inertia and is forced to accept this phenomenon as a postulate. Another issue is that of the notion of mass, about which Newton said it is derived from weight and proportional to it [1], although it is not clear what is the relation between this quantity and the quantity of matter contained in a body. This state of indeterminacy, or rather sheer confusion between these two notions, is best illustrated in the brochure published by the International Bureau of Weights and Measures (BIPM), where the kilogram is defined as the unit of mass and a few paragraphs later the unit of amount of substance in a body, the mole, is defined in terms of the kilogram [2]. These two physical quantities are considered to belong to the group of seven base, or fundamental, units of measure from which other physical quantities should be derived. If they both refer to the quantity of matter contained in a body, why is it that there are two fundamental units for this physical quantity? Or should we understand that mass is "something more" than the quantity of matter contained in a body? If the latter is true, then what is the difference between them?

All these issues will become clear in the present work, where it is assumed that the results arrived at in [3] are valid and that, indeed, the gravitational force is Archimedic in nature, acting on all bodies immersed in the vast ocean of aether. The magnitude of this force is given by the general formula

$$F_G = -\nabla p \cdot d \cdot V$$

where ∇p is the aether pressure gradient that exists in regions of space where gravitation is felt, V is the volume of the macroscopic body and d is the absolute density of its matter, a dimensionless quantity given by

$$d = \frac{N \cdot w}{V}$$

in which w is the volume of an atom and N is the total number of atoms that constitute the macroscopic body of volume V.

The results mentioned above will form the basis on which will be interpreted the motions of bodies in free fall and under the action of a constant force. It will be seen that, following this approach, the concepts introduced by Newton as postulates evolve in a natural way and their physical significance acquire a clear and unequivocal meaning.

Aether Properties Revealed by Experiments of Free Fall

The observation that all material bodies, irrespective of their weight, volume or other conceivable property, have identical free fall motion was made long before Galilei demonstrated it with the help of inclined planes and pendulums. The experiments can be easily reproduced by letting different bodies fall in tubes from which the air has been removed to a high degree, forming a Torricellian vacuum. Two important effects can be noticed during these experiments: (a) that the distance covered by the falling bodies is always proportional with the square of the time t passed from the beginning of their motion from rest and (b) that their motion is purely translational, that is, the falling bodies do not show any tendency to rotate around their center of weight, being indifferent to the relative position between their axis of symmetry and the trajectory of motion.

Although the cause of the motion of bodies in free fall is correctly attributed to gravitation, the opinion held today according to which this is the only force acting upon the falling body is untenable. This view is not only contradictory to all the phenomenology known to science, where not even one phenomenon was discovered in which only one force is at action, but it cannot be accepted at the philosophical level. For matter, incapable of generating motion by and through itself, cannot be conceived to have any innate property that can affect its own motion, much less the power to always respond with a constant acceleration to the action of a constant force. Rather, it is conceivable that, if it were possible for a material body to be brought under the action of only one force, the speed of the respective body would increase at an infinite rate. However, what happens in the case of a body in free fall is different, for the experimental evidence (a) states that, from all the possibilities that exist for the rate of increase of the speed of the falling body, only one is realized every time and this is that of increase of speed proportional with time. What can be concluded from this observation is that gravitation is not the only one force acting upon the body in free fall, but a supplementary force must exist that acts oppositely to gravitation and limits its action so that the increase of the speed of the falling body is not faster than $u \propto t$. Since the free fall motion takes place in the Torricellian vacuum where only the aether and the falling body are present, this opposing force can be attributed solely to the action of the aether upon the moving body.

From the invariance of the free fall motion of bodies with their size, weight, chemical nature or other conceivable property, the above argument can be restated in terms of aether pressure to the effect that, for the case of free fall occurring in the Torricellian vacuum, the tendency of a material body to have its speed increase at infinite rate under the action of the aether pressure gradient $-\nabla p$ [3] will eventually be curbed down by the same aether, which is able to exert a pressure that equals $-\nabla p$ once the increase rate of the speed of the body becomes proportional with time. For obvious reasons, the former kind of pressure will be called static, the latter dynamic, and their equality yields the equation:

$$-\nabla p = \frac{du}{dt} \qquad \text{Eqn.1}$$

The above argument implies that there is a very short time interval of finite length between the moments of the release of the body from rest and its movement at speeds increasing at constant rate. Although no experiments have been made that study what happens during this interval of time, it can be stated that, in all probabilities, the presence of the aether and its ability to exert dynamical pressures will cause the speed of the body to increase following a continuous function of time, although the rate of this increase must necessarily be slower than $u \propto t$.

The resistance manifested by the aether towards the bodies in free fall in the Torricellian vacuum can be likened with that offered by air to bodies falling in atmosphere, although these forces are qualitatively different. In the latter case air acts on the body with forces whose magnitudes are proportional with some power of the speed of the body, while in the former the force is always proportional with the increase rate of its speed.

The experimental evidence (b) is significant in that it reveals the important fact that the aether exerts its static and dynamic pressures locally within the substance of the body, causing its motion as a whole, indifferent to the spatial distribution of matter relative to the trajectory of motion. This character of locality of the aether action can only be interpreted by admitting that the aether acts on every atom that makes up the substance of the falling body.

Equation 1 is therefore valid for every single atom of matter that composes the body in free fall under the action of an aether pressure gradient. Besides the fact that the equation serves to define the unit of measure for pressure equal to $1\, m^2 \cdot s^{-2}$, it can be seen that it actually leads to an equation between the aether parameters pressure and speed. Indeed, the movement of the atom through the aether implies that the former will successively occupy regions of space that have been occupied by the latter. The moving atom will set in motion the aether, giving rise to an aether velocity field dependent not only on the time but also on the spatial coordinates. Equation 1 becomes:

$$-\nabla p = \frac{\partial u}{\partial t} + u \cdot \nabla u \qquad \text{Eqn.2}$$

Further, if the fluid aether is considered in a state of rest at infinity, then all aether flows must be irrotational [4]:

$$\nabla \times u = 0 \qquad \text{Eqn.3}$$

This condition is fulfilled only if the speed u of the aether can be expressed in terms of a scalar function φ

$$u = \nabla \varphi \qquad \text{Eqn.4}$$

where the function φ is called velocity potential function. Considering eqn. 2 and eqn. 4, equation 1 becomes

$$-\nabla p = \nabla \frac{\partial \varphi}{\partial t} + u \cdot \nabla u \qquad \text{Eqn.5}$$

and integration yields,

$$p + \frac{u^2}{2} + \frac{\partial \varphi}{\partial t} = E(t) \qquad \text{Eqn.6}$$

showing the relation between the static and dynamic pressures that exist within the aether in motion with speeds variable in time.

Stationary aether flow conditions are described by the absence of pure accelerations, i.e.,

$$\partial u / \partial t = 0$$

In this situation eqn.2 becomes

$$\frac{du}{dt} = u \cdot \nabla u \,,$$

eqn.1 simplifies to

$$-\nabla p = u \cdot \nabla u \,,$$

and can be integrated to give

$$p + \frac{u^2}{2} = E \,. \qquad \text{Eqn.7}$$

Due to its resemblance with Bernoulli equation of hydrodynamics [5], eqn.7 it will be called the Bernoulli equation for the stationary aether, while the more general result of eqn.6 - the general Bernoulli equation for the aether.

The peculiarity of this equation rests in the fact that, unlike the Bernoulli equation obeyed by material fluids, the parameters mass or density of the aether do not enter the equation. This is because of the experimentally observed invariance of the motion of the bodies in free fall with their size, weight or chemical nature, that led to eqn.1 being actually an equation between aether parameters static pressure and speed. The absence of the parameters mass or aether density from Bernoulli equations for the aether is significant and shows that these physical quantities may not exist for the case of the aether. Whatever the case, it will become apparent in what follows that the parameters aether pressure and aether velocity are sufficient to obtain the law of motion for material bodies also known as Newton's second law.

In the same time, any investigation related to the cause that generates the existence of a static and a dynamic pressure in this medium is untimely at this stage due to the scarcity of information available regarding the aether. For now it may be sufficient that equations 6 and 7 have known and accepted equivalents in the mechanics of fluid media composed of material particles. The properties and general behavior of the aether was speculated upon on so many occasions throughout the history of science that a wiser approach would seem to be to postpone the assignment of any supplementary properties it might have once other phenomena occurring in the Torricellian vacuum have been discovered. Not every new phenomena may demand, however, that new properties be assigned to the aether. Such is the case, for example, of

Ampere's effect, which it was shown [6, 7] that it could be explained solely on the base of eqn.7. It is apparent in the same works that the long standing problem of propagation of waves in the aether is solved completely by allowing the aether motion to originate in the wake of a moving charge. No supplementary aether properties such as viscosity are necessary in order to account for the further propagation of this motion through the aether.

Lastly, the very important fact should be noted that, in deriving the above Bernoulli equations for the aether, no Newtonian concept was used. Not even the equality between the static and dynamic pressures was written following Newton's laws, but followed as a necessary inference from the fact that the latter must equal the former if the speed u of the free falling body is to obey the condition of increasing at the rate $u \propto t$. The notion of force, whenever mentioned, was not meant in the Newtonian sense, but with the broader meaning of a principle, or reason, that causes the motion of bodies. Quantifying this physical notion can be done by defining it in terms of pressure

$$F = p \cdot A \qquad \text{Eqn.8}$$

from which it can be seen that its unit of measure is $m^4 \cdot s^{-2}$. Its definition as a physical quantity will be given in the conclusions of this study.

Explaining the Effect of Inertia. The significance of mass

Inertia is the tendency of material bodies to keep their state of motion, or of rest. This tendency can be observed experimentally when, applying a force to a body to change its state of motion or of rest, the body seems to exert a resisting force that opposes it. Classical mechanics states that this is a property inherent to matter and is somehow related to the physical quantity mass, although it does not elaborate on why and how matter displays this behavior, or why it is permissible to assign *a priori* to matter this property. In this chapter it will be shown that this view is not tenable and that inertia is not due to mass, but to the interaction between the aether and the atoms composing the substance of the body. This will lead to the necessity of reconsidering what physical meaning, if any, can be attached to the notion of mass.

The important equation of motion for the aether was derived in the preceding chapter solely from its behavior inferred from observations on the free falling of bodies. Apart from this behavior, the aether was said to have the property of remaining in the volumes from which all mater was evacuated, i.e. in the Torricellian spaces, showing the property of incompressibility. This can be shown mathematically by considering a constant control volume w of space occupied by the aether. The total material derivative of the aether volume within w is zero:

$$\frac{Dw}{Dt} = \frac{\partial w}{\partial t} + w \cdot \nabla u = 0 \qquad \text{Eqn.9}$$

and yields

$$\nabla \cdot u = 0 \qquad \text{Eqn.10}$$

for the case of incompressible aether, in which $\partial w/\partial t = 0$.

Considering the above together with the property of aether flow to be irrotational (eqn.3 and eqn.4), the following equation is obtained

$$\nabla \cdot \nabla \varphi = 0,$$

This is equivalent with $\nabla^2 \varphi = 0$, and is often written as

$$\Delta \varphi = 0 \qquad \text{Eqn.11}$$

The above equation determines the motion of incompressible fluid aether and its solutions give the complete velocity field for such situations. It can be used, for example, to find the velocity distribution around a sphere of radius R and volume w moving through the fluid aether at the constant speed u. It can be shown that the solution of eqn.11 for this case is

$$\varphi = \frac{u}{2} \cdot \frac{R^3}{r^2} \cdot \cos\theta \qquad \text{Eqn.12}$$

Consider now the general case in which the speed of the sphere is variable. The conditions of irrotational flow and incompressibility of the aether still hold and eqn.12 is a solution for the instantaneous speed of the sphere.

The total force exerted upon the sphere is obtained by using the definition of the force given in eqn.8 and adding all the contributions of the pressures on the surface of the sphere, (see fig. 1):

$$D = \int_0^{\pi} p \cdot \cos\theta \cdot 2\pi \cdot R \cdot \sin\theta \cdot R \cdot d\theta \qquad \text{Eqn.13}$$

Using eqn.6, the general Bernoulli equation for the aether, and eqn.12 for the potential function φ, the pressure p is obtained as:

$$p = -\frac{1}{2} R \frac{\partial u}{\partial t} \cos\theta + \frac{9}{16} u^2 \cos 2\theta - \frac{u^2}{16} + p_0 \qquad \text{Eqn.14}$$

where p_0 is the aether pressure at infinity.

Equations 13 and 14 give for the force D the final result

$$D = \frac{2}{3} \cdot \pi \cdot R^3 \cdot \frac{\partial u}{\partial t} \qquad \text{Eqn.15}$$

which can be written as

$$D = \frac{w}{2} \cdot \frac{\partial u}{\partial t} \qquad \text{Eqn.16}$$

since $w = (4/3) \cdot \pi \cdot R^3$

The result is extremely important in that it shows that a sphere in motion through the aether encounters an opposing force from this medium that is proportional with the acceleration $\partial u/\partial t$ of the body, while no such force is detected for situations in which $u = const.$

Considering a solid composed of N such atoms, eqn.16 becomes:

$$D = \frac{N \cdot w}{2} \cdot \frac{\partial u}{\partial t} \qquad \text{Eqn.17}$$

which further shows that a solid body in accelerated motion through the aether receives from this medium a resistive force D proportional with the quantity of matter it contains and with the acceleration it moves. The quantity of matter contained in a body is defined here as the product of the number N of atoms composing the respective body and the volume w of one atom, having thus the physical meaning of the total volume of space occupied by its substance. This result is identical with that obtained in [3], where these quantities were related to the volume V of the macroscopic body through the quantity absolute density d mentioned in the introduction.

With these observations, it can be seen that eqn.17 represents in fact a mathematical proof of the inertia effect. Apart from its striking resemblance with the second law of motion which Newton introduced as a postulate, it can be seen that the constant of proportionality which Newton defined as mass corresponds to the quantity of matter as defined above. The fact that the calculations yielded for the constant of proportionality only half of the product $N \cdot w$ (eqn.17) is due to the ideal situation which was considered in which the macroscopic body is composed of spherical atoms, neglecting thus the existence of the chemical bonds that keep the atoms together. The geometry of these bonds may be approximated as cylinders that unite the composing atoms. This observation is relevant because the potential function for a cylinder is different from that for a sphere (eqn. 12) and is of the form:

$$\varphi = u \cdot \frac{R^2}{r} \cdot \cos\theta \qquad \text{Eqn.18}$$

Following the same calculations as above, it will be seen that the drag force for the case of a cylinder becomes proportional with the total volume dislocated in the aether by the chemical bonds [8]:

$$D = N \cdot w \cdot \frac{\partial u}{\partial t} \qquad \text{Eqn.19}$$

The conclusion is then that the force of resistance displayed by a material body when an external force acts upon it and tends to change its speed, the force of inertia that is, is actually a hydrodynamical effect occurring within the fluid aether. In fact, this effect is well known in the mechanics of fluid media, where it is observed that a solid body encounters a supplementary force of resistance from the fluid it is immersed in every time the respective body changes its speed, i.e. has non-zero acceleration. This is why it may seem more appropriate to call inertia an aetherodynamical effect, rather than saying that it is a hydrodynamical effect in the aether. In any case, the results presented above lead to the conclusion that a material body does not possess an intrinsic physical property called mass that causes the effect of inertia of the respective body. Instead, a material body is to be considered characterized only by the quantity of matter it contains and defined above, having the unit of measure m^3. The observed

tendency to keep its state of motion or to resist forces that tend to move it from rest is to be explained in terms of the interaction of its atoms with the fluid aether, which was elaborated on in detail in this chapter.

Conclusions

The present work discussed the movement of solid bodies through the fluid aether. The phenomena of free fall yielded the novel conclusion that the aether is capable of exerting a dynamical pressure on a body moving through it, from which a relation between the static and dynamic pressures that can exist within this medium was found. The equation of flow for the aether was found to be very similar with the equation discovered by Bernoulli in his studies on hydrodynamics.

A second result was the expression for the drag force on a spherical body moving through the incompressible aether. This force was shown to be proportional with the acceleration of the body, leading to a rational explanation for the effect of inertia and of the second law of motion of Newtonian mechanics.

All these arguments show that the notion of inertial mass is useless and have no physical significance. The same argument was made in [3] for the case of gravitational mass in the discussion of the Archimedic nature of the gravitational force. Both studies reached the same conclusion that the quantity of matter, or the amount of substance, contained in a body is given by product of the number N of atoms composing the respective body and the volume w of one atom, having therefore the unit of measure m^3. These offer support for the replacement of the base units kilogram and mole of the SI with that of m^3 to designate the amount of substance contained in a body.

These results show the necessity of changing the definitions of pressure and of force. Two proposals are formulated below:

1) $1\,m^2 \cdot s^{-2}$ is the aether pressure difference between two points of space situated $1\,m$ apart in Torricellian vacuum which causes a free body to move with a speed increasing at a rate of $1\,m \cdot s^{-2}$ (derived from eqn.1)

2) $1\,m^4 \cdot s^{-2}$ is the force equal to the weight of a system of N atoms of carbon 12 measured in a Torricellian vacuum where there is an aether pressure gradient of $1\,m \cdot s^{-2}$ (derived from eqn. $F_G = -\nabla p \cdot N \cdot w$ mentioned in introduction). In this definition the atom of carbon 12 is characterized by its radius in ground state and unbound, from which its volume w can be calculated. The numerical value of N, the number of atoms to be considered in the definition, is then equal to $1/w$.

Finally, the important observation should be made that, contrary to the common belief accepted today, the circumstances in which the motion of a body in free fall occurs are not identical with those of the motion of a body under the action of a constant force. The former

takes place under the combined action of an aether pressure gradient and the dynamic pressure of the aether, while the latter occurs in the aether at constant static pressure.

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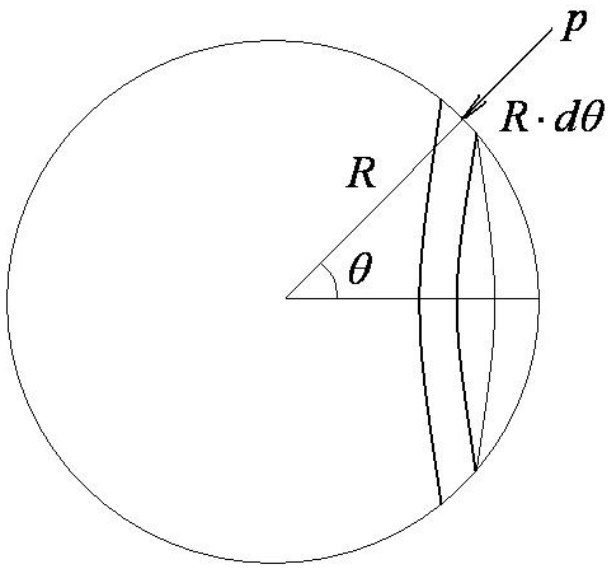
Fig. 1



Notes

The present article was submitted to the peer-reviewed journal Foundations of Physics (http://www.springer.com/physics/journal/10701) on the 1st of January 2008 and has been under review until the 11th of May 2008.

I reproduce below the Decision Letter by which I was informed that the article was found not appropriate for publication in the journal. I did not answer to this letter, but I want to use this opportunity to thank the editors of the journal for having had the curiosity to at least send this work out to reviewers and ask for their opinion. The only comments I received (from only one reviewer) did not invalidate this work. I want to thank this reviewer for his/her honesty.

It may be superfluous to restate my strong belief that the approach adopted in this paper constitutes the final answer to our ongoing problems with the understanding of the gravitational and inertial phenomena, that is the final solution to the problems that Newton left for us to solve. You, dear reader, be the judge.

From: "Foundations of Physics" <jenna.cataluna@springer.com>
To: nysics_central@yahoo.com
Date: 11 May 2008 16:28:12 -0400
Subject: Your Submission FOOP336

Dear Mr. Ionel Dinu,

We have received the reports from our advisors on your manuscript FOOP336 "New Fundaments for Classical Mechanics".

With regret, I must inform you that, based on the advice received, the Editors have decided that your manuscript cannot be accepted for publication in Foundations of Physics.

Below, please find the comments for your perusal.

I would like to thank you very much for forwarding your manuscript to us for consideration and wish you every success in finding an alternative place of publication.

With kind regards,
Gerard 't Hooft, Chief Editor

Comments for the Author:

Reviewer: This paper seeks to advance the author's research program of deriving the principles of Newtonian mechanics from the dynamics of a fluid aether. This program is being pursued independently of work in physics over the last hundred years and so fails to connect with the mainstream of modern physics. The work does not appear to be historical in motivation but appears to seek the true physical theory of gravitation and inertia. As a result, it is not appropriate for the journal Foundations of Physics.