Descartes, the Inventor of the Principle of *Inertia*

by Johann Marins¬ek

In mechanics the principle of inertia is the result of an erroneous thought-experiment *(Gedankenexperiment)* and not a law of experience. The inventor of the thought experiment was Descartes, Euler perfected it and postulated it as one of the fundamental laws of mechanics.

Instead of describing the origin of the principle of inertia in great detail, I will try to capture the essence of the doctrine through the assumptions and conclusions of the *Gedankenexperiment*:

First assumption:

Only one body is moving *in vacuo*.

Second assumption:

Velocity is a *state* of the body like its shape, its hardness or its colour.

That is to say: velocity is absolute and belongs to the body and is therefore without any relationship to other bodies. In other words: velocity is an intrinsic property of the body.

Third assumption:

The body is „dead“ and does not have inner forces in the meaning of *motor* or *impetus*.

First conclusion:

The state of velocity □**v** is persisting: **v** = *const*. Therefore, the motion continues in the present state of velocity, moving uniformly forward in a straight line. There is no sufficient reason for the body to change its state of velocity or its direction of movement.

Second conclusion:

Only an external force □**F** □can disturb the body persisting in its inert state (or in its laziness) □**v** = *const*., hence change this state. Without an accelerating or decelerating force □**F**,□the velocity and therefore also the momentum m**v** of the body is preserved: □m**v** = *const*. (m... mass).

Third conclusion:

The quantity of the force necessary for a change of velocity (acceleration) is proportional to the mass m of the body, mass being understood as the quantity of matter.

However, this is not a conclusion, but only a suggestion, because a valid reason is missing. Here real life practice suggested the idea.

One problem had to be solved by this doctrine: Even the smallest force would accelerate the biggest mass infinitely because the body does not have any support in the vacuum. In order to get rid of this difficulty, a persisting state of velocity or momentum was invented.

One had to pretend that the body resists the external force owing to this capability of persistence. But according to Euler the reaction of the body’s disturbed inertial

state to the external force can't be a real force because the inanimate matter does not have an internal force reacting „out of" the body.
The so called force of inertia is only the consequence of the disturbance of the state of laziness or *inertia* by the external force.
Conclusion: In classical inertial mechanics the so called force of inertia, namely the product mass times acceleration – m**a** – is an apparent force *(Scheinkraft),* not a real one.
Historic note: It was the reflection that the smallest force would accelerate the biggest body infinitely which Aristotle used as an argument against the possibility of a vacuum.
FORCELESS DYNAMICS?
If in the doctrine of inertia the term „ma" in Newton's second law of motion
F = m**a** it is not a real force, then the term „F" in the equation formula can't be a real force either because the equated terms „ma" and „F" have necessarily the same quality. Force or not force, that is the question!
This surprising epistemological result seems to be in contradiction to common sense and daily practice of physicists'.
Most physicists' make use of Newton's second law as follows: Mass times acceleration is equated with the sum of external forces, meaning that external forces are *real* forces.
But we must distinguish physicists' common sense from the inner logic of physics. If the inertial doctrine is accepted as a natural law then it follows necessarily that neither the so called inertial force nor any other forces are *real* ones.
And as a matter of fact forces as real existing entities have been eliminated in the development of mechanics. One reason for this elimination was the doctrine of inertia.
Another opposition against force as a primordial concept in physics came from the ideological battle of empirism against metaphysics and especially against occult qualities.
For example Schrödinger believed that positivism had banished the concept of force, *„the most dangerous remains of animism..."*
One method to banish force was to introduce force only as *„auxiliary variable"* (Kirchhoff and others) in order to simplify expressions.
In the same way Mach defined force as mass multiplied by acceleration,
meaning that „force" is only the name for the term „ma".
This nominal or abbreviational definition was part of Mach's instrumentalistic *„economy of thoughts"*.
On the other hand inertia is for Mach caused by all *„distant masses"*, therefore by *real* forces! Mach's *new* mechanics was confused: He denied the absurd explanation of inertia and replaced it by his reactive forces of *distant masses*, but by his nominal definition of „force" by „ma" the allegedly banished inertia came back in through the back door.

IN CLASSICAL MECHANICS FORCE IS DERIVED

In fact, in physics the term m**a** was baptized „force“, therefore force is a *derived* concept whereas mass is the *fundamental* concept.

The persistence of this error in the axiomatics of physics is irrefutably proven by the commonly accepted *dimension* of force: $[ML/T^2]$. That means that force has not a fundamental dimension [F] but only a derived one. The premise for a derived dimension for force is the definition of force in the nominal or in the essential meaning by the formula $F = m\mathbf{a}$.

But both the nominal definition and the definition of essence of force by m**a** are erroneous:

In a correct definition $\mathbf{F} \equiv m\mathbf{a}$, **F** should be logically independent from m. Because $m = E/c^2$, $dE = \mathbf{F} \bullet d\mathbf{r}$ the contrary is true.

The expression m**a** is not the force-law for any kind of force but a special force law, namely that for the *inertial force* in classical mechanics.

Force is not derivable and not explainable by mass. As for instance a „particle“ cannot have infinite hardness, we need forces for a causal explanation of the elasticity of matter. Therefore, force is prior to mass.

What Descartes, Euler and other physicists' present in their metaphysics of inertia, is not a conceptual hair-splitting without consequences. A confused thought experiment is one fundamental pillar of physics – with consequences that we have not overcome so far.

VELOCITY IS A RELATIONSHIP AND NOT AN ABSOLUTE STATE

It is an irony of the history of philosophy that some medieval scholastics (e. g. Blasius from Parma, Oresme, the Terminists of Paris) considered motion a steady absolute quality of the body.

The physics of modern times turned against occult qualities. The pretended persisting state of velocity, and therefore of the momentum of a body in the vacuum, however, is exemplary of occultism. Therefore, enlightenment against the darkness of erroneous metaphysics is necessary:

Firstly, thought experiments *in vacuo* (*nothing* by definition) cannot be carried out. Without nature no natural laws can be established. In the vacuum even velocity is not determined because there is no frame of reference.

Secondly, motion is relative, not absolute and belonging to the body. Thus, velocity cannot be an (absolute) state of the body. Thus, neither velocity nor momentum and kinetic energy are *states* or properties of *one* moving body.

The alledged natural law for the conservation of momentum in the absence of forces, $m\mathbf{v} = const.$, is *science fiction* based on a *Gedankenexperiment*.

In a *plenum* of anisotropic force-fields neither conservation of momentum nor acceleration on a straight line are possible.

The so called kinetic energy for example is in inertial mechanics only the defined energy of the inertial effect, namely

$$E_{kin} \equiv \int_0^1 m\mathbf{a}\,d\mathbf{r} = m(v_1^2 - v_0^2)/2.$$

In classical mechanics a moving body does not carry *kinetic* energy along with it. There is no possibility of storage of binding energy say by elastic deformation due

to acceleration because *in vacuo* deforming forces are absent. And the *apparent* inertial force cannot be a *working force!*

In classical mechanics only greater velocity causes greater energy, for instance in a collision.

Velocity is a relationship:

• relative velocity between bodies;

• relative velocity of the body with respect to the universe, this is the *real* velocity.

The expression *absolute velocity*, meaning the velocity referred to the universe is misleading because every velocity is *relative*. But as *façon de parler* „absolute velocity“ may be tolerated.

The universe is *absolute*. The universe as a whole is *immobile*. *Internal* motion is an essential quality of the universe. Motion cannot be an absolute state of *one* body. Therefore, the principle of inertia is based on a categorical error.

A body as part of the universe does not move uniformly on a straight line. *Natural* motion occurs on continuous curves with continuously changing velocity.

The so called forces of inertia are not apparent forces but real ones. The metaphysics of inertia does not give a causal explanation of those forces. It cannot be proven by a-priori reasoning that the force of inertia equals m**a**.

A perplexing property of the inertial force in classical mechanics is its independence of velocity.

But there is also no causal explanation possible that inertia works *in vacuo* according to the propageted formula „d(m**v**)/dt“ with a velocity dependent mass.

This formula has also by no means an electrodynamic foundation. But in the alleged derivation of the velocity dependent mass: m = m(v) the work of the inertial force is equated with the energy according to „E = mc^2“:

$$d(m\mathbf{v})/dt \bullet d\mathbf{r} = c^2 dm$$

But „E = mc^2“ is based on electrodynamics! The derivation mentioned therefore is wrong. It is not possible to compare apples with pears as an Austrian proverb says.

INERTIAL MASS: BASIS OF THE CGS-SYSTEM

Starting from the wrong metaphysics of inertia the following fundamental concepts of mechanics were postulated:

inertial mass, space and time.

Hence, force is not a fundamental concept and not an *essence* of physics, but force is only a derived concept in the axiomatics of mechanics.

As a result of being in the wrong system, force does not have its own *dimension* like time [T], space [L] and mass [M], but force has a dimension according to its definition $\mathbf{F} \equiv m\mathbf{a}$: [ML/T^2]. So we see that the cgs-system of units is based upon the wrong axioms of inertial metaphysics.

This gives a strange result for the law of gravity: If we put the dimensions in the formula $G\, m_1 m_2/r^2$ (G... dimensionsless magnitude; m_i... masses; r... distance) then we get [M^2/L^2] and not [ML/T^2], the dimension of force necessary by definition! The mistake was compensated by a second one: The dimension [L^3/MT^2] was ascribed to the dimensionsless magnitude G (which only depends

on the conventional cgs-system of standard units) so that the result is the correct dimension of force: $[ML/T^2]$.
Furthermore in today's accepted physics the inertial force is not supposed to be a real force. In relativistic papers you can find the apparent inertial force in addition to the forces coming from distant masses according to Mach, which should be the „proper" forces of inertia. [13]
According to perfect *geometricism,* the inert motion persists on „straight" lines of curved space-time.
Real force was rejected reputedly being an occult, „metaphysical" concept. Yes, forces cannot be seen but they can be felt and measured all right. Incidentally, it might be difficult to explain static tension by the doctrine of inertia!

FORCE IS FUNDAMENTAL AND NOT INERTIAL MASS

As a first consequence of the erroneous metaphysics of inertia, mechanics has to be rewritten. The law of motion must be understood as a force law:

$$\sum \mathbf{F}_{\text{active external forces}} = \mathbf{F}_{\text{reactive „inertial force"}}$$

Second, for the axiomatic system of concepts and for the system of units, force has to be set fundamental. This follows from conceptual con-siderations within macrophysics, no reference to modern microphysics is necessary.
Force can be defined by the following reference: *this* here is force! and by some further explanations: Force is a vector magnitude. Force can be directly measured. In contrast, mass as quantity of matter cannot be explained without any knowledge of the nature of matter.
However mass is measurable only by forces. Mass is explainable as a scalar magnitude in force-laws.
Force-laws must be discovered by a combination of theoretical reasoning and experiment.
Later in the history of physics, mass was related to energy: $m = E/c^2$.
Because energy is definded by

$$E \equiv \int \mathbf{F} \bullet d\mathbf{r} \quad [F][L] \quad (F \ldots \text{the fundamental dimension for force})$$

it is also comprehensible that mass is a derived concept and force a fundamental one.

A CAUSAL EXPLANATION OF „INERTIAL FORCE"

Bergman and Wesley succeded in showing that inertia is not an intrinsic property of matter in the sense of inertial mechanics and that the so called inertial forces are real forces. Their argument is not based on a conceptual analysis of the axioms of classical mechanics but on a quasi electrodynamic mechanism for moving charged particles which they showed to be the cause for the inertial effect. The quantity of inertial force depends upon velocity and acceleration.

This causal explanation of inertial forces as real selfinduced reaction forces is based on electrodynamic effects on the spinning charged ring model of elementary particles like the electron or the positron.
According to this explanation, inertial mass is a derived concept and not a fundamental one. Because primary electrodynamic force laws determine inertial mass, force is necessarily the fundamental concept in physics.
This conclusion is in accordance with the conceptual analysis of classical physics given above.
The ring model of the electron is a big step forward for a causal explanation of *substance* by electrodynamics, i. e. to explain stable „particles" as *field patterns* of the force field. In a unified electromagnetic force-field theory is no place for confusing dualities like particles/field or carrier/field. Replacing the mechanical ether as carrier by an electromagnetical ether would repeat earlier conceptual confusions. There is no carrier for electomagnetic fields, they themselves are the „building material" of our universe.

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