On centrifugal forces and Newton Third Law of Mechanics

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Abstract: This article presents two brief arguments regarding the reality of centrifugal forces: the first based on Newton's Third Law of Mechanics, and the second on the Law of Dimensional Homogeneity. As a consequence, either centrifugal forces are real, or both the Law of Action and Reaction and the Law of Dimensional Homogeneity are not universal laws.

Keywords: Centrifugal forces, Newton's Third Law of Mechanics, Law of Dimensional Homogeneity.

1. Introduction

The content of this article is a clear consequence of what happens when insufficient attention is paid to the use of language—whether formal or colloquial—in the development of a science, as is the case with contemporary physics, in which physicists simply "shut up and calculate" [2]. A situation already denounced by other authors far more prominent than myself [1, p. xiv]. A particularly serious case is that of centrifugal forces, repeatedly declared to be fictitious forces, yet which contemporary physics continues to use in relation to certain aspects of rotational motion. Why does it do so? Why does not it give a name to these "observable effects" of rotational motion and stop using fictitious concepts and magnitudes?

> Centrifugal force is introduced as A FICTITIOUS FORCE, BUT WITH REAL PHYSICAL EFFECTS... Clear conclusion: IT IS NOT A FUNDAMENTAL FORCE, BUT ITS EFFECTS ARE NOT IMAGINARY (ChatGPT 5.4).

The suspicion that something was amiss in this matter motivated me to investigate it (in formal terms), and here I present the results, which, as you will see, are highly significant both for physics and for the behavior of physicists. I assume it is not necessary to recall here neither Newton Third Law of mechanics nor the Law of Dimensional Homogeneity.

2. On the reality of centrifugal forces: proof 1

FORMAL SCENARIO: Consider an elongated arm A fixed at one end to the axis of rotation E of a motor M attached to a fixed base. Arm A rotates at the same rotational speed as the axis E when the motor M starts. Suppose that, with the motor stopped, we place a solid S on arm A near the axis of rotation E, such that when the motor starts, and due to the frictional force $\mathbf{F}_f$ between S and A, solid S does not move on arm A but rotates together with arm A around the axis E. Both S and A are subject to real centripetal forces that enable their continuous changes in direction during their respective rotations. On the other hand, the state of rest of S relative to arm A, or the motion of S along A, will be observed both by observers outside the rotating reference frame and by observers inside the rotating reference frame who are fixed to arm A.

The central idea of this argument is that the real centripetal forces acting on A and on S cause Newtonian reactions (Newton's Third Law of Mechanics) in the other body with which each of them is in mechanical contact: respectively S and A. According to Newton's Law of Action and Reaction, arm A exerts on S a real force equal to its centripetal force, and in response S exerts on A an equal and opposite real force; however, A cannot move in response to that real force because it is physically attached to the axis of the stationary motor M. For its part, S exerts on A a real force equal to its real centripetal force, and by the same Newtonian law, A exerts on S an equal and opposite real force. But S could move in response to that real force if the frictional force between A and S allowed it. We can move S away from the axis of rotation E until the reaction force of A

on S overcomes the frictional force between the two physical objects, and under these conditions S will move in a radial and centrifugal direction. Consequently, the reaction force exerted by A on S is a real force that causes the real, radial and centrifugal motion of S. It seems appropriate to call the force exerted by A on S centrifugal force.

The above argument would also explain why these two forces, centripetal $\mathbf{F}_{cp}$ and centrifugal $\mathbf{F}_{cf}$, have the same mathematical expression: $\mathbf{F}_{cp} = \mathbf{F}_{cf} = m\,\omega^2\mathbf{r}\ \ Kg\,m/s^2$, where m is the mass of S, ω the rotation velocity, and r the turning radius of S. The above argument is a beautiful and unexpected confirmation of Newton's Third Law of mechanics. The alternative would be that Newton's Third Laws of mechanics is not a universal law, and its exceptions should be explicitly declared.

3. On the reality of centrifugal forces: proof 2

In the above formal scenario of proof 1, consider the following physical facts:

1.- On solid S a real and radial centripetal force $\mathbf{F}_{cp}$ acts, responsible for its continuous change of direction. Suppose we slowly increase the angular velocity ω until S begins to move radially and centrifugally.

2.- According to the Law of Dimensional Homogeneity, if there is movement of S on the arm A, the friction force $\mathbf{F}_f$ between S and A (with dimensional equation MLT^{-2}) must be subtracted from another force with the same dimensional equation MLT^{-2} as the friction force $\mathbf{F}_f$, and only from another force with the same dimensional equation MLT^{-2} as the friction force $\mathbf{F}_f$ (Law of Dimensional Homogeneity).

3.- Therefore, neither inertia (with dimensional equation M) nor the moment of inertia (with dimensional equation ML^2) can be the cause of the centrifugal movement of S. It must be a force with the same dimensional equation MLT^{-2} as the friction force $\mathbf{F}_f$.

4.- Consequently, and taking into account that the movement of S is always radial and centrifugal, the force responsible for that observed movement of S can only be a force MLT^{-2} with a radial direction, a centrifugal sense, and a magnitude greater than the magnitude of the friction force $\mathbf{F}_f$.

5.- Considering its vectorial characteristics, it seems appropriate to call the real force responsible for the observed real motion of S on the arm A CENTRIFUGAL FORCE $\mathbf{F}_{cf}$.

The only alternative to the previous argument would be that the Law of Dimensional Homogeneity is not a universal law of physics, and that the frictional force MLT^{-2} could be subtracted from other physical magnitudes with dimensional equations different from MLT^{-2}. In that case, exceptions to the Law of Dimensional Homogeneity would have to be explicitly stated, which is not the case in contemporary physics.

Bibliographical References

[1] T. Maudlin. *Philosophy of Pysics. Space and Time*. Princeton University Press, New Jersey, 2015.

[2] N. D. Mermin. Could feynman have said this? *Physics Today*, pages 10–11, 2004.