International Journal of Advanced Engineering and Management Research

Vol. 9, No. 06; 2024

ISSN: 2456-3676

The Coriolis Force Does Not Exist

Duc Thanh Le[1], Thuy Thi Thu Le[2]

[1]University of Transport Ho Chi Minh City,

Ho Chi Minh, Vietnam

[2]University of Transport and Communications

No. 3, Cau Giay Street, Lang Thuong Ward, Dong Da District, Hanoi 100000, Vietnam

doi.org/10.51505/ijaemr.2024.9605 URL: http://dx.doi.org/10.51505/ijaemr.2024.9605

Received: Oct 30, 2024 Accepted: Nov 05, 2024 Online Published: Nov 23, 2024

Abstract

The Coriolis force has existed for a long time, and current physics recognizes the existence of this force. This study aims to prove that the Coriolis force does not exist, contributing to knowledge related to physics. The author points out fundamental mistakes about the Coriolis force/acceleration in classic problems. These problems are in textbooks of prestigious universities or reputable publishers. These examples clarify the confusion about the existence of the Coriolis acceleration. To further strengthen the argument of the proof, the article analyzes the nature of the phenomena that are the origin of the Coriolis force, leading to misunderstandings. The main result of this study is to provide solid theoretical foundations that are useful for theoretical physicists and applied science and technology. For example, understanding the nature of physics will be an essential basis for developing the following theory, making more accurate weather forecast models, or helping calculate factors that affect spacecraft launches. Although the author asserts that the Coriolis force does not exist in theory, it still needs to be tested experimentally. The Coriolis acceleration has existed since the 19th century (1835). Therefore, proving that the Coriolis force does not exist is very important.

Keywords: Classical Physics, Coriolis, force, prove, non-existence

1. Introduction

Classic textbooks define the Coriolis acceleration as follows:

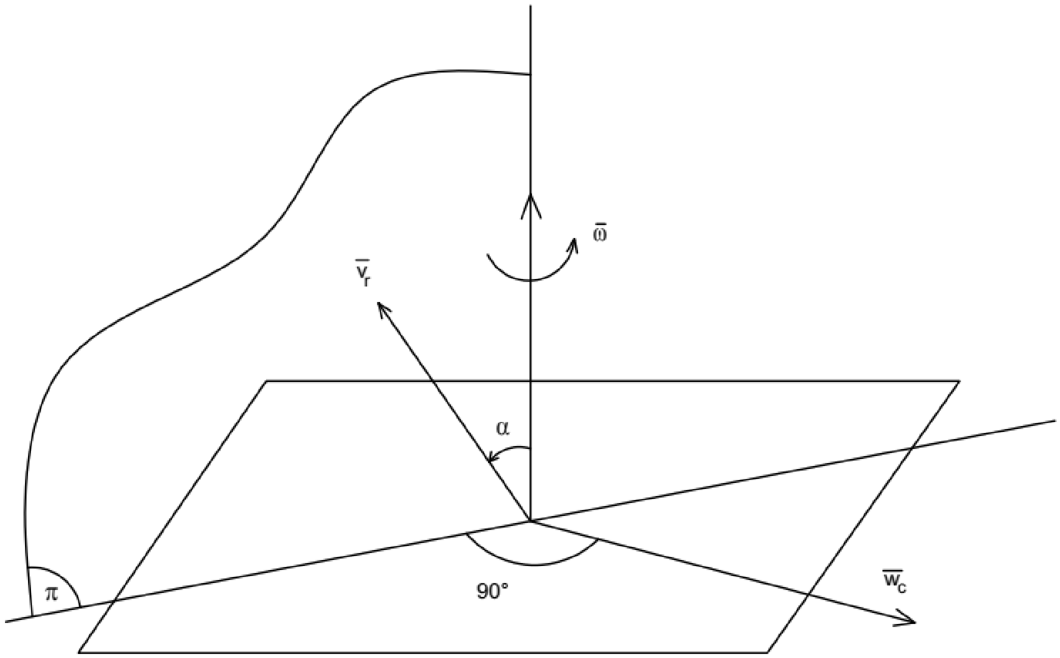

Figure 1 - Diagram depicting Coriolis acceleration (Coriolis force)

$\bar{w}_c$ is the Coriolis acceleration (which generates the Coriolis force), which is calculated as follows:

$\bar{w}_c = 2(\bar{\omega} \times \bar{v}_r)$

Science is currently facing difficulties when considering and studying atmospheric currents moving on Earth, ocean currents in the sea, meteorological and hydrological phenomena, storms and floods. Even in technological fields such as aircraft design or spacecraft launch, science currently does not achieve complete control of the surrounding environment when these devices operate. This is because scientific knowledge related to these issues is lacking or, more seriously, wrong. This is directly related to human life. This understanding also reduces losses of money and time.

Coriolis force is related to the above problems. For a long time, people have misunderstood its existence. Coriolis force is an force that does not exist in reality.

2. Method

Examples of classic problems that lead to misunderstandings about the existence of Coriolis force will be proven and corrected so that the models become correct. The origin of this force will be described, and unreasonable points will be pointed out.

Coriolis believes that when mass m is simultaneously affected by rotation angle and translational velocity v, a force will arise (called Coriolis). But actually, no force arises at all.

Until now, there have not been any computer systems and sensors to measure this force.
The Coriolis force usually considers the rotating frame of reference, the Earth. When the Earth rotates, the air frictions with the ground (because the ground is uneven) will, therefore, be pulled along with this rotation. To make it easier to imagine, let us look at the description below.
Consider the Earth's atmosphere to consist of layers of air. Due to inertial forces, the air layers above will move more slowly than the layer in contact with the ground.

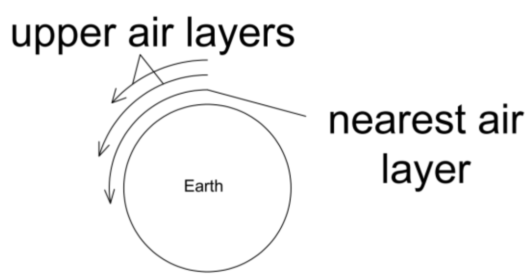

Figure 2 - Illustration of uneven velocity between air layers as the earth rotates.

The Earth rotates around the North-South axis. Therefore, points located on or near the equator will move faster than points at other latitudes.

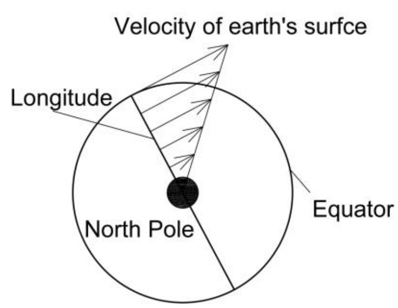

Figure 3 – The velocity of the earth's surface corresponds to different latitudes

This effect, along with friction and inertial forces of air masses and gas layers, is the direct cause of movement, as depicted in the drawing below.

ISSN: 2456-3676

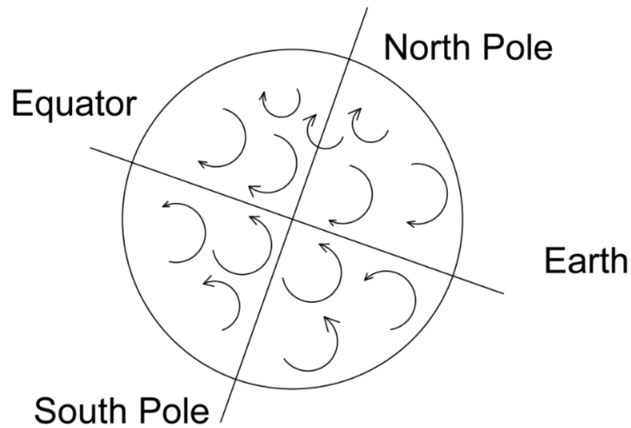

Figure 4 - Effect of speed variation with latitude

This confused scientists for a long time, as it created the effect purely as an imaginary Coriolis force. Air convection is also the cause of Coriolis's misunderstanding. Thermal radiation occurs faster in the upper air layers closer to the sun, so the layers are colder and have a higher density. As a consequence, these layers of air tend to sink, pushing lighter layers of hot air upward. These processes take place continuously, causing an impact on the movement of gas flows.

In addition to the above factors, there are a few other influential effects. For example, the Earth receives different amounts of heat in winter and summer. However, within the framework of this article, mentioning those effects is not necessary.

For ocean currents at sea, the above rules also follow. Those rules are:

- Convection of hot and cold seawater.
- The Earth's rotation causes the inertial force of ocean water. This inertia force is influenced by latitude. Different rotation speeds, leading to different seawater velocities, interactions between forces (mainly inertial forces) and rotation speeds contribute to shaping the flow direction of ocean currents.

In classic physics, the Coriolis force is relied on to explain the phenomenon. But we see that, without the existence of the Coriolis force, the above effects still exist and still fully explain the phenomenon proposed by Coriolis.

It should also be added that tides are also an important factor affecting ocean currents. The article does not mention this factor.

In the case of launching a spacecraft, the centrifugal force caused by the rotation of the earth is the main factor. In addition, the impact is caused by the atmosphere. There is always an atmosphere surrounding the ship when launched. Due to the effects mentioned above, the atmosphere affects the ship's trajectory.

Regarding the flight trajectory of an aircraft or the trajectory of a bullet fired by artillery, the same phenomena occur as when launching a spaceship.

Next, we will see a few example cases from reference documents to clearly see the problem:

2.1 Problem 1: Excercise 1099 [8]

A body is dropped from rest at a height h above the surface of the earth and at a latitude $40^0 N$. For h = 100 m calculate the lateral displacement of the point of impact due to the Coriolis force. (Columbia)

Solution of the book [8]: If the body has mass m, in the rotating frame of the earth, a Coriolis force, -2mw × r˙ is seen to act on the body. We choose a frame with origin at the point on the earth's surface below the starting point of the body, with z-axis pointing south, y-axis pointing east and z-axis pointing vertically up. (Fig. 1.71). Then the equation of the motion of the body in the earth frame is

$$m\ddot{r} = -mgk - 2m\omega \times \dot{r}$$

$$= -mgk - 2m\begin{vmatrix} i & j & k \\ -\omega\cos 40^0 & 0 & \omega\sin 40^0 \\ \dot{x} & \dot{y} & \dot{z} \end{vmatrix}$$

From the above, expressions for $\ddot{x}$, $\ddot{y}$ and $\ddot{z}$, can be obtained, which are readily integrated to give $\dot{x}$, $\dot{y}$, and $\dot{z}$. These results are then used in the expressions for $\ddot{x}$, $\ddot{y}$ and $\ddot{z}$.

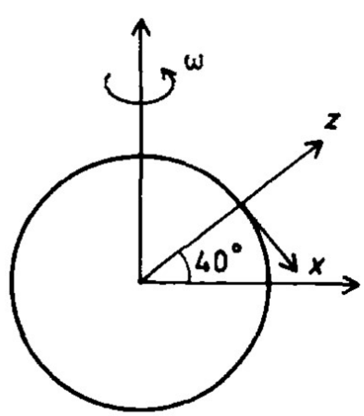

Figure 5. Illustration of parameters in the example.

As the time of the drop of the body is short compared with the period of rotation of the Earth, we can ignore terms of order ω^2 and write the following:

$$\ddot{x} = 0$$

$$\ddot{y} = 2gt\omega\cos 40^0$$

$$\ddot{z} = -g$$

Integrating the above twice and using the initial conditions, we obtain

$$x = 0$$

$$y = \frac{1}{3} g t^2 \omega \cos 40^0$$

$$z - h = -\frac{gt^2}{2}$$

The last equation gives the time of arrival of the body at the earth's surface z = 0

$$t = \sqrt{\frac{2h}{g}}$$

Then the lateral displacement of the body at impact is

$$y = \frac{1}{3}\sqrt{\frac{8h^3}{g}}\omega \cos 40^0 = 0.017m$$

2.2 Problem 2: Excercise 1101[8]

Under especially favourable conditions, an ocean current circulating counter-clockwise when viewed from directly overhead was discovered in a well-isolated layer beneath the surface. The period of rotation was 14 hours. At what latitude and in which hemisphere was the current detected ?

Solution of the book [8]:

We choose a coordinate frame attached to the earth with origin at the point on the earth's surface where the ocean current is, x-axis pointing south, y-axis pointing east and z-axis pointing vertically upward. The circulation in the ocean is due to the Coriolis force which causes an additional acceleration:

$$a = -2\omega \times v$$

Where $\omega = \omega \cos\theta i + \omega \sin\theta k$ is the earth's rotational angular velocity, θ is the latitude and v is the velocity of ocean current. Thus:

$$a = -2\omega \begin{vmatrix} i & j & k \\ -\cos\theta & 0 & \sin\theta \\ v_x & v_y & 0 \end{vmatrix}$$

The horizontal component of the acceleration which effects the circulation of ocean current is

$$a_H = -2\omega \sin\theta(-v_y i + v_x j) = -2\omega_z k \times v$$

ISSN: 2456-3676

As a_H is always normal to v,it does not change the magnitude of the latter but only its direction. It causes the current to circulate in a circular path. Let Ω be the angular velocity of the circular motion. Then

$$|a_H| = 2\omega v \sin\theta = \frac{v^2}{r} = v\Omega$$

where r is the radius of the circular path. Hence:

$$\sin\theta = \frac{\Omega}{2\omega} = \frac{2\pi}{14}.\frac{24}{4\pi} = \frac{6}{7}$$

If the ocean current is on the northern hemisphere, ωzk points toward the north pole and aH always points to the right of the velocity v. This makes v turn right and gives rise to clockwise circulation. In a similar way, in the southern hemisphere, the Coriolis force causes counter-clockwise circulation. Hence, the circulating ocean current was detected at a latitude of $59^0 S$

<u>The author of this article remarks:</u> In the solution of the above example, there is a problem: If the Coriolis force changes the flow trajectory, it means it does work. So, according to the energy conservation law, where does that work get the energy from? .

2.3 Problem 3: Foucault's Pendulum [9]

This is the classic example of a consequence of the Coriolis force. It unequivocally shows that the earth rotates. The basic idea is that due to the rotation of the earth, the plane of a swinging pendulum rotates slowly, with a calculable frequency. In the special case where the pendulum is at one of the poles, this rotation is easy to understand. Consider the North Pole. An external observer, hovering above the north pole and watching the earth rotate, sees the pendulum's plane stay fixed (with respect to the distant stars) while the earth rotates counterclockwise beneath it. Therefore, to an observer on the earth, the pendulum's plane rotates clockwise (viewed from above). The frequency of this rotation is of course just the frequency of the earth's rotation, so the earth-based observer sees the pendulum's plane make one revolution each day.

The author of this article remarks: Foucault's pendulum has been misunderstood. When the pendulum is at the North or South pole. There will be force components appearing.

• One is caused by gravity.
• Second, it is caused by centrifugal force. P¬cent
• Third, due to the inertial force of the surrounding environment (e.g., air) acting on the weight of the pendulum. This inertial force arises when the earth rotates, dragging the air environment along (this phenomenon was mentioned above)

The author does not have the conditions to experiment within the framework of this article. But it can be affirmed that putting the Foucault pendulum in an airless environment means eliminating the influence of inertial force caused by air. The Coriolis force will disappear.

Vol. 9, No. 06; 2024

ISSN: 2456-3676

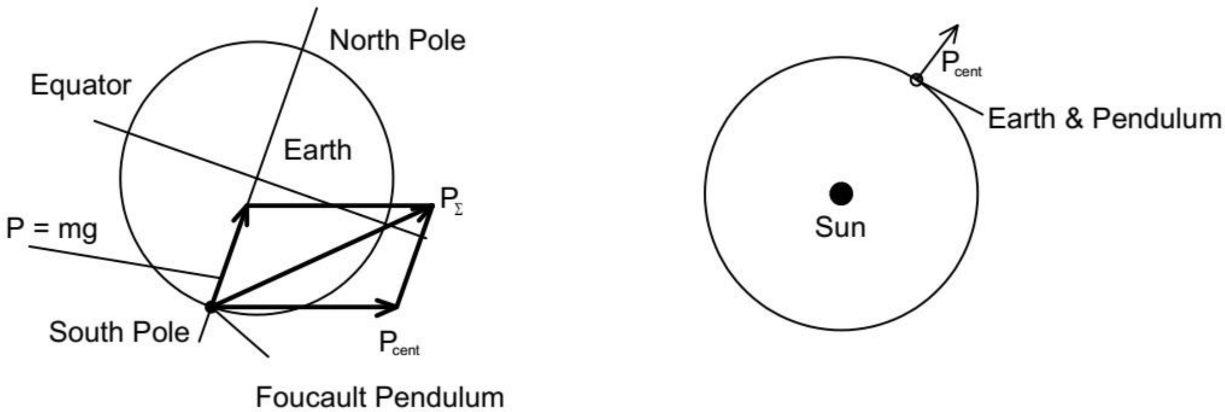

Figure 6 - Diagram depicting the force affecting the Foucault pendulum.

When the Foucault pendulum is brought to the equator, as shown below:

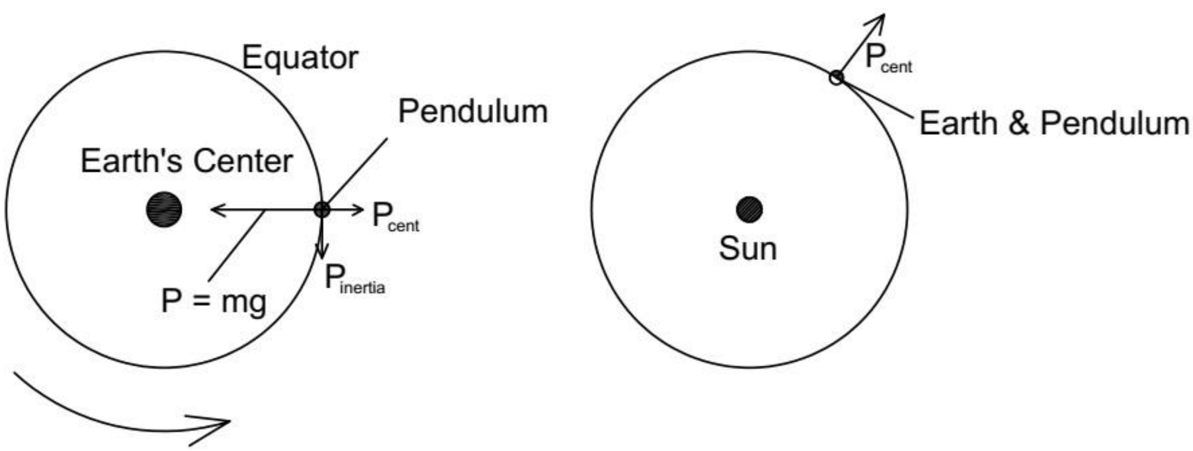

Figure 7 - Forces acting when the Foucault pendulum is placed at the equator

3. Result and Discussion

It also needs to be added that: At the time of the birth of the Coriolis force, modern measuring tools did not exist and related knowledge was not yet complete. For the design of machine mechanisms and machine parts with complex orbits and continuous direction changes. Measuring force creates difficulties, leading to the inability to verify correctness or error when applied. Measurement is even more difficult at large scales (for example, meteorological phenomena and ocean currents).

ISSN: 2456-3676

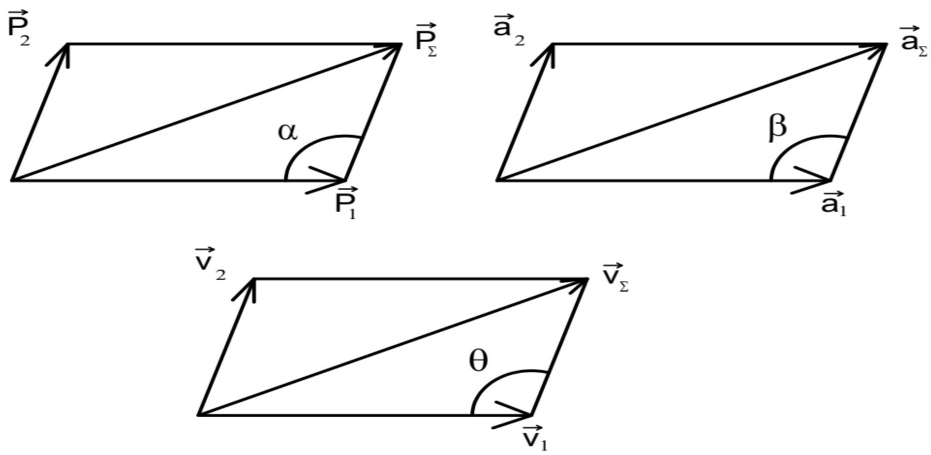

Figure 8 - Alternative calculation method when Coriolis force disappear

Use mathematical knowledge to calculate the required total vector

$$\vec{P}_\Sigma = \vec{P}_1 + \vec{P}_2 \Rightarrow P_\Sigma^2 = P_1^2 + P_2^2 - 2P_1.P_2 \cos\alpha$$

$$\vec{a}_\Sigma = \vec{a}_1 + \vec{a}_2 \Rightarrow a_\Sigma^2 = a_1^2 + a_2^2 - 2a_1.a_2 \cos\beta$$

$$\vec{v}_\Sigma = \vec{v}_1 + \vec{v}_2 \Rightarrow v_\Sigma^2 = v_1^2 + v_2^2 - 2v_1.v_2 \cos\theta$$

P: force, v: velocity, a: acceleration.

The above recommendation is the basis for completely ending problems related to the Coriolis force

References

Wikibook: https://en.m.wikipedia.org/wiki/Coriolis_force.

LATEX (Wikibook), <http://en.wikibooks.org/wiki/LaTeX/>.

Dietrich Belitz, Lectures on Theoretical Mechanics, (Department of Physics, University of Oregon).

Tom W.B. Kibble, Frank H. Berkshire, Classical Mechanics, 5th edition, Imperial College Press.(2004)

A.P. French, M.G. Ebison Introduction to CLASSICAL MECHANICS, Kluwer Academic Publishers.(2001)

Herbert GoldStein, Charles Poole, John Safko Classical Mechanics, 3rd edition, Pearson.(2002)

Sophie Goldie, Series Editor: Roger Porkess Mechanics, Hodder Education, an Hachette UK company.(2012)

Refereed by: QiangYuan-qi, Gu En-pu, Cheng Jia-fu, ti Ze-hua,Ylang De-tian, edited by: LirnYung-kuo Problems and Solutions on Mechanics, World Scientific Publishing Co. Pte. Ltd (2002)

David Morin, Introduction to Classical Mechanics With Problems and Solutions Harvard University, Cambridge University Press, 2007 p.467