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# Approximate Inertial Coordinate System Selections for Rotation Problems

*- The Gravitational Field of the Celestial Body Higher than the Object Being Rotated*

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**Abstract**

Selection of the coordinate system is essential for rotation problems. Otherwise, mistakes may occur due to inaccurate measurement of angular speed. Approximate inertial coordinate system selections for rotation problems should be the gravitational field of the celestial body higher than the object being rotated: (1) the Earth fixed Cartesian coordinate system for normal rotation problem; (2) heliocentric - geocentric Cartesian coordinate system for satellites orbiting the Earth; (3) the Galaxy Heart - heliocentric Cartesian coordinates for Earth's rotation around the Sun. In astrophysics, mass calculation error and angular velocity measurement error lead to a black hole conjecture.

**Keywords** rotation; inertia; coordinate system; angular velocity; gravitational field; black hole

Centrifugal force formula (Cheng & Jiang, 1979)

$$F = m\omega^2 R \tag{1}$$

in which $F$ is centrifugal force, $m$ is mass, $\omega$ is angular velocity, $R$ is gyration radius.

A ball turns around an axis with angular velocity $\omega_a$. The axis rotates with the Earth with angular velocity $\omega_e$. The Earth rotates around the Sun with angular velocity $\omega_s$. The solar system rotates around the Milky Way with angular velocity $\omega_g$ ……. Thus, total angular velocity

$$\omega = \omega_a + \omega_e + \omega_s + \omega_g + \ldots\ldots \tag{2}$$

will be an infinite value.

Total centrifugal force

$$\mathbf{F} = m[(\boldsymbol{\omega}_a \bullet \boldsymbol{\omega}_a)\mathbf{R}_a + (\boldsymbol{\omega}_e \bullet \boldsymbol{\omega}_e)\mathbf{R}_e + (\boldsymbol{\omega}_s \bullet \boldsymbol{\omega}_s)\mathbf{R}_s + (\boldsymbol{\omega}_g \bullet \boldsymbol{\omega}_g)\mathbf{R}_g + \ldots\ldots] \tag{3}$$

in which $F$ is vector of total centrifugal force, $R_a$ is vector of gyration radius of the ball turns around the axis, $R_e$ is vector of gyration radius of the axis rotates with the Earth, $R_s$ is vector of gyration radius of the Earth rotates around the Sun, $R_g$ is vector of gyration radius of the solar system rotates around the Milky Way. It will also contain unlimited items.

Only in the inertial coordinate system (Zhao & Luo, 1995a, 1995b), formula (1) and formula (3) are set up. In formula (1) and formula (3), mass $m$ is a known quantity, gyration radius is a known quantity. How to determine the angular velocity? How to select an approximate inertial coordinate system to make centrifugal force can be calculated and has a certain accuracy?

## 1. Normal Rotation Problem- the Earth Fixed Cartesian Coordinate System

The problem discussed here is the general rotation on the Earth. Then, gyration radius $R_a$ is much smaller than the radius of the Earth. For such problems, Cartesian coordinate system can be fixed on the Earth, as shown in Figure 1. It is only needed that the Cartesian coordinate system fixed on the Earth and to move together with the

Earth. Only consider the role of $\omega_a$, while ignoring the Earth's rotation itself and the Earth's rotation around the Sun. In such problems, the Cartesian coordinate system cannot be rotated together with the ball.

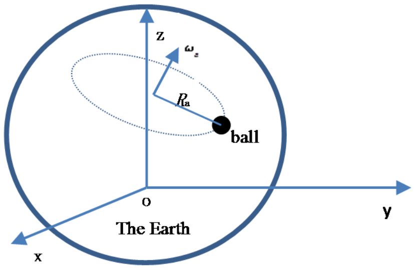


Figure 1. Coordinate system for normal rotation problem

**2. Satellites Orbiting the Earth-Heliocentric-Geocentric Cartesian Coordinate System**

For problems such as satellites orbiting the earth, gyration radius $R_e$ is not much smaller than the radius of the Earth, or even hundreds of times larger than that. For such problems, heliocentric-geocentric Cartesian coordinate system can be used as shown in Figure 2. Take the origin O of coordinates at the Sun centroid; Z-axis as the Sun centroid - centroid Earth connection; Y-axis through the centroid of the Sun, in the plane of the Earth revolves around the Sun, and perpendicular to the Z axis; X-axis through the centroid of the Sun, perpendicular to the Earth's orbital plane around the Sun; OXYZ is right-handed Cartesian coordinate system.

Only consider the role of $\omega_e$, while ignoring the Earth's rotation around the Sun, etc. In such problems, the Cartesian coordinate system cannot be fixed on the Earth. Otherwise, there will be synchronous satellite rotational angular velocity is zero - satellite falls errors.

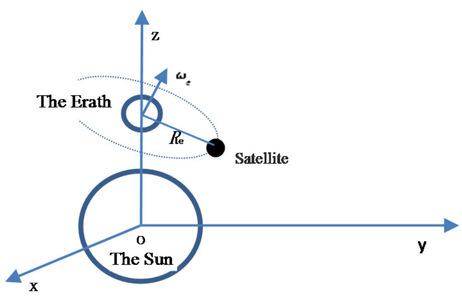


Figure 2. Coordinate system for satellites orbiting the Earth

**3 Earth's Rotation Around the Sun- the Galaxy Heart - Heliocentric Cartesian Coordinates**

Gyration radius $R_s$ is larger than the Sun's radius. Such problems can use Galactic center - heliocentric Cartesian coordinates, as shown in Figure 3. Take the origin O of coordinates at the Galaxy centroid; Z-axis is Galaxy centroid – Sun centroid connection; Y-axis through the centroid of the Galaxy, in the plane of the Sun revolves around the Galaxy, and perpendicular to the Z axis; X-axis through the centroid of the Galaxy, perpendicular to the Sun's orbital plane around the Galaxy; OXYZ is right-handed Cartesian coordinate system.

Only consider the role of $\omega_s$, while ignoring the Sun's rotation around the Galaxy, etc. In such problems, heliocentric - geocentric Cartesian coordinate system cannot be selected. Otherwise, the angular velocity of the Earth revolves around the Sun would be zero.

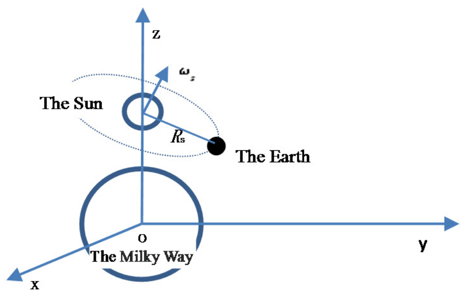


Figure 3. Cartesian coordinates for Earth's rotation around the Sun

## 4. Coordinate System Selection Rule- the Gravitational Field of the celestial body higher than the Object Being Rotated

It can be seen from the above three examples that the angular velocity in the formula of the centrifugal force is relative to the gravitational field of the celestial body higher than the object being rotated: (1) the earth fixed Cartesian coordinate system for normal rotation problem; (2) heliocentric - geocentric Cartesian coordinate system for satellites orbiting the Earth; (3) the Galaxy Heart - heliocentric Cartesian coordinates for Earth's rotation around the Sun.

## 5. Astronomical Mass Calculation Error and Angular Velocity Measurement Error Lead to a Black Hole Conjecture

For the problem of celestial bodies orbiting, the centrifugal force should be equal to gravitation force (Cheng & Jiang, 1979)

$$m_1\omega^2 R_1 = \frac{Gm_1 M}{R_1^2} \tag{4}$$

in which $m_1$ is the mass of orbiting celestial body, $R_1$ is the orbiting radius， $G$ is the gravitational constant, $M$ is the mass of the celestial body being orbited.

Sometimes, due to $\omega$ measurement error and $M$ calculation error，results in

$$m_1\omega^2 R_1 > \frac{Gm_1 M}{R_1^2} \tag{5}$$

The centrifugal force is larger than gravitation force. This is not allowed. Thus, astronomers suspect that there is a black hole with a mass of $M_b$ in the body of celestial being d orbited (Li, 2009a, 2009b), makes

$$m_1\omega^2 R_1 = \frac{Gm_1(M + M_b)}{R_1^2} \tag{6}$$

This is the black hole conjecture.

In fact，the reason resulting (5) is mass calculation error and/or $\omega$ measurement error, and/or $G$ has been changed. This paper argues that the main factor is $\omega$ measurement error.

## 6. Conclusions

Approximate inertial coordinate system selections for rotation problems should be the gravitational field of the celestial body higher than the object being rotated. In astrophysics, mass calculation error and angular velocity measurement error lead to a black hole conjecture.

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