IJESKA
contribution to science

International Journal of Earth Sciences Knowledge and Applications
journal homepage: http://www.ijeska.com/index.php/ijeska

Review Article
e-ISSN: 2687-5993

Why are the Axes of All Stars in The Milky Way Tilted and Wobbling? (In Torus Representation)

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INFORMATION

Article history
Received 26 April 2024
Revised 25 July 2024
Accepted 26 July 2024

Keywords
Tilted star axis of spinning
Wobbling star axes of spinning
Explaining the cycles of precession
Explaining planetary ellipses
Sagittarius Dwarf Galaxy

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ABSTRACT

Our galaxy is warped because it had swallowed a smaller galaxy in the past - the Sagittarius Dwarf Galaxy, which we can still see in our telescopes orbiting around the center of our Galaxy while being gradually assimilated. As the Sagittarius Dwarf Galaxy orbits around the central Black Hole of our galaxy, the powerful magnetic field (which its central Black Hole cranks) makes the axes of all stars in the galaxy tilted and wobbling in synchrony with the Sagittarius Dwarf orbiting. Also, the presence of this smaller galaxy (with a Black Hole weighting millions of Solar masses) is the factor that elongated the circular orbits of all planets in our galaxy into ellipses. Before our galaxy swallowed the Sagittarius Dwarf Galaxy, the earth's orbit was a circle and the earth's year was 360 days, after our galaxy swallowed the Sagittarius Dwarf Galaxy, the Earth's orbit became elliptical and the Earth's year became 365 days 6 hours and 42 minutes. The Aztecs and Mayas called the 5 additional days in the year 'unlucky days' because the presence of the Sagittarius Dwarf Galaxy into our galaxy brought a lot of misfortunes on Earth.

1. Introduction

The author has published a number of articles using torus representation (Kuman, 2019a; Kuman, 2019b). Since the electromagnetic fields of our Sun (and the planets orbiting it) have the shape of a torus (donut), their simplest and most elegant mathematical description is in torus coordinates, which offer a graphical representation enabling us to see what is happening. Nonlinear mathematical model was used in this article to explain why the axes of all stars in the Milky Way were found to be tilted and wobbling.

2. Nonlinear Mathematical Model

We are trying to describe mathematically the wobbling of the stars, which are periodic functions. They will be solutions of our equation of evolution. Since the solutions are periodic, according to the nonlinear theory (Iooss and Joseph, 1980), the equation of evolution will be non-autonomous, which means the function F describing the evolution will depend directly on the time t.

$$dU/dt = F(t, \mu, U) = F(t+nT, \mu, U) \tag{1}$$

where $U(t) = U(t+nT)$

If perturbation v is present, the evolution equation will be.

$$d(u+v)/dt = f(t, \mu, u(\mu, t) + v(t)) \tag{2}$$

where $u(\mu, t) + v(t)) = u(\mu, t + nT) + v(t + nT))$ is the new equilibrium solution.

Let expand the function u in a series around the initial point $u=0$.

$$du/dt = f(t,\mu,u)=f_u(t,\mu | u)+½f_{uu}(t,\mu | u)+1/3!f_{uuu}(t,\mu | u)+\ldots \tag{3}$$

Let us write this as

$$du/dt = f_u(t,\mu | u) + N(t,\mu,u) \tag{4}$$

where $N(t,\mu,u)$ includes all nonlinear terms.

$$N(t,\mu,u) = f(t,\mu,u) - f_u(t,\mu \mid u) \quad (5)$$

Let $u = \varepsilon + v$. Then

$$dv/dt = f(\mu(\varepsilon), \varepsilon + v) - f(\mu(\varepsilon), \varepsilon) \quad (6)$$

After representing $f(\mu(\varepsilon), \varepsilon + v)$ as

$$f(\mu(\varepsilon), \varepsilon + v) = f(\mu(\varepsilon), \varepsilon) + f_\varepsilon (\mu(\varepsilon), \varepsilon)v + R(\varepsilon, v) \quad (7)$$

Assuming the perturbation is small and neglecting all nonlinear terms $R(\varepsilon, v)$, we are getting.

$$dv/dt = f_\varepsilon (\mu(\varepsilon), \varepsilon)v \quad (8)$$

Assuming now that $f_\varepsilon (\mu(\varepsilon), \varepsilon)$ does not depend on t and replacing it with

$$\sigma(\varepsilon) = f_\varepsilon (\mu(\varepsilon), \varepsilon) \quad (9)$$

We are getting for v the expression.

$$v (t) = v_0\, e^{\sigma(\varepsilon)t} \quad (10)$$

where $v(0) = v_0$ and $\sigma(\varepsilon)$ is called exponent of Flock (Iooss and Joseph, 1980).

In the common case

$$\sigma(\varepsilon) = \xi(\varepsilon) + i\eta(\varepsilon) \quad (11)$$

This allows us to substitute $v(t)$ with

$$v(t) = e^{\sigma(\varepsilon)t} \zeta \quad (10')$$

The equation

$$dv/dt = f_u(t, \mu(\varepsilon),u(t, \varepsilon) \mid v) = f_u(t + nT, \mu(\varepsilon),u(t, \varepsilon) \mid v) \quad (11)$$

Can be also written as

$$dv/dt = A(\mu)v \quad (12)$$

or

$$dv_i/dt = A_{ij}v_j \quad (12')$$

Let us introduce the operator.

$$J(\varepsilon) = -d/dt + f_u (t, \mu(\varepsilon), 0 \mid v) \quad (13)$$

Then

$$J(\varepsilon)\, \zeta = \sigma(\varepsilon)\, \zeta \quad (13')$$

And $\sigma(\varepsilon)$ are the eigenvalues of the operator $J(\varepsilon)$, where ε is the amplitude of change on the torus in torus representation. ε is proportional to the intensity of perturbation.

$$\varepsilon = 1/2\pi \int_0^{2\pi} \rho(\theta, \mu)d\theta. \quad (14)$$

In our case, the amplitude of change ε determines the deviation of the wobbling stars' axes of spinning with eccentricities ε of their wobbling (Kuman, 2019a).

3. Torus Representation with a Different Set of Parameters

Instead of the torus variables used in §2: ρ - radius of the torus, $0 \leq \vartheta \leq 2\pi$ - angle describing the thickness of the torus, and $0 \leq \varphi \leq 2\pi$ - angle measured at the center of the torus, let us use the variables of Action I and angle $0 \leq \vartheta \leq 2\pi$ used by Michael Barnsley in Barnsley (1986).

Instead of the equations

$$p = \partial H/\partial q;\ q = \partial H/\partial p \quad (15)$$

Used in Decart coordinates, let us use in torus representation the equations.

$$\omega = d\theta/dt = \partial H/\partial I;\ I = -\partial H/\partial \theta \quad (16)$$

In this representation the energy is no longer divided to kinetic and potential. Systems that can be represented in this form are by definition integrable. Each integrable system with L degrees of freedom has L independent constants of motion. The motion is:

$$\theta (t) = \theta (0) + \omega t = \theta_0 + \omega t \quad (17)$$

Generally, the motion is multiply periodic, thus admitting Fourier expention.

$$q(t) = \Sigma\, q_m (t)\exp (\theta_0 + \omega t);\ p(t) = \Sigma\, p_m (t)\exp (\theta_0 + \omega t); \quad (18)$$

L-irreducible circuits represent each L-dimensional torus. Then the L-variables can be associated with the symplectic (linear) area of the L-irreducible circuits of the l-dimensional torus, as long as all possible deformations of a given irreducible loop have the same action.

This condition is satisfied by invariant tori of an integrable system because all the deformations of an irreducible circuit are obtained by adding to it a reducible loop of zero action. If so, we can define the action variable as:

$$I_j = (1/2\pi) \int p\, dq \quad (19)$$

Taken over the *j-th* irreducible circuit.

It is not difficult to show that the variables ϑ are canonically conjugated to I. The existence of a generating function $S(p, q)= \int p(q)dq$ follows the Lagrangean property of the torus. The function S takes multiple values because the plane q = const intersects the L-dimensional torus in a discrete number of points within the 2L-dimensional phase space.
By choosing S as a generating function for the canonical transformation $(p,q) \rightarrow (I, \vartheta)$, we can define the transformation as;

$$\partial S/\partial q = p \rightarrow \partial S/\partial I = \theta' \quad (20)$$

For an irreducible circuit Ω_I of the torus, the change of the angle ϑ_j' is simply.

$$\Delta \theta_j' = \Delta_\Omega \partial S/\partial I_j = \partial \Delta S/\partial I_j = \partial/\partial I_j (2\pi I_j) = 2\pi \delta_{ij} \tag{21}$$

The conjugate angles $\vartheta_j = \vartheta_j'$ are privileged angle coordinates of the torus (Ozorio de Almeida, 1988).

Let the unperturbed Hamiltonian is $H_0 (I)$. Let us consider perturbation v that changes the unperturbed Hamiltonian $H_0 (I)$ to $H(I)$.

$$H (I) = H_0 (I) + \varepsilon H' (I, \theta) \tag{22}$$

Let the perturbation be a multiple periodic function. Thus, let

$$H' (I, \theta) = \Sigma H'_m (I) e^{im\theta} \tag{23}$$

Where m is adequate of the magnetic quantum number and reflects the projection of the magnetic influence of Sagittarius Dwarf Galaxy on our Galaxy.

Then the function that generates the transformation

$$S (I', \theta) = I'. \theta + \varepsilon S' (I', \theta) \tag{24}$$

where;

$$S' (I', \theta) = \Sigma S'_m (I') e^{im\theta} \tag{25}$$

From the transform definition (38)

$$\begin{aligned} \theta' &= \partial S/\partial I' = \theta + \varepsilon \partial S'(I', \theta) /\partial I'; \\ I &= \partial S/\partial \theta = I' + \varepsilon \partial S'(I', \theta) /\partial \theta; \end{aligned} \tag{26}$$

or

$$\begin{aligned} \theta &= \theta' - \varepsilon \partial S'(I', \theta) /\partial I' + O (\varepsilon^2); \\ I &= I' + \varepsilon \partial S'(I', \theta) /\partial \theta + O (\varepsilon^2) \end{aligned} \tag{27}$$

Since the Hamiltonian is invariant to this transformation, with accuracy up to O (ε^2) we should have.

$$\begin{aligned} &\partial S'(I', \theta) /\partial \theta = im \Sigma S'_m (I') e^{im\theta} \\ &\omega \partial S'(I', \theta) /\partial \theta = im\omega \Sigma S'_m (I') e^{im\theta} = im\omega S'(I',\theta) = -\Sigma H'_m (I') e^{im\theta} \end{aligned} \tag{27}$$

4. Conclusion

The presence of the Sagittarius Dwarf Galaxy in our Galaxy perturbs gravitationally and magnetically (through the powerful magnetic field of its Black Hole) the movement of all stars in the Milky Way making their axes of spinning to be tilted and wobble in synchrony with the orbiting (of the Black Hole and the leftover stars) of the Sagittarius Dwarf Galaxy around the center of our galaxy. It also elongated the circular orbits of the planets orbiting the stars to ellipses. Before the Sagittarius Dwarf Galaxy was swallowed, the earth orbited the Sun in a circular orbit for 360 days. Now (when the Sagittarius Dwarf Galaxy is present) our earth orbits the Sun in elliptical orbit for 365 days 6 hours and 42 minutes.

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