Astrophys Space Sci (2013) 348:57–63
DOI 10.1007/s10509-013-1556-5

ORIGINAL ARTICLE

The planetary spin and rotation period: a modern approach

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Received: 11 February 2013 / Accepted: 2 July 2013 / Published online: 24 July 2013

Abstract Using a new approach, we have obtained a formula for calculating the rotation period and radius of planets. In the ordinary gravitomagnetism the gravitational spin (S) orbit (L) coupling, $\vec{L}\cdot\vec{S}\propto L^2$, while our model predicts that $\vec{L}\cdot\vec{S}\propto \frac{m}{M}L^2$, where M and m are the central and orbiting masses, respectively. Hence, planets during their evolution exchange L and S until they reach a final stability at which $MS\propto mL$, or $S\propto\frac{m^2}{v}$, where v is the orbital velocity of the planet. Rotational properties of our planetary system and exoplanets are in agreement with our predictions. The radius (R) and rotational period (D) of tidally locked planet at a distance a from its star, are related by, $D^2\propto\sqrt{\frac{M}{m^3}}R^3$ and that $R\propto\sqrt{\frac{m}{M}}a$.

Keywords Spin-orbit coupling · Gravitomagnetism · Modified Newton's law of gravitation · Gravitational spin · Rotation period of planets

1 Introduction

Kepler's laws best describe the dynamics of our planetary system as regards to the orbital motion. However, Newton's law of gravitation provided the theoretical framework of these laws. In central potential the orbital angular momentum is conserved. In polar coordinates, the gravitational force consists of the ordinary attraction gravitational force and a repulsive centripetal force. The Newton's law of gravitation has been successful in many respects. However, this law fails to account for very minute gravitational effects like deflection of light by an intervening star, precession of the perihelion of the planetary orbit and the gravitational red-shift of light passing a differential gravitational potential. Einstein's general theory of gravitation generalizes Newton's theory of gravitational to give a full account for all these observed gravitational phenomena. Einstein treats these phenomena as arising from the curvature of space. Hence, Einstein's theory has become now the only accepted theory of gravitation. The inclusion of energy and momentum of matter (mass) in question leads to the curvature of space, while the inclusion of spin leads to torsion in space. Einstein's theory deals with matter of the former case, while Einstein-Cartan deals with the latter case. Thus, Einstein space is torsion free. In classical electrodynamics the spin of a particle is a quantum effect with no classical analogue. However, the spin of a gravitating object (e.g., planets) is defined as a rotation of an object relative to its center of mass. This is expressed as $S = I\omega$, where I and ω are the moment of inertia and angular velocity of the rotating object, respectively. The spin is generally a conserved quantity in physics. Besides the spin, an object (m) revolving at a distant r around a central mass (M) with speed v is described by its orbital angular momentum. This is defined as $L=\vec{r}\times m\vec{v}$. This quantity is also conserved, except when an external torque is acting on the object. In quantum mechanics, the spin and angular momentum of a fundamental particle are quantized. No such quantization is deemed to exist in gravitation. To incorporate quantum mechanics in gravitation we invoke a Planck-like constant characterizing every gravitational system (Arbab 2004, 2005). This would

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