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Editorial

Physics of Gyroscopic Effects

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The history of sciences contains unusual examples of the achievements in physics and mathematics, which methods did not use for problems in applied science during the centuries. One such example is the intricate motions and acting forces of the ordinary revolving disc, which theory was worked out in our time. The top toys were invented in ancient times, which intricate motions astonished the people of different civilizations. The unusual motions and acting forces of the top toys today are called gyro effects [1].

From the middle of the seventeenth century, scientists and researchers began studying the phenomena of gyro effects. The problem of gyro effects proved so complicated that achievements in physics and mathematics could not find correct decisions. It is confirmed by the numerous publications of manuscripts and dozens of hypothetical gyroscope theories which most of them did not validate practically. The classic of mathematics L. Euler described one gyro effect, which is the precession torque of the angular momentum. Other gyro effects did not get mathematical models [2, 3].

The absence of the analytical approach for gyro effects delayed describing their physics and publishing their exact theory for several reasons. The nature of gyro effects is based on several physical laws, which were discovered in the course of two hundred years, namely from the seventeen century and to the middle of nineteen one. This is the reason that gyro effects could not be solved in principle by the scientist of past centuries. The following centuries did not bring forward scientists that could use achievements in physics and mathematics to derive the theory of gyro effects. Unexplainable properties of revolving bodies forced researchers to spawn artificial terms and anti-scientific statements that gyroscopic devices possess non-inertial and non-gravitational properties, etc. For engineering, scientists developed numerical models for gyroscopic effects with the software. These models do not give exact results and the physics of gyro effects are explained vaguely. Today, the physics of gyro effects are solved and presented by the theory based on the mechanical energy conservation law of the revolving body [4].

The gyro effects are objects to the dynamics of the revolving body that are a crucial part of the knowledge in engineering. The movable, spinning components of different mechanisms manifest gyroscopic effects. Rotating movable objects created many problems in computing acting inertial torques and motions. These rotating parts are the propellers of aircraft, helicopters, and ships, gas turbines, projectiles, wheels, cones, rotors, spheres, paraboloids, etc. The gyro effects result in the motions of the revolving body in space. These motions should be analytically described and the physics of acting forces explained [5].

Recent investigations and detailed analysis of the inertial torques acting on the revolving body discovered the set of torques kinetically interrelated. The set of torques is originated by centrifugal and Coriolis forces of the rotating mass elements and the precession torque generated by the center mass. The latter one makes up less than the tenth part of the total inertial torques of the revolving body and does not play a significant role in gyro effects. The known publications use only the torque of the change in the angular momentum. The new property of gyro effects is the kinetic interrelation of inertial torques that is presented by the ratio of the angular velocities of the revolving body about the axes of the rotations. The set of inertial torques of the revolving body expresses its kinetic energy and makes up the basis of the gyroscope theory. These new principles are based on causality dependencies of the internal torques and used for mathematical modeling for the motions of gyroscopic devices. The mathematical models of the gyro effects have been formulated for the ordinary revolving disc, but the derived method is universal and can be applied to any design of the revolving body.

The mathematical models for the inertial torques depend on the form of revolving bodies because distributed masses are disposed on their radii and lengths that manifest the gyro effects [6].

The physics of the gyro effects are more sophisticated in mathematics than presented in known publications with simplified analytical models. The study of gyroscopic inertial torques shows the distributed masses of the revolving body play a major role in gyro effects. The theory of gyro effects uses the method of combining of the axle of the revolving body with the axis of the Cartesian 3D coordinate system. This method enables drastically simplifying the mathematical models presented by 3D Lagrange's and Euler's angles. The theory of gyro effects contains exact mathematical models without simplifications and describes the gyroscope's lift up ("anti-gravity effect"), oscillation, and nutation, and other gyro effects that were unsolvable. The basic mathematical models for gyro effects were validated practically for the gyroscope suspended from the flexible cord and with one side pivoted support [7].

Multi-stepped analytical approaches and multi-integrated mathematical models have formulated the gyroscope theory for the revolving body. The mathematical modeling of the complex problem is a routine process with omissions and improvements that finally gives the correct result in science and engineering. The theory of gyroscopic effects presents a new approach to the dynamics of classical mechanics [8]. Science receives the theory of gyroscopic effects that was long-awaited for centuries.

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Volume 2 Issue 2 February 2022