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Gyroscope is a long-time spinning top which was so named, around the mid-19th Century, by Leon Foucault (1819-1868) who used such a physical device to take over Earth rotation. Since then, it was mainly employed for instrumental purposes, equipping it from time to time with further auxiliary devices which enriched its phenomenology and functionality. In the early 20th Century, Elmer A. Sperry (1860-1930) developed, on the basis of the previous work made by H. Anschütz-Kaempfe (1872-1931), the first automatic pilot for airplanes using a gyroscope, there installing the first gyrostabilizer to reduce roll on ships. While gyroscopes were not initially very successful at navigating ocean travel, navigation broadly meant (above all the naval and air one) is their predominant use today (e.g., gyrocompass). They can be found in ships, missiles, airplanes, the various space shuttles, and satellites, as well as used in measurements of general relativity and gravitational physics (e.g., Stanford gyroscope experiment[1]). Roughly speaking, the gyroscope basically is a flywheel assembled upon a double Cardan suspension (*gimbal*) which allows every movement around its gravity's centre[2]. The rotation flywheel axis is perpendicular to the support axis. The action of centrifugal forces overcomes the one due to gravity. If endowed with a high velocity, it always keeps its orientation in the space. If one directs the axis of gyroscope for example towards a star, then it will remain along this direction independently of any movement of

[1] See (Pizzella 1993, Chapter 3, Section 3.11).
[2] See, for instance, (Castelfranchi 1968, Chapter VII, Section 139).

the related gyroscope support (gimbal): for instance, at the ground, it will be indifferent to the Earth rotation, so yielding a precise geographical tracking. Placed, for example, in a rocket or a missile, it provides an high-reliable reference system for the self-guidance and the inertial navigation, as well as making possible an active control of satellites[3] and autopiloting. In particular, for inertial navigation procedures, gyroscopes measure the angular velocity of the mobile system in the inertial reference frame, hence, by using the original orientation of such a mobile system in the inertial reference frame as initial condition, then integrating the angular velocity, it is possible to have the mobile system's current orientation at all times. Inertial navigation systems were originally developed for rockets, above all after the work of Robert H. Goddard[4] (1882-1945) who initially experimented with rudimentary gyroscopic systems for US Naval Force, in the first half of 19th century. At the same time, such systems were also used in German 3rd Reich by Wernher von Braun (1912-1977) (starting from the research work of his teacher Hermann Oberth (1894-1989)), engaged by General Dr. W. Dornberg (1895-1980), the leader of Germany V2 rocket program[5]. The systems entered more widespread use with the advent of spacecraft, guided missiles, and commercial airliners. Early German World War II V2 guidance systems arranged by von Braun basically combined two gyroscopes and a lateral accelerometer with a simple automatic servomechanism to settle the azimuth for the rocket in flight. The guidance, navigation and control system for V2 provided many innovations for rocket fly. In 1945, von Braun moved to United States, shortly becoming a leader of many U.S. Army rocket research programs, among which some missile guidance programs. Since then, gyroscopic effects have entered in any other inertial terrestrial and extraterrestrial navigation system worked out until now. The latest generations of gyroscope are the optic gyroscopes (e.g., laser gyroscopes and fibre optic gyroscopes) in which many optical components replace the mechanical ones of classical gyroscopes, with a great increasing in the measurement precision. Furthermore, the recent 2002 discovery of ultracold atoms forming long-lasting waves through atomic soliton trains, by Kevin E. Strecker, Guthrie B. Partridge, Andrew G. Truscott and Randall G. Hulet of the Rice University[6], might be find very useful precision measurement applications for example in atom interferometry, drawing benefit from an atomic soliton laser based just on solitons like the ones observed by the Hulet's Atom Cooling Research Group of the Rice University at Houston. According to these researchers, there

[3] See (Pasquarelli 1988, Chapter IV), (De Landa 1996, Chapter 1, Section Volo) and (Mengali 2001, Chapter 12).
[4] See the history of *Goddard Space Flight Center* at http://www.nasa.gov/centers/goddard/home/index.html
[5] See, for example, (Provost 2011, Chapter 36). See also http://www.nasa.gov/pdf/153410main_Rockets_History.pdf and http://www.history.nasa.gov/SP-400/ch2.htm
[6] According to the report of (Strecker et al. 2002), Bose-Einstein condensate atoms trapped in a thin beam of light and forced to march in a single file, can give rise atom waves that maintain a constant shape while propagating. In their experiments, Hulet and his colleagues observed localized wave packets, or solitons, of lithium atoms traveling great distances – over a period of up to several seconds – without spreading.

could also be practical applications of these atom solitons: in fact, a kind of atomic-soliton laser – they say – may turn out to be useful for precision measurements applications, as the input source to bright matter-wave soliton interferometer-based inertial and rotational sensors. US Naval Force is interested in this research[7], for instance to build up atomic-soliton gyroscopes much more precise and useful above all for the navigation of submarines because they have difficult to reach GPS satellite net. Gyroscopic instruments are widely used in naval military warships to keep missile tracking releasing this from rolling and pitching movements of ship. Finally, optical gyroscopes are implemented in the instrumentation for the inertial guidance of artificial satellites, spatial probes and nacelles, keeping their orientation with respect to fixed stars; in particular, they are included into the fine guidance sensor (FGS) aboard instrumentation for keeping fixed, with very high precision, the Hubble Space Telescope pointing control system[8].

[7] See (Kasevich 2001; 2009). See also the Italian review of (Strecker et al. 2002), i.e., ''Solitoni atomici'', *Le Scienze*, 4 Maggio 2002.
[8] See NASA-Reports/facts, No. FS-2007-09-092-GSFC (SM4 #09).

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