

## A Convenient Method for Measuring the Speed of a Gyroscope

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If a gyroscope whose moment of inertia is  $I$  is spinning with a velocity of  $\Omega$  radians per second around its horizontal axis, and if a torque of  $L$  dyne centimeters is acting perpendicular to the spin axis, the latter will rotate about a vertical axis through its point of support, this rotation being known as precession. If the velocity of precession is  $\omega$  radians per second, then

$$L = I \omega \Omega$$

To test this relation we have used the following method.

The moment of inertia of the wheel is found by a weight and string wound around the shaft in the customary way. The wheel is then started by means of a motor and friction disc. By adjustment of the counterpoise and lever the precession is made slow, on the order of one revolution in 5 seconds, while the spin velocity is 30 or 40 revolutions per second. The thing which was new to us was the determination of the spin velocity. A disc of bakelite, 3 cm. in diameter, with six holes arranged in a circle, has been fixed on the shaft, and serves as a miniature siren. Compressed air is used with it, after the wheel has been started, and a sonometer wire quickly tuned to its pitch by sliding a bridge. The gyroscope is then allowed to precess while one revolution is accurately timed; immediately the siren is again used, and a second sonometer wire tuned to it. The vibration rate of the wires is then found by measuring lengths, and tuning to standard tuning forks. From these values is calculated the average spin velocity of the wheel, in radians per second, during the precession. The torque about the horizontal axis, due to the counterpoise, is found by using a spring balance to find the force in dynes necessary to produce equilibrium. The torque is

$$L = Fl$$

where  $l$  is the lever arm of this force.

The value thus obtained agrees reasonably well with the product of the moment of inertia, the spin velocity, and the precession velocity. Using it as a regular experiment in the general physics course, errors are usually within 5 per cent.