

THE GYROSCOPE (PRECESSIONAL MOTION)

MED 09.18c



Material

Item-no.	Qty.	Description
DM354-1K	1	Gyroscope, complete set

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Precessional motion of a gyroscope

In contrast to the experiment MED 09.18b the basic behavior of a gyroscope that is not free of forces is to be shown here. This is a gyroscope that, due to its location, cannot be regarded as a closed system and therefore external forces can act on it. A gyroscope that is not free is therefore not positioned in the centre of gravity or gimbaled. These two possible types of storage of a freely moving gyroscope are described in the experiment MED 09.18b.

Experiment 1 - a suspended gyroscope

Attach the end of the cord to one of the two brass bolts that protrude from the frame. The cord is wound up to about 40 cm on the handle.

The gyroscope is placed in the fork and set into rotation.

The rotating gyroscope is lifted out of the fork. One side of the gyroscope is held up with the cord (on the handle), the second hand holds the gyroscope on the opposite brass bolt or on the frame.

Now let go of the stabilizing hand so that the gyroscope only hangs on the cord. What is happening?



Result

The vertical position of the gyroscope wheel and the horizontal position of the axis are retained. The axis initially moves approximately in one plane on a circular path. During this movement, the cord and the axis maintain the angle they made before they were released.

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Experiment 2 – a gyroscope standing on its tip

The bearing rod is inserted and fixed in the round base with the pan facing upwards. The gyroscope is placed in the fork of the round base and rotated. The rotating gyroscope is lifted out of the fork and placed with the ball of the brass bearing in the pan of the bearing rod.



Result

The gyroscope does not fall to the ground. It executes a slow rotary movement (precession movement) around the axis of the bearing rod. The gyroscope axis moves on a so-called precession cone.

Note

Due to the unavoidable friction the angular momentum of the gyroscope decreases over time and gravity "wins" - the axis lowers. This effect should definitely be explained! The precession of a gyroscope can be shown quite well with these experiments.

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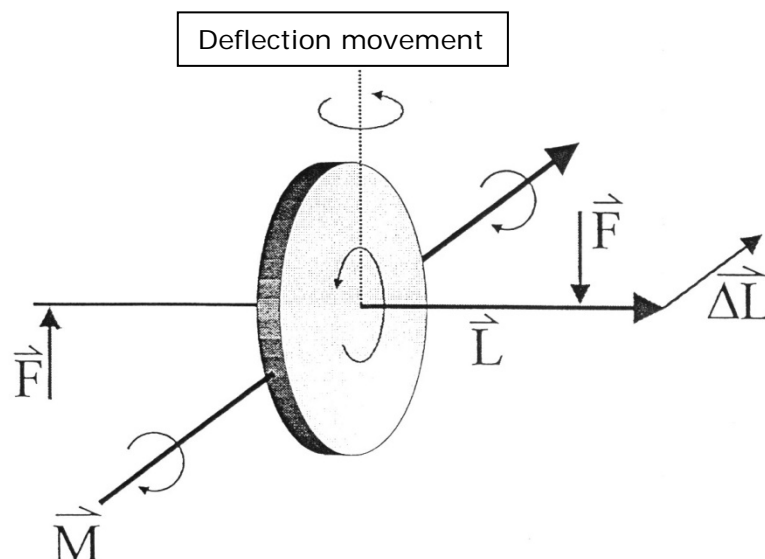
Physically speaking:

The phenomenon observable in these two experiments is the basis for the movement shown which is referred to as the precession movement.

The gyroscope is a symmetrical gyroscope. A characteristic of such a gyroscope is that its axis always remains in the same spatial direction, no matter how its environment moves.

Of course this only applies if no external forces act on the gyroscope or the gyroscope axis, as is the case with a gimbal suspension (which makes a freely moving gyroscope out of the gyroscope) of a gyroscope.

If a force now acts on the gyroscopic axis it deviates at right angles to the direction of the attacking force. This connection is to be illustrated in the drawing.



The occurring phenomena could be described like this:

A symmetric gyroscope rotates and therefore has the angular momentum \vec{L} .

If a force acts \vec{F} on the gyroscope axis the torque \vec{M} acts on the gyroscope as well.

The interaction of the torque with the angular momentum results in a further angular momentum $\Delta\vec{L}$ which leads to a deflection of the gyroscope in the direction shown above.