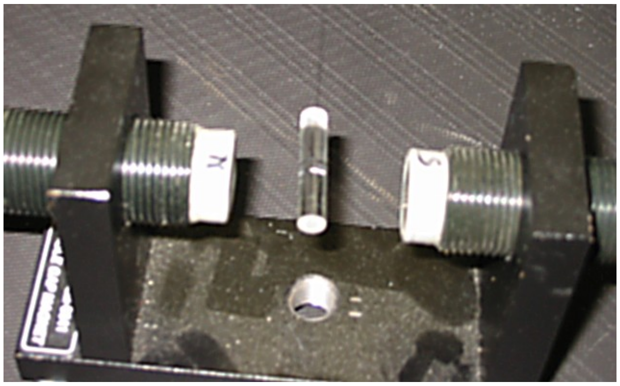
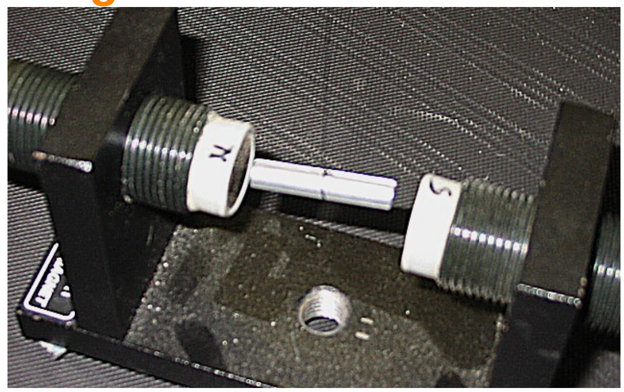
Para- and Diamagnetism





Glass Rod (Diamagnetism) **Al Tube (Paramagnetism)**

Purpose: Demonstrates the contrasting behavior of diamagnetic and paramagnetic materials.

This demo also uses part of the equipment based around Pasco's variable-gap magnet.

Here, a small rod (either glass or aluminum) is suspended by threads between the magnet pole faces. Once the oscillations due to the thread's twist die out, you can show that the glass rod comes to equilibrium perpendicular to the lines of ***B*** whereas the aluminum rod stays parallel. You can slowly rotate the magnets, and the rods follow the motion.

Note: The aluminum rod is really a tube, and slit to inhibit eddy current effects.

Recall that, in an external ***B*** field, there is a magnetic dipole moment μ_{ind} induced in the materials. For

Paramagnetic materials: μ_{ind} is parallel to ***B***,
Diamagnetic materials: μ_{ind} is antiparallel to ***B***.

Now, the fact is (not mentioned in most of the intro texts) that the force on a magnetic moment in the external field is related to the *gradient* of the field†:

$$F_z = \mu_{ind}\partial B_z/\partial z$$

Hence, paramagnetic materials (*e.g.* aluminum) are attracted towards regions of stronger gradient, such as near the pole faces, and so align with the external magnet. In contrast, diamagnetic materials (*e.g.* glass) are repelled from the pole faces.

†A nice derivation of this, using the integral form of Gauss's law for ***B***, is given in Purcell's *Berkeley Physics Course, Volume 2: Electricity and Magnetism*.

Extra Equipment: None

Location: Shelf F3