

Ring Launcher



Launcher and Rings



Firing the Light

Purpose: Demonstrates (AC) induced currents.

A large, AC magnetic field induces a current in the rings (except of course the one that is slit) which in turn react with the field and fly off. Also included is a coil and light to prove that a real, sustained AC current is induced.

Note: What makes the rings fly upward? The general propaganda is this demonstrates Lenz's Law. However, this is one of those demos where the more you try to explain the physics, the more trouble you get into:

Consider the state of affairs during the first half of the AC cycle with the field of the coil pointing up. In the first $\frac{1}{4}$ cycle the field increases in strength, so by Lenz's law the ring has a current induced in the clockwise direction (seen from above), and the ring would be repelled upward. In the following $\frac{1}{4}$ cycle however, the field decreases in strength, so that the induced current is now counterclockwise. The field still points in the same direction, so now

the ring is attracted downward. Over one cycle, the force should average to zero!

The explanation of the levitation is more complicated. Here is what S.Y. Mak and K. Young (AJP **54**, 808 (1986)) have to say:

Consider the total field (coil plus that due to the ring current) resolved into vertical and horizontal (radial) components, B_v and B_h . The force on the ring is proportional to IB_h . The ring current I is related to the change in flux through the ring, and so proportional to dB_v/dt . If B_v and B_h were in phase, then the product IB_h (oscillating like $\sin\omega t \times \cos\omega t$) averages to zero.

That the average force is not zero is due to a phase difference θ between B_v and B_h . The net force is found to be due to two factors of roughly equal importance: 1) θ due to the nonzero inductance L of the ring, and 2) the spatial non-uniformity of this phase: $d\theta/dz$.

Extra Equipment: None

Location: Shelf F1