Does an axially-rotating magnet induce an electric field?

**Introduction: Faraday Generator Concept**

Metal disk rotates, Voltage and Current are generated

![Diagram of Faraday Generator Concept]

No current is induced in the metal disk when it is rotating over the magnet while the wire stays stationary.

Magnet rotates, NO Voltage or Current induced

![Diagram of No Current Induced]

No current is induced in the closed circuit.

**Two possible explanations:**

The magnet rotates but the flux does not, so no current is induced in the circuit

No current is induced anywhere because the flux does not rotate with respect to the magnet.

The magnet and flux rotate but the forces cancel out

No current is induced anywhere because all the forces caused by the moving flux over a closed circuit cancel out.

**Proposed Experiment**

Rotating sensor and axially rotating magnetic flux should cause alternating current

Rotating sensor with stationary flux causes no alternating current

The sensor plates are rotated around its central axis and pointed in the direction of the magnetic flux. If the axially orientated flux rotates with the magnet this will induce an alternating current in the sensor as shown in the picture on the left. If there is no moving flux there should be no alternating current generated as shown in the picture on the right.

The device detects current across the center wire. It also detects the angle of the plates relative to the center axis. This will give us a way to detect the electric field generated by the flux lines crossing along detector plates.

The alternating current should only occur if an electric field is present or we have changing flux of sufficient magnitude.

The device is sensitive to an electric field on the order of 10 V/m. How powerful of a magnet do we need and how fast do we need to rotate the magnet to see this effect if at all? The answer in short is that we could use a magnet of about 1 Tesla and to rotate it at about 11500 rpm.
Physical Model

\[ F = q(v \times B) + E = \text{Electric field (SI unit = Volts, V), } B = \text{Magnetic field (Tesla, T)} \]
\[ F = \text{Force (Newtons), } q = \text{Charge value (Coulombs), } v = \text{Velocity (meters/second)} \]
\[ r = \frac{v \times E}{\sigma} \text{ where } r = \text{radius of the flux being sampled by the sensor and } \frac{v}{\sigma} \text{ is the ratio of the flux above the magnet.} \]

If the magnetic flux does rotate and induce an electric field, the induced electric field should increase linearly with radial distance, and should be directed radially inward toward the center, parallel to the magnet’s surface.

CONCLUSION: According to the Lorentz Force Law, a charge moving in a magnetic field is affected just as it would be in an electric field. But there is an uncertainty in how to interpret the velocity term in this law. The answer is usually the velocity of the charge. This, however, leaves the question of “relative to what” unanswered. If our experiment indicates that there is moving flux causing an electric field, then one could surmise that the velocity vector in the equation above instead represents the velocity vector of the electron as seen by the flux. This result would suggest that electric and magnetic flux concept may be more fundamental to electromagnetism than the corresponding and more well-known fields.