

Plasma ball

The graceful purple arcs of plasma dancing in a plasma ball are created by a large alternating voltage at its centre, and that alternating voltage creates an electromagnetic field with which we can light a fluorescent tube.

Apparatus

- 1 × plasma ball
- 1 (or more) × reinforced fluorescent tube(s)

The demonstration

1. Turn on the plasma globe.
2. Bring the fluorescent tube near the plasma ball. Before they touch, the tube should light!

How it works

At the centre of a plasma ball is a large alternating voltage, typically a few kilovolts oscillating at around 30 kHz. The low density of the gas in the globe (often neon) makes discharge significantly more favourable than it is in air at atmospheric pressure (the breakdown voltage of air which causes sparks from a Van de Graaff generator, for example, is 30,000 V/cm, whilst this can create arcs many centimetres long with just a few thousand volts). These fronds of plasma make their way from the centre of the globe to the edge, in a bid to reach earth. Creating an enhanced path to earth by touching the globe increases the strength of the discharge, which is why the arcs are attracted to your hand if you touch the globe.



Vital statistics

oscillating voltage:
2–5 kV at around 30 kHz

gas inside the globe:
usually neon

The alternating voltage at the centre creates electromagnetic waves, and the arcs of plasma act as antennae, meaning that the extent of the electromagnetic field surrounding the ball is significantly larger than the bounds of the glass globe. Bringing the fluorescent tube near to the plasma ball allows the electrons inside to be accelerated by this field, and those moving electrons constitute an electric current, which causes the bulb to light up.

This demonstrates that an electromagnetic wave can be used to accelerate particles, providing an alternative to the large, static voltages supplied by Van de Graaff generators. In a real particle accelerator, radio-frequency, or RF, cavities are used to give the particles a kick with an electromagnetic standing wave.