Capacitor Drop Experiment

By James Keele
3313 Camino Cielo Vista
Santa Fe, NM 87507
jkeele5@sisna.com

The force between parallel capacitor plates [1] is given by:

\[ f = \frac{-V^2 A \varepsilon}{2t^2} \]

where \( V \) is the voltage, \( A \) is the area of the plates, \( \varepsilon \) is the permittivity of the dielectric and \( t \) is the thickness of the dielectric. The voltage \( V \) applied across the 5 inch square parallel plates, separated by a dielectric, is measured at the instant a 253 gram weight pulls them apart. An apparatus was constructed that automatically varies and monitors the voltage. When the constant weight pulls apart the plates, the voltage is sent to a computer and stored on a hard drive. The experiment is continuously repeated. Some variations in the voltage are noted over long time periods. Data is presented in graph form. Some interpretation of the observed voltage variations is presented.

Introduction

This experiment places in opposition the force of gravity with the force of Coulomb’s Law:

\[ F \rightarrow \frac{Gm_1 m_2}{r^2} \rightleftharpoons \frac{k q_1 q_2}{r_c^2} \]

In more practical terms these equations are represented by:

\[ F \rightarrow mg \rightleftharpoons \frac{V^2 A \varepsilon}{2t^2} \]

where \( g \) is the acceleration of earth’s gravity, and \( m \) is the mass of the weight pulling the capacitor plates apart.

The weight is kept constant (253 grams). Initially \( V \) is set to a constant high value, enough to hold the plates together with the weight pulling on them. Then \( V \) is gradually lowered until the weight pulls apart the capacitor plates. A reading of \( V \) is taken at this time. Attempts are made to keep \( A, \varepsilon, \) and \( t \) constant. A purpose of the experiment is to observe if any variations in \( V \) occur over periods of time amounting to intervals of days and weeks. It is desired to determine if slight variations in the acceleration of gravity and/or variations in Coulomb’s Law may be observed.

One of the driving motivations for this experiment is to demonstrate G. E. Ivanchenko’s general principle of relativity (GPR) [2] which is: ‘in all coordinate systems, all measuring devices for measurement of any parameter of a body or material process give identical, numerically equal, indications, if the measuring device and the object of measurement are motionless with respect to each other, and if they are of similar kind (measurer of a magnetic field-size of body, measurer of length-size of body, measurer of time-duration of process and so on).’ Ivanchenko’s interpretation of the null results of the Michelson and Morley experiment, pre-supposes an ether and he arrives at his stated GPR. The same results is also true for Special Relativity Theory (SRT). In Einstein’s famous relativity principle (RP) he asserted “all inertial frames are totally equivalent for the performance of all physical experiments” [3].

Therefore, the results for this experiment, with the plates traversing ‘through the ether’ at the earth’s rotational speed at its surface, should be a flat line with time in the course of a day. This should also be true if there is no ether and SRT is true, unless other causes exists. Another variation in the voltage that may appear is a variation due to changes in the acceleration of gravity. This may appear as a two-cycle/day variation related to tidal forces created by sun and moon phases.

Experimental Apparatus

Several different dielectric materials have been employed: a paper dielectric, a plastic dielectric, and a glass dielectric. The paper dielectric is 6 mils thick paper, supposing to have a relative dielectric constant of 3.30. The plastic dielectric has a thickness of 9 mils and an unknown relative dielectric constant. The glass dielectric has a mean thickness of 8.7 mils and a dielectric constant of 6.7. The glass dielectric is preferable since it is more rigid that the others and thought to be less subject to thickness change due to compression. The dielectrics are set between the plates without any means to secure them to the plates such as glue. This allows them to fit more flat against the surfaces of the plates. The dielectric constants and the thickness of the dielectrics are subject to temperature variations, so an attempt was made to keep the temperature constant.
The capacitor plates are constructed of 5 inch square, 1/8 inch aluminum alloy material. A constant weight of 253 grams was employed. Electrical circuits that automatically sense the separation of the plates, restore the plates to an original "together" position, increase the applied voltage to above the holding voltage, and slowly vary the applied voltage until the plates are pulled apart, are employed. A relay reverses the applied voltage after each cycle to average out the effects of dielectric hysteresis. A cycle time is approximately 1 to 2 minutes.

The voltage is continuously monitored by a HP3490A Multimeter and is sent to an HP9816 computer that detects via software the low voltage at which the plates are pulled apart. The low voltage and time are then recorded in a hard drive file. The data from this file is transported to an IBM type PC where it is processed and plotted with use of a spreadsheet program. The initial peak voltage is set to a constant value for each dielectric.

The normal to the plane of the capacitor plates is orientated to point in an east-west direction such that if there were an ether, the plates would be traveling through it due to the rotation of the earth.

A temperature controlled box and electrical circuits were designed and implemented to keep the plates at a constant temperature. This was accomplished by a linear-servo type feedback circuit. The heating elements (power resistors) were controlled linearly instead of in an on-off type operation. This temperature box only adjusts for ambient room temperature variations of about 65 °F to 82 °F. Since the ambient temperature in the room exceeded the 82 °F limit this circuit lost temperature control. It was replaced with an on-off type circuit which held the temperature to within about 1.5 °F.

**Force Analysis**

Calculated results of the magnitudes of the forces involved using the paper dielectric are summarized in Fig. 1. The mobile capacitor plate was suspended with strings from a mechanical support in order to eliminate static friction that would incur if its weight were resting directly on a surface. Static friction can introduce force drift errors and uncertainty in the measured results. Effort was expended to make the force of the attraction of the plates to equal the force of the weight since small deviations of force (or voltage) are to be measured. However, this attempt failed because there always was an unknown or "sticky" force presence constituting about 30% of the holding force between the plates. This "sticky" force may be due to the Casimir effect [4] given by the following formula:

\[
F = \frac{\pi^2}{240} \frac{hcA}{r^4}
\]

where \(A\) is the surface area of each plate and \(r\) is the plate separation. This force due to the aluminum plates alone is calculated to be 3.87 x 10^{-14} N separated at 6 mils. However, if this force is present between each aluminum plate and the paper dielectric with contact separation distance, then the force could be substantially higher, possibly enough to account for the observed "sticky" action. Since this force varies by the forth power of the separation distance, slight differences in this distance could be responsible for the observed force drifts.

**Some Results**

Figure 2 shows plotted data taken on days before New Moons for three consecutive months. A one-cycle daily variation is observed from this data. The data suggests that these daily variations are due to positions of the sun and moon with respect to the earth. The author thinks at this stage of testing nothing can be definitely concluded about the principles of GPR & SRT. Also, the author makes no interpretation of the data as to whether an ether exists.

Figure 3 shows graph plots of data taken on days before Full Moon for three consecutive months. The daily cyclic variations are not as pronounced as they are in Figure 2 for the New Moon. Daily cyclic measured voltage variations are a fact and they are different at Full
Moon and New Moon. Worthy of note is that the voltage fell within a day’s time from a high of 370 volts to the low, as shown in the last plot of Figure 3, of around 351 volts. (Each point plotted in Figures 2 and 3 is the average of 10 consecutive readings.)

**Discussion**

This experiment evolved over a period of more than six months. Improvements in the circuits, the plate suspension, software detection, etc. also evolved over this time period. As a consequence the conditions under which the data was taken had not remained consistent. The last data was taken with the most stable and reliable apparatus.

Since many factors or variables are involved in the experiment, they all must be controlled or eliminated as causes in the results. Air pressure and humidity have not been eliminated as causes. Also, other effects such as having different magnitudes of the starting or initial voltage has not been determined. (The starting voltage for a given dielectric was held constant throughout the data taking.) Also, the paper and plastic dielectrics may experience some compression, thus effecting the measured voltage. This was the main reason for choosing a glass dielectric that was not employed until recently. Another factor that has not been studied is capacitor plates’ orientation with respect to earth directions.

In defiance of these drawbacks, the daily voltage variations observed in the test results are a fact. They are intriguing and warrant further investigation. Experimental techniques have been successfully developed.

**References**

Figure 2. Graph plots of data taken on just one day before the New Moons for three consecutive months.
Figure 3. Graph plots of data taken on just one day before Full Moons for three consecutive months.