One main problem about the study and understanding of plasma is that it is still a young topic with many things to be learned about it. By using well-constructed probes and methods, such as the Boltzmann Relation, scientists have been able to obtain some understanding about plasma, such as measuring temperature and density. But are these results processed and obtained correctly? Are these methods working? Are they actually useful? During this investigation our main purpose was to corroborate or to prove if the Boltzmann Relation is actually correct. To accomplish our main objective, plasma was made at a voltage of 600 volts at a pressure of 150 mTorr. Obtaining the measurements of temperature and density, the two primordial properties of plasma. To make these calculations, a Single Langmuir Probe was utilized to measure different areas of the cathode. The measurements taken by the probe were applied to create an enhanced simulation to prove if the creation of plasma under the same circumstances as the PUPR plasma lab was possible using the Boltzmann relation. The reason for confining and simulating Plasma is to obtain both the quantitative detail and the visual. In the simulation the density and temperature are processed applying the Boltzmann Relation. After calculating and analyzing the results, these were not similar to the ones that were expected. An extremely large percent error was obtained. The results also portrayed a rare case, a double Maxwellian Distribution. The latter, could be held responsible for the differential results since both electron populations are held at two different temperatures.

**Introduction:**

Plasma is the fourth state of matter, better known among some scientists as the primary state of matter. Plasma is formed by adding energy to a gas to break the internal bonds of its individual atoms, ionizing these atoms and freeing electrons. At Polytechnic University, students can obtain plasma through the inertial electrostatic confinement method, a concept for retaining plasma using electrostatic fields. The fields accelerate charged particles radially inward, usually in a spherical but sometimes, in a cylindrical geometry. A single Langmuir probe located at two different sites of a spherical vessel were used to record measurements that would later be used for a comparative in efforts to prove or disprove the usefulness of the Boltzmann Relation.

**Objectives:**

- Measure the temperature and density of plasma using a voltage of -600 volts at a pressure of 150 mTorr.
- Corroborate if the Boltzmann Relation functions appropriately through the simulation of the data obtained through MATLAB.
- Determine if the Boltzmann Relation is modeling the sphere of plasma properly.
- If the Boltzmann Relation does not work in the scenario, evaluate why.

**Methodology:**

1. Create plasma at a voltage of -600v and a pressure 150mTorr with a deviation of ±17 from the center of the sphere and a second with a deviation of 0.0 from the center.
2. Use a Single Langmuir Probe located at these sites on a spherical shaped cathode to record measurements that would later be used for a comparative in efforts to prove or disprove the usefulness of the Boltzmann Relation.
3. Submit the obtained measurements from the LABVIEW program with both instances to the MATLAB program.
4. Using these programs we apply the Boltzmann Relation to the measurements obtained at the PUPR plasma laboratory to obtain the temperature and density of the simulation.
5. Using a program, the differential, otherwise known as the percent error, was obtained. This confirms or denies if the Boltzmann Relation functions.

**Results:**

In plasma, particles move around with a variety of velocities in different directions. It is possible to use the velocity distribution function to approximate the velocity a particle may have since it is hard to say what velocity an individual particle may have. A double Maxwellian is described by two pairs of values for density and temperature. Since there is a relationship between energy and velocity relative to the mass of the particle, the same approach can be used to describe the energy distribution.

While a Bi-Maxwellian distribution is another example where an unstable velocity is one in which there is a temperature anisotropy, meaning that the temperature characterizing the movement of the particles is different from that of another direction. These differing velocities may be the cause of the two Maxwellian Distributions and, furthermore, the high differential obtained.

**References:**