



**CALIFORNIA STATE SCIENCE FAIR  
2013 PROJECT SUMMARY**

<b>Name(s)</b> <b>Marc J. Matossian</b>	<b>Project Number</b> <b>S1812</b>
<b>Project Title</b> <b>The Physics of Operating a Negative Corona Discharge</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> The objective of my science project was to study the physics of operating a negative corona discharge; specifically the radial and angular flow field of ions exiting a corona discharge, as well as the type of gas species produced. My hypothesis was that only electronegative ions could exit a negative corona discharge and that the intensity of negative ions would decrease with radial distance and angle from the exit plane of the discharge. In addition, I expected the gas species produced to depend on the gas type used to operate the corona discharge.</p> <p><b>Methods/Materials</b> A negative corona discharge source was assembled and consisted of a small high voltage DC power supply providing -7.5 kV to an array of 7 sharp nails (serving as cathodes) that were concentric with 7 copper cylinders (serving as anodes). The source was placed inside a plastic enclosure which could be pressurized with electronegative gases such as CO<sub>2</sub>, N<sub>2</sub>, and Air, as well as an inert gas such as Ar. Ions and neutral species exited the plastic enclosure through small holes at one end. An ion counter was used to measure the ion polarity (+ or -) as a function of radial distance and angle from the source. Colorimetric gas detection tubes were used to measure various gas species produced by the corona discharge (NO<sub>x</sub>, CO<sub>2</sub>, CO, HC, and O<sub>3</sub>).</p> <p><b>Results</b></p> <ol style="list-style-type: none"><li>1. Positive ions are unable to exit a negative corona discharge</li><li>2. Only negative ions are emitted from a negative corona discharge<ol style="list-style-type: none"><li>a. The negative ion count decreases exponentially with radial distance</li><li>b. The negative ions are contained within + 15 degrees of the centerline</li><li>c. The negative ion count is independent of the discharge voltage</li><li>d. The exact type of negative ions exiting the source was not determined</li></ol></li><li>3. The dominant gas species produced were ozone (O<sub>3</sub>) and CO<sub>2</sub><ol style="list-style-type: none"><li>a. CO<sub>2</sub>, N<sub>2</sub>, and Argon gases produced more ozone compared to air</li><li>b. CO<sub>2</sub> production increased during corona discharge operation</li></ol></li></ol> <p><b>Conclusions/Discussion</b> The negative ion density from a negative corona discharge decreases exponentially with distance from the source and is constrained to a +/- 15 degree region from the exit plane. Ozone and CO<sub>2</sub> were the dominant gas specie produced for all gas types.</p>	
<b>Summary Statement</b> My project studies the radial and angular flow field of negative ions and gas species exiting a negative corona discharge.	
<b>Help Received</b> Father helped with some of the assembly, helpful discussions with Professor John Williams of Colorado State University to discuss the results.	