

## SPECTROSCOPIC STUDIES OF A LOW-TEMPERATURE ATMOSPHERIC PLASMOID ANALOGOUS TO BALL LIGHTNING

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Atmospheric-pressure, low-temperature plasmas exist in nature in the form of ball lightning, and last year a natural ball lightning event was finally observed with scientific equipment.<sup>a</sup> Production of ball lightning in the laboratory dates back to Tesla's work at Colorado Springs.<sup>b</sup> Today, Tesla's "fireballs" are easily produced in the laboratory by discharging kilojoules of energy slightly above an electrolyte solution via a metal electrode.<sup>c</sup> For the sake of clarity, those plasmas produced using this technique are referred to as "plasmoids." Valuable information is obtained from previous experiments, such as the identification of water clusters and the temperature of the interior of plasmoids.<sup>c</sup> We perform mass spectrometry and Fourier-transform infrared emission spectroscopy in an effort to characterize these plasmoids. We present, to our knowledge, the first mass spectrometric data and infrared emission spectra of plasmoid discharges. Mass spectrometry reveals the presence of small protonated water clusters [ $\text{H}^+(\text{H}_2\text{O})_2$ ,  $\text{H}^+(\text{H}_2\text{O})_3$ ] and nitrogen-containing molecules [ $\text{NO}^+$ ,  $\text{NO}^+-\text{H}_2\text{O}$ ]. IR spectra exhibit signals observed in the water emission region ( $1300\text{-}2000\text{ cm}^{-1}$ ,  $3000\text{-}4000\text{ cm}^{-1}$ ), and signals in several other regions of interest. Fundamental properties of these plasmoids including the electron energy distribution function, component densities, and collisional cross sections will be discussed.

<sup>a</sup>Cen, J.; Yuan, P.; Xue, S. *Phys. Rev. Lett.* **2014**, *112*, 035001

<sup>b</sup>Tesla, N. *Colorado Springs Notes 1899-1900*; Marinčić, A., Ed.; Nolit: Beograd, Yugoslavia, **1978**; pp 368-370

<sup>c</sup>Friday, D.M.; Broughton, P.B.; Lee, T.A.; Schutz, G.A.; Betz, J.N.; Lindsay, C.M. *J. Phys. Chem. A* **2013**, *117* (39), 9931-9940