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A "nearly semi-quantitative" explanation of electrical breakdown effects reported by Julius Caesar and Pliny the Elder

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Over the last 2000 years or so, the atmospheric phenomenon now known as "St Elmo's fire" (see Wikipedia) has been reported by very many authors in very many contexts, with the earliest known reports being associated with the names of Julius Caesar and Pliny the Elder (who both reported observations of its appearance on the tips of their soldiers' javelins). Pliny also noted its appearance on the masts of ships. It is now well established that the effect is a form of Corona discharge, and is most prominently observed on dark, wet, stormy nights. The effect is also very often associated with objects that are either relatively tall or relatively sharp, or both. As always, the scientific questions are: what initiates/sustains the discharge, what is the underlying physics, and can we model it? But, as far as I am aware, there has been no successful attempt to date to develop a quantitative model. Recently, the electrostatic phenomena that occur with carbon nanotube field electron emitters have received much attention, as these things affect the design of large-area electron sources. It has become clear that many aspects of nanoscale electrostatics are a consequence of underlying electron thermodynamics, and hence are of general applicability. By putting some of the scientific lessons learnt in nanoscale electrostatics together with the results (now available on-line) of Stephen Grey's reliable 18th-Century experiments on "Gilbert-Grey cone-jets" (often called "Taylor cones"), and other experimental evidence, one can begin to build a possible "nearly semi-quantitative" explanation for the occurrence of St Elmo's fire in various specific contexts. Interestingly, at a high level, this has some elements of resemblance with the recent Helsinki work on the origins of vacuum breakdown. The work may also be of relevance to the issue of how lightning (protection) rods work, though other factors very probably play the dominant role in this case. Finally, one should not forget that dispelling superstition remains part of the role of science.

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