

This Week's Citation Classic

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[Bell Telephone Laboratories, Murray Hill, NJ]

The problem of the motion of ions in a gaseous medium, when acted on by an electric field, is naturally handled by a Boltzmann equation which is linear. If the field is also weak we simply get Ohm's law. However, even if the field is strong, the mathematics remains simple and the results retain certain simple features. Thus, the article contains, in addition to exact results, certain 'rules' which are semiquantitatively valid, and practically very useful. [The SCJ[®] indicates that this paper has been cited over 145 times since 1961.]

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"I have suspected for some time that this article of mine is the most popular I have ever written, and I am happy to see this judgment confirmed. What is curious about it is that I would rate the paper at most fourth in quality within my scientific output. It is thus interesting to speculate about what makes a popular and useful paper, as compared to a brilliant one.

"I wrote this paper at the age of 42, having just succeeded in one of my life's ambitions, namely to become a member of the technical staff of Bell Telephone Laboratories. I was therefore anxious to be of use to my employer and my colleagues. The topic of the paper —'Motion of gaseous ions in strong electric fields' —was being worked on intensely by the research group to which I was assigned. There was thus an

audience waiting for me, ready to welcome theoretical guidance. This same attitude existed among workers in gaseous electronics generally; I believe that this ingredient was the most essential to the success of the paper.

"Naturally, there was a second element necessary for success, namely that I should be able to rise to the expectations placed on me. This needs, in addition to ability, a certain amount of good luck. The good luck here took the form of exceptionally tractable mathematics. The basic equation of the field is a Boltzmann equation which is linear, that is, much easier than Boltzmann's original equation. The whole arsenal of linear mathematics was thus open to me. In addition, the field had been obscured by murky definitions and I had the opportunity of bringing in sunshine simply by sweeping these definitions aside. At the same time the readers of the *Bell System Technical journal* had a right to expect that I would emphasize quality over novelty. I could therefore incorporate older work into my analysis. The final article thus became a blend of review and original thinking. In this way an authoritative article was produced, which is what my colleagues desired.

"Another reason for the popularity of the paper was that there were certain semi-quantitative relationships waiting to be discovered, involving mobility, energy, temperature, and diffusion of ions. These relations can easily be used by any worker in the field, and represent physically valid simplifications. I believe that correct simplification is one of the essential elements of science and, apparently, at least some scientists agree with me.

"I conclude from this experience that a successful paper needs more than an author tackling successfully a relevant research problem. It needs an audience waiting for him, one which is ready to make use of his findings in their further research activities, and which is willing to give him credit for his contribution."