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This Week's Citation Classic™

Giaever I & Megerle K. Study of superconductors by electron tunneling. *Phys. Rev.* **122**:1101-11, 1961.
[General Electric Research Laboratory, Schenectady, NY]

The energy gap in the electronic density of state is the central feature in the Bardeen, Cooper, and Schrieffer (BCS) theory of superconductivity.[1] Electron tunneling was introduced to study the energy gap in this paper, and it turned out to be an easy and illuminating method.[2] [The *SCI*® indicates that this paper has been cited in over 190 publications since 1961.]

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"An apocryphal story has it that Louis Pasteur spent his declining years rereading his own papers while muttering to himself, 'Beautiful, oh so beautiful' [in French, of course]. Getting a *Citation Classic* gives more ordinary scientists an excuse to take a second look at an early paper. I certainly did while muttering to myself, 'Has it really been more than 20 years?' [in Norwegian, of course]. It was the very first full-length paper I wrote, and presumably the Swedish Academy read it while muttering to themselves, 'Not bad for a Norwegian' [in Swedish, of course]. The paper is an extension of two earlier *Physical Review Letters* papers[3,4] describing tunneling into superconductors which led to a share in the 1973 Nobel prize in physics (along with Brian Josephson and Leo Esaki).

"I suspect the paper has been so highly cited because it describes an experiment that confirmed the relatively new theory of superconductivity by Bardeen, Cooper, and Schrieffer (BCS). At the time, many other theorists were still developing their own explanations for the strange, coherent phenomena that occur in superconductors. Central to the BCS theory is the prediction of an energy gap in the electron density of state. The experiment described in the paper was conceived to measure the postulated gap. The success of the experiment in that regard was phenomenal, and all but the most stubborn scientists accepted the BCS theory. [Disproving Max Planck's statement, 'New theories are never accepted, the opposition just dies.']

"I feel very lucky to have played a part in all of this. When I started the tunneling experiments at the prodding of John Fisher, I really didn't believe that electrons could tunnel because at the time I was a mechanical engineer. When I became convinced that tunneling took place in my experiment, I read skepticism in the eyes of my much more experienced colleagues at General Electric, and I searched for the more conclusive experiment. While taking a course in solid-state physics given by Hil Huntington at Rensselaer Polytechnic Institute, I learned about the superconducting energy gap, and all I really did was put the tunneling together with superconductivity.

"It was a very exciting and enjoyable time. Maybe I am just getting old, but it seems to me that the research climate in this country has changed greatly in the 20 or so years that have gone by. Today, there is a general lack of faith in the value of basic research. As a result, young scientists tend to be closely supervised and their work narrowly focused. Like ourselves 20 years ago, they need time to think about the important problems that expand human understanding. And they need more time to wrestle, suffer, and hopefully solve some of them. Given these opportunities they will develop into mature, capable scientists whom we will need so desperately tomorrow."

1. **Bardeen J, Cooper L N & Schrieffer J R.** Theory of superconductivity. *Phys. Rev.* **108**:1175-204, 1957. (Cited 2,465 times since 1957.)
2. **Barone A & Paterno G.** *Physics and applications of the Josephson effect.* New York: Wiley, 1982. 529 p.
3. **Giaever I.** Energy gap in superconductors measured by electron tunneling. *Phys. Rev. Lett.* **5**:147-8, 1960. (Cited 145 times since 1960.)
4. ----------. Electron tunneling between two superconductors. *Phys. Rev. Lett.* **5**:464-6, 1960. (Cited 115 times since 1960.)

