

Daniel Kleppner's Reference Frame piece implies incorrectly that the crossover between Bardeen-Cooper-Schrieffer and Bose-Einstein condensation theory was first studied by Anthony Leggett in 1980. Actually, my early work on this topic was published 11 years before then.¹

In the mid-1980s, I and colleagues in Australia also found the first example² of a system that lay on the Bose-gas side of the BCS-Bose gas transition, in a ceramic sample of 3% zirconium-doped strontium titanate (SrTiO_3), although with a pairing temperature much lower than that predicted for the 1969 model used for this material. In three dimensions there is a threshold in the coupling strength for the existence of Bose-gas superconductivity at very low carrier concentrations, and for strengths slightly above the threshold, the pair-binding energy is proportional to the square of the difference of the coupling from the threshold value. Thus, for example, a calculated coupling error that gives a value 5% above threshold instead of 1% above would make a factor of 25 error in the pair-binding energy.

A later attempt³ to reach the Bose-gas regime in macrocrystalline samples of Zr-doped SrTiO_3 with similar carrier concentrations to those in the ceramic sample mentioned indicated that some nonuniform state prevented the Bose-gas regime being reached. However, there is still much interesting physics awaiting study in this material.

References

1. D. M. Eagles, *Phys. Rev.* **186**, 456 (1969).
2. R. J. Tainsh, C. Andrikidis, *Solid State Commun.* **60**, 517 (1986); D. M. Eagles, *Solid State Commun.* **60**, 521 (1986).
3. C. Andrikidis, R. J. Tainsh, D. M. Eagles, *Physica B* **165**, 1517 (1990).

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Pauli Oscillations

Horst Meyer's letter in the June 2004 issue of PHYSICS TODAY (page 16) reminded me of an amusing incident involving Wolfgang Pauli that occurred two years after Horst had left Zürich. As part of a faculty exchange arrangement with the University of Rochester, I spent the academic year 1954–55 at the Physics Institute of the University of Basel in Switzerland. In May 1955 I traveled to Lausanne to deliver a



Albert Einstein to Arnold Sommerfeld¹

Translated and annotated by Bertram Schwarzschild

Einstein was still a patent officer in the Swiss capital, two years after his annus mirabilis, when he wrote this letter to Arnold Sommerfeld, the eminent professor of theoretical physics at the University of Munich. At the time, the idea of a maximum signal-propagation velocity was still in dispute. The letter also discusses Einstein's equivalence principle, which would become the foundation of his general theory of relativity, completed eight years later. Einstein remained at the patent office until October 1909, when he finally got his first academic position—a professorship at ETH, the Swiss Federal Institute of Technology in Zürich.

Bern, 5 January 1908

Highly honored Professor,

Many thanks for sending me your latest papers. Of greatest interest to me, of course, is the one on the speed of signal propagation. Last summer I had a lively exchange of letters on this subject with Professor [Wilhelm] Wien. I didn't succeed in convincing him of my view.² From [Emil] Wiechert's result—that the Maxwell-Lorentz equations can be replaced by action at a distance propagating at the speed of light (c)—I concluded that a signal whose propagation is due solely to electromagnetic interaction between point particles cannot possibly propagate faster than c .

Recently I've been working on the question of whether the relativity principle can be generalized to uniformly accelerated coordinate systems. After all, the fact that all bodies are equally accelerated by the gravitational field strongly invites us to view an accelerated coordinate system and an unaccelerated coordinate system with a homogeneous gravitational field as completely identical things. On the basis of that assumption, one arrives at entirely plausible conclusions.³ As soon as I receive reprints of my paper on this subject, I'll send you one.

Yours with great respect,

A. Einstein

References and notes

1. *The Collected Papers of Albert Einstein*, vol. 5, M. J. Klein, A. J. Fox, R. Schulmann, eds., Princeton U. Press, Princeton, NJ (1993), p. 85.
2. In the printed version of a lecture in 1907, Sommerfeld had written that the phase velocity of a light pulse, but not the signal velocity, can exceed c in a dispersive medium. Wien had expressed doubt about Sommerfeld's conclusion.
3. A. Einstein, *Jahrbuch d. Radioaktivität u. Elektronik* **4**, 411 (1907), available in *The Collected Papers of Albert Einstein*, vol. 2 English translation, A. Beck, trans., Princeton U. Press, Princeton, NJ (1989), p. 252. This early paper already discusses the consequences of the equivalence principle for clocks and light in a gravitational field. Enthusiastically telling Sommerfeld of his bold conjecture, Einstein could hardly have known that, in a December 1907 letter to Hendrik Lorentz, Sommerfeld had characterized Einstein's work as containing an unhealthy dogmatism in the "abstract-conceptual manner of the Semite" [die abstrakt-begriffliche Art des Semiten].

paper at a meeting of the Swiss Physical Society, where two simultaneous sessions were held in adjacent lecture halls. Pauli, seated in the front row, presided over the session that I attended. When a speaker presenting a paper stated that one result of his work disagreed with a prediction made by Hans Bethe, Pauli stood up. After apologizing for interrupting the speaker, he said that he couldn't help remarking that "it is always a sign of progress in physics when one of Bethe's theories is disproved." Then he sat down again, allowing the speaker to continue his talk. While listening, he resumed his habit of rocking his

head back and forth, a habit that a Swiss colleague described as Pauli's *Eigenschwingungen* (that is, "characteristic oscillations").

After the session, many of the participants adjourned to a nearby park on a slope bordering Lake Geneva. Pauli lumbered uphill with some effort and settled on the stump of a recently felled tree while he conversed with several people. With his large girth in those days, I remember thinking that he reminded me of pictures of the old Aga Khan.

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