

Columbia University

Department of Physics Colloquium



“THE DISCOVERY OF THE ANDERSON-HIGGS MECHANISM”

Landau introduced the idea of the ground state of a condensed matter system as a “vacuum” and of the elementary excitations as “quasiparticles” moving in this vacuum. He and Tisza noted that spontaneous orderings such as magnetism could be thought of as spontaneous symmetry-breaking of this vacuum, and based theories of phase transitions on this idea. In studying antiferromagnetism, I realized that symmetry-breaking could also have dynamical consequences, and suggested for condensed matter what later came to be known as Goldstone’s theorem.

With the appearance of the BCS theory of superconductivity and Nambu’s transcription of it into a theory of the interaction mass of hadrons, interest grew in broken symmetry in the real vacuum. At the same time, there was concern about gauge invariance of BCS; and papers by Nambu, Bogoliubov and Shirkov, and PWA in 1958 addressed that issue by studying the collective excitation spectrum; but only PWA correctly included the electromagnetic interaction and found an empty energy gap: Goldstone’s theorem fails! When I learned in 1962 that Goldstone’s theorem was an obstacle to serious theories, I tried as best I could to explain the physics in quasirelativistic terms, hence my 1963 paper. It can be seen as successfully predicting heavy gauge bosons, and PWA 1958 even contains a brief remark on a Higgs; Littlewood and Varma claim to have found such an object in the ‘90’s. At least two of the three “Higgs” groups were quite familiar with either the ‘63 or ‘58 paper. As for me, I was too aware of the zero-point energy problem and busy doing other things.



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