CC/NUMBER 47
NOVEMBER 21, 1983

This Week's Citation Classic

Singwi K S, Tosi M P, Land R H & Sjölander A. Electron correlations at metallic densities. *Phys. Rev.* **176**:589-99, 1968.
[Argonne National Laboratory, Argonne, IL and Institute of Theoretical Physics, Chalmers University of Technology, Gothenburg, Sweden]

This paper presents a theory of the wave number and frequency dependent dielectric function of an electron liquid which has the merit of including short-range correlations arising from both Coulomb and exchange effects. The theory is self-consistent in that the dielectric function is a functional of the static structure factor of the electron liquid. [The *SCI*® indicates that this paper has been cited in over 390 publications since 1968.]

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October 15, 1983

"Under the sponsorship of NORDITA, I was spending the academic year 1966-1967 at the Institute of Theoretical Physics of Chalmers Tekniska Högskola, Göteborg, Sweden. At the institute, I was collaborating with Alf Sjölander toward developing a theory of the self-motion of atoms in monatomic classical fluids using a simplified Liouville equation. We were very pleased with this work[1] since we were able to derive from first principles a nonlinear integral equation for the velocity autocorrelation function, whose solution, in the case of liquid argon, gave results which were in reasonably good agreement with the molecular dynamics calculations.

"Coffee time at four o'clock in the afternoon at the institute was almost a daily ritual with all of us. One day during the coffee break, the question came up as to the consequences of the approximation, as applied to the quantum electron fluid, in which the two-particle phase-space distribution function in the Liouville equation is written as a product of single-particle distribution functions and the instantaneous pair-correlation function. Once we had the idea, the germ of which in a sense was already contained in reference 1, it took us only a few days before we were able to derive an expression for the wave number and frequency dependent dielectric response of an electron liquid. This expression is the central result of the paper under review and the approximation is now referred to as STLS.

"For some time we did not fully appreciate the full significance of our new result until one day we were able to derive in a straightforward manner the celebrated result of the late John Hubbard for the so-called local field factor.[1] This was to be the turning point in our future effort. We quickly wrote a short communication for *Physical Review Letters* and also sent a preprint to Hubbard, then at AERE, Harwell.

"Our paper was not accepted for publication on the ground that it did not contain numerical results for the pair-correlation function, etc. Fortunately, at Argonne National Laboratory, in collaboration with Mario Tosi and Bob Land, we had already begun a program of numerical computation. Meanwhile, a communication from Hubbard appeared in *Physics Letters*[2] in which he showed, using our expression for the dielectric function, that the value of the pair-correlation function at zero separation remained positive for most of the metallic density range—a definite triumph over the random phase approximation (RPA). From then on, Mario, Alf, and I began working toward exploiting various consequences of our theory. This effort resulted in a series of papers[3] over the next several years.

"The STLS approximation did not find much favor in the beginning with the practitioners of the art in the field. Over the course of time, however, the mist cleared when it was realized that the theory in many of its applications was able to predict results in reasonable agreement with experiment. The only reason, I can find, for the popularity of this paper is that the dielectric function of a gas of electrons has a very wide range of applicability in solid-state physics."

1. **Singwi K S & Sjölander A.** Theory of atomic motions in simple classical liquids. *Phys. Rev.* **167**:152-65, 1968.
2. **Hubbard J.** Electron correlations at metallic densities. *Phys. Lett. A* **25**:709-10, 1967.
3. **Singwi K S, Sjölander A, Tosi M P & Land R H.** Electron correlations at metallic densities. IV. *Phys. Rev. B* **1**:1044-53, 1970. (Cited 470 times.)