Letters to the Editor

ON THE PROBLEM OF CALCULATING THE DIAMAGNETIC SUSCEPTIBILITY OF HELIUM

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DAMBURG and Iolin [1] used Hylleraas functions with 80 variable parameters to obtain $\overline{r^2} = 1.1935$ (in atomic units) for an electron in the ground state of helium. These authors suggested that it is desirable to check the experimental value of the magnetic susceptibility. However, it seems to us there are no sufficient reasons to doubt the experimental value. The reason for the discrepancy between the theoretical calculations and the experimental data ($\overline{r^2} = 1.220 \pm 0.006$) is the poor convergence of the selected functions, which was mentioned by Damburg and Iolin themselves. We wish to point out that the high precision of the calculated values of the energies is proof of the satisfactory nature of the functions only for medium distances, while in calculations of $\overline{r^2}$ it is the large distances which are important.

We have calculated $\overline{r^2}$ using functions [2,3] of the extended Fock method [4] in one-, two-, and three-configuration approximations. In the three-configuration approximation (five variable parameters) there is better agreement with experiment (we rounded out the value of the parameter [2] to 2.19) than that obtained in [1]:

	$1s^2$	$1s^2, 2p^2$	$1s^2, 2s^2$	$1s^2, 2s^2, 2p^2$
$\overline{r^2}$:	1.233	1.233	1.207	1.208

A very rough estimate of the contribution of the configurations $3s^2$, $3p^2$, $3d^2$ indicates that the agreement may be improved by another 0.005.

Thus the functions of the extended Fock method are well-behaved not only at small and medium distances, which is confirmed by energy and hyperfine structure calculations, [5] but also at large distances.

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[5] D. A. Goodings, Phys. Rev. **123**, 1706 (1961).

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DEPENDENCE OF THE FORBIDDEN-BAND WIDTH OF SEMICONDUCTING FILMS ON THEIR THICKNESS AND TEMPERATURE

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QUANTUM effects should appear in solid films when their thickness becomes comparable with the effective wavelength (λ) of the charge carriers. [1] The cited papers refer to metals for which the appropriate film thicknesses are very small, 10^{-8}—10^{-7} cm, owing to the large Fermi energy. In the case of semiconductors, however, the situation is much more favorable. Indeed, since $\lambda \propto h/\sqrt{2mkT}$, and assuming the effective mass to be $m \approx 10^{-2}m_0$, we find that at $T \approx 100°K$ the wavelength is $\lambda \approx 10^{-5}$ cm. In the case of degenerate semiconductors we should use $kT\mu^*$ instead of kT, where μ^* is the reduced Fermi level. Obviously this does not greatly alter the estimate of the wavelength.

Owing to carrier scattering at the film boundaries, which is diffuse in the classical limit, the quantum effects may be strongly masked.

It follows from the uncertainty principle that, irrespective of the details of the energy spectrum, the continuous spectrum for semiconducting films should be shifted by $\Delta \approx \hbar^2/2ma^2$, where a is the film thickness. This should appear as an increase of the forbidden-band width with decrease of the film thickness.

This effect can obviously appear, for example, in the dependence of the red edge of the fundamental absorption on the film thickness or on temperature for a film of given thickness.

If we consider the simplest model of a film (a potential well with a flat bottom and infinitely high walls) the stepwise nature of the function of the density of states per unit energy interval will