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Exercises for Advanced Physics 2, 2018 term 3

Exercise Set 6

(Due date: Tuesday, November 27, 2018)

Exercise 9 (Larmor diamagnetism) (10 points)

For the Larmor diamagnetism of insulators, determine the magnetic moment induced by a homogeneous field $\vec{B}_0 = B_0 \vec{e}_z$ and the corresponding diamagnetic susceptibility. To do this, use the classical picture that the electrons of the concerned atom move classically in stable orbits. The orbital angular momentum \vec{l} associated with the orbital motion executes a Larmor precession about the direction of the field with a frequency $\omega_L = \frac{eB_0}{2m}$ (electron mass m , electron charge $-e$). Compare the result with the quantum mechanically correct expression

$$\chi^{\text{dia}} = -\frac{Ne^2}{6mV} \sum_{i=1}^n \langle 0 | r_i^2 | 0 \rangle.$$

Is there a contradiction to the Bohr-van Leeuwen theorem?