



Okayama, November 19, 2019

Exercises for Advanced Physics 1, 2019 term 3

Exercise Set 6

(Due date: Tuesday, November 26, 2019)

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

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

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

Note:

- This is an optional exercise. Please solve it to get some extra points if you have not solved enough of the previous five exercise sets.
- There is no class on Nov. 26. Please hand your solution until Nov. 26 to M. Shimizu (Room B253).