

Appendix:

Solid State Physics , Homework 03

Ahmed Saad Sabit

Integral calculation to compute average $\langle r^2 \rangle$

Define the wavefunction

$$\text{In[3]:= } f[r] = (\text{Pi} * a_0^3)^{(-1/2)} * \text{Exp}[-r/a_0]$$

$$\text{Out[3]= } \frac{e^{-\frac{r}{a_0}}}{\sqrt{\pi} \sqrt{a_0^3}}$$

Check the normalization

$$\text{In[11]:= } 4 * \text{Pi} * \text{Integrate}[r^2 * f[r]^2, \{r, 0, \text{Infinity}\}]$$

Out[11]=

$$1 \text{ if } \text{Re}[a_0] > 0$$

Take the integral as required for the problem

$$\text{In[13]:= } 4 * \text{Pi} * \text{Integrate}[r^4 * (f[r])^2, \{r, 0, \text{Infinity}\}]$$

Out[13]=

$$3 a_0^2 \text{ if } \text{Re}[a_0] > 0$$

Numerical Calculation of Larmor χ

Out[14]=

$$\frac{h^2 a_0}{2 m}$$

In[15]:= **h = 1.054571817 × 10⁻³⁴**

Out[15]=

$$1.05457 \times 10^{-34}$$

In[16]:= **a₀ = 5.29 × 10⁻¹⁰**

Out[16]=

$$5.29 \times 10^{-10}$$

$$m = 9.1093837 \times 10^{-31}$$

Out[17]=

$$9.10938 \times 10^{-31}$$

In[20]:= **e = 1.602 × 10⁻¹⁹**

Out[20]=

$$1.602 \times 10^{-19}$$

In[28]:= **μ₀ = 4 Pi × 10⁻⁷**

Out[28]=

$$\frac{\pi}{2500000}$$

In[29]:= **A₀ = 6.022 × 10²³**

Out[29]=

$$6.022 \times 10^{23}$$

Computation of χ per atom

$$\frac{a_0^2 e^2 \mu_0}{2 m}$$

Out[32]=

$$-4.95367 \times 10^{-33}$$

