Home Assignment -3 (Due on 24-01-25)

1. The value of $\sqrt{\langle r^2 \rangle_{av}}$ for carbon is known from X-ray diffraction measurements to be around 0.7 Å. The density is 2220 kg/m^3. Calculate the value of susceptibility (give your answer in SI and cgs units). The measured value is -13.82×10^{-6} per unit volume. The agreement for carbon is better than that for most diamagnets. Comment on possible sources of error in the derivation.

2. ***Diamagnetic susceptibility of atomic hydrogen.*** The wave function of the hydrogen atom in its ground state (1*s*) is $\psi = (\pi a_0^3)^{-1/2} \exp(-r/a_0)$, where $a_0 = \hbar^2/me^2 = 0.529 \times 10^{-8}$ cm. The charge density is $\rho(x, y, z) = -e|\psi|^2$, according to the statistical interpretation of the wave function. Show that for this state $\langle r^2 \rangle = 3a_0^2$ and calculate the molar diamagnetic susceptibility of atomic hydrogen (-2.36×10^{-6} cm^3/mole).