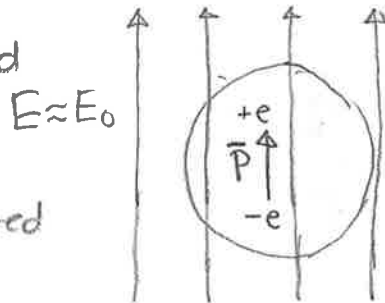# BB 6.2 (Atomic hydrogen susceptibility)

- What is the electric field exerted by an atom on the orbiting electron? For an electron orbiting at distance $r_0 \approx 0.5\text{Å}$, it will be

$$E_0 = \frac{Ze}{4\pi\epsilon_0 r_0^2} \qquad \text{if the atomic number is } Z.$$

- If we apply an external electric field of this magnitude, the atom becomes polarized

A dipole moment is created

$$p = er_0$$

$E \approx E_0$

+e
$\bar{P}\uparrow$
-e

- If the susceptibility is defined as $\chi_e \equiv \dfrac{P}{\epsilon_0 E}$

where P is the dipole moment per unit volume, then what is the susceptibility of our substance?

- Well, $P = \dfrac{\#\text{ atoms}}{\text{Volume}} \cdot \dfrac{\text{dipole moment}}{\text{atom}} = Np$

So $\chi_e = \dfrac{Np}{\epsilon_0 E} = \dfrac{N\cancel{e}r_0}{\cancel{\epsilon_0}\left[Z\cancel{e}/4\pi\cancel{\epsilon_0}r_0^2\right]} =$

$$\boxed{\chi_e = \frac{4\pi N r_0^3}{Z}}$$

For oxygen, $N \approx 6\times10^{23}/\text{cm}^3$
$r_0 \approx 0.5\text{Å}$, $Z=8$ $\chi_e = 0.118$