On electric fields in Crystals 1/17/2014

1. Atomic fields $E_A \sim \frac{e^2}{a^2} \sim \frac{V_{at}}{a} \sim \frac{10V}{\mathring{A}} = 100 \frac{GV}{m}$

2. Collective field of free electrons separated from atoms (full charge separation)

$$E_p \sim 4\pi n_e e / \omega_p \cdot c \sim 100 \frac{GeV}{m} \cdot \sqrt{n_e [10^{18}]} = 10{,}000 \frac{GeV}{m} = \frac{1 kV}{\mathring{A}}$$

3. Field of (extreme) channeling particle

$\gamma = 1000$

one proton

$$E \approx \frac{2e}{a^2}\gamma = 2000\, E_A = \frac{20 kV}{\mathring{A}}$$

$N = 10^4$ $l = 0.1 \mu m$

μ-bunch

$$E = \frac{2Q}{l}\frac{1}{a} = \left(\frac{2N}{l/a}\right) \cdot E_A = \frac{2 \cdot 10^4}{10^{-7}/10^{-10}} = 20\, E_A = \frac{200V}{m}$$

e.g. Tevatron bunch $\frac{3 \cdot 10^{11}}{0.3 m} = 10^{12} \frac{1}{m}$ vs $\frac{10^4}{10^{-7}} = 10^{11}/m$

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