upper limit on velocity in condensed matter

none

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Abstract

Generated by the Physics Derivation Graph. https://arxiv.org/pdf/2004.04818.pdf

Eq. 1 is an initial equation.

$$v = \sqrt{\frac{K + (4/3)G}{\rho}} \tag{1}$$

Eq. 2 is an initial equation.

$$K = f\frac{E}{a^3} \tag{2}$$

Based on the assumption $K >> G$, drop non-dominant term in Eq. **??**; yeilds Eq. **??**

$$v = \sqrt{\frac{K}{\rho}} \tag{3}$$

Substitute LHS of Eq. 2 into Eq. 3; yields Eq. 4.

$$v = \sqrt{\left(f\frac{E}{a^3}\right)\frac{1}{\rho}} \tag{4}$$

Eq. 5 is an initial equation.

$$\rho = \frac{m}{a^3} \tag{5}$$

Multiply both sides of Eq. 5 by a^3; yields Eq. 6.

$$a^3\rho = m \tag{6}$$

Substitute RHS of Eq. 6 into Eq. 4; yields Eq. 7.

$$v = \sqrt{f}\sqrt{\frac{E}{m}} \tag{7}$$

Based on the assumption $\sqrt{f} \approx 2$, drop non-dominant term in Eq. **??**; yeilds Eq. **??**

$$v = \sqrt{\frac{E}{m}} \tag{8}$$

Eq. 9 is an initial equation.

$$E_{\text{Rydberg}} = \frac{m_e e^4}{32\pi^2\epsilon_0^2\hbar^2} \tag{9}$$

Eq. 10 is an assumption.

$$E_{\text{Rydberg}} = E \tag{10}$$

Eq. 11 is an initial equation.

$$\alpha = \frac{1}{4\pi\epsilon_0}\frac{e^2}{\hbar c} \tag{11}$$

Multiply both sides of Eq. 11 by c; yields Eq. 12.

$$\alpha c = \frac{1}{4\pi\epsilon_0}\frac{e^2}{\hbar} \tag{12}$$

Substitute LHS of Eq. 10 into Eq. 9; yields Eq. 13.

$$E = \frac{m_e e^4}{32\pi^2\epsilon_0^2\hbar^2} \tag{13}$$

Substitute LHS of Eq. 13 into Eq. 8; yields Eq. 14.

$$v = \sqrt{\frac{m_e}{m}\frac{e^4}{32\pi^2\epsilon_0^2\hbar^2}} \tag{14}$$

Simplify Eq. 14; yields Eq. 15.

$$v = \frac{e^2}{4\pi\epsilon_0\hbar}\sqrt{\frac{m_e}{2m}} \tag{15}$$

Substitute LHS of Eq. 12 into Eq. 15; yields Eq. 16.

$$v = \alpha c\sqrt{\frac{m_e}{2m}} \tag{16}$$

Eq. 17 is an initial equation.

$$m = Am_p \tag{17}$$

Substitute LHS of Eq. 17 into Eq. 16; yields Eq. 18.

$$v = \alpha c\sqrt{\frac{m_e}{Am_p}} \tag{18}$$

The maximum of Eq. 18 with respect to A is Eq. 19

$$v_u = \alpha c\sqrt{\frac{m_e}{m_p}} \tag{19}$$

Eq. 19 is one of the final equations.

References