

Relativistic Quantum Waves (Klein-Gordon Equation

Marcus Allen Denslow

2025-11-14

Contents

Chapter 1	Deriving the KG Equation	Page 2
1.1	double deriving	2

Chapter 1

Deriving the KG Equation

1.1 double deriving

Definition 1.1.1: Relativity: the mass shell

$$p \cdot p = (mc)^2 \rightarrow (mc)^2 = \left(\frac{E}{c}\right)^2 - p_x^2 - p_y^2 - p_z^2$$

Definition 1.1.2: Quantum: energy and momentum operators

$$\hat{E} = i\hbar \frac{\partial}{\partial t}, \text{ so } \left(\frac{E}{c}\right)^2 \text{ becomes } -\frac{\hbar^2}{c^2} \frac{\partial^2}{\partial t^2}.$$

$$\hat{p} = -i\hbar \nabla, \text{ so } -p_x^2 \text{ becomes } \hbar^2 \frac{\partial^2}{\partial x^2}.$$