

Elementary
excitation
energy

Holes

Particles

$|\varepsilon_{\mathbf{p}}|$

\mathbf{p}

The diagram illustrates the relationship between elementary excitation energy and momentum \mathbf{p} . The vertical axis represents the elementary excitation energy, and the horizontal axis represents the momentum \mathbf{p} . The energy is zero at $\mathbf{p} = 0$. For positive momentum, the energy increases linearly, labeled 'Particles'. For negative momentum, the energy decreases linearly, labeled 'Holes'. The magnitude of the energy is denoted as $|\varepsilon_{\mathbf{p}}|$. A dashed line extends from the origin into the negative \mathbf{p} region.