FOUR-MOMENTUM: EXAMPLE

As a simple example of the calculation of four-momentum, suppose we have a neutral pion $\pi^0$ moving at a speed $v = \frac{3}{5}$ at an angle of $38.7^\circ$ in the first quadrant. The rest mass of a $\pi^0$ is $m = 135$ MeV.

The four-momentum is defined as

$$ p = \gamma m [1, v_x, v_y, v_z] $$

(1)

where $\gamma = 1/\sqrt{1 - v^2}$.

The angle is chosen because $\cos 38.7^\circ = \frac{4}{5}$ and $\sin 38.7^\circ = \frac{3}{5}$, so

$$ v_x = \frac{12}{25} $$
$$ v_y = \frac{9}{25} $$

(2)

(3)

$$ \gamma = \frac{5}{4} $$

(4)

Thus

$$ p = [168.75, 81, 60.75, 0] $$

(5)