

FOUR-MOMENTUM: EXAMPLE

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Reference: Moore, Thomas A., *A General Relativity Workbook*, University Science Books (2013) - Chapter 3; Problem 3.3.

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

The four-momentum is defined as

$$\mathbf{p} = \gamma m [1, v_x, v_y, v_z] \quad (1)$$

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

$$v_x = \frac{12}{25} \quad (2)$$

$$v_y = \frac{9}{25} \quad (3)$$

$$\gamma = \frac{5}{4} \quad (4)$$

Thus

$$\mathbf{p} = [168.75, 81, 60.75, 0] \quad (5)$$