

### Formulas

Frame B moves with a velocity  $v$  in the  $+x$  direction relative to frame A.

$\Delta x_A = \gamma(\Delta x_B + v\Delta t_B)$	$\Delta t_A = \gamma[\Delta t_B + (v/c^2) \Delta x_B]$
$\Delta x_B = \gamma(\Delta x_A - v\Delta t_A)$	$\Delta t_B = \gamma[\Delta t_A - (v/c^2) \Delta x_A]$

$$f_{\text{obs}} = f_s \sqrt{\frac{1+v/c}{1-v/c}}, \quad \gamma mc^2, \quad \gamma mv, \quad E^2 = p^2 c^2 + m^2 c^4, \quad \gamma = \frac{1}{\sqrt{1 - \left(\frac{v}{c}\right)^2}}$$

Notation  $\Rightarrow V_{\text{CreltoA}} = V_{\text{C,A}}$        $V_{\text{C,A}} = \frac{V_{\text{C,B}} + V_{\text{B,A}}}{1 + \frac{V_{\text{C,B}} \times V_{\text{B,A}}}{c^2}}$        $f \lambda = c$

Object	Mass (u)	MeV/c <sup>2</sup>
	1.00	931.5
Electron	0.00054858	
Proton	1.007276	
Neutron	1.008665	
H	1.007825	