

# Velocity Transformation

- Velocity depends on distance and time
- Lorentz transformations affect only one component of distance, but they also affect time
- Thus, all components of velocity are affected by Lorentz transformation

# Velocity Transformation

$$u_x = \frac{u'_x + V}{1 + Vu'_x / c^2}$$

$$u_y = \frac{u'_y}{\gamma(1 + Vu'_x / c^2)}$$

$$u_z = \frac{u'_z}{\gamma(1 + Vu'_x / c^2)}$$

# Relativistic Momentum

- Relativistic momentum is relativistic mass times velocity
- Relativistic mass is  $\gamma m_0$ , where  $m_0$  is the mass measured in the rest frame of the particle and is known as the rest mass
- Relativistic momentum transforms as a Lorentz vector
- Easier to transform momentum than velocity

# Relativistic Momentum, Energy

- $\mathbf{P}=(p_x, p_y, p_z, iE/c)$
- $E^2 = c^2p^2 + m_0^2c^4$
- $E = K + E_0 = \gamma m_0 c^2$
- Aggregation of particles will have negative binding energy

# General Relativity

- Applies to accelerated reference frames
- Gravity is due to distortion of space by mass-energy
- General relativity is used in GPS satellites
- Black holes apparently exist—neither light nor mass can escape
- Detect black holes by effect on binary companions