

$$\lambda \cdot f = c$$

$$\Delta ct = \gamma \cdot (\Delta ct' + \frac{v}{c} \Delta x')$$

$$+ \Delta x$$

$$\Delta x = \frac{v}{c} \cdot \Delta ct$$

$$\Delta ct = \gamma (\Delta ct') + \frac{v}{c} \gamma \Delta ct'$$

$$= (1 + \frac{v}{c}) \gamma \Delta ct'$$

$$\frac{c}{f} = \gamma (1 + \frac{v}{c}) \frac{c}{f'}$$

$$\lambda = \frac{1 + \frac{v}{c}}{\sqrt{1 - \frac{v^2}{c^2}}} \lambda' > \lambda'$$

$$= (1 + z) \lambda'$$

Doppler Shift

Example

$\lambda =$ spatially constant

$$\begin{pmatrix} x_0 \\ x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} \begin{pmatrix} x^0 \\ x^1 \\ x^2 \\ x^3 \end{pmatrix}$$

$g_{\mu\nu}$

$$(\Delta s)^2 = \sum_{\mu, \nu=0}^3 g_{\mu\nu} \Delta x^\mu \Delta x^\nu$$

$x^\mu \quad \mu = 0, 1, 2, 3$

$$x^0 = ct$$

$$x^1 = x$$

$$x^2 = y$$

$$x^3 = z$$

$$x_0 = x^0 = ct$$

$$x_1 = -x^1 = -x$$

$$x_2 = -x^2 = -y$$

$$x_3 = -x^3 = -z$$

$$\Delta x^\mu = x^\mu_{1e} - x^\mu_{2e}$$

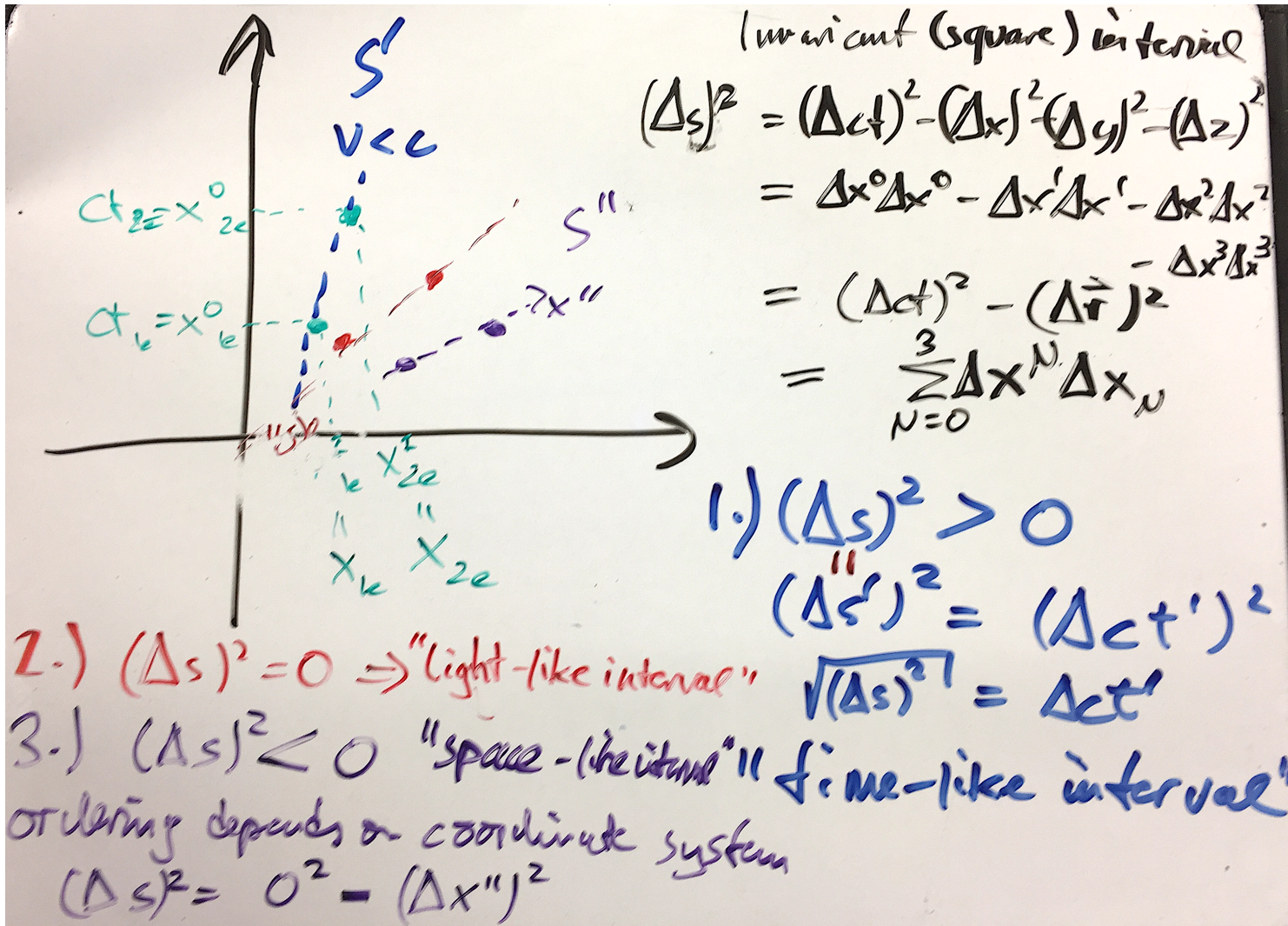
$$\Delta x^0 = ct_{1e} - ct_{2e}$$

$$\Delta x^1 = x_{1e} - x_{2e}$$

$$\Delta x^2 = y_{1e} - y_{2e}$$

$$\Delta x^3 = z_{1e} - z_{2e}$$

Formal rules for "scalar product" in 4-dimensional space-time. Metric g .



Invariant intervals