

FOUR-ACCELERATION

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The four-velocity \mathbf{u} has the property that, for any object with a non-zero rest mass, $\mathbf{u} \cdot \mathbf{u} = -1$ (For a photon, four-velocity cannot be defined.). If we define the four-acceleration as the derivative of \mathbf{u} with respect to proper time τ

$$\mathbf{a} \equiv \frac{d\mathbf{u}}{d\tau} \quad (1)$$

then if we take the derivative of the square of the four-velocity, we get

$$\frac{d(\mathbf{u} \cdot \mathbf{u})}{d\tau} = 0 \quad (2)$$

$$2\mathbf{u} \cdot \frac{d\mathbf{u}}{d\tau} = 0 \quad (3)$$

$$\mathbf{u} \cdot \mathbf{a} = 0 \quad (4)$$

Thus for any object with a non-zero rest mass, the four-velocity is orthogonal to the four-acceleration.