

FOUR-ACCELERATION

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Reference: Moore, Thomas A., *A General Relativity Workbook*, University Science Books (2013) - Chapter 4; Problems 4.11.

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

$$(0.1) \quad \mathbf{a} \equiv \frac{d\mathbf{u}}{d\tau}$$

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

$$(0.2) \quad \frac{d(\mathbf{u} \cdot \mathbf{u})}{d\tau} = 0$$

$$(0.3) \quad 2\mathbf{u} \cdot \frac{d\mathbf{u}}{d\tau} = 0$$

$$(0.4) \quad \mathbf{u} \cdot \mathbf{a} = 0$$

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