Scalar Equation of Motion

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Abstract

In classical mechanics, this paper presents a scalar equation of motion, which can be applied in any reference frame (rotating or non-rotating) (inertial or non-inertial) without the necessity of introducing fictitious forces.

Scalar Equation of Motion

If we consider two particles A and B of mass m_a and m_b respectively, then the scalar equation of motion, is given by:

$$\frac{1}{2}\, m_a m_b \left[\frac{(\mathbf{r}_a - \mathbf{r}_b)}{|\mathbf{r}_a - \mathbf{r}_b|} \cdot (\mathbf{v}_a - \mathbf{v}_b) \right]^2 = \int m_a m_b \left[\frac{(\mathbf{r}_a - \mathbf{r}_b)}{|\mathbf{r}_a - \mathbf{r}_b|} \cdot \left(\frac{\mathbf{F}_a}{m_a} - \frac{\mathbf{F}_b}{m_b} \right) \right] d \left[\frac{(\mathbf{r}_a - \mathbf{r}_b)}{|\mathbf{r}_a - \mathbf{r}_b|} \cdot (\mathbf{r}_a - \mathbf{r}_b) \right]$$

where $\mathbf{r}_a$ and $\mathbf{r}_b$ are the positions of particles A and B, $\mathbf{v}_a$ and $\mathbf{v}_b$ are the velocities of particles A and B, and $\mathbf{F}_a$ and $\mathbf{F}_b$ are the net forces acting on particles A and B.

This scalar equation of motion can be applied in any reference frame (rotating or non-rotating) (inertial or non-inertial) without the necessity of introducing fictitious forces. In addition, this scalar equation of motion is invariant under transformations between reference frames.