A Principle of Conservation of Relational Energy

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Abstract

In classical mechanics, this paper presents a principle of conservation of relational energy which can be applied in any reference frame without the necessity of introducing fictitious forces.

The Principle of Conservation

The kinetic energy K of a system of N particles of total mass M, is given by:

$$K = \sum_{i=1}^{\mathrm{N}} \sum_{j>i}^{\mathrm{N}} \frac{m_i m_j}{M} \left(\dot{r}_{ij} \, \dot{r}_{ij} + \ddot{r}_{ij} \, r_{ij} \right)$$

The principle of conservation of relational energy states that in an isolated system of particles that is only subject to conservative forces (proportional to $1/r^2$) the relational energy of the system of particles remains constant.

$$K + U = constant$$

where $r_{ij} = |\vec{r}_i - \vec{r}_j|$, $\dot{r}_{ij} = d|\vec{r}_i - \vec{r}_j|/dt$, $\ddot{r}_{ij} = d^2|\vec{r}_i - \vec{r}_j|/dt^2$, $\vec{r}_i$ and $\vec{r}_j$ are the positions of the i-th and j-th particles, m_i and m_j are the masses of the i-th and j-th particles. U is the internal potential energy of the isolated system of particles.

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