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The Relative Mechanical Motion and Inertiality - Bodies in Outer Space

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The paper addresses the issue of mechanical representation of relative motions without direct reference to an inertial reference system. Even though classical mechanics states that it is not possible to find an inertial reference frame, relative measurements are used to determine the mechanical behaviour of celestial bodies with very small dimensions compared to the distances between them. This paper aims to demonstrate that the two fundamental theorems of mechanics, the momentum theorem and the angular momentum theorem, remain valid if we use only observations, measurements, and determinations of the distances, velocities, and relative accelerations between these celestial bodies along with the corresponding forces. The starting point for developing such a result is that the basic assumptions of Newtonian mechanics are considered to be valid and are used with the assumption that an inertial reference frame can exist, even if only hypothetically. In a first stage, the representation of relative motion was analysed using observations and measurements in an inertial frame. Then, in the next stage, relative motion was analysed using observations and measurements in a non-inertial reference frame that could be in a physical relationship with point bodies in relative motion.. Relationships are established between the relative accelerations and the corresponding global forces acting on each body in a two-body assembly, and the reduced mass is deduced as a physical quantity representing the inertia manifested in the relative motion. Based on this result, the other properties of relative motion are then expressed, including the two fundamental theorems of mechanics.

Keywords: inertial reference frames, inertiality in relative motions, equations of relative motion

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