Fundamental tests of relativity and electrodynamic theories: conceptual investigations of the Trouton-Noble, the differential form of Faraday's law, and *hidden* momentum effects.

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ABSTRACT.
Lately, many papers have been published on themes related to the so called "electrodynamics controversy." This stems from a scientific debate between those in favor of the standard relativistic interpretation of classical electrodynamics and others that favor a different approach to electrodynamics. Some aspects of this controversy refer to the test of electromagnetic (em) forces on current elements and the presumed differences between the Ampere and Grassman formulas based on the Biot-Savart law.
In this paper we comment briefly on the problem of the longitudinal forces but review mainly certain controversial aspects of some experimental tests of electromagnetic forces and fields that imply unexpected and novel predictions of standard classical electrodynamics.
According to the interpretation of Faraday's law of induction applied to the Faraday disk, a positive result for an experiment of the Trouton-Noble type is predicted theoretically if the effect of the magnetic field of the Earth on the capacitor is taken into account. This result is relevant both for the interpretation of recent experiments of the Trouton-Noble type and as a test of Faraday's law in differential form. In fact, Faraday’s law in integral form is well proven experimentally in terms of the law of induction for closed circuits, but there are no quantitative tests for the measurement of the local, differential em fields or forces.
Another unsolved and fairly recent problem deals with the correct expression of the force on a magnetic dipole that accounts for the *hidden* momentum and, thus, differs from the standard expression usually used in classical electrodynamics.
It is worth mentioning that the *hidden* momentum is closely related to the classical momentum of the electromagnetic fields. The importance of this em momentum and its properties, such as its vorticity, is not restricted to classical electrodynamics, but is relevant in determining the non-locality in the quantum effects of the Aharonov-Bohm type for matter waves that are analogous to the corresponding effects of light, water and acoustic waves.
The conceptual details of the experimental arrangements that can be used for the realization of these two tests of the relativistic interpretation of electrodynamics are outlined.

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