Derivation of the magnetic Lorentz force via a unified approach to classical and relativistic dynamics for variable mass systems

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Special relativity categorizes the description of physical phenomena based on the velocity of the objects involved. For velocities significantly lower than the speed of light in a vacuum (c) a classical framework is employed; however, as velocities approach c, the description shifts to a relativistic one. The precise boundaries governing the applicability of these two approaches are often difficult to define. While magnetism is traditionally associated with relativistic effects, the velocities of moving charges in many practical scenarios remain within non-relativistic limits. Consequently, these phenomena frequently reside in the classical rather than the relativistic domain.

In this presentation, we introduce a novel approach to magnetism that reconciles these two distinct frameworks, establishing a universal description valid across the entire velocity spectrum [1,2]. Classically, this is achieved by treating the motion as that of a body with variable mass. The core relativistic principle integrated into this theory is mass-energy equivalence. Experimental evidence confirms that mass varies with motion, a factor that must be explicitly accounted for in the equation of motion. While variable mass equations are well-established—commonly used, for instance, to describe rocket propulsion—mass-energy equivalence is equally prevalent, appearing at the micro-scale in isotope production and at the macro-scale in stellar radiation.

By applying this unified dynamical framework to objects such as point charges, we utilize the governing equations of variable mass systems. From this, two distinct components emerge, one of which accounts for magnetism. This allows for the formal definition of the magnetic interaction as a fundamental consequence of the system's dynamics. Within three-dimensional physical space, the formulas for the magnetic induction vector and the Lorentz force are subsequently derived.

References:

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