Hidden momentum and Hall effect

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This contribution concerns the problem of momentum balance in electromechanical systems exposed to static electromagnetic field. While the conversion of electromagnetic momentum into mechanical one is satisfactorily solved for quickly oscillating electromagnetic fields, either theoretically or experimentally, the interaction of ponderable systems with static electromagnetic fields is for more than 120 years a persisting challenge without unambiguous solution [1]. The expected effects are very subtle, of order $\sim 1/c^2$, so they have never been investigated experimentally. They are only subject of abstract theoretical studies. Among the concepts involved, a somewhat puzzling entity, "hidden momentum", representing momentum of non-electromagnetic nature completing the momentum balance plays significant role [2]. To resolve uneasy questions connected with this entity, we suggest to use a robust experimentally manageable phenomenon operating in static electromagnetic fields, ordinary Hall effect, which is sensitive enough to track reliably the exchange of momenta between electromagnetic fields and ponderable matter. Interpreting this effect anew in terms of Poynting vector flows, the importance of time factor characterizing the system assembly is shown, even though the effect formally works in static fields (cf. [3]). This aspect may be crucial also for correct interpretation of other effects belonging to the realm of classical theory of electromagnetic fields.

[1] J. J. Thomson: *On Momentum in the Electric Field*. Phil. Mag. **8** (1904) 331-356

[2] K. T. McDonald: *On the Definition of "Hidden" Momentum*. (July 9, 2012, https://physics.princeton.edu/~mcdonald/examples/hiddendef.pdf)

[3] F. Redfern: *Hidden momentum: A misapplication of the center of energy theorem*. ResearchGate Nov. 2016 (http://dx.doi.org/10.13140/RG.2.2.12838.11840)