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Revisiting Classical Diamagnetism: A Surprise of Physics NARENDRA KUMAR, Raman Research Institute, VIJAY KUMAR KRISHNAMURTHY, Indian Institute of Science — The Classic Bohr-van Leeuwen (BvL) theorem states that the orbital diamagnetism of a classical system of charged particles in thermal equilibrium is identically zero. This theorem is universally accepted and has entered textbooks. Physically, the theorem derives from the exact cancellation of the orbital diamagnetic moment associated with the completed cyclotron orbits of the charged particles by the paramagnetic moment subtended by the incomplete orbits skipping the boundary cuspidally in the opposite sense. In this work we have revisited the problem of this crucial but subtle role of the boundary by considering the case of a finite but unbounded system, namely that of a charged particle moving on a sphere in the presence of an externally applied magnetic field. The orbital moment calculated on the basis of the classical Langevin equation in the infinite time limit now indeed turns out to be non-zero, and has the diamagnetic sign. This violates the BvL theorem as stated in the literature. To the best of our knowledge, this is the first report of non-zero classical diamagnetism. It is explicitly owing to the above avoided cancellation. We also present possible experimental realization of the predicted classical diamagnetism.

Vijay Kumar KrishnaMurthy
Indian Institute of Science

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