Non-destructive measurement of orbital angular momentum of an electron beam

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Free electrons with a helical phase-front, referred to as "twisted" electrons, possess a quantized magnetic dipole moment along their propagation direction [1]. This intrinsic magnetic moment can be used to probe material properties; thus, twisted electrons find numerous potential applications in materials science [2]. Determining the electron beam's magnetic dipole moment is an essential key to these applications. All currently available techniques, adopted from their optical counterparts, rely on a series of projective measurements that subsequently change the orbital angular momentum (OAM) carried by the electrons, and consequently their magnetic moment [3]. We propose a non-destructive way of measuring an electron beam's OAM through the interaction of this magnetic dipole with a conductive loop. Such an interaction results in the generation of induced currents within the loop, which are found to be directly proportional to the electron's OAM value. Moreover, the electron experiences no OAM variations and minimal energy losses upon the measurement, and hence the non-destructive nature of the proposed technique.

References

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