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Numerical study on high orbital angular momentum vortex electron beams in hafnium dioxide

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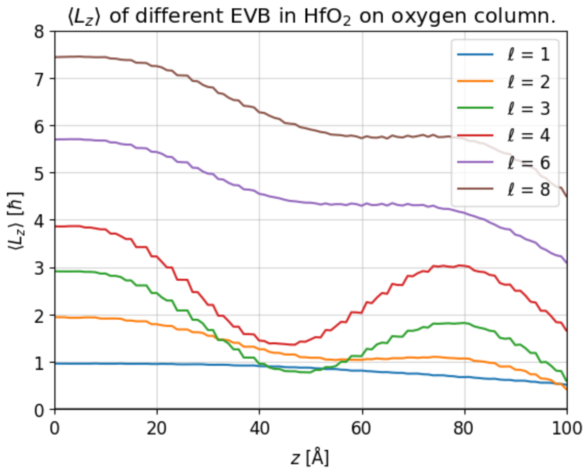
Background incl. aims
Electron vortex beams (EVB) are electron beams that have a quantized orbital angular momentum (OAM) along their propagation axis. These beams have found applications in electron magnetic circular dichroism (EMCD) and beam focusing, and have attracted new attention with the development of programmable phase plates [1, 2]. In this study we aim to improve our understanding of the behavior of vortex beams and their OAM in complex electronic materials.

Methods
We present a numerical study of vortex electron beams modeled as Bessel beams [3, 4]. The commonly used multislice algorithm is utilized to propagate the beam through crystalline material.

Results
We compare our results with previous work [3, 4] for OAM with quantum number l=1 and make predictions for higher angular momentum beams in new materials. The results indicate a reduction in the expectation value of the OAM with propagation depth inside the crystal potential, which depends on the initial value of l. We present simulation results for HfO_2 systematically investigating different beam shaping parameters. Furthermore, we investigate the numerical limits of our method.

Conclusion
Our method is capable of reproducing previously published work for low OAM. It shows physically conclusive results for higher angular momentum vortex beams.

Graphic:



Keywords:

electron vortex beam; multislice simulation

Reference:

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