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## Novel Light-Field Imaging Device with Enhanced Light Collection for Cold Atom Clouds

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Long baseline atom interferometry offers new opportunities to expand the search for ultra-light dark matter, mid-band gravitational waves, and very weakly-coupled fifth forces. In this context, we developed a novel light-field imaging system that captures multiple views of an atom cloud with a single shot while also maximizing light collection. This enables a single-shot, 3D tomographic reconstruction of cold atom clouds, enhancing the physics capabilities of current and future quantum experiments using cold atom clouds. Simulation results demonstrate that this system is capable of single-shot tomography of atom clouds of size  $O(1\text{mm})$  with  $O(100\mu\text{m})$  features, reconstructing the 3D distribution of atoms and features not accessible from any single view angle in isolation. We also demonstrate this system with a 3D-printed prototype. The prototype is used to take images of  $O(1\text{mm})$  sized objects, and 3D reconstruction algorithms running on a single-shot image successfully reconstruct target features. The prototype also shows that the system can be built with 3D printing technology and hence can be deployed quickly and cost-effectively in experiments with needs for enhanced light collection or 3D reconstruction.

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