# Tomographic reconstruction of the 3-D momentum distribution in velocity map imaging experiments

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**Synopsis** We apply tomography, a general method for reconstructing 3-D distributions from multiple projections, to reconstruct the momentum distribution of electrons produced by photoionization. The projections are obtained by rotating the electron distribution via the polarization of the ionizing laser beam and recording a momentum spectrum at each angle with a 2-D velocity map imaging spectrometer. For linearly polarized light the tomographic reconstruction agrees with the distribution obtained using an Abel inversion. Electron tomography, which can be applied to any polarization, will simplify the technology of electron imaging. Our method can be directly generalized to other charged particles.

In velocity map imaging experiments, an inhomogeneous electric field is used to to project the velocity vector of charged particles into the 2-D plane of a detector. Since one component of the velocity vector is integrated over by the spectrometer's DC electric field, this component is not observable unless additional information is provided such as (a) symmetry assumptions, or (b) measurements from multiple directions. The former is a condition for Abel inversion [1] and allows the inversion of a single projection. The latter is a requirement for tomographic inversion [2] and is a more general approach.

We present results of a general method to measure the complete three-dimensional momentum distribution of charged particles in a velocity map imaging spectrometer. The method requires no knowledge of the symmetry of the distribution. It can be applied to any laser polarization. This means that 3-D momentum distributions can be obtained for any photoionization or photofragment experiment involving charged particles. As in all tomographic methods, multiple projections of the 3-D distribution are required. The projections are obtained by placing a half wave plate in the ionizing laser beam and recording spectra for each angle of the wave plate. Using multiphoton ionization of argon as an example, we confirm that the retrieved image agrees with those obtained with an Abel inversion for the case where an Abel inversion is possible. We present 3-D distributions of the electron momentum distribution created in linearly and elliptically ($E_1/E_2 = 0.89$) polarized light.

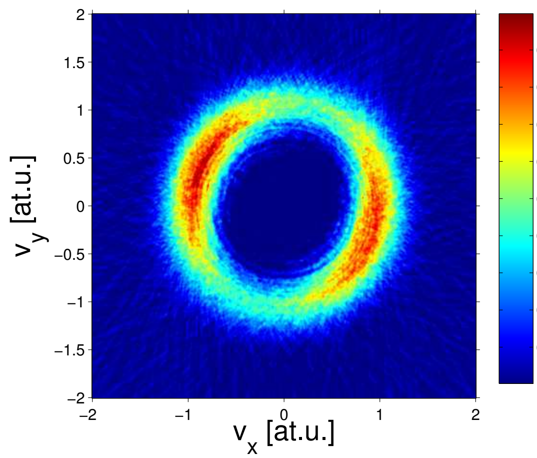


**Fig. 1**. Reconstructed electron velocity distribution in the plane of laser polarization. The color code represents the probability to measure an electron at a particular momentum.

## References

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