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Insights derived from hydrodynamic interpretations of atomic-scale interactions

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Many of the properties and much of the behavior of gaseous or plasma environments are governed by interactions at the atomic-scale, that is, interactions among electrons, photons, ions, atoms, and molecules. New insight into the fundamental dynamics of these interactions, such as how energy and momentum are transferred, can be gained by considering a hydrodynamic view of the evolution of the electronic probability density. In particular, the creation, evolution, interaction, dissipation, and asymptotic survival of zeroes of the probability density, and the corresponding vortices in the electronic probability current, play significant and often dominant roles in energy and momentum transfer that has not heretofore been well recognized. Recent work to elucidate the role of these phenomena in atomic collisions and photoionization will be described as well as collaboration with the Frankfurt group to experimentally demonstrate the persistence of the predicted zeroes to macroscopic scales in reaction microscope measurements.