Vortices catapult droplets in atomization

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Atomization of a liquid stream with a gas stream parallel to its surface is studied numerically and experimentally. At large gas velocities, any disturbance on the liquid surface grows into a Kelvin-Helmholtz (KH) wave and the crest of the KH-wave forms a tongue that flaps as the wave grows downstream. Increasing the speed of the gas, the wave tongue breaks up and the resulting droplets are ejected into the gas stream at a considerably large angle. In a flow where most of the momentum is in the horizontal direction, it is paradoxical, to observe such acute droplet ejections. DNS computations and smoke visualisation clearly shows that the gas flow field over the liquid surface separates to form a recirculation vortex behind the KH-wave. The liquid tongue of the KH-wave breaks up, in the recirculation region, to form droplets. Moreover, when the density difference is sufficiently large, the recirculation region behind the KH-wave becomes unstable leading to vortex shedding at regular intervals. The liquid wave tongue is blown from below by the recirculation vortex which is then stripped off by the incoming gas to form droplets that are eventually catapult into the gas stream by the vortex that is being shed.