Classical Wave-Particle Analog of Anderson Localization

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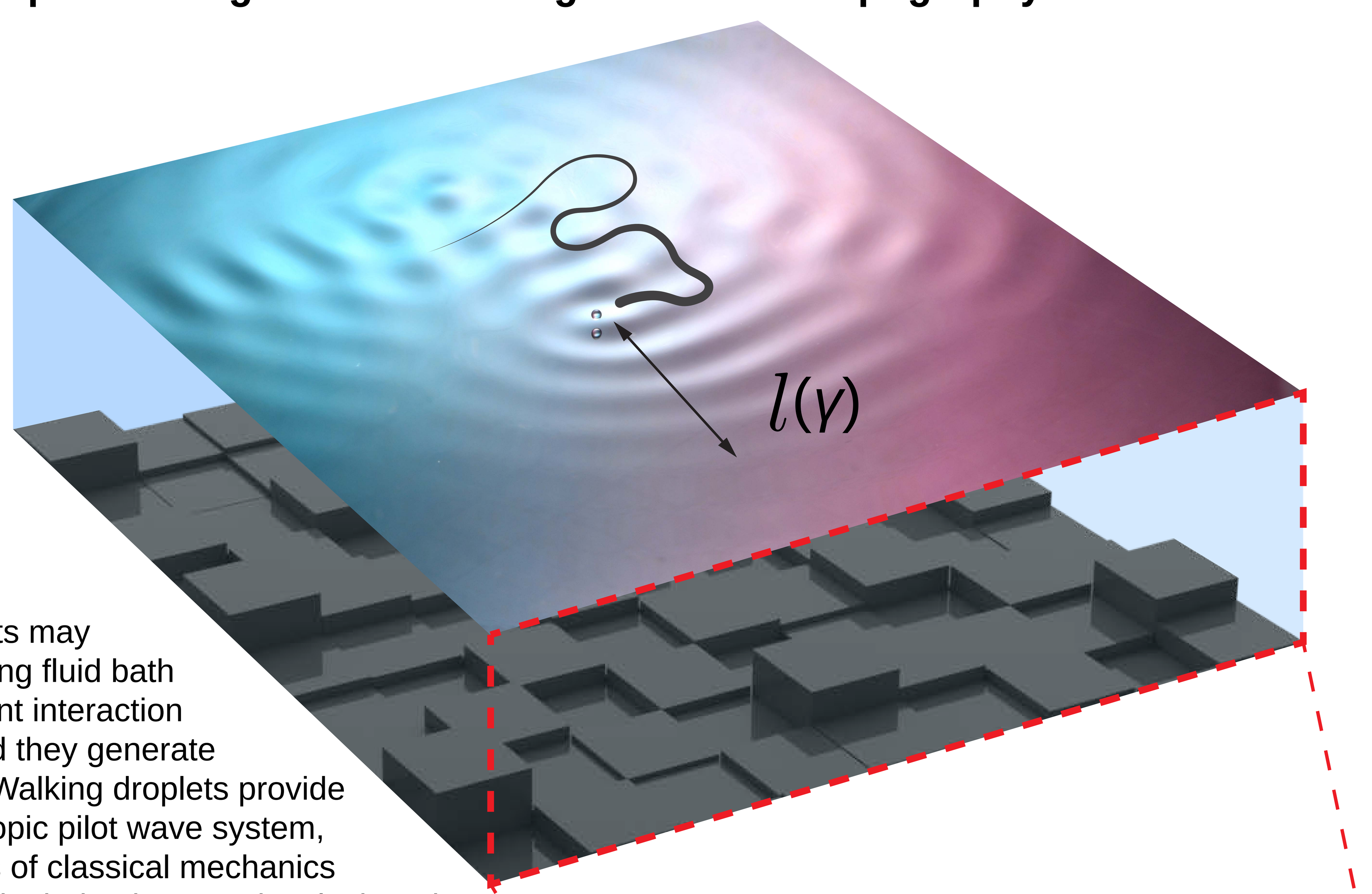
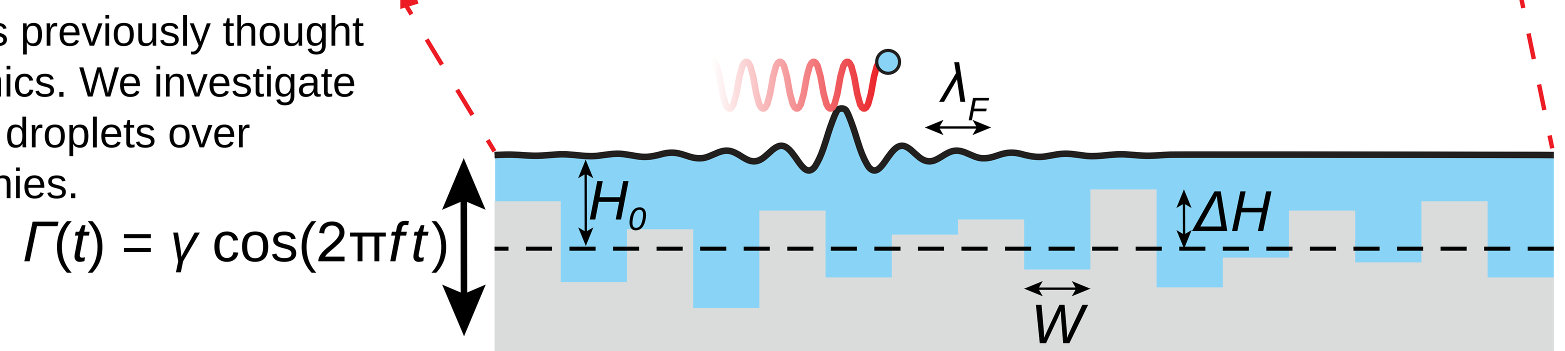
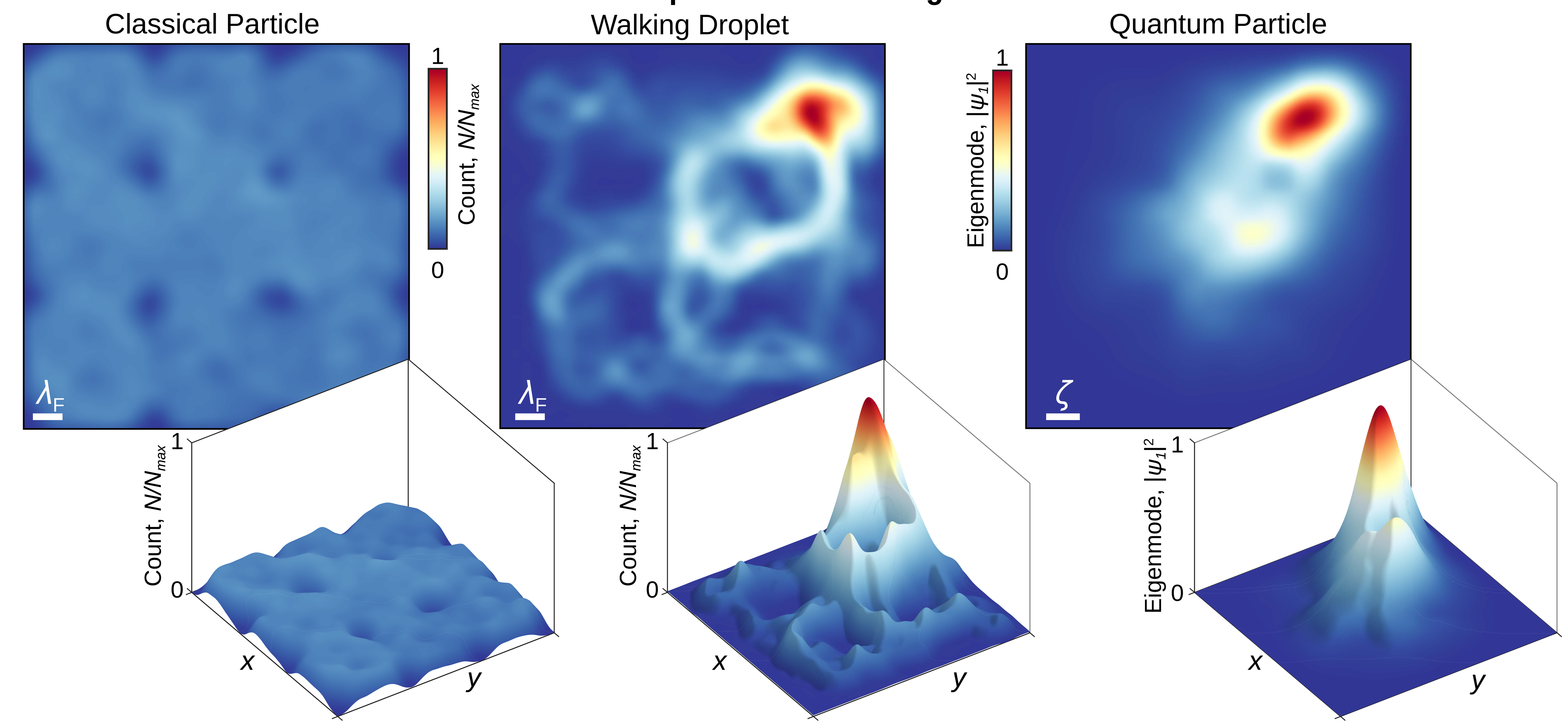
A Walking Droplet Moving Over a Submerged Random Topography



Millimetric droplets may 'walk' on a vibrating fluid bath through a resonant interaction with the wavefield they generate on each impact. Walking droplets provide the first macroscopic pilot wave system, pushing the limits of classical mechanics to include wave-like behaviors previously thought exclusive to quantum mechanics. We investigate the exotic diffusion of walking droplets over submerged random topographies.

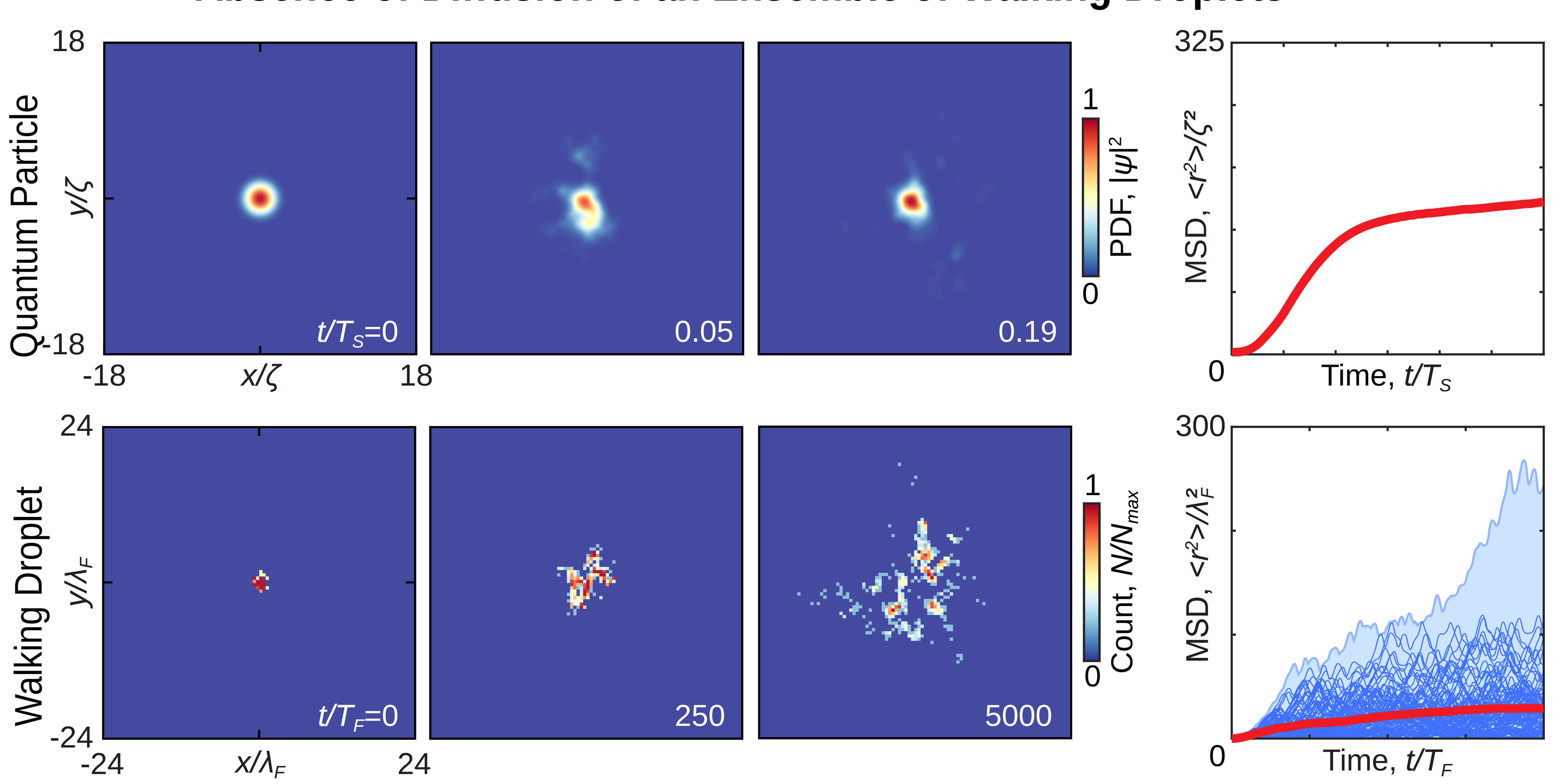


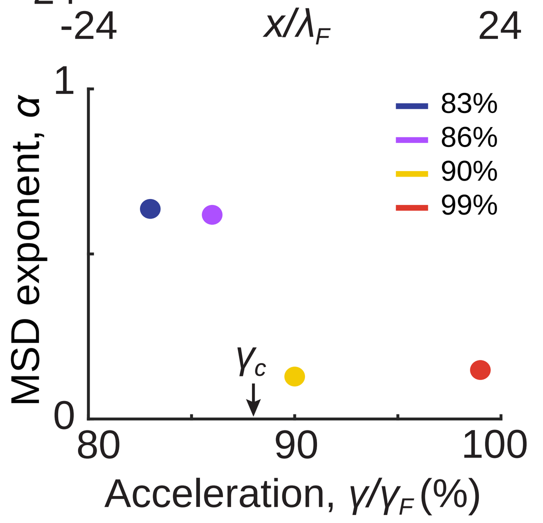
Localization in the Droplet Position Histogram



While simple classical particles move diffusively when their energy is higher than the random potential background, walking droplets develop a peak in the position histogram, as our experiments show. This unexpected behavior is also seen in quantum mechanics in an effect called Anderson Localization, where electrons have localized, or exponentially confined, eigenmodes even when their energy is higher than the disordered potential.

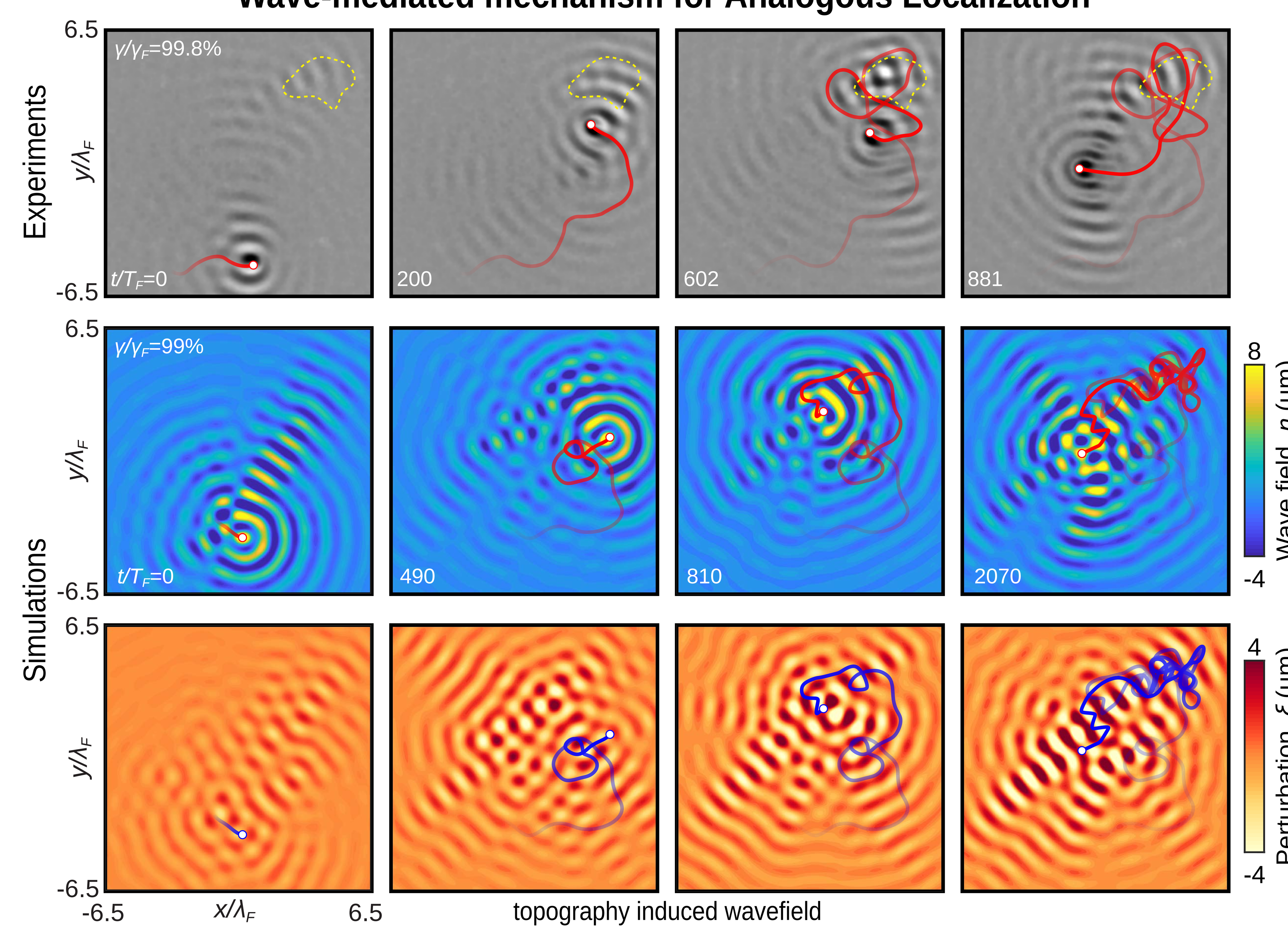
Absence of Diffusion of an Ensemble of Walking Droplets





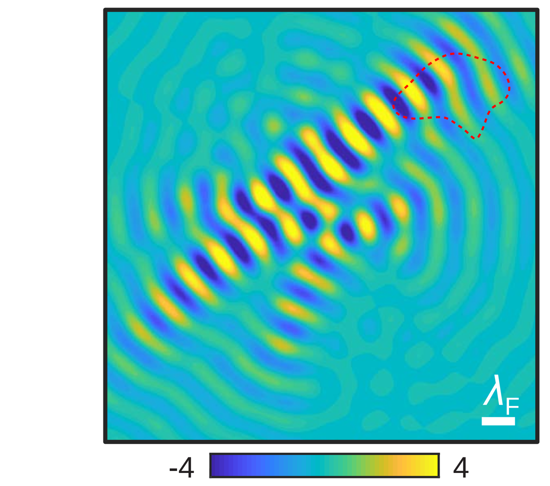
An ensemble of walking droplets, simulated over many random topographies does not diffuse, but saturates over time, as can be seen in the mean-square displacement. This behavior is similar to electrons in the Anderson regime which also saturate in disordered potentials. By tuning the acceleration and in turn the strength of the wavefield, we are able to show a transition from diffusive behavior to localization.

Wave-mediated mechanism for Analogous Localization



Our experiments and simulations show the walking droplet wave forms beams which pull it into the localization region, causing it to remain there for longer and form stronger beams on exit. By subtracting the wavefield of a droplet moving without a topography, we are able to isolate the effect of the random topography on the waves the walking droplet excites.

Most Unstable Wave Mode



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