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# Exploring Quantum-Classical Boundary by Ultrafast Optics

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It is observed in a double-slit experiment by Tonomura and coworkers that single electrons recorded as dots on a detector screen build up to show an interference pattern, which is delocalized over the screen [1]. This observation indicates that a delocalized wave function of an isolated electron interacts with the screen, which is a bulk solid composed of many nuclei and electrons interacting with each other, and becomes localized in space. This change, referred to as "collapse" in quantum mechanics, is often accepted as a discontinuous event, but a basic question arises: when and how the delocalized wave function becomes localized? It could be hypothesized that the wave function is delocalized over many particles in the screen just after the arrival of an electron, and the interaction among those many particles promotes localization of this delocalized wave function continuously, but very fast as if it changed discontinuously. My dream is testing this hypothesis by observing the spatiotemporal evolution of a wave function delocalized over many particles interacting with each other. Having this dream in mind, we have developed an experimental toolbox in which ultrafast wave-packet interference in a molecule is visualized and controlled by tailored laser fields with precisions on the picometer spatial and attosecond temporal scales [2-5]. Now we apply this ultrafast and ultrahigh-precision coherent control to delocalized wave functions of macroscopic many-particle systems such as an ensemble of ultracold Rydberg atoms and a bulk solid [6-8], envisaging the quantum-classical boundary connected smoothly.

## References

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