The Kennard Phase Has Been Observed for The First Time Since 1927

In the early days of quantum mechanics, it was shown that the wave function of a particle in a linear potential accumulates not only a position-dependent phase, associated with the momentum change, but also a position-independent phase that scales with the third power of time and the acceleration squared. This phase was first predicted by Earle Hesse Kennard in 1927 for a Gaussian wave packet [1] and mentioned since then in many works and in textbooks. However, while there are several proposals to measure this phase [2], there has not been a single experiment to verify this theory till now.

Nearly a century later, a new study [3] measures the Kennard phase**,** by utilizing a hydrodynamic system shown in Fig. 1, in which surface gravity water-waves propagate in an effective linear potential. These waves satisfy the well-known Schrödinger-like equation in the moving frame and their full waveforms can be easily recorded. In this experiment, both amplitude and phase can be extracted from the waveform and thus reveal the cubic phase of accelerating wave packets. In addition to Gaussian wave packets, the authors report measurement of the cubic phases of inverse and regular Airy wave packets. They show that with the appropriate flow well-known phenomenon of the self-acceleration of the Airy wave packets can be eliminated.

Thus, the analogy between quantum mechanics and hydrodynamics provides an experimental framework for observing quantum mechanical phenomena in a classical setup. Moreover, the measurement of the Kennard phase establishes an intriguing method to probe potentials and accelerations.

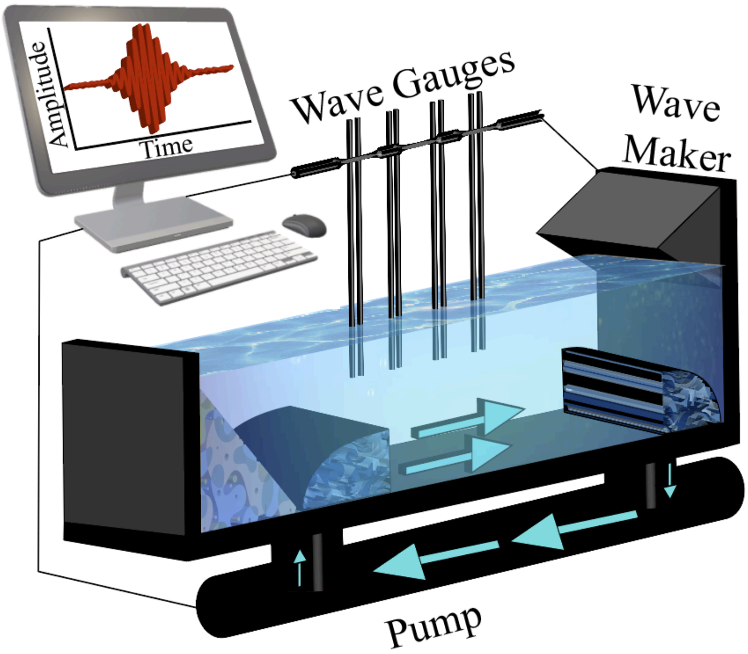

Figure 1: Measurement of the Kennard phase using the analogy between quantum mechanics and hydrodynamics. Gaussian and Airy surface gravity water wave packets are created using a computer-controlled wave maker and measured by wave gauges. The linear potential is induced by a water pump that generates a time-dependent homogeneous flow.

[1] E.H. Kennard, Zeitschrift für Physik 44, 326 (1927); J. Frank. Inst. 207, 47 (1929)
[2] M. Zimmermann, M.A. Efremov, A. Roura, W.P. Schleich, S.A. DeSavage, J.P. Davis, A. Srinivasan, F.A. Narducci, S.A. Werner, and E.M. Rasel, Appl. Phys. B 123, 102 (2017)
[3] G. G. Rozenman, M. Zimmermann, M. A. Efremov, W. P. Schleich, L. Shemer and A. Arie, Phys. Rev. Lett. 122, 124302 *(2019).*