Effective quantum dynamics in a weakly anharmonic interaction in the vicinity of a focusing point

We describe here the dynamic behaviors of a quantum ensemble of particles in a one-dimensional anharmonic potential well and of the corresponding classical ensemble in the vicinity of a focusing point. The anharmonicity of the interaction is chosen to be very small and small. Accordingly, the perturbation theory is used, and the accurate analytical solutions of the problem in both the quantum and classical cases are obtained. The dynamics of the quantum ensemble is considered through a detailed morphological analysis of the families of amplitudes squared and phases of the particle wave functions. We explore the dependence of the quantum solution of the problem on the anharmonicity and its relation to the classical solution. In addition, a solution of the problem based on catastrophe theory is given and compared with the quantum solution. It has been proven that an effective quantum dynamics of the ensemble can be clearly observed. In addition, we have concluded that, when the anharmonicity increases, the difference between the effective quantum behavior and classical behavior becomes larger.

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