



Contribution ID: 86

Type: Sectional reports

EFFECTIVE ALGORITHM OF CALCULATING THE WIGNER FUNCTION FOR A QUANTUM SYSTEM WITH A POLYNOMIAL POTENTIAL

Tuesday, 6 July 2021 14:00 (15 minutes)

When considering quantum systems in phase space, the Wigner function is used as a function of quasidensity of probabilities. Finding the Wigner function is related to the calculation of the Fourier transform from a certain composition of wave functions of the corresponding quantum system. As a rule, knowledge of the Wigner function is not the ultimate goal, and calculations of mean values of different quantum characteristics of the system are required. The explicit solution of the Schrödinger equation can be obtained only for a narrow class of potentials, so in most cases it is necessary to use numerical methods for finding wave functions. As a result, finding the Wigner function is connected with the numerical integration of grid wave functions. When considering a one-dimensional system, the calculation of N^2 Fourier intervals from the grid wave function is required. To provide the necessary accuracy for wave functions corresponding to the higher states of the quantum system, a larger number of grid nodes is needed.

The purpose of the given work was to construct a numerical-analytical method for finding the Wigner function, which allows one to significantly reduce the number of computational operations. Quantum systems with polynomial potentials, for which the Wigner function is represented as a series in some certain functions, were considered.

The results described were obtained within a unified consideration of classical and quantum systems in the generalized phase space on the basis of the infinite self-interlocking chain of Vlasov equations. It is essential that using the apparatus of quantum mechanics in the phase space, one can estimate the required parameters of quantum systems, and the proposed numerical methods make it possible to perform such calculations efficiently. The availability of exact solutions to model nonlinear systems plays a cardinal role in designing complex physical facilities, for example, such as the SPD detector of the NICA project. Such solutions are used as tests when writing a program code and can also be encapsulated in finite difference schemes within the numerical solution of boundary value problems for nonlinear differential equations. The proposed efficient numerical algorithm can be applied to solve the Schrödinger equation and the magnetostatics problem in a region with a non-smooth boundary.

The work was supported by the RFBR grant No. 18-29-10014.

Summary

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Session Classification: Quantum information processing

Track Classification: 8. Quantum information processing