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On the approximation of the von Neumann equation in the semi-classical limit

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We propose a new approach to discretize the von Neumann equation, which is efficient in the semi-classical limit. This method is first based on the so called Weyl's variables to address the stiffness associated with the equation. Then, by applying a truncated Hermite expansion of the density operator, we successfully handle this stiffness. Additionally, we develop a finite volume approximation for practical implementation and conduct numerical simulations to illustrate the efficiency of our approach. This asymptotic preserving numerical approximation, combined with the use of Hermite polynomials, provides an efficient tool for solving the von Neumann equation in all regimes, near classical or not.

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