Stein's method and many interacting worlds in quantum mechanics

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Abstract

Hall, Deckert and Wiseman (Phys. Rev. X, 2014) proposed a many-interacting-worlds (MIW) theory for interpreting quantum mechanics. In this theory, quantum theory can be understood as the continuum limit of a deterministic theory in which there is a large, but finite, number of interacting classical "worlds". Here, a world means an entire universe with well-defined properties, determined by the classical configuration of its particles and fields. Hall et al proposed a MIW harmonic oscillator model for N one-dimensional worlds. They used an energy minimization argument to derive a recursion equation for the ground state locations of the N worlds viewed as particles, and conjectured that the empirical distribution of these locations converges to a Gaussian distribution as N tends to infinity, which is the ground state probability distribution of the quantum harmonic oscillator.

In this talk, we use Stein's method to prove the Gaussian limit and obtain optimal rates of convergence in both the Wasserstein and Kolmogorov distances. We will also discuss how Stein's method can be used to prove convergence to the two-sided Maxwell distribution and obtain rates of convergence for the empirical distribution of the particle locations in the first energy state above the ground state. The two-sided Maxwell distribution is the probability distribution in the corresponding energy state of the quantum harmonic oscillator.

This talk is based on my joint work with Le Van Thanh (preprint, 2019) and work by Mckeague and others (*Ann. Appl. Probab*, 2016 and *Bernoulli*, 2019).