# On T-Reflection via Analytic Continuation in Quantum Mechanics

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One of the central problems in theoretical physics is understanding dark energy, an enigmatic phenomenon that is hypothesized to be driving the accelerating expansion of the universe. Calculating the vacuum energy, the background energy that permeates throughout the universe, could provide a path to understanding dark energy. A recently discovered mathematical tool for calculating the vacuum energies of quantum systems is T-reflection. Unfortunately, T-reflection is problematic for certain quantum systems because infinities arise in the necessary calculations. These infinities occlude the physical meaning obtained through T-reflection. However, it is possible to derive physical information from these unphysical infinities by using a method from complex analysis called analytic continuation. I examined the robustness of T-reflection implemented via analytic continuation in quantum mechanics. I showed that certain quantum systems with discrete "periodic" spectra, energy levels that periodically recur in a pattern, possess T-reflection via analytic continuation. I also constructed a T-reflective quantum system with an aperiodic spectrum. Moreover, I showed that by using a certain ordering of infinite limits, the free particle and similar quantum systems with continuous spectra can have T-reflection via analytic continuation. By mathematically proving that periodic, aperiodic, and continuous spectra can have T-reflection via analytic continuation, I demonstrated that T-reflection via analytic continuation is robust in quantum mechanics. Thus, T-reflection, implemented via analytic continuation, may be a useful tool for studying vacuum energies of quantum systems, thereby providing a viable path to understanding dark energy.

**Awards Won:**

Third Award of $1,000