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Exact WKB analysis for PT symmetric quantum mechanics: Study of the Ai-Bender-Sarkar conjecture

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We consider exact WKB analysis to a $calPT$ symmetric quantum mechanics defined by the potential, $V(x) = \omega^2 x^2 + g x^2 (ix)^{\epsilon=2}$ with $\omega \in \mathbb{R}_{\geq 0}$, $g \in \mathbb{R}_{>0}$. We in particular aim to verify a conjecture proposed by Ai-Bender-Sarkar (ABS), that pertains to a relation between D -dimensional $calPT$ -symmetric theories and analytic continuation (AC) of Hermitian theories concerning the energy spectrum or Euclidean partition function. For the purpose, we construct energy quantization conditions by exact WKB analysis and write down their transseries solution by solving the conditions. By performing alien calculus to the energy solutions, we verify validity of the ABS conjecture and seek a possibility of its alternative form by Borel resummation theory if it is violated. Our results claim that the validity of the ABS conjecture drastically changes depending on whether $\omega > 0$ or $\omega = 0$: If $\omega > 0$, then the ABS conjecture is violated when exceeding the semi-classical level of the first non-perturbative order, but its alternative form is constructable by Borel resummation theory. If $\omega = 0$, then, these energies are independent solutions, and no alternative form of the ABS conjecture can be reformulated by Borel resummation theory.

References

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- * S. Kamata, "Exact WKB analysis for PT-symmetric quantum mechanics: Study of the Ai-Bender-Sarkar conjecture," Phys. Rev. D 109 no. 8, (2024) 085023, arXiv:2401.00574 [hep-th].

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