Spectrum of $\mathcal{PT}$ symmetric operators

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A prominent class of objects studied in $\mathcal{PT}$ symmetric quantum mechanic consists of the $\mathcal{PT}$ symmetric Hamiltonians

$$(\tau y)(x) := -y''(x) + x^2(ix)^\epsilon y(x), \quad \epsilon \geq 2, \text{ and } x \in \Gamma,$$

where Γ is a contour in $\mathbb{C}$ which is, in general, different from the real line and satisfies, according to the rules of $\mathcal{PT}$ symmetry, some additional conditions.

To the differential expression τ one can associate a $\mathcal{PT}$ symmetric operator which is simultaneously selfadjoint in the Krein space $(L_2(\mathbb{R}), [\cdot,\cdot])$, where $[\cdot,\cdot]$ is given by $[\cdot,\cdot] := (\mathcal{P}\,\cdot,\cdot)$ and $(\cdot,\cdot)$ stands for the usual L_2–product, $\mathcal{P}$ is the parity.

We will show that the spectrum of such an operator consists of isolated eigenvalues only which accumulate at ∞. Moreover, we discuss the location of the (point) spectrum of such operators and we will determine areas in the complex plane which are free of eigenvalues. Contrary to physical intuition, we will single out many cases where the real axis does only contain finitely many eigenvalues, i.e. there are infinitely many eigenvalues in the non-real plane.