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**Effective Potential prediction of the sign of Vacuum Condensate within  $\mathcal{PT}$ -Symmetric and non-Hermitian Quantum Field Theories**  
ABOUZEID SHALABY<sup>1</sup>, Associate Professor of Physics, Math., Stat and Physics Department, College of Arts and Science, Qatar University — In the literature there exists a confusion about the sign of the vacuum condensate of  $\mathcal{PT}$ -Symmetric and non-Hermitian field theories. Some techniques predict only negative imaginary vacuum condensate for the class of Hamiltonian  $-(i\phi)^\alpha$  while others admit both signs of imaginary vacuum condensate. In this work, we stress this problem by calculating the the effective potential for the cases  $\alpha = 3$  and  $\alpha = 4$ . Compared to the numerical calculations in the literature, we found very accurate results for the absolute value of the vacuum condensate. However, the effective potential technique we used predicts negative imaginary condensate for the  $\alpha = 3$  case but it admits both positive as well as negative imaginary condensate for the  $\alpha = 4$  case. We show that the negative sign reported in the literature for  $\alpha = 4$  was due the constraint set on the complex contour used to be in the lower half of the complex plane while one can show that contours from the above half would not change the physical content of the theory. For  $\alpha = 3$  on the other hand, only complex contours from the lower half of the complex plane can lead to a stable effective potential.

<sup>1</sup>The work we submit is new and shed light on an existing problem in the research area where different techniques predict different signs of the vacuum condensate in non-Hermitian Field Theories.

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