Observation of PT-Symmetry Breaking in Optics
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In 1998, Bender and Boettcher found that a wide class of Hamiltonians, even though non-Hermitian, can still exhibit entirely real spectra provided that they obey parity-time requirements or PT symmetry. Recent studies described the analogy to PT-symmetry breaking within the realm of optics\textsuperscript{1-3}. What makes this analogy possible is the formal equivalence between the quantum mechanical Schrödinger equation and the optical paraxial equation.

In our presentation we will discuss the first experiment\textsuperscript{4} to explore the analog of PT symmetry breaking in any optical system and the observation of an unexpected loss induced optical transparency resulting. Our experiment made use of a two-waveguide strictly absorptive system, where the absorption has considerable imbalance between the waveguides, whereas the refractive index structure is fully symmetric. We fabricated two coupled waveguides, one with loss and one without loss. A PT phase transition was predicted once the loss in one of the arms exceeds a certain critical value at $\alpha = 4 \kappa$, where $\alpha$ is the absorption coefficient and $\kappa$ is the coupling strength between the two waveguides. As the loss initially increases, the overall transmission significantly drops (Fig.1). Surprisingly, once the loss exceeds the critical transition value, the transmission is predicted to increase in spite of the increase in losses in one of the waveguides. This remarkable and counterintuitive prediction is purely an outcome of a spontaneous PT symmetry breaking. To test this prediction a TM-polarized laser beam at $\lambda = 1.55$ $\mu$m was focused and launched into the no loss waveguide and the output power was recorded. In fig.1, the blue curve shows numerical simulation results, the green dots show experimental data. This passive PT-phase transition behavior is clearly demonstrated experimentally. The overall transmission drops from 66% at loss level of 0.65 cm$^{-1}$ to 7% at a loss level of 4 cm$^{-1}$ and subsequently starts to increase and eventually reaches almost 65% at a loss of 37 cm$^{-1}$! This abrupt transition was revealed by varying the loss in one arm of a PT double well potential system. Good agreement is obtained between theory and experiment\textsuperscript{4}.