Tuning of Fano resonances by rotation of continuum: wave faucet

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Typically the Fano resonance asymmetric shape is tuned by reconstruction of eigenvalue spectrum by, for example, application of finger gate potential in quantum dots or magnetic field in rings. But in fact the resonances of open quantum system are given by poles of the S-matrix or the complex eigenvalues of the effective non Hermitian Hamiltonian [1] $\widehat{H}_{eff} = \widehat{H}_R - i\widehat{W}\widehat{W}^{\dagger}$ where $\widehat{H}_R$ describes the closed system (resonator) with discrete eigenvalue spectrum and $\widehat{W}$ describes the coupling matrix between the closed system and the continua (of attached waveguides) [2]. Typically the real parts of complex eigenvalues of the effective Hamiltonian which define the resonance positions follow the eigenvalues of the closed resonator when the coupling is weak. However with growth of the coupling the resonances become to interfere to give rise to tune the Fano resonance profiles. First this way to tune the Fano resonance was demonstrated by Rotter *et al* [3] by implementation of changeable diaphragms at the waveguide junctions.

We consider a system which changes only a phase of the coupling matrix by rotation of one of waveguides and show that gives rise to drastic effects beginning with opening and closing the wave transmission (wave faucet) and ending by the bound states in the continuum (BSC). Rotation of one of the waveguide relative to another can be performed in a realistic acoustic or electromagnetic experiment by the use of piston-like hollow-stem waveguides tightly fit to the interior boundaries of a cylindric cavity. The most striking effect of the rotation is a collapse of the Fano resonances that evidences an occurrence of bound states in the continuum (BSCs) when the resonator traps the propagating mode inside. The last has become one of the actively studied phenomena in different areas of physics [4].

References

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