Turbulence control by dynamic non-Hermitian potentials

Kęstutis Staliūnas
Universitat Politecnica Catalunya, Barcelona, Spain
Laser Research Center, Vilnius University, Vilnius, Lithuania
kestutis.staliunas@icrea.cat

We propose a new method for a smart control of turbulence, in particular of optical turbulence, by modifying the energy flow cascade of turbulence. The method is based on the asymmetric coupling between the spatial excitation modes due to non-Hermitian background potentials.

The non-Hermitian potentials are known, since recently, to introduce unidirectional coupling between the waves. A particular case of non-Hermitian potentials are the PT-symmetric potentials. The unidirectional coupling in wavenumber domain is on the root of recently proposed exotic effects as unidirectional invisibility, unidirectional lasing, and others. We consider the unidirectional coupling in an extended wavevector-frequency domain. We demonstrate that such a unidirectional coupling towards larger (smaller) wavenumbers-frequencies can increase (reduce) the energy flow to turbulent states, and therefore influence the strength and the character of the turbulence [1].

The study is based on the Complex Ginzburg-Landau Equation which is a universal model for the pattern formation and turbulence in a wide range of systems, and in particular in active nonlinear optical systems, like spatially extended lasers. We show that enhancement or reduction of the turbulence is indeed governed by the introduced direction of the energy flow, controlled by the phase shift between the real and imaginary parts of the temporal oscillation part of the non-Hermitian potential.

The proposed turbulence control mechanism can be applied to efficiently control the radiation in micro-lasers, in particular in Broad Area Edge Emitting lasers.

Literatūra

[1] S.B. Ivars, M. Botey, R. Herrero, and K. Staliūnas, Turbulence control by non-Hermitian potentials, PRL submitted, 2021