Spatial and temporal localization of quasimodes in Vogel spirals

M. Prado,[1,*] F. Sgrignuoli,[2,†] Y. Chen,[2,‡] L. Dal Negro,[2,3,4,§] and F. A. Pinheiro[1,¶]

[1] *Instituto de Fisica, Universidade Federal do Rio de Janeiro, Rio de Janeiro-RJ, 21941-972, Brazil*
[2] *Department of Electrical and Computer Engineering, Boston University, 8 Saint Mary's Street, Boston, Massachusetts 02215, USA*
[3] *Division of Material Science and Engineering, Boston University, 15 Saint Mary's Street, Brookline, Massachusetts 02446, USA*
[4] *Department of Physics, Boston University, 590 Commonwealth Avenue, Boston, Massachusetts 02215, USA*

We investigate the spatial and temporal localization properties of quasimodes (*i.e.* scattering resonances) of two-dimensional Vogel spirals, composed of deterministic, aperiodic arrays of electric dipoles. By determining the structural entropy and localization maps of Vogel spirals using the Green's matrix method, we show that three distinctive decay types of quasimodes coexist in Vogel spirals: exponential, power-law, and gaussian. While the former has been expected to occur in disordered media only, the latter is demonstrated to characterize the most localized quasimodes of Vogel spirals, both spatially (smallest participation ratios) and temporarily (longest lifetimes). These decay forms are demonstrated by a no-fitting analysis of the localization maps, independently corroborated by calculating the electric field in real space, which also provides a direct evidence of the algebraic decay of critical quasimodes. Altogether our findings unveil a rich spectrum of both long-lived and spatially localized quasimodes that coexist in Vogel spirals and can be of direct relevance to novel optical functionalities for applications to light sources and sensing devices.

* Presenting author: mvap@pos.if.ufrj.br
† sgrigno@bu.edu
‡ yuyao@bu.edu
§ dalnegro@bu.edu
¶ fpinheiro@if.ufrj.br