Fractionality and PT - symmetry in a square lattice

M. I. Molina
Departamento de Física, Facultad de Ciencias, Universidad de Chile, Casilla 653, Santiago, Chile
mmolina@uchile.cl

Introduction

We study the spectral stability of a 2D discrete Schrödinger equation on a square lattice, in the simultaneous presence of a fractional Laplacian and PT symmetry. For that purpose, we compute the plane-wave spectrum in closed form, as a function of the gain/loss parameter and the fractional exponent. Examination of the spectrum reveals that an increase of the gain/loss parameter favors the early appearance of complex eigenvalues, thus is, the onset of a broken PT symmetry. On the other hand, as the fractional exponent decreases from unity, at a critical value a gap opens up separating the upper and lower bands, and the spectrum becomes real. Further decrease of the exponent increases the width of the gap and the system remains in the PT -symmetric phase down to a vanishing value of the fractional exponent. Examination of the density of states and the participation ratio reinforce these observations and lead one to conclude that, unlike the standard, non-fractional case where the binary lattice is always in the broken PT phase, for the fractional case it is possible to have a symmetric PT phase in the presence of a finite gain/loss parameter and a small enough fractional exponent.

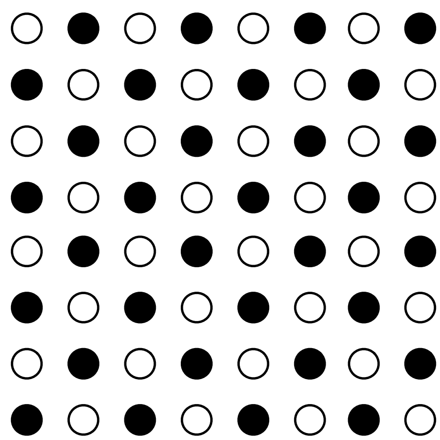

Figura 1: *Square lattice with binary gain/loss distribution. White (black) sites are endowed with gain (loss).*

Acknowledgments

This work was supported by Fondecyt Grant 1200120.

References

[1] C. M. Bender and S. Boettcher, Real Spectra in Non-Hermitian Hamiltonians Having P T Symmetry, Phys. Rev. Lett. **80**, 5243 (1998).
[2] C. M. Bender, D. C. Brody, and H. F. Jones, Complex Extension of Quantum Mechanics, Phys. Rev. Lett. **89**, 270401 (2002).
[3] N. Laskin, Fractional quantum mechanics, Phys. Rev. E **62**, 3135 (2000).
[4] N. Laskin, Fractional Schödinger equation, Phys. Rev. E **66**, 056108 (2002).
[5] M. I. Molina, The Fractional Discrete Nonlinear Schrödinger Equation, Phys. Lett. A **384**, 126180 (2020).
[6] M. I. Molina, The Two-Dimensional Fractional Discrete Nonlinear Schrödinger Equation, Phys. Lett. A **384**, 126835 (2020).
[7] M. I. Molina, Fractionality and $\mathcal{PT}$ symmetry in a square lattice, Phys. Rev, A **106**, L040202 (2022).