**The modulation instability triggered band relaxation in photonic Chern insulator**

A. Mančić1, M. Nedić2, D. Leykam3, A. Maluckov2\*

1*COHERENCE, Faculty of Sciences and Mathematics, University of Niš, Serbia*

2*COHERENCE, Institute of Nuclear Sciences Vinča, National Institute of the Republic of Serbia,*

*University of Belgrade, Serbia*

*3Center of Quantum Technologies, National University of Singapore*

\*e-mail:sandram@vin.bg.ac.rs

Photonic lattices represent a fruitful testbed for investigating various topological phases, nonlinear phenomena, and intriguing consequences of the development of modulational instability in topologically nontrivial media, as the inter-relation between topological edge states [1], edge solitons [2] and bulk solitons [3]. They provide the possibility not only to highlight the equivalent phenomena in condensed matter systems but to go beyond them into new land of exotic nonlinearly driven topologically moderated states.

Recently, we have shown that the modulational instability of nonlinear Bloch modes could be used to probe the band topology in non-driven lattices [4]. As an extension, here, we report on the results of the study of the relaxation of the optical wave fields in nonlinear two-dimensional Chern insulators [5]. They undergo a transition from an ordered bulk state to a disordered state, triggered by the modulational instability [6]. The phenomenon of the memory loss of the initial state is related to nonlinear wave-mixing and ergodization within the gapped bands [7].

The testbed for our numerical study is two-dimensional π-flux square lattice in which we investigate the population of topological bands by the wave mixing of nonlinear Bloch waves. We tune the strength of the nonlinearity and lattice parameters in order to observe different dynamical regimes: toplogical transitions, stable and unstable propagation. We have found that the unstable propagation gives rise to a new quasi-steady state characterized by a convergence of certain wave field characteristics (participation ratio, Chern number, purity gap) to constant values. Next, in order to find the correspondence between this steady state and thermalized wave field we apply a grand canonical approach to calculate the effective temperature and chemical potential of the wave field. We have found that the effective temperature and chemical potential exhibit a strong k – dependence throughout the Brillouin zone. This implies the existence of a long-lived pre-thermalized regime and the absence of thermalization.

REFERENCES

[1] Galilo B, Lee D K and Barnett R 2015 Phys.Rev.Lett. 115 245302.

[2] Leykam D and Chong Y D 2016 Phys.Rev.Lett.117 143901

[3] Lumer Y, Plotnik Y, Rechtsman M C and Segev M 2013 Phys.Rev.Lett. 111 243905

[4] Leykam D, Smolina E, Maluckov A, Flach S and Smirnova D A 2021 Phys. Rev. Lett. 126 073901

[5] Mančić A, Leykam D and Maluckov A 2023 Phys. Scr. 98 055513

[6] Zakharov V E and Ostrovsky L A 2009 Physica D 238 540

[7] Buonsante P, Franzosi R and Smerzi A 2017 Phys. Rev. E 95 052135