

# Photon BECs in dye-filled microcavities and VCSELs

Monday 2 September 2024 15:00 (20 minutes)

The talk provides an overview of current theoretical challenges for describing a photon Bose-Einstein condensate (BEC), which represents a modern prime example for an open dissipative quantum many-body system. In the original experimental platform of dye-filled microcavities [1] the technique of direct laser writing [2] allows to microstructure potentials with different geometries on the mirror surfaces. In this way soon lattices of coupled photon condensates containing hundreds of individual sites are realizable, which are expected to have spiral vortices [3]. We show that their shape can be approximately determined analytically with a projection optimization method, which extends the variational optimization method for BECs of closed systems to open-dissipative condensates [4]. Furthermore, quite recently photon BECs have also been observed in vertical cavity surface-emitting lasers (VCSELs) [5,6]. Here frequent photon absorption and emission processes occur due to the creation and annihilation of excitons in the semiconductor device, yielding a thermalization of photons. But it was found experimentally that the extracted spectral temperatures are significantly lower than those of the device, which warrants a theoretical explanation.

## References

- [1] J. Klaers, J. Schmitt, F. Vewinger and M. Weitz, *Nature* 468, 545 (2010).
- [2] J. Schulz, J. Noh, W. A. Benalcazar, G. Bahl, and G. von Freymann, *Nature Comm.* 13, 6597 (2022).
- [3] V. N. Gladilin and M. Wouters, *Phys. Rev. Lett.* 125, 215301 (2020).
- [4] J. Krauß, M.A.G. dos Santos Filho, F.E.A. dos Santos, and A. Pelster, *arXiv:2311.10027* (2023).
- [5] R. C. Schofield, M. Fu, E. Clarke, I. Farrer, A. Trapalis, H. S. Dhar, R. Mukherjee, J. Heffernan, F. Mintert, R. A. Nyman, and R. F. Oulton, *Nature Photonics* (in press), *arXiv:2306.15314* (2023).
- [6] M. Pieczarka, M. Gębski, A. N. Piasecka, J. A. Lott, A. Pelster, M. Wasiak, and T. Czyszanowski, *Nature Photonics* (in press), *arXiv:2307.00081* (2023).

## Short bio (50 words) or link to website

<https://www-user.rhrk.uni-kl.de/~apelster>

## Relevant publications (optional)

## Career stage

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**Track Classification:** FINES