A Statistical Physics Approach to Model Photon Bose-Einstein Condensation in Semiconductor Cavities and Lasing

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The regime of Photon Bose-Einstein condensation has been observed in cavities filled with pumped dyes. In this talk, we discuss photon condensates in semiconductors taking advantage of the existence of well-established models for the gain medium. This enables to clarify similarities and differences between the laser regime, the condensation regime and the equilibrium regime [1]. In the second part of the talk, we introduce a statistical physics approach of light emission using the fluctuational electrodynamics approach. This approach has been used to model thermal emission. We show that it can be extended to amplifying media and used to evaluate both the non-lasing and the lasing emission by a pumped semiconductor in a cavity [2].

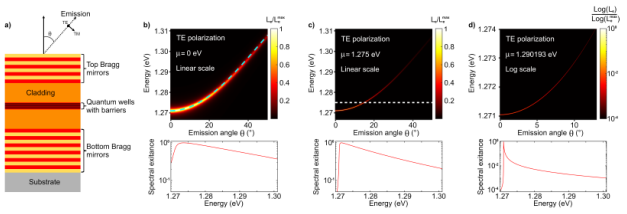

Figure 1: Transition from the LED regime (b) to the lasing regime (c) of light emitted by quantum wells in a planar cavity using the statistical physics approach. The model predicts the spectral and angular dependence of the emission as a function of the difference of the quasi-Fermi levels denoted μ

References

[1] A Loirette-Pelous and J-J Greffet, Laser Photonics Rev. **17**, 2300366 (2023)

[2] J-J Greffet, P Bouchon, G Brucoli and F Marquier, Phys. Rev. X **8**, 021008 (2018)