

Cavity controlled inverse harmonic generation

Interaction between quantized light and matter lies at the heart of a broad range of applications, such as frequency down-conversion in ultrastrong cavity QED [1]. Frequency down-conversion schemes are often treated with few-level approximations of the matter subsystem. In the present work, we consider the case of a semiconductor quantum ring described in real space coupled to more than one mode and investigate a down-conversion process. We show that the down-converted photons have unique features such as non-classicality and entanglement. In addition, we show shortcomings of few-level approximations and mean-field theory. An interesting outcome for down-conversion is that ultrastrong coupling is more efficient than just increasing the incoming field strength.

[1] Anton F. Kockum et al., *Scientific Reports* vol. 7, 5313 (2017).