Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **3823** Type: **Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)**

(G*) Robust Triggering of Solid-State Quantum Light Sources: Notch-filtered Adiabatic Rapid Passage (NARP)

Monday 19 June 2023 14:15 (15 minutes)

Single photon sources play a critical role in many emerging applications in quantum information science. Single photon quantum computing [1], and single photon quantum cryptography [2] both rely heavily on high-brightness, and high-indistinguishability single photon sources where subsequent single photons are identical in all degrees of freedom. In order to maximize indistinguishability, the quantum emitter must be driven resonantly so that incoherent relaxation pathways are eliminated. This, however, necessitates an efficient method for separating the single photons from the scattered excitation light. We present a novel driving scheme called Notched Adiabatic Rapid Passage (NARP) [3] where a frequency swept optical pulse containing a spectral hole resonant with the quantum emitter is used. The frequency-swept nature of the pulse allows the scheme to retain the benefits of Adiabatic Rapid Passage (ARP), including robustness to variations of the properties of pump laser and quantum emitter. It also enables the suppression of decoherence tied to electron-phonon coupling [4]. The spectral hole allows for the single photons to be spectrally filtered from the scattered laser light. Together, this excitation scheme would enable <10-8 scattered photons per single photon emission with a detection loss of 4%. We have demonstrated this scheme in a single semiconductor quantum dot.

[1] Madsen, L. S., et. al. Quantum computational advantage with a programmable photonic processor. Nature, 606(7912), 75-81 (2022).
[2] Bozzio, M., Vyvlecka, M., Cosacchi, M. et al. Enhancing quantum cryptography with quantum dot single-photon sources. npj Quantum Inf 8, 104 (2022).
[3] Wilbur, G. R., Binai-Motlagh, A., Clarke, A., Ramachandran, A., Milson, N., Healey, J. P., O'Neal, S., Deppe, D. G., Hall, K. C. Notch-filtered Adiabatic Rapid Passage for Optically-Driven Quantum Light Sources. APL Photonics (in press) (2022).
[4] A. Ramachandran, G. R. Wilbur, S. O'Neal, D. G. Deppe, and K. C. Hall, "Suppression of decoherence tied to electron–phonon coupling in telecom-compatible quantum dots: low-threshold reappearance regime for quantum state inversion," Opt. Lett. 45, 6498-6501 (2020)

Keyword-1

quantum dot

Keyword-2

quantum emitter

Keyword-3

adiabatic rapid passage

Authors: WILBUR, Grant (Dalhousie University); Mr BINAI-MOTLAGH, Ali (Dalhousie University)

Co-authors: CLARKE, Alison (Dalhousie University); MILSON, Nick (Dalhousie University); HEALEY, John (Dalhousie University); O'NEAL, Sabine (University of Central Florida); DEPPE, Dennis (University of Central Florida); HALL, Kimberley (Dalhousie University)

Presenter: WILBUR, Grant (Dalhousie University)

Session Classification: (DCMMP) M2-8 Low Dimensional Materials and Heterostructures | Matériaux de faible dimension et hétérostructures (DPMCM)

Track Classification: Technical Sessions / Sessions techniques: Condensed Matter and Materials Physics / Physique de la matière condensée et matériaux (DCMMP-DPMCM)