Canadian Association of Physicists
Association canadienne des physiciens et physiciennes

Contribution ID: **374** Type: **Invited Speaker / Conférencier(ère) invité(e)**

Integrated silicon colour centre devices

Tuesday 10 June 2025 10:15 (30 minutes)

Silicon colour centres are an emerging quantum information platform with technological appeal: they emit in or near the optical telecommunications bands, host long coherence spin qubits, and integrate with silicon photonic and electronic circuits for scalable on-chip devices. Potential applications include single-photon sources and quantum repeaters for quantum networks, and resource-state generators for all-optical quantum computers. In particular, the silicon T centre has been identified as a candidate for distributed spin-photon quantum computing and is the focus of ongoing commercialization efforts. In this talk I review the rapid progress in the field of silicon colour centres, including integrated photonic devices with single G, W and T centres, as well as newly discovered or theorized centres contending to be the ultimate silicon emitter, and present recent results with the silicon T centre. Cavity-integrated centres show dramatic Purcell enhancements, enabling faster and more coherent emission. Indistinguishable emission from separate T centre devices has enabled entanglement between T centre processors in separate cryostats, one of only a handful of solid-state quantum platforms to achieve this milestone. New classes of opto-electronic silicon colour centre devices combining optical resonators and PIN junctions enable a host of new spin-photon techniques including electrically-injected single-photon emission, electrical spin initialization, and electrically-triggered remote entanglement schemes. These techniques expand the toolbox of controls available for silicon colour centre quantum processors and networks.

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Session Classification: (DQI) T1-11 | (DIQ)