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Towards single-longitudinal mode monolithic diamond Raman lasers

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Raman lasers are a promising platform for narrow linewidth single-longitudinal mode lasers, and their Raman shifts provide access to wavelength ranges not easily reached with commercial lasers. Moreover, the Raman process provides intrinsic line narrowing, recently shown to greatly reduce linewidth and suppress high-frequency noise relative to the pump. Diamond, in particular, has the highest known thermal conductivity for a bulk material, making it less susceptible to thermal effects; and possesses a high laser damage threshold, making it ideal for high power operation. These properties make diamond Raman lasers attractive for both high-power applications and for systems requiring narrow linewidth and low high-frequency phase noise, such as quantum technologies and precision metrology.

However, diamond presents challenges in terms of polishing and coating compared to other materials, meaning that existing continuous wave diamond Raman lasers have so far been realized only in free-space cavities. These systems are sensitive to alignment, suffer from excess low-frequency noise due to cavity length fluctuations, and are not easily miniaturized. In contrast, a monolithic cavity geometry—formed entirely within either a single crystal or multiple bonded crystals—offers improved passive stability, reduced vibration sensitivity, and a more compact and robust design.

Herein, we discuss our progress towards demonstrating a continuous wave monolithic diamond Raman laser through both a total-internal reflection geometry and through bonding cavity mirrors to diamond.

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