Motion Sensing Using Quantum Memories in Warm Vapours

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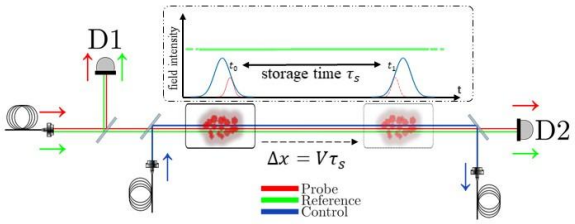

Figure 1: Illustration of the optical setup, with the inset showing the pulse sequence aligned to the vapor cell's position. During the storage interval, the vapor cell is translated by a motorized stage. By recording the phase of the retrieved pulse and comparing it to a reference field, we accurately determine the displacement of the stored pulse over the course of the storage period.

Quantum memories (QMs) play a key role in quantum information and communication systems, enabling robust storage and manipulation of information for large-scale quantum networks. Among the various approaches, electromagnetically induced transparency (EIT) QMs stand out for their high efficiency, extended storage duration, and excellent phase coherence. Here, we demonstrate the spatial translation of stopped light in a room-temperature medium across distances exceeding one optical wavelength. By employing an interferometric technique, we also measure the speed of this translation, thus repurposing stopped-light experiments for sensing applications. These results validate our earlier concept paper, which proposed using quantum memories for motion sensing [1]. They additionally mark the first realization of such effects at room temperature, and the first instance of employing optical memory beyond quantum communication and information—opening new avenues for highly sensitive velocity measurement techniques.

References

[1] Ahmadi A, Yağız M, Müstecaplıoğlu ÖE, Kuan P, Gündoğan M, Krutzik M. Research Directions: Quantum Technologies 2025; 3.