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A dual-species trapped ion quantum simulator for studying quantum dynamics of large number of spins[1] NIKHIL KOTIBHASKAR, SAINATH MOTLAKUNTA, CHUNG-YOU SHIH, NIKOLAY VIDENOV, ILANGO MARAN, KALEB RUSCITTI, FERESHTEH RAJABI, RAJIBUL ISLAM, Institute for Quantum Computing and Department of Physics and Astronomy, University of Waterloo — Long decoherence times, high fidelity initialization and detection of qubit states, and the flexibility to engineer various types of interactions make trapped ions an ideal platform for quantum computation and simulation. Here, we report on our progress towards developing a Yb+/Ba+ dual species quantum simulator for studying many-body quantum Hamiltonians with a large number of Yb+ spins or qubits. The Ba+ ions will be used for sympathetic cooling and will take part in collective vibrational states that mediate spins-spin interactions. We optimize our system for 50-100 spins, where classical computation of quantum spin dynamics may become intractable. We engineer the simulator to be scalable and robust. For example, most of the laser beams will be combined and delivered to the ion chain along their axial direction through a single photonic crystal fiber, drastically simplifying the optics and efficiently using optical power in a scalable way. High numerical aperture (up to NA= 0.5) optical access for the imaging setup will allow for fast and high fidelity spin state detection. The high NA setup will also allow high fidelity quantum operations by precise optical engineering of the coherent Raman beams using a spatial light modulator.

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