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Discrete Time Crystals in a Bouncing BEC

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Discrete time crystals (DTC) created in a Bose-Einstein condensate (BEC) bouncing resonantly on a periodically driven mirror [1] allow dramatic breaking of discrete time translation symmetry and the creation of big time crystals, with response periods up to about 100 times the driving period [2]. Here, we present an experimental protocol for realizing big time crystals for the case of a potassium-39 BEC bouncing on a repulsive light sheet. We also present calculations using a fully comprehensive multi-mode quantum treatment based on the truncated Wigner approximation to study many-body effects and quantum fluctuations, for the case of a period-doubling DTC [3]. We find that the quantum depletion produced by the quantum fluctuations is strongly suppressed, except at interaction strengths close to the threshold for DTC formation, and the thermalisation is quenched within a very long time window, implying that the absence of the system's thermalisation is a genuine many-body effect and a direct consequence of driving in the presence of a sufficiently strong interaction.

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2. K. Giergiel, T. Tran, A. Zaheer, A. Singh, A. Sidorov, K. Sacha and P. Hannaford, *New J. Phys.* **22**, 085004 (2020).
3. J. Wang, P. Hannaford and B. J. Dalton, arXiv: 2011.14783 (2022).