Contribution ID: **61** Type: **Poster**

Towards Discrete Time Crystals with Bouncing Bose-Einstein Condensates

Sunday, 10 September 2023 22:40 (20 minutes)

Our project aims to experimentally demonstrate that weakly interacting Bose condensed atoms bouncing on a periodically driven atomic mirror can spontaneously break time-translational symmetry to form a discrete time crystal [1]. The resonantly tuned bouncing ensemble can evolve along long-lived stable orbits with a period multiple times larger than the driving period [2] thus creating a large number of atomic lattice sites in the time domain. Our approach [3] is based on the use of Bose condensed potassium-39 atoms which have several convenient Feshbach resonances to precisely tune attractive atomic interactions in the vicinity of the zero crossing. Our apparatus employs conventional methods of loading the 3D magneto-optical trap (MOT) from a 2D MOT, laser cooling of the potassium atoms with small hyperfine splitting to sub-Doppler temperatures using a blue-detuned grey molasses and loading the atoms into a crossed dipole trap formed by a single-frequency 1064 nm fibre laser. We will report on our progress towards evaporative cooling of the trapped atoms towards quantum degeneracy to prepare the atomic ensemble about 200 um above the driven atomic mirror made from a 532 nm fibre laser. In a successful demonstration the creation of time crystals with large atom numbers occupying multiple temporal lattice sites will offer a unique way to perform condensed matter physics experiments in the time domain [4].

[1] K. Sacha, *Phys. Rev. A* **91**, 033617 (2015).
[2] K. Giergiel, A. Kosior, P. Hannaford and K. Sacha, *Phys. Rev. A* **98**, 013613 (2018).
[3] K. Giergiel, T. Tran, A. Zaheer, A. Singh, A. Sidorov, K. Sacha, and P. Hannaford, *New J. Phys.* **22**, 085004 (2020).
[4] P. Hannaford, K. Sacha, *AAPPS Bulletin* **32**, 12 (2022).

Primary author: Prof. SIDOROV, Andrei (Swinburne University of Technology)

Co-authors: ZAHEER, Ali (Swinburne University of Technology); SINGH, Arpana (Swinburne University of Technology); GUNAWARDANA, Chamali (Swinburne University of Technology); Dr GIERGIEL, Krzysztof (Swinburne University of Technology); Prof. SACHA, Krzysztof (Universytet Jagiellonski, Krakow); Prof. HANNAFORD, Peter (Swinburne University of Technology); Prof. TOJO, Satoshi (Swinburne University of Technology)

Presenter: Prof. SIDOROV, Andrei (Swinburne University of Technology)

Session Classification: Poster Session I

Track Classification: Hybrid Quantum Systems