

# Time Crystal Behavior of Excited Eigenstates

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In analogy to spontaneous breaking of continuous space translation symmetry in the process of space crystal formation, it was proposed that spontaneous breaking of continuous time translation symmetry could lead to time crystal formation. In other words, a time-independent system prepared in the energy ground state is expected to reveal periodic motion under infinitely weak perturbation. In the case of the system proposed originally by Wilczek [1], spontaneous breaking of time translation symmetry cannot be observed if one starts with the ground state. We point out that the symmetry breaking can take place if the system is prepared in an excited eigenstate. The latter can be realized experimentally in ultracold atomic gases. We simulate the process of the spontaneous symmetry breaking due to measurements of particle positions and analyze the lifetime of the resulting symmetry broken state [2].

## References

[1] F. Wilczek, Phys. Rev. Lett. **109**, 160401 (2012).

[2] A. Syrwid, J. Zakrzewski, K. Sacha, Phys. Rev. Lett. **119**, 250602 (2017).

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