On time crystals

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It has been argued that the existence of time crystals requires a spontaneous breakdown of the continuous time translation symmetry so to account for the unexpected non-stationary behavior of quantum observables in the ground state. We point out that such effects do emerge from position (q_i) and/or momentum (p_i) noncommutativity, i.e., from $[q_i, q_j,]\neq 0$ and/or $[p_i, p_j,]\neq 0$ (for $i\neq j$). In such a context, a predictive analysis is carried out for the 2-dim noncommutative quantum harmonic oscillator through a procedure supported by the Weyl-Wigner-Groenewold-Moyal framework. This allows for the understanding of how the phase-space noncommutativity drives the amplitude of periodic oscillations that can be identified as time crystals.