

Synchronous Discrete Harmonic Oscillator

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Abstract

We introduce the synchronous discrete harmonic oscillator, and present an analytical, numerical and graphical study of its characteristics. The oscillator is synchronous when the time T for one revolution covering an angle of 360 degrees in phase space, is an integral multiple N of the discrete time step t . It is fully synchronous when N is even. It is pseudo-synchronous when T divided by t is rational. In the energy conserving hyperincurive representation, the phase space trajectories are perfectly stable at all time scales, and in both synchronous and pseudo-synchronous modes they cycle through a finite number of phase space points. Consequently, both the synchronous and the pseudo-synchronous hyperincurive modes of time-discretization provide a physically realistic and mathematically coherent, procedure for dynamic, background independent, discretization of spacetime. The procedure is applicable to any stable periodic dynamical system, and provokes an intrinsic correlation between space and time, whereby space-discretization is a direct consequence of background-independent time discretization. Hence, synchronous discretization moves the formalism of classical mechanics towards that of special relativity. The frequency of the hyperincurive discrete harmonic oscillator is “blue shifted” relative to its continuum counterpart. The frequency shift has the precise value needed to make the speed of the system point in phase space independent of the discretizing time interval Δt . That is the speed of the system point is the same on the polygonal (in the discrete case) and the circular (in the continuum case) phase space trajectories.

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