Photoinduced spontaneous translational symmetry breakage, not against quantum conservation laws

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Real time quantum dynamics of the spontaneous translational symmetry breakage in the early stage of photoinduced structural phase transitions is reviewed and theoretically extended, under the guide of the Toyozawa theory[1], so that, it can be not against quantum conservation laws of the total momentum, the total energy and even *"the total symmetry"*.

At the Franck–Condon state, an electronic excitation just created by a visible light, is in a plane wave state, extended all over the crystal. While, after the lattice relaxation having been completed, it is localized around a certain lattice site of the crystal, as a new excitation (electronic and structural) domain. Is there a sudden shrinkage of the excitation wave function, in between? No! The wave function never shrinks, but only the spatial (or inter lattice-site) quantum coherence (interference) of the excitation disappears, as the lattice relaxation proceeds. This is nothing but the spontaneous breakage of translational symmetry.

The key point is that, this relaxation occurs only in the relative space, whose center is occupied by a site-localized excitation, while other infinitely large number of noncentral sites in the relative space remain unoccupied. Since the centers are different, these relative spaces are nutually orthogonal, but they are not directly fixed at the original ground state crystal lattice[2,3]. A phonon wave packet created by the electronic excitation at the center, propagates away to distant noncentral lattice sites within one relative space, resulting in the relaxation and the decoherence. Since this propagation occurs entirely equally and simultaneously in all the relative spaces, it is not against aforementioned quantum conservation laws.

References:

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[2] K.Nasu, Appl.Sci.(MDPI)**8**(2018)332.
[3] K.Nasu, EJPB,Colloquium **75**(2010)415.