Relativistic coupling between lattice vibrations and nuclear excitation

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For many years we have been interested in understanding the origin of the coupling between the condensed matter system and nuclei in connection with the anomalies that have been observed in Fleischmann-Pons and related experiments. Over the past two years, it has become clear that collimated x-rays in the Karabut experiment can only be consistent with our coherent energy exchange theory if there exists a very strong coupling between lattice vibrations and nuclear transitions.

We have examined the problem many times in previous years, usually with the conclusion that there can be no such effect in the non-relativistic problem. This is a consequence of the clean separation between the center of mass dynamics and relative dynamics which occurs in non-relativistic models.

This motivated us to study the same issue for relativistic dynamics. In this case the fundamental theory includes a very strong coupling between the center of mass momentum operator, and internal nuclear transitions. This coupling is connected to changes in the internal structure of a composite when it moves (as a result of the Lorentz transform), compared to the rest frame wavefunction. Under normal conditions a generalized Foldy-Wouthuysen transformation eliminates this strong coupling, which results in a model in the rotated frame with no residual first-order interaction. As a result, one would expect generally not expect any significant coupling to survive. The conditions under which any residual coupling would be expected are the same conditions where the generalized Foldy-Wouthuysen rotation "breaks down".

Since the Foldy-Wouthuysen transformation is a simple mathematical operation associated with a change of basis, it can't not work. However, there are certainly examples where it is sufficiently unhelpful that we might think of it as breaking down. One example is in the spin-boson model, where a generalized Foldy-Wouthuysen transformation eliminates the first-order coupling, leaving only a small residual higher-order interaction. In the presence of strong Brillouin-Wigner loss, the model acts very differently, allowing coherent energy exchange under conditions where a large quantum is fractionated. In this case the Foldy-Wouthuysen transformation "breaks down" in that it becomes very difficult to deal with the loss operator in the rotated picture.

Under conditions where the Foldy-Wouthuysen transformation "breaks down" in this sense due to the presence of a strong Brillouin-Wigner loss operator, there exists no useful general non-relativistic limit. In this case, the strong coupling between the center of mass momentum and internal nuclear states remains, and can be used for coherent dynamical processes. In our view, this is the physical origin of the anomalies.