

**Comment on
COEXISTENCE OF QUANTUM THEORY AND
SPECIAL RELATIVITY IN SIGNALING
SCENARIOS**

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Sancho studies one-particle interferences in particular entangled two-particle systems and their connection with signaling. He states that he considers only the stationary problem. Since for a pair of particles which are completely correlated in momentum by $\mathbf{p}_1 + \mathbf{p}_2 = 0$ the uncertainty relations would imply a complete delocalization of the center of mass of the source he tries to reach an adequate compromise between the localization of the center of mass of the source and the deviations with respect to the exact momentum relation.

He considers two spatially separated double slits by which the particles are diffracted. In one of the slits he introduces some physical element which produces a phase shift ϕ to the particles passing through the slit. In this way he endeavors to obtain an explicit example of nonlocality going beyond the nonlocal correlations obtained in Bell-type experiments. He calls this type of nonlocality “dynamic sig-

naling”. Later he then shows that this, together with a *non-unitary* time-development operator, may perhaps lead to superluminal communication.

The non-unitarity Sancho considers is of an effective type, i.e. the particles absorbed by the screen surrounding the slits are missing in the two-particles description and thus the total probability is not conserved. Often this is described phenomenologically by a complex potential and he exhibits it here by using Feynman path integrals.

Now, this “effective” non-unitarity and its connection to possible superluminal communication raises interesting questions. It is believed that such an effective non-unitarity is due to the restriction to a two-particle system and that the time-development becomes unitary in a bigger, infinite particle, Hilbert space which includes the absorbing material. This complete description will necessarily become a field theory. The question then is whether the claimed superluminal communication persists also in this unitary case and, if so, whether one can find a way to avoid this by field theoretical means. In this context the discussion in [1, 2] may be illuminating.

References

- [1] G. C. Hegerfeldt, Causality, Particle Localization and Positivity of the Energy in Quantum Theory, in: *Irreversibility and Causality*. Edited by A. Bohm, H.-D. Doebner, and P. Kielanowski. Springer Lecture Notes in Physics 504, p. 238-245 (1998)
- [2] G. C. Hegerfeldt, Localization of Particles, Spreading and the Notion of Einstein Causality, in: *New developments in fundamental interaction theories : 37th Karpacz Winter School of Theoretical Physics, Karpacz, Poland, 2001*. Edited by J. Lukierski and J. Rembielinski. Melville, N.Y.: American Institute of Physics, 2001. p. 357