Abstract Submitted
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What is the right time for path integrals?[1] ERIC JONES, ROGER BACH, HERMAN BATELAAN, University of Nebraska-Lincoln — The Feynman path integral formulation of quantum mechanics has proven to be a powerful tool for calculations in matter optics. It is natural to introduce the path integral in the context of Young's double slit experiment for matter waves as Feynman did,[2] perhaps after discussing the analogous situation for optics. While intuitive, this approach can lead to a *pedagogical* misrepresentation of the theory, namely in the phase accumulated along single free-particle trajectories. How is the use of the accumulated phase, $2\pi L/\lambda_{dB}$, along a path of length L justified? The free-particle action gives a phase that differs by a factor of two. The guiding principle that interference occurs only for two paths that are indistinguishable from one another provides a correct solution: interfering paths must originate and terminate at equal times. We will present several simple thought experiments to illustrate incorrect and correct methods for determining phase shifts.

[1]We gratefully acknowledge support from NSF and the DoE GAANN. We thank Ron Cappelletti for interesting discussions.
[2]R. P. Feynman, Rev. Mod. Phys. **20**, 367-387 (1948).

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