Abstract Submitted
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What Phase Matters for Diffraction?[1] ERIC JONES, ROGER BACH, HERMAN BATELAAN, University of Nebraska-Lincoln — Young's double-slit experiment for matter is often compared to that of optics. In rudimentary explanations of the locations of the diffraction maxima and minima far from the slits, paths are sometimes superimposed over waves drawn from the two slits to the detection screen, leading to a phase difference of $\Delta\phi = 2\pi\Delta L/\lambda_{dB}$ between paths. Despite the intuitive connection of the two kinds of wave phenomena, this approach can lead to a misunderstanding of the theory for matter waves. The Feynman path-integral formalism [1] justifies the use of paths to determine the phase difference; however, the phase accumulated along single free-particle paths according to the formalism is not $\phi = 2\pi L/\lambda_{dB}$, even though the expression for the phase difference is correct. The resulting factor of 2 difference in the single path phase from the intuitive value arises from the particular treatment of time-dependence in interpreting the problem [2]. The nature of this misunderstanding will be discussed, and a possible resolution proposed based on the quantum mechanical principle of indistinguishability: the time duration of all interfering paths must be equal.

[1] R. P. Feynman, Rev. Mod. Phys. **20**, 367-387 (1948).
[2] J. Schmiedmayer *et al.*, in *Atom Interferometry*, edited by P. R. Berman (Academic Press, 1997), p. 20.

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Eric Jones
University of Nebraska-Lincoln

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