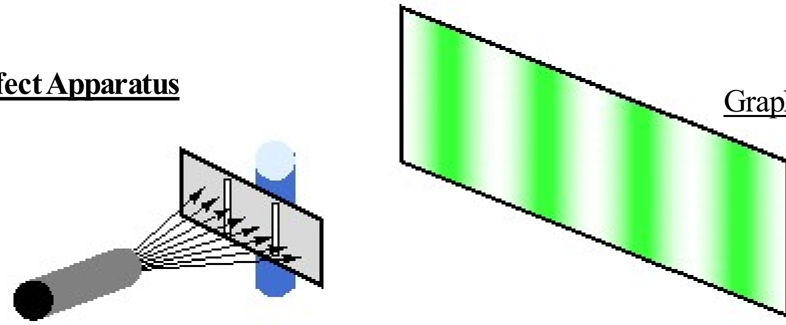
XXV. Simulating the Aharonov–Bohm Effect - Wikipedia

The Aharonov–Bohm effect is a quantum-mechanical phenomenon in which an electrically charged particle is influenced by the vector potential **A** in regions in which the magnetic field **B** is zero. A beam of monoenergetic electrons passes through a double slit on opposite sides of a solenoid. In QM, the same particle can travel between two paths. The expected interference pattern of the waves going through the two slits is shifted by an additional phase difference **ϕ** when the solenoid encloses a magnetic field, despite the magnetic field being zero in the regions through which the electrons pass. This can be observed experimentally by the horizontal displacement of the interference fringes.

Aharonov–Bohm Effect Apparatus

Graphic from Wikipedia



Note: The same pattern occurs when light goes through a double slit.

Illustration of how double-slit experiment in which Aharonov–Bohm effect can be observed: electrons pass through two slits, interfering at an observation screen, with the interference pattern shifted when a magnetic field B is turned on in the cylindrical solenoid. **The effect on the interference fringes is calculated and displayed below.**

Slit Positions	Slit Width	**AB Relative Phase Shift**
$x_L := 1 \quad x_R := 2$	$\delta := 0.2$	Phase $\phi := \pi$ for $exp(i\cdot\phi)$

$$\Psi(p) := \frac{1}{\sqrt{2}}\left(\int_{x_L-\frac{\delta}{2}}^{x_L+\frac{\delta}{2}} \frac{1}{\sqrt{2\cdot\pi}}\cdot exp(-i\cdot p\cdot x)\cdot\frac{1}{\sqrt{\delta}}\,dx + \int_{x_R-\frac{\delta}{2}}^{x_R+\frac{\delta}{2}} \frac{1}{\sqrt{2\cdot\pi}}\cdot exp(-i\cdot p\cdot x)\cdot\frac{1}{\sqrt{\delta}}\,dx\right)$$

$$\Phi(p,\phi) := \frac{1}{\sqrt{2}}\left(\int_{x_L-\frac{\delta}{2}}^{x_L+\frac{\delta}{2}} \frac{1}{\sqrt{2\cdot\pi}}\cdot exp(-i\cdot p\cdot x)\cdot\frac{1}{\sqrt{\delta}}\,dx + exp(i\cdot\phi)\cdot\int_{x_R-\frac{\delta}{2}}^{x_R+\frac{\delta}{2}} \frac{1}{\sqrt{2\cdot\pi}}\cdot exp(-i\cdot p\cdot x)\cdot\frac{1}{\sqrt{\delta}}\,dx\right)$$

Aharonov–Bohm Effect Interference Pattern with 180 degree Phase Difference