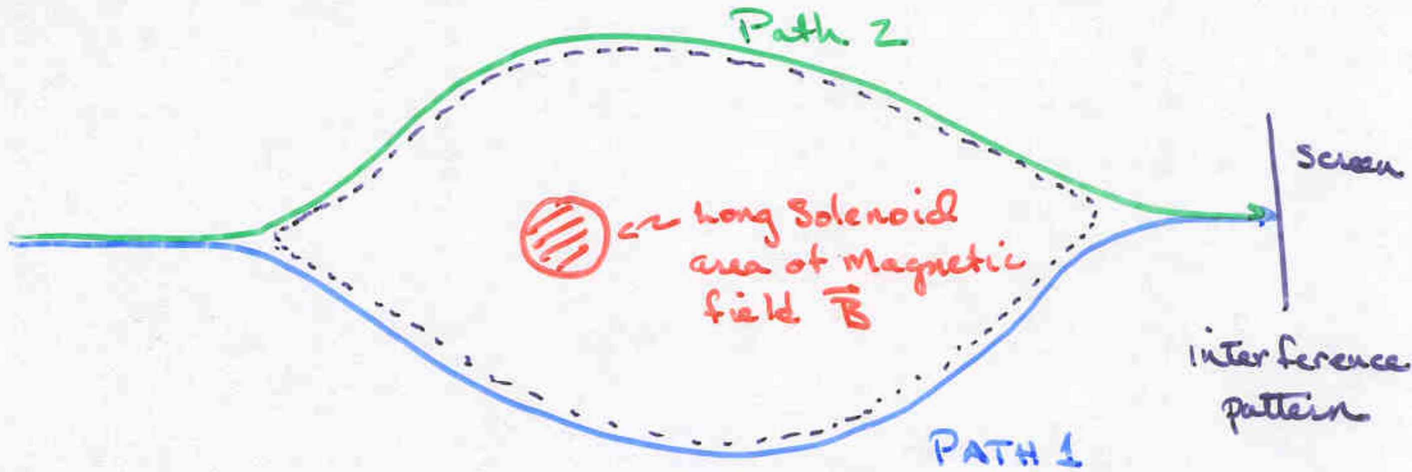
Magnetic Monopole Quantization [Dirac]
[Note: in Gaussian Units]

Aharanov - Bohm Effect [PR 115, 485 (1959)]



$$\Delta\varphi_{\text{phase}} = \underset{\text{difference in action}}{\Delta S} = \frac{e}{\hbar c} \underset{\text{(dotted line above)}}{\oint_L \vec{A} \cdot d\ell}$$

$$= \frac{e}{\hbar c} \int_S (\nabla \times A) \cdot dS$$

$$= \frac{e}{\hbar c} \int H \cdot dS = \frac{e}{\hbar c} \underset{\substack{\uparrow \\ \text{magnetic flux}}}{\Phi_M}$$

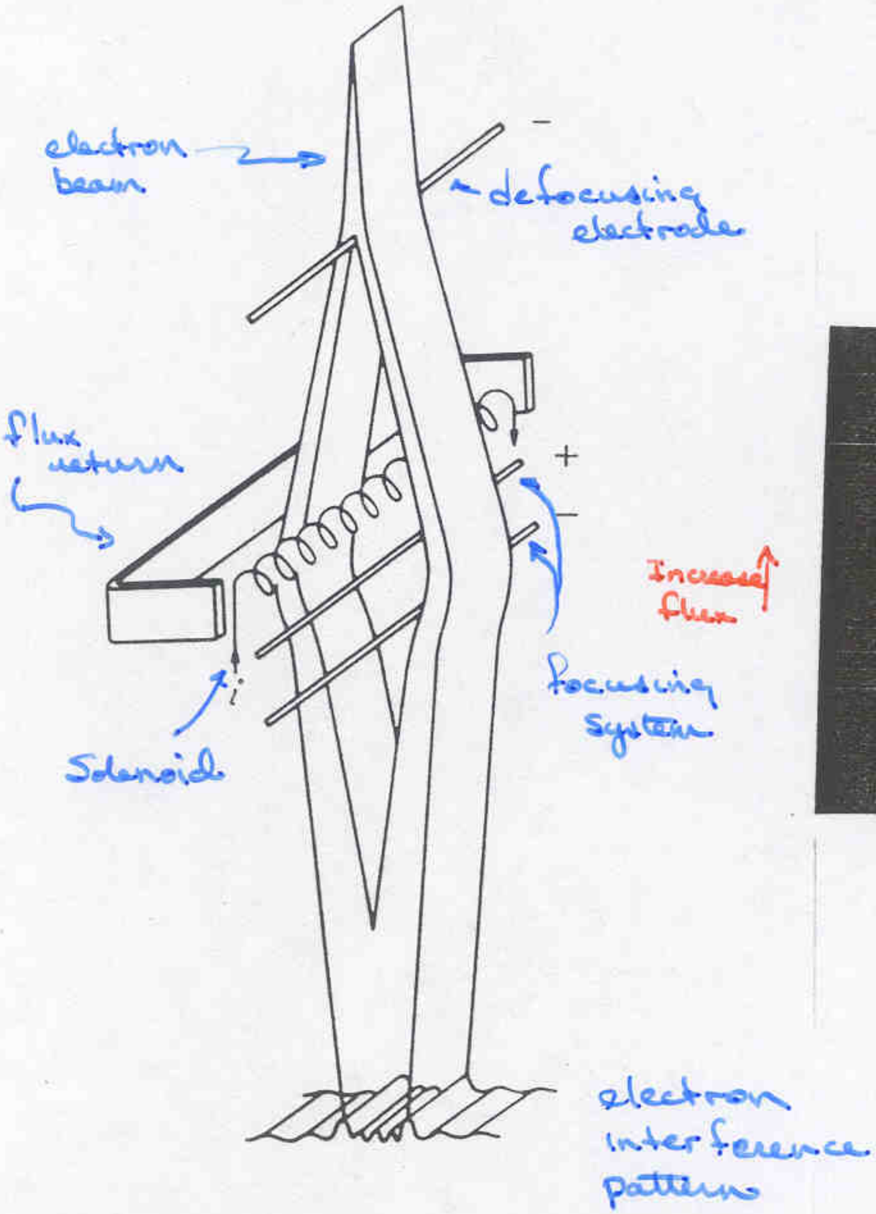
$\Rightarrow$ Strength of field effects interference pattern on screen.

Conclusion: Even though electron never experiences magnetic field - vector potential has physical consequences.

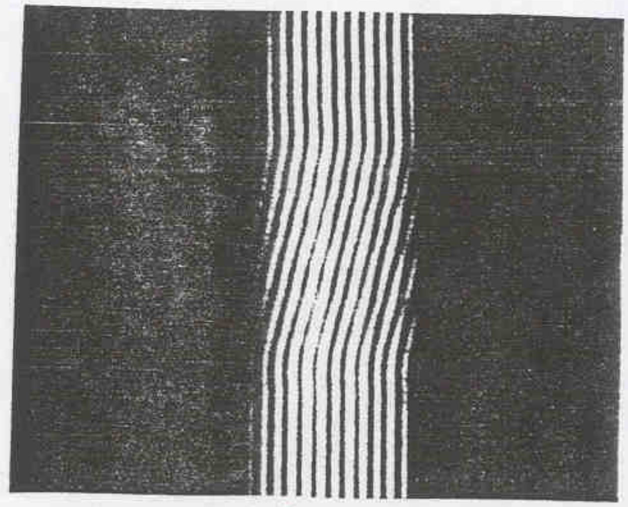
Aharanov - Bohm Effect

Experimental:

Bayh, Z. Phys. <u>169</u>, 492 (1962)
(in German)



Field in solenoid



No field in solenoid

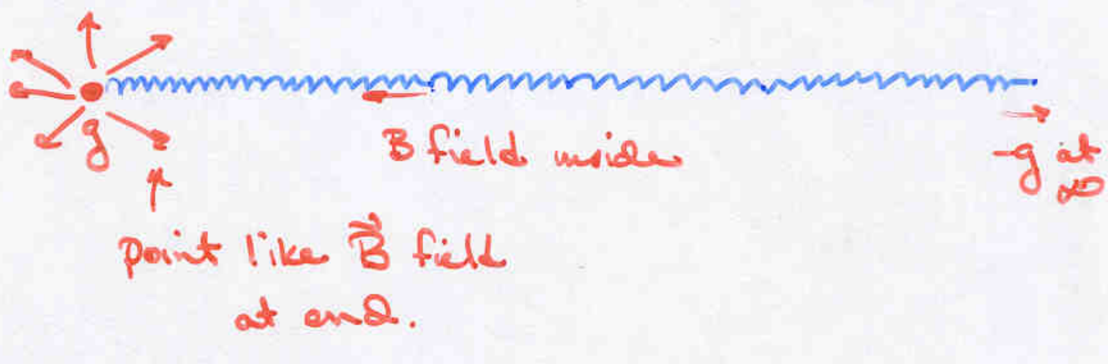
photograph moved as a function of time.

Review article: Olaria & Popescu, Rev Mod. Phy. <u>57</u>, 339 (1985)

First experimental result: Chambers, PRL <u>5</u>, 3 (1960)

Model of magnetic Monopole

Model: long tightly wound solenoid with one end at ∞.



$4\pi g = \Phi_m$ = flux

Assume: line of solenoid doesn't make a difference

$\Rightarrow$ phase change by taking electron around solenoid $= 2\pi n$

$$\frac{e}{\hbar c} \cdot 4\pi g = 2\pi n$$

$$\boxed{\frac{eg}{\hbar c} = \frac{n}{2}}$$ quantization condition

$$\Rightarrow \quad \frac{g^2}{\hbar c} = \frac{n^2}{4} \frac{1}{e^2/\hbar c} \approx \frac{137}{4} n^2$$

(1) Very strong interaction:
(2) Highly ionizing
(3) Easily attracted to magnetic fields.