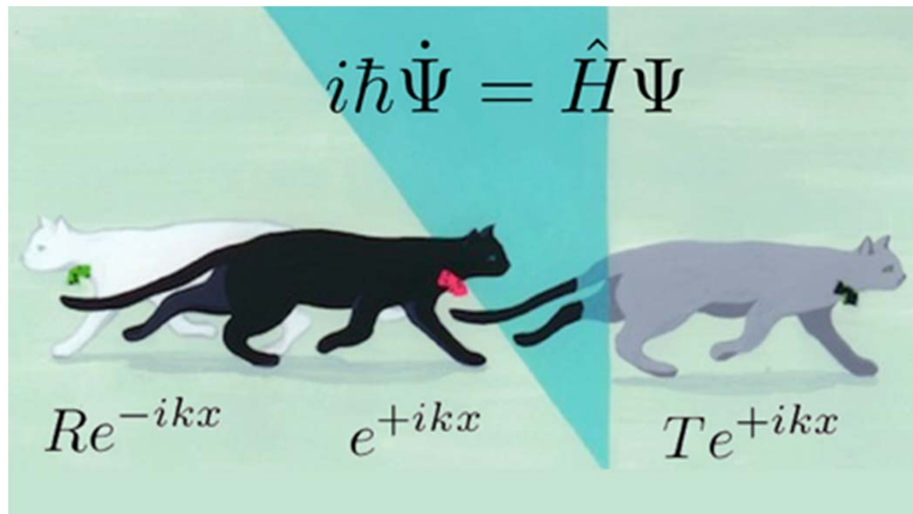
Exploring Quantum Physics

Coursera, Spring 2013 Instructors: Charles W. Clark and Victor Galitski

Wave-function and Schrödinger equation

Part III: Pioneering experiments (continued)



An explosion in the lab leads to strange results

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THE

PHYSICAL REVIEW

DIFFRACTION OF ELECTRONS BY A CRYSTAL OF NICKEL

By C. Davisson and L. H. Germer

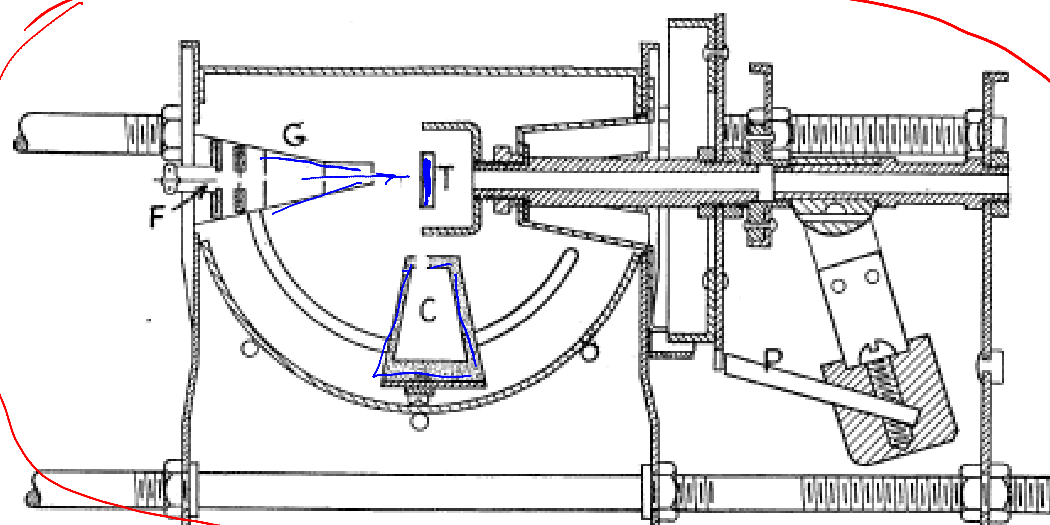


Fig. 2. Cross-sectional view of the experimental apparatus—glass bulb not shown.

What did they actually see?

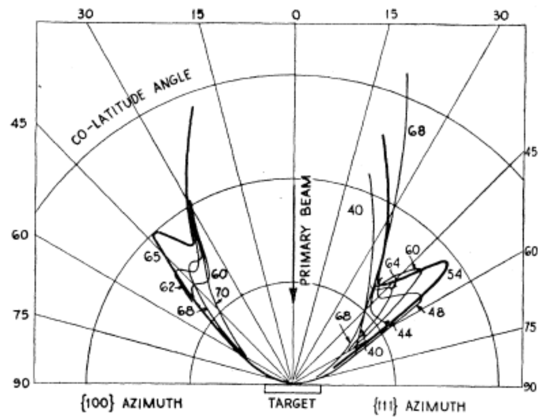
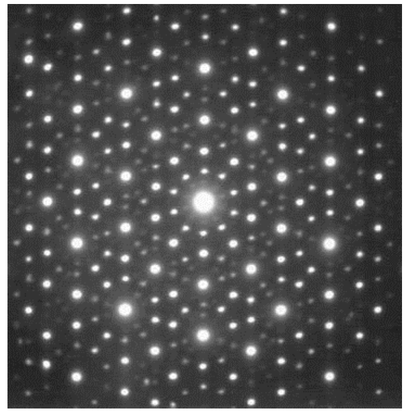
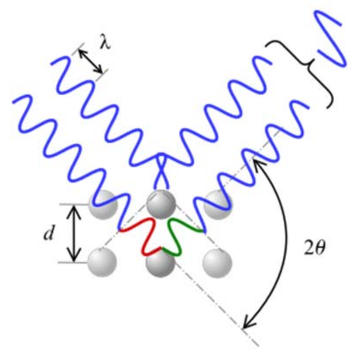
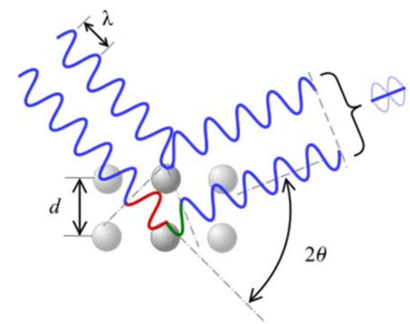


Fig. 10. Scattering curves showing the occurrence of the "54 volt" electron beam and the "65 volt" electron beam. (On each scattering curve is indicated the bombarding potential in volts.)







But this is what waves are supposed to do! Davisson (Nobel, 1937) and Germer say in the paper:

"The most striking characteristic of these beams is a one to one correspondence ...which the strongest of them bear to the Laue beams that would be found issuing from the same crystal if the incident beam were a beam of x-rays. Certain others appear to be analogues ... of optical diffraction beams from plane reflection gratings. Because of these similarities ... a description ... in terms of an equivalent wave radiation ... is not only possible, but most simple and natural. This involves the association of a wavelength with the incident electron beam, and this wavelength turns out to be in acceptable agreement with the value h/mv …, Planck's action constant divided by the momentum of the electron."

This correspondence was predicted by Prince de Broglie (Nobel, 1929): $\lambda = h/mv$

Summary

- We have learned about two Nobel-prize winning works (photoeffect and electron diffraction) and all in all "met" in passing 6 Nobel laureates in our first lecture (Feynman, Michelson, Lenard, Einstein, Davisson, De Broglie)

- We have seen that there is clear experimental evidence that light behaves (sometimes) as a beam of particles carrying energy quanta.

$$E = \frac{hc}{\lambda} = \hbar\omega$$

- On the other hand, there is also evidence that electrons (sometimes) behave as waves.

$$\lambda = h/mv$$

What's going on?