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THE QUANTUM THEORY*

ONE of the most surprising and interesting developments of the quantum theory is that which shows that quantum numbers determine not only the size and form of the electronic Keplerian orbits in atoms, but also the orientation of these orbits in space with regard to a favored direction such as that provided by an intra-atomic or by an external magnetic or electric field of force. For any arbitrary value of the azimuthal quantum number k, the simple theory shows that there are exactly $k+1$ quantum positions of the orbital plane characterized by whole numbers. For example, if $k=1$ the normal to the orbit may be either parallel to the direction of the controlling field or at right angles to it. If $k=2$ the normal to the orbit may take up in addition to these two positions a third one, in which the normal to the orbit makes an angle of 60° with the field. For higher values of the quantum number k, the possible orientations of the corresponding orbits become regularly more numerous.

A striking confirmation of this theory is afforded by the very beautiful experiments of Gerlach and Stern.[1] In these a stream of atoms of vaporized silver was allowed to flow past a wedge-shaped pole of an electromagnet which provided a radial non-uniform magnetic field. The atoms were caught on a glass plate placed immediately behind the pole, and it was found that they were deposited in two distinct sharply defined layers, indicating that the atoms were sorted out into two distinct and separate beams. The positions of the bands on the plate showed that one of the beams was attracted by the pole and the other repelled by it, the attraction being slightly the greater in intensity. No evidence was obtained of an undeflected beam. From these results it was concluded that all the silver atoms in the stream of vapor possessed a definite magnetic moment, and that while the atoms were passing through the magnetic field their magnetic axes had two distinct orientations in space.

By assuming the correctness of this interpretation, Gerlach and Stern found from measurements on the

* Concluding part of the address of the president of the Section of Mathematics and Physics, British Association for the Advancement of Science, Liverpool, September, 1923.

[1] Gerlach and Stern, *Zeit. für Phys.*, vol. 7, p. 249, 1921; vol. 8, p. 110, 1921; vol. 9, p. 349 and p. 353, 1922.