

SOME NOTES ON THE PHYSICS OF GOLF

Being a discussion on the article "Underspin the Essential," published in GOLF ILLUSTRATED, January 1915

THE interesting article by his honor Mr. Recorder Weir entitled "Underspin the Essential" affords an instance of the increased fascination of the game of golf to one of its devotees able to appreciate the fine points of the various strokes from the scientific aspect. In fact scientific men have often found in games many illustrations of dynamical laws, leading in many instances to valuable contributions to physical science. Professor P. G. Tait relates that it was through the game of tennis that the attention of the great Newton himself was drawn to the peculiar swerve characterizing the motion of a ball struck slantingly so as to produce a rapid spin. In fact Newton's explanation of the phenomenon (1671-72) is substantially that given to-day. This peculiar behavior is due fundamentally to the effect of the air carried around by the rough surface of the ball through the agency of fluid friction. If the ball is moving forward in a direction at right angles to the axis of spin, it is readily seen that near the surface the velocity of the air relative to the ball is greater in consequence of this "swirl" on one side than on the other. Now it is one of the fundamental laws of fluid motion that where the velocity is least, there is the pressure greatest. As a result there is brought into play an excess of pressure tending to make the direction of flight curve in the sense of the ball's rotation.

Almost exactly two centuries later (1877) the idealized version of the problem was discussed mathematically by Lord Rayleigh ("On the Irregular Flight of a Tennis Ball," *Scientific Papers*, Volume I, page 344), and the form of the trajectory worked out under various circumstances.

The influence of underspin in golf does not appear to have been fully appreciated until the problem was examined comparatively recently (1896) by Professor Tait ("On the Path of a Rotating Spherical Projectile," *Scientific Papers*, Volume II, pages 356-387). In reading Tait's memoirs one is at a loss whether to admire more the enthusiasm of the golfer or the patience of the scientific man as the inspiration of the immense amount of labor which they represent.

The question raised in the Recorder's paper as to the influence of spin on the "run" of a golf ball does not appear to have hitherto

been dealt with by scientific writers. This factor of spin on the nature of the impact is of prime importance in the game of billiards: the writer remembers being shown, a few years ago at the College de France in Paris, a specially constructed billiard table, having a smooth marble bed and massive "cushions" of the same material; by means of specially actuated hammers balls of various materials were impelled against the sides with measured velocities. By means of this historical piece of apparatus the laws of impact of rough spheres on plane surfaces were worked out about a century ago. The physical laws thus deduced are now incorporated in all the treatises on rigid dynamics, while problems relating to the impact of rough spheres on plane surfaces under all possible conditions of flight and spin have yielded material for testing the skill of many generations of Cambridge mathematicians. Solutions of many of these problems are to be found in Routh's "Rigid Dynamics" (Volume I, page 163, Macmillan and Co., 1897).

While the main peculiarities of the flight of a golf ball are found capable of explanations through the influence of "spin," the actual game presents never-ending possibilities through the agency of continually changing factors which constitute, in fact, one of the chief fascinations of the game.

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McGill University, February 23, 1915.

I feel much indebted, in common I am sure with readers of this magazine, to Professor Vessot-King for his interesting and instructive article. The result may possibly be that reflective and observant golfers both will take fresh interest in the game from a new point of view.

Professor A. S. Eve who also read my article on "Underspin" is interested in my reference to the underspin of a thrown stone, and suggests that the variation from upright to more or less "flat" spinning (as when a boy makes his stone "skip" on the water) may throw some light upon pulled and sliced balls in golf. Professor Eve would like this tested out as he says. I should be glad if he or his colleague Professor Vessot-King would do this.

All golfers know that, like the stone in the boy's fingers, the flight of the ball depends enormously upon the way the club meets it and that there are many possible variations of impact. The toe of the club may be forward or back i. e., the ball may be struck off the heel or off the toe with more or less disastrous results; its flight may be high or low owing to the degree of loft of the club or the place where the ball was hit. As our old friend Omar Khayyam says:

The ball no question makes of Ayes or Noes.

But right or left as strikes the player goes.

In the meantime I am convinced that in Underspin we have the real soul of golf.

R. Stanley Weir.