Physics in the Game: When a Goal is Scored as if by Magic

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Miracles happen over and over again. Even in the sport which the Germans love the most – soccer. But when the ball flies in a curve and hits the goal it has nothing to do with magic powers. Here it is rather a question of physical powers taking effect. And these powers can be calculated. That is what Metin Tolan, professor for experimental physics at the Universität Dortmund, is convinced about. With that he clearly disagrees with Rudi Assauer who once said: “Soccer is unpredictable”.

With his special lecture during the summer term Professor Tolan is on the track of selected phenomena in soccer. In view of the World Championship the 40year-old prolongs his regular lecture about quantum mechanics by half an hour. His students can find out all about a curving cross, for example.

Tolan knows that “Balls with a strong spin fly around corners”. That is due to air friction, (head-)wind and gravitation effecting the ball. When the ball is strongly cut with a spin of about five rotations it can move five meters sideward and with ten rotations about ten meters. Physicists call this the Magnus-Effect: Overpressure pushes the ball sideward so that it flies in a curve – preferably hitting the goal. The Brazilian Roberto Carlos, for example, succeeded in doing this in a game against France in 1997. The more the ball rotates the stronger the effect.

If a curving cross is successful, however, depends on the surface of the ball. As the seams of the ball – consisting of twelve pentagons and twenty hexagons – are anything but just design. They rather provide for

the strongly modified air friction. They cause the air turbulences developing behind the ball. With this knowledge one can not only shine in context with this year's World Championship.

The basic rules of mechanics and aerodynamics also took effect on the most controversial goal in soccer history in Wembley in 1966. According to the rules it is a goal when the ball is one rotation behind the line. In the game Germany against England the ball bounced off the crossbar and flew out of the goal. The linesman counted it as a hit – and he could have been right: "It was a goal when the speed of the ball was between 75 and 100 km/h and when the cross bar gave it a spin of about ten rotations per minute. That is to say it flew in a curve and was in the air behind the line for 0.02 seconds". That is how Tolan explains his calculations. Smiling and well-knowing that this scientific analysis can only be done without personal emotions.

Source: Universitaet Dortmund

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