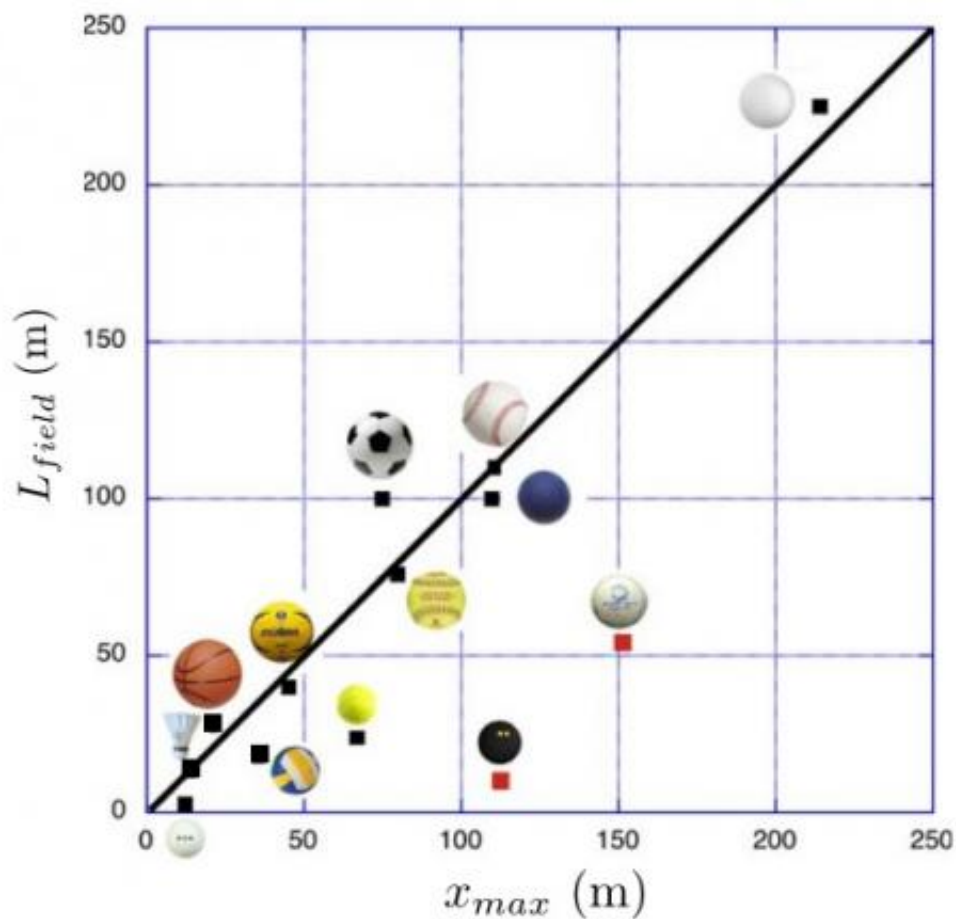


# What does physics reveal about the sizes of sports fields?

April 7 2014, by Lisa Zyga



The size of a sports field increases with the size of the maximum range of the ball used to play the sport. Credit: Texier, et al. ©2014 IOP Publishing Ltd

(Phys.org) —From ping pong tables to golf courses, the sizes of sports fields vary widely. Although the sizes of sports fields were originally defined empirically—that is, by simply playing the sport rather than performing calculations—researchers in a new study have found that sports field sizes follow some universal laws. Specifically, the size of a sport field is strongly correlated with the associated ball's maximum range, which in turn can be calculated from the ball's physical properties. Furthermore, this correlation allows many sports to be classified into two main categories: "precision and reflex" and "target" sports, reflecting two different styles of human activity.

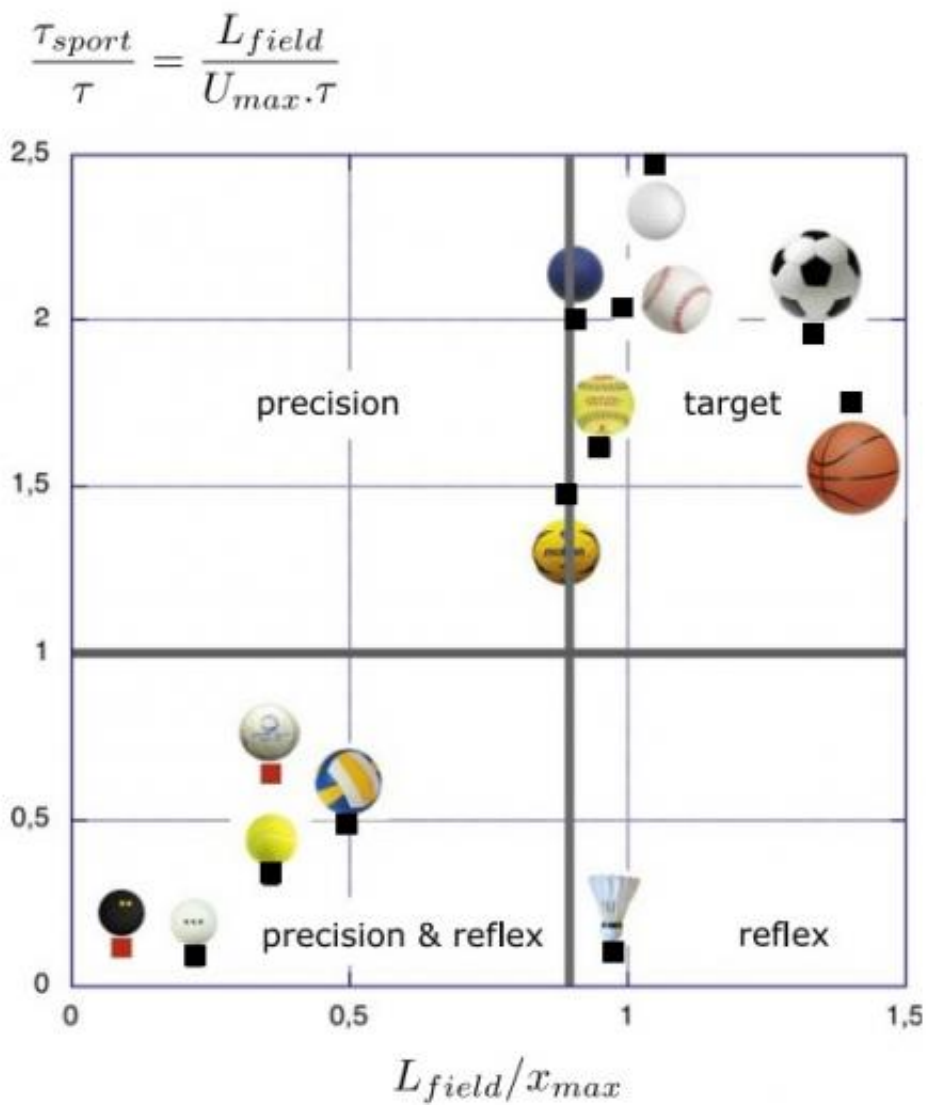
The researchers, Baptiste Darbois Texier, et al., from the École Polytechnique in Palaiseau and ESPCI in Paris, have published a paper on the correlation between sports field size and ball range in a recent issue of the *New Journal of Physics*.

While analyzing the sizes of sports fields may at first seem like a trivial task, the scientists explain how it may be more important than it appears.

"What is the importance of analyzing the fall of an apple?" coauthor Christophe Clanet at the École Polytechnique told *Phys.org*. "Well, some could answer none. Some could answer that it reveals some universal feature of our environment that is (in this case) that everything on Earth is attracted towards the center of the planet. This kind of universal behavior is what physics is about. We did not expect the size of sports fields to follow any law, and we were very surprised to find one, which is simple. The same law, for almost the same reasons, is going to apply to the size of battlefields.

"Concerning the greatest significance of our results, I would say that even if our environment has evolved empirically to converge to some solutions, those solutions have underlying laws that can be revealed by physics. The size of [sports fields](#) is one of these examples."

In their study, the researchers analyzed 13 sports, each involving a ball or other projectile (for example, a shuttlecock or "birdie" in badminton). Each ball has a different range, defined as the maximum distance that the ball can travel in one shot. At one end of the spectrum, a golf ball can be hit hundreds of meters. At the other end is a badminton birdie, which has a maximum range of about 4-5 meters due to its greater air resistance.



The researchers' analysis suggests two main families of sports: "precision and

reflex” sports and “target” sports. Badminton, in the lower right quadrant, can be defined as a pure reflex game. Credit: Texier, et al. ©2014 IOP Publishing Ltd.

While the range for each ball can be determined empirically, the researchers show that it can also be determined by a calculation that involves the ball's radius, mass, maximum velocity, terminal velocity or levitation speed, and the optimal angle of launching the ball to maximize the range. By plotting the field size as a function of ball range, the researchers discovered a strong linear relationship: the longer the ball range, the larger the field.

The correlation between the size of the sports field and the ball range implies that, once a ball is chosen, it's possible to predict the size of the field on which the sport should be played.

Of the 13 sports analyzed here, two of them (squash and jai alai) deviate from the correlation by having a smaller field than predicted. However, both sports are played with walls on the sides to keep the ball in the field, which explains the deviations.

In the second part of their study, the researchers looked at the time it takes for a ball to move over the whole field length at its maximum speed. For some sports, including squash, ping pong, tennis, volleyball, and jai alai, this time is shorter than or roughly equal to the reaction time of a player (which is typically about 1 second). In this family of sports, reflexes and precision are highly important. Since these sports have small fields compared to their ball range, it's often difficult to keep the ball in bounds.

In the second main family of sports, which includes baseball, softball, handball, lacrosse, golf, soccer, and basketball, the time it takes for a ball

to move across the field is significantly longer than a player's reaction time, and often requires several shots to move from one side to the other. All of these large-field sports involve a target, whether it be a basketball hoop or home base. These sports also require strategy, skill, and (usually) teamwork instead of fast reflexes.

The researchers also found that some sports don't quite fit into either family. One of these sports is badminton, since the birdie can quickly fly over the whole court (like the precision and reflex sports), but staying in bounds isn't very difficult (like the target sports). These traits imply that badminton can be considered a "pure reflex game," and precision is of lesser importance. On the other hand, an activity that would be the opposite of badminton would be one that requires a high degree of precision but little reflex. The researchers suggest billiards fits this description, although it is beyond the scope of the study.

A deeper understanding of sports, including the different types of skills required to play them, may have implications for understanding human activities that go far beyond the world of athletics. As the researchers explain, sports are often seen as metaphors of [human activity](#). In science, for example, taking a quick, intuitive approach to solving problems reflects the reflex and precision family of sports, while using a step-by-step deductive approach reflects the strategy required by target sports.

The researchers recall how Genia Peierls, wife of the WWII-era nuclear physicist Rudolf Peierls, used to classify scientists as either "tennis players," who run toward the net and take advantage of confrontation with others, or "golfers," who patiently push the ball many times in a lone quest for a goal. The researchers conclude that, whether it be on the [sports](#) field or in a work environment, both styles are essential.

**More information:** Baptiste Darbois Texier, et al. "On the size of sports fields." *New Journal of Physics* 16 (2014) 033039. DOI:

[10.1088/1367-2630/16/3/033039](https://doi.org/10.1088/1367-2630/16/3/033039)

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