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A photonic curveball has real-world examples in soccer, baseball

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Will the football end up inside the goal? Credit: Wikimedia Commons

Have you ever been amazed by a curveball goal scored by Diego Maradona, Lionel Messi or Christiano Ronaldo? Then you have—possibly without knowing it—been exposed to the Magnus effect: the fact that spinning objects tend to move along curved paths. In a new publication that appeared in *Physical Review Letters* this week, Robert

Spreeuw shows that the same effect occurs to atoms moving through light—and that this effect has practical consequences.

Even though many people may have never heard the name, the Magnus effect is well known in our daily lives. On YouTube, videos show football playersscoring incredible-looking goalsusing the effect, and there exists a 45-million-view video that shows what happens when youthrow a spinning basketball off a dam. All of these videos show the same basic effect: when a spinning object moves through the air, a pressure difference caused by the spinning causes the path of the object to curve.

Physicist Robert Spreeuw (UvA Institute of Physics) has now shown that the same effect occurs also on a much smaller scale. Replace the football by an atom, or any other microscopic object that has a so-called 'dipole moment', an asymmetry in the way that its electric charge is distributed. Don't let this atom move through the air, like the ball did—air itself consists of atoms, so the moving atom would simply bounce back and forth—but let it move through a beam of laser light instead. The light will exert a pressure on the atom just like the air did on the football, and voilá: the atom experiences a sideways force. This in turn has an effect on the light: just like the stream of air around the football is affected by its spin, the laser beam also measurably bends around the atom.

The result is not just useful for scoring goals in the world's smallest miniature football game. The optical Magnus effect also affects optical tweezers: devices that use light to delicately handle and move individual atoms. Such tweezers, for which a Nobel Prize was awarded in 2018, are a much-used tool—for example in the development of quantum computers. Atoms in optical tweezers also experience a sideways force caused by the optical Magnus effect, and therefore the new knowledge of this effect will help us handle these devices in an even more precise manner.

More information: Robert J. C. Spreeuw. Off-Axis Dipole Forces in Optical Tweezers by an Optical Analog of the Magnus Effect, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.125.233201

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