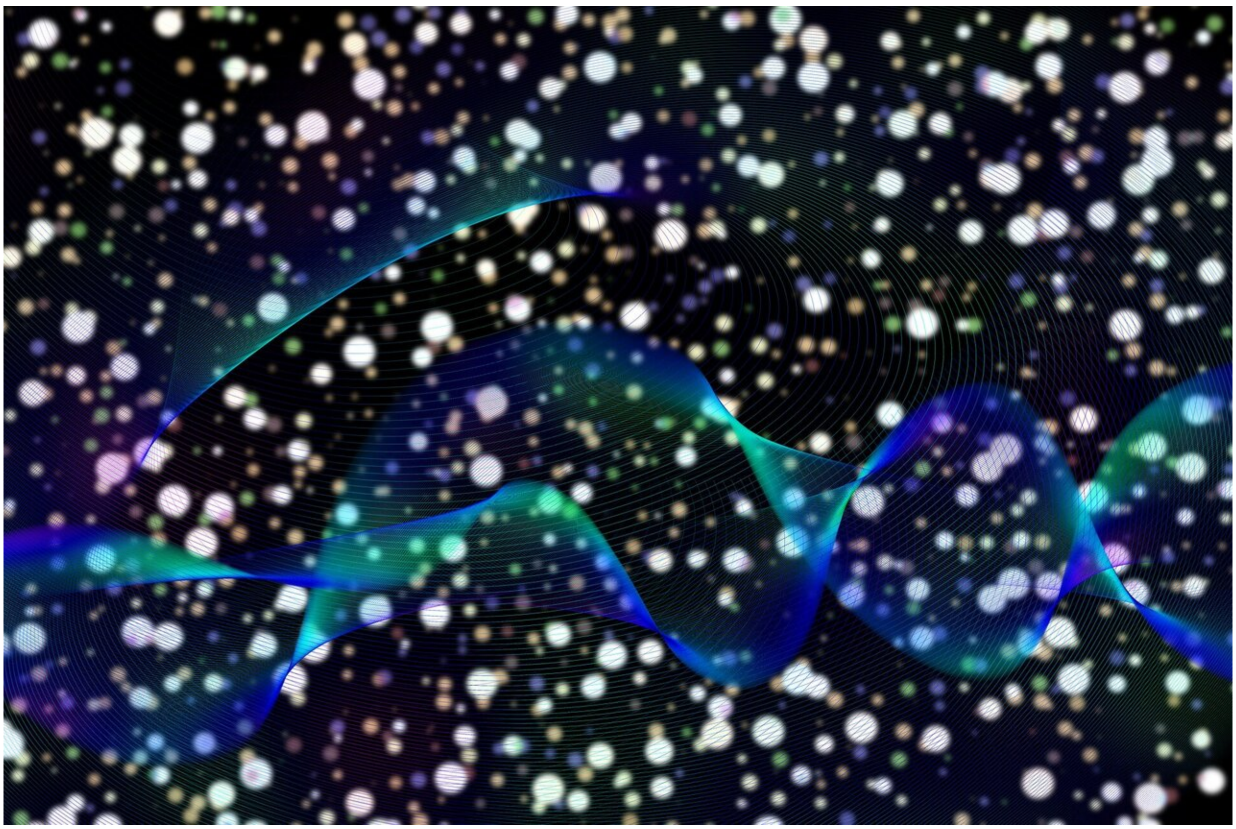
What if we could teach photons to behave like electrons?

February 19 2020



Credit: CC0 Public Domain

To develop futuristic technologies like quantum computers, scientists will need to find ways to control photons, the basic particles of light, just as precisely as they can already control electrons, the basic particles in electronic computing. Unfortunately, photons are far more difficult to manipulate than electrons, which respond to forces as simple as the sort of magnetism that even children understand.

But now, for the first time, a Stanford-led team has created a pseudo-magnetic force that can precisely control photons. In the short term, this control mechanism could be used to send more internet data through fiber optic cables. In the future, this discovery could lead to the creation of light-based chips that would deliver far greater computational power than electronic chips. "What we've done is so novel that the possibilities are only just beginning to materialize," said postdoctoral scholar Avik Dutt, first author of an article describing the discovery in *Science*.

Essentially, the researchers tricked the photons—which are intrinsically non-magnetic—into behaving like charged electrons. They accomplished this by sending the photons through carefully designed mazes in a way that caused the light particles to behave as if they were being acted upon by what the scientists called a "synthetic" or "artificial" magnetic field.

"We designed structures that created magnetic forces capable of pushing photons in predictable and useful ways," said Shanhui Fan, a professor of electrical engineering and senior scientist behind the research effort.

Although still in the experimental stage, these structures represent an advance on the existing mode of computing. Storing information is all about controlling the variable states of particles, and today, scientists do so by switching electrons in a chip on and off to create digital zeroes and ones. A chip that uses magnetism to control the interplay between the photon's color (or energy level) and spin (whether it is traveling in a clockwise or counterclockwise direction) creates more variable states than is possible with simple on-off electrons. Those possibilities will enable scientists to process, store and transmit far more data on photon-based devices than is possible with electronic chips today.

To bring photons into the proximities required to create these magnetic effects, the Stanford researchers used lasers, fiber optic cables and other off-the-shelf scientific equipment. Building these tabletop structures enabled the scientists to deduce the design principles behind the effects they discovered. Eventually they'll have to create nanoscale structures that embody these same principles to build the chip. In the meantime, says Fan, "we've found a relatively simple new mechanism to control light, and that's exciting."

More information: Avik Dutt et al, A single photonic cavity with two independent physical synthetic dimensions, *Science* (2019). DOI: 10.1126/science.aaz3071

Provided by Stanford University

Citation: What if we could teach photons to behave like electrons? (2020, February 19) retrieved 16 August 2024 from https://phys.org/news/2020-02-photons-electrons.html