Superpositions of Chiral Molecules

Matter-wave diffraction can put chiral molecules into superpositions of left- and right-handed forms, enabling new studies of how the two states interact with their environment.

By Christopher Crockett

Many complex molecules come in two configurations that look like mirror images of each other. The left- and right-handed versions of these so-called chiral molecules can behave very differently from each other in biological settings. Now, researchers show how to prepare a beam of chiral molecules in a quantum superposition of left- and right-handed variations that could enable precision studies of these differences [1].

The proposed experiment would leverage a unique quantum property of chiral molecules: They oscillate periodically between the two forms. When not fully left- or right-handed, they are in a quantum superposition of both states. Each molecule in a beam, however, is in a different stage of these oscillations. If it were possible to coordinate this cycling so that many molecules switched configurations in sync, one would have a beam of chiral molecules in well-defined states.

Benjamin Stickler of the University of Duisburg-Essen in Germany and colleagues propose to achieve this synchronization by aiming a beam of chiral molecules at a specially tailored laser-based diffraction grating. Molecules reaching the grating in their left-handed forms would go to one diffraction order and those in their right-handed forms to another. Spatial filtering of these orders would select molecules of a certain state: The filtered molecules would continue to flip between forms, but they would now do so in sync. This filtered beam could then be used to sense chiral-dependent interactions, which would introduce phase shifts between the left- and right-handed states.

The team suggests that derivatives of the helix-shaped molecule [4]-helicene will be ideal for this work: The oscillation times are suitable for exploiting chiral quantum superpositions, and the strong optical response means that a moderate-intensity laser can separate the configurations.

Christopher Crockett is a freelance writer based in Arlington, Virginia.

REFERENCES