Swirled to the Left or Right? Nanofibers Align in Stirred Liquid

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Is the vortex in a stirred liquid swirling clockwise or counterclockwise? A zinc porphyrin dendrimer—a branched molecule with a central zinc atom—can answer this question. As Japanese researchers report in the journal *Angewandte Chemie*, the optical activity of a solution containing this substance changes rapidly when the direction of stirring is changed.

It is possible that vortexes in the distant past were responsible for breaking the symmetry in nature to give us the "handed" life we see today, which has clear preferences for "left-" or "right-handed" molecular building blocks like sugars and amino acids. Vortexes in liquids clearly twist either one way or the other, as do screws, our hair, or snail shells. They can be related to each other like mirror images or left and right hands. This is called "handedness" (chirality).

Vortexes are very complex structures, containing many regions with currents moving in completely different directions. For example, if a liquid is stirred in a cuvette, a dense circular current forms at the center while a loose spiral-shaped flow is present in the outer regions of the vortex.

A research team headed by Takuzo Aida and Akihiko Tsuda has now synthesized a zinc porphyrin dendrimer that makes these individual local currents observable by spectroscopy. The highly branched zinc-containing molecules aggregate in solution to form long nanofibers. If the solution is not stirred, it is not optically active. As soon as it is stirred, it becomes optically active: The stirred solution rotates right- and left-circularly polarized light to different degrees. This difference (circular dichroism), when measured over all wavelengths, results in a characteristic spectrum. If the direction of stirring is changed, the sign of the circular dichroism switches. In addition, the magnitude of the circular dichroism increases with increased stirring.

This phenomenon does not stem, as first thought, from the twisting of individual nanofibers. It is evidently caused by a special macroscopic spatial arrangement of the fibers within the sample cuvette: Like a flag waving in the breeze, the individual fibers are directed by the current. Along the beam of light shining through the cuvette, the different currents within the vortex drive the fibers into a helical arrangement—a structure reminiscent of certain liquid-crystalline phases. When the direction of stirring is changed, the helical structure also changes the direction it twists.

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