Detection of helical water flows in sub-nanometer channels

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This study published in *Nature Communications* reveals a previously unknown behavior of water at the nanoscale. The team discovered that inside peptide-based nanochannels – structures below 1 nanometer in diameter – water flows in both traditional laminar and newly identified helical patterns. These nanochannels form when diphenylalanine-based peptides self-assemble into ring structures, which then align into long, tubular formations that can extend over several centimeters.

The researchers use a combination of solid-state nuclear magnetic resonance spectroscopy and water vapor sorption measurements to characterize the structure and dynamics of water within the nanotubes. Computational simulations provide further insight into the direction and nature of water flow, leading to the underlying dual-flow model of coexistent laminar and helical patterns within the nanochannels, moving at different speeds. The helical flow arises due to the screw-like arrangement of the ionic groups along the inner walls of the peptide channels. Remarkably, this flow type can be influenced by external water vapor pressure, introducing potential for precise control of nanoscale fluid dynamics.

This phenomenon mirrors natural occurrences of helical flows, such as blood circulation in the human aorta and vortex formations in superfluidic states, and suggests that similar helical flows might exist in other nanoporous systems such as zeolites and microporous polymers, which are used in catalysis, water purification, gas separation, energy technologies like fuel cells or batteries, and other nanofluidic applications. These findings may also shed light on cellular transport mechanisms and inspire novel approaches in biotechnology and medicine, because peptide nanotubes are model systems for ion transport in biological systems. The study was supported by the Foundation for Science and Technology (FCT), the European Research Council (ERC), and the Portuguese Recovery and Resilience Plan (PRR).

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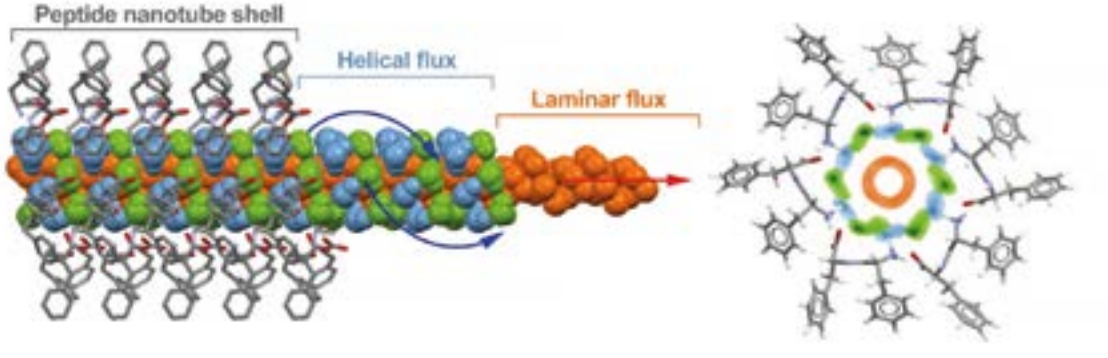

FIGURE 1
Arrangement of water flows in the sub-nanometer peptide channel: (left) side view and (right) axial view.