Chiral symmetry breaking and entropy production in Dean vortices

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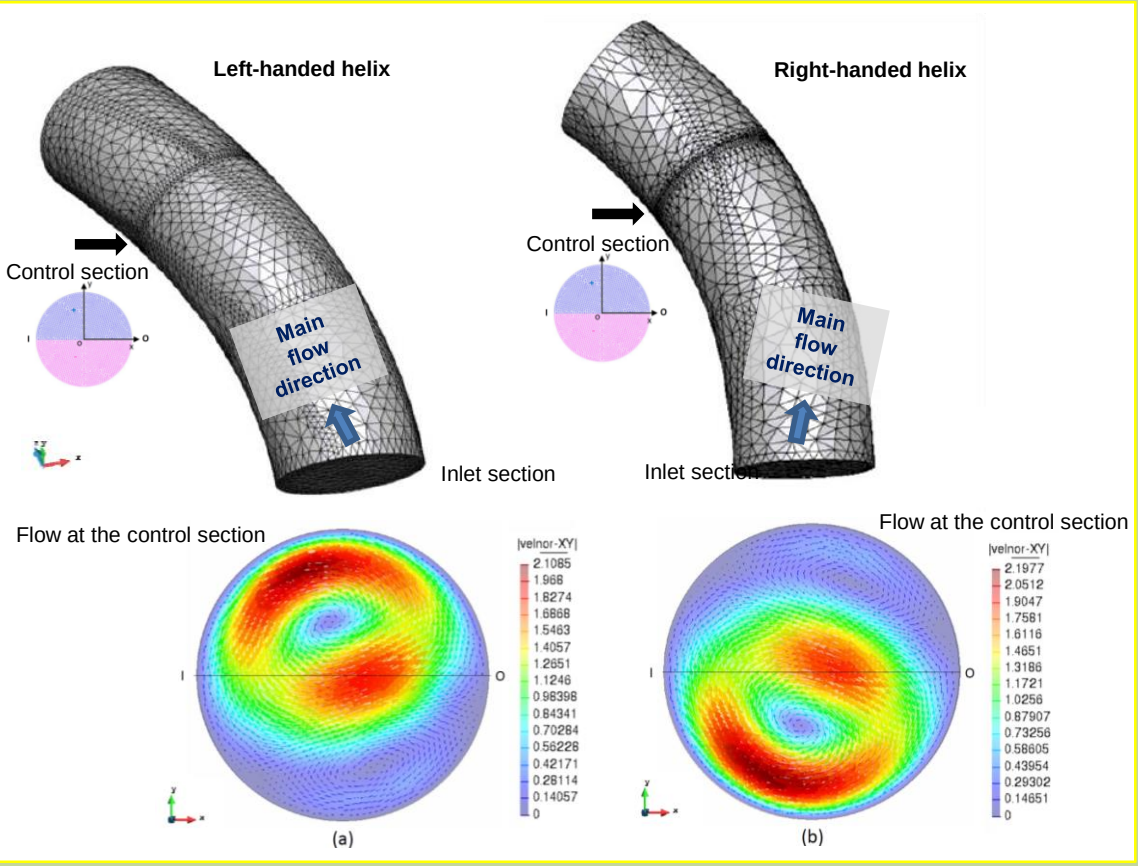

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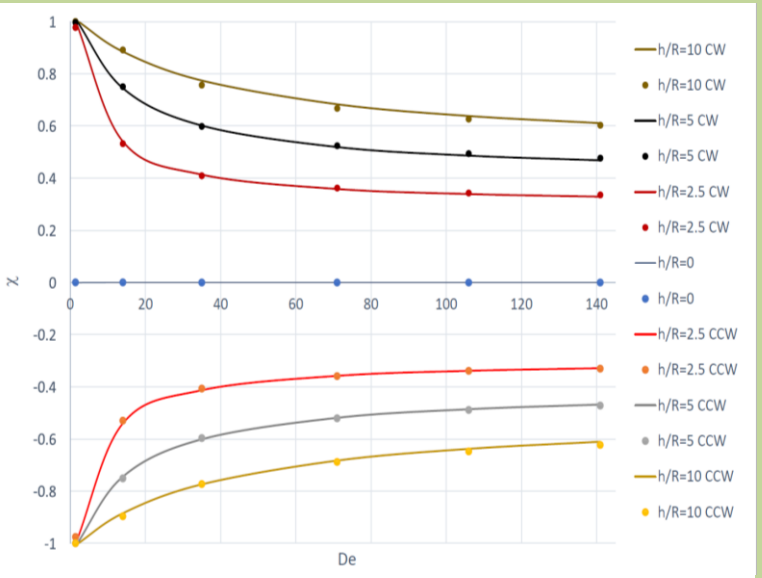
Our model allows the quantification and prediction of the chiral symmetry breaking in a helical flow reactor

The chemistry of life on Earth is based on a basic asymmetry of certain molecules whose three-dimensional geometrical structure or conformation is not identical to that of their mirror image, or spatial reflection through a mirror. Parity P, or space inversion, a discrete spatial symmetry transformation of fundamental physics, is broken at the molecular level. Such molecules are said to possess chirality or handedness. The mirror image structures of a chiral molecule are called enantiomers. Homochirality is ubiquitous in biological chemistry from its very start. Amino acids, the building blocks of proteins, and the sugar backbones present in DNA and RNA, are chiral molecules. The origin of biological homochirality has intrigued the scientific community ever since its initial discovery by Pasteur.



Variation of the chiral parameter, χ, with *De* number and helical *pitch*

To unravel its possible origin, we have conducted a combined theoretical and numerical study on the physics of fluid flows in curved pipes.

In such coiled ducts, hydrodynamic flows develop a net chirality which can then be transmitted, via viscous shear forces, to the level of molecular self-assembly. This establishes a purely fluid-mechanical mechanism of mirror symmetry breaking from the fluid flow to the constituent molecules.

HERREROS AND HOCHBERG, PHYSICS OF FLUIDS, 35(4):043614, 2023; HTTPS://DOI.ORG/10.1063/5.0142665