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December 11, 2024

The Editors,
Proceedings of the National Academy of Sciences

Dear Editor,

We are pleased to submit our manuscript entitled **“Experimental and theoretical evidence of universality in superfluid vortex reconnections”** to be considerated for publication in the *Proceedings of the National Academy of Sciences.* This paper presents experimental and numerical insights into the dynamics of vortex reconnections in superfluid helium at zero and non-zero temperatures, with significant implications for understanding the more general physics of vortex reconnections with respect to energy dissipation/transfer and irreversibility.

For the first time in the study of vortex reconnections, we combine experiments with numerical simulations, finding very good agreement. Our work shows that the scaling law describing the minimum distance between pre and post reconnecting vortices is universal: it is not only valid in Bose-Einstein Condensates (BECs) and classical viscous fluids (as established in previous studies), but also in superfluid helium. As in BECs and Navier-Stokes fluids, superfluid vortices separate faster than they approach each other. This property is related to dissipation of kinetic energy, hence to irreversibility.

We also demonstrate that each reconnection event in superfluid helium injects energy into the normal fluid, the thermal component of superfluid helium. By estimating the reconnection frequency and examining energy dissipation, we show that if the vortex line density is sufficiently large, these energy injections can maintain the normal fluid in a dynamically perturbed state which has no analogue in classical fluids as it arises from the quantum-mechanical constraints governing the flow of low-temperature helium.

We believe that our findings will be of interest to readers of the *Proceedings of the National Academy of Sciences* as they provide a deeper understanding of superfluid dynamics and highlight universal aspects of vortex reconnections across fluid systems. Furthermore, we reckon that our research should have an impact also beyond fluid dynamics.Reconnections of coherent filamentary structures play in fact a fundamental role also in several other distinct physical systems, namely: plasmas, nematic liquid crystals and optical beams.

Pubblication in the *Proceedings of the National Academy of Sciences* of past studies on quantum vortex reconnections reflects the multidisciplinar character of this topic. With respect to the latter, our work makes important steps forward: it is the first joint experimental and theoretical work; the motion of quantum vortices is for the first time monitored both *before* and *after* reconnections (previous experimental work were able to observe vortex motion only after the reconnection event), which is essential to demonstrate the irreversible character of reconnections, one of the main findings of our work.

We have contacted NAS member Katepalli R. Sreenivasan who would be happy to act as Editor of our submission. In alternative, please find in the next page the motivations for our choice of other suggested PNAS Member Editors.

Thank you for considering this manuscript; we look forward to your response.

On behalf of the authors,

Piotr Stasiak

- Prof. Bagnato, Vanderlei S. : expert in experimental investigation of atomic Bose-Einstein Condensates, Quantum Turbulence and Quantum Vortex Dynamics;
- Prof. Moffatt, H. Keith: expert in Fluid Dynamics, Helicity (Topology) and Vortex Dynamics.