Scientists discover rigid structure in centre of turbulence

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Pioneering mathematical engineers have discovered for the first time a rigid structure which exists within the centre of turbulence, leading to hope that its chaotic movement could be controlled in the future.

Dr Sotos Generalis from Aston University in Birmingham, UK and Dr Tomoaki Itano from Kansai University in Osaka, Japan, believe their discovery of the *Hairpin Vortex Solution* could revolutionise our understanding of turbulence and our ability to control it.

This rigid, set structure, named after its hairpin like shape was found within *Plane Couette flow*. This is a prototype of turbulent shear flow, where turbulence is created in fluid flow between the space of two opposite moving planar fluid boundaries, when high- and low-speed fluids collide.

Everyone from Formula One drivers experiencing drag, through to aeroplane passengers suffering a bumpy flight, will have experienced clear-air turbulence, the mixing of high- and low-speed air in the atmosphere.

This newly found turbulent state is constituted by a number of elements found in a coherent flow structure and has been described by the research team as a "tapestry of knotted vortices."

While structures, known as wall structures have been found on the ‘edge’ of turbulence, an elusive middle or wake structure has never been

discovered, until now.

Dr Generalis believes that finding a regimented structure within the very heart of Couette flow could prove invaluable to controlling turbulence and the effects of turbulence between two moving boundaries, in the future. This could include working machinery parts, medical treatment involving blood flow, and turbulence in air, sea and road travel.

“Ten years ago scientists believed turbulence was in a ‘world’ of its own, until we began to find ‘wall structures’ on its side. We believed a middle or wake structure might exist, and now we can prove there is regimented structure at the very centre of turbulence. This new discovery paves the way for the ‘marriage’ between wake and wall structures in shear flow turbulence and provides a unique picture of the Couette flow turbulent eddies only observed but *never* understood before.

The team’s findings of this missing central link have been published in Physical Review Letters and come after nearly five years of research, created by thousands of computer generated shear flow models. The result was obtained by replicating the exposure of two opposite plates to hot and cold conditions, moving from a static to dynamic position. The research team are now aiming to find if similar structures exist within other cases of turbulent fluid flow.

“The hairpins expose an all new ‘view’ of the transition to turbulence and it is our aim to ‘unify’ this idea discovered in Couette flow, into other areas of shear flow in general,” added Dr Generalis.

More information: Hairpin Vortex Solution in Planar Couette Flow: A Tapestry of Knotted Vortices, *Physical Review Letters*, Volume 102, Number 11

Source: Aston University