Groundbreaking research to help control liquids at micro and nano scales

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From targeted drug delivery to the self-assembly of nano robots, new research by Northumbria University, Newcastle, is using super-sized atoms to reveal the behaviour of liquids in microscopic channels.

The study, which has been led by Dr Rodrigo Ledesma-Aguilar; a senior lecturer in the Department of Physics and Electrical Engineering in Northumbria University, is a collaborative effort between Oxford University, the University of Barcelona and UT Malaysia.

Using the already established 'lab on a chip' device which can perform complex laboratory functions in a tiny space, the team has unveiled how fluids behave under extreme confinement by using micron-sized particles known as colloids to act as oversized atoms.

Atoms are tiny and cannot be seen under a microscope. This is not the same for colloidal particles, however, and this makes it possible for scientists to understand the behaviour of fluids – such as water – at extremely small scales.

The team used a colloidal mix to figure out how fluids behave in micron sized channels. Using a technique called 'confocal microscopy' they managed to observe in detail, for the first time, the flow of a two-phase mixture; very similar to having oil separated from water.

The new research shows how simple changes in the channel size can be used to create very small structures, including droplets and jets.

This ability to control fluid structures at such small scales can be potentially used to devise new ways that improve the delivery and the effectiveness of drugs, and to assist the assembly of more complex structures such as micro robots that can travel, for example, around the bloodstream to deliver lifesaving drugs.

Dr Ledesma-Aguilar said: "We have revealed the next piece of a puzzle that over time can lead to the controlled tailoring of liquids at extremely small scales. This knowledge opens the door to developing new devices that target other liquids, such as water-based solutions, to tailor the formation of drops, jets and streams of a few nanometres in size."

Prof Ignacio Pagonabarraga, from the University of Barcelona, said: "The ability to control drops can also be used to guide the assembly of micro robots, or to act as microscopic beakers for chemical reactions for the development of smart materials such as clever sensors."

Dr Ledesma-Aguilar added:" "Using knowledge from one system to understand another is not particular to the way we have used colloidal mixtures to understand liquids, it is an underpinning principle of how physics works to make sense of the world around us, and unveiling such generality is perhaps one of the most beautiful aspects of it."

Provided by Northumbria University