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Wild 'Waterbending' Technique Uses Waves to Precisely Manipulate Floating Objects

Researchers can manipulate water waves to move ping-pong balls and grains of rice with a precision that seems straight out of a sci-fi movie.

Imagine jumping onto a large floating object in a lake or swimming pool and trying to move. We've all been there -- without a paddle, sail, or propulsion engine, you're stuck. But what if we could make the water move you on its own?

An international team of researchers has developed a technique to manipulate water and move floating objects with a precision that seems straight out of a sci-fi movie. Aside from its inherent cool factor, the research could have practical applications, from molecular experiments to maneuvering boats across large bodies of water.

The water-manipulation technique is powered by waves. After studying computer simulations, the team used 3D-printed plastic structures to generate different kinds of waves in a water tank. One of the structures was a ring of 24 tubes connected to a speaker that emitted a low humming sound that created ripples in the water within the ring.

By controlling the size and frequency of the waves generated by these structures, the researchers produced complex patterns on the water's surface, such as loops and vortices, allowing them to control the movement of floating objects such as foam balls, ping-pong balls and rice grains.

As detailed in a study published in Nature in early February, the researchers used the waves to perform tricks such as pinning floating objects in place or coaxing them to move along circular or spiraling paths. They even noticed that the small external waves didn't greatly interfere with the patterns and the objects' movements. Overall, the floating objects were only deviated from their paths by less than a fifth of an inch (about 5 millimeters). Despite appearances, the researchers are not waterbenders — it's all based in physics.

"Our discovery is the first step in exploring how water waves can be shaped to move objects, with many potential applications in the future," said one of the study leaders, Shen Yijie of Nanyang Technological University in Singapore, in a university statement.

Shen is an optical engineer whose recent research was inspired by his studies of patterns in light. He and his colleagues had previously shown that light waves can move tiny particles in patterns of light, which led him to wonder if water could behave similarly.

"We have demonstrated that water waves can be used to precisely move floating objects as small as rice grains. Future research may investigate even smaller waves, such as cell-scale waves that are hundreds of times smaller, and larger waves that are a thousand times larger," Shen Yijie added.

At the molecular scale, this technique could bring particles together without direct manipulation. On a larger scale, we could control the movement of boats over bodies of water, although the researchers acknowledge that the effects of strong natural waves must be taken into account. Could this technique also move liquids in water? Similar water treatment techniques could help clean up floating chemical pollutants. However, it's also worth noting that scientists would likely have to use very large wave-generating structures over large expanses of water.

Given the similarities between water waves, light waves, and the movement of electrons, the researchers believe that water could offer a more accessible way to study certain quantum phenomena. If you think this is very futuristic, wait and see — according to the statement, future research could even investigate the possibility of using water patterns to store data.

For now, however, the team aims to investigate whether waves can generate similar patterns beneath the surface of the water.

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狂野的“御水术”技术利用波浪精确操纵漂浮物体

研究人员可以操纵水波来移动乒乓球和米粒，其精确度似乎直接来自科幻电影。

想象一下，跳到湖里或游泳池里的一个大漂浮物上，然后试图移动。我们都有过这样的经历——没有划桨、风帆或推进发动机，你就被困住了。但如果我们能让水自己移动你呢？

一个国际研究小组已经开发出一种技术来操纵水和移动漂浮物，其精度似乎就像科幻电影里的那样。除了其固有的酷因素外，这项研究还可以有实际应用，从分子实验到在大片水域中操纵船只。

水操纵技术是由波浪驱动的。在研究了计算机模拟后，该团队使用 3D 打印的塑料结构在水箱中产生不同种类的波。其中一个结构是一个由 24 根管子连接到扬声器的环，它发出低沉的嗡嗡声，在环内的水中产生涟漪。

通过控制这些结构产生的波浪的大小和频率，研究人员在水面上产生了复杂的图案，比如环路和漩涡，从而使他们能够控制泡沫球、乒乓球和米粒等漂浮物的运动。

正如 2 月初发表在《自然》杂志上的一项研究所详述的那样，研究人员利用波浪来完成一些技巧，比如把漂浮物固定在原地，或者诱导它们沿着圆形或螺旋形的路径移动。他们甚至注意到，外部的小波并没有极大地干扰图案和物体的运动。总的来说，漂浮物只偏离了它们的路径不到五分之一英寸（约 5 毫米）。尽管表面如此，研究人员并不是御水师——这一切都是基于物理学的。

“我们的发现是探索如何塑造水波来移动物体的第一步，在未来有许多潜在的应用，”来自新加坡南洋理工大学的研究负责人之一沈义杰（音译）在一份大学声明中说。

沈义杰是一名光学工程师，他最近的研究受到了他对光模式的研究的启发。他和他的同事们之前已经证明，光波可以在光的模式中移动微小的粒子，这让他想知道水是否也能有类似的行为。

“我们已经证明，水波可以用来精确移动像米粒一样小的漂浮物。未来的研究可能会研究更小的海浪，比如小几百倍的细胞规模的海浪，以及大一千倍的更大的海浪，”沈义杰补充道。

在分子尺度上，这种技术可以在没有直接操作的情况下将粒子聚集在一起。在更大的范围内，我们可以控制船只在水体上的运动，尽管研究人员承认，强烈的自然波浪的影响必须考虑在内。这项技术也能移动水中的液体吗？类似的水处理技术可能有助于清理漂浮的化学污染物。然而，同样值得注意的是，科学家们可能必须在大片水域中使用非常大的波浪产生结构。

考虑到水波、光波和电子运动之间的相似之处，研究人员认为，水可以为研究某些量子现象提供一种更容易接近的方法。如果你认为这是非常未来的想法，那就等着瞧吧——根据这份声明，未来的研究甚至可以研究利用水的模式来存储数据的可能性。

然而，目前，研究小组的目标是调查波浪是否能在水面下产生类似的图案。

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