Pasta-shaped radio waves beamed across Venice

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A group of Italian and Swedish researchers appears to have solved the problem of radio congestion by cleverly twisting radio waves into the shape of fusilli pasta, allowing a potentially infinite number of channels to be broadcast and received.

Furthermore, the researchers have demonstrated this in real-life conditions by beaming two twisted radio waves across the waters of Venice.

Their results have been reported today, Friday 2 March, in the Institute of Physics and German Physical Society's New Journal of Physics and are accompanied by a video abstract that gives an excellent insight into the authors' work.

As the world continues to adapt in the digital age, the introduction of new mobile smartphones, wireless internet and digital TVs means the number of radio frequency bands available to broadcast information gets smaller and smaller.

"You just have to try sending a text message at midnight on New Year's Eve to realise how congested the bands are," said lead author Dr Fabrizio Tamburini. The researchers, from the University of Padova, Italy, and the Angstrom Laboratory, Sweden, devised a solution to this by manipulating waves so that they can hold more than one channel of information.

A wave can twist about its axis a certain number of times in either a clockwise or anti-clockwise direction, meaning there are several configurations that it can adopt.

"In a three-dimensional perspective, this phase twist looks like a fusillli-pasta-shaped beam. Each of these twisted beams can be independently generated, propagated and detected even in the very same frequency band, behaving as independent communication channels," Tamburini continued.

To demonstrate this, the researchers transmitted two twisted radio waves, in the 2.4 GHz band, over a distance of 442 metres from a lighthouse on San Georgio Island to a satellite dish on a balcony of Palazzo Ducale on the mainland of Venice, where it was able to pick up the two separate channels.

"Within reasonable economic boundaries, one can think about using five orbital angular momentum states, from -5 (counter-clockwise) up to 5 (clockwise), including untwisted waves. In this instance, we can have 11 channels in one frequency band.

"It is possible to use multiplexing, like in digital TV, on each of these to implement even more channels on the same states, which means one could obtain 55 channels in the same frequency band," said Tamburini.

In addition to increasing the quantity of information being passed around our planet, this new discovery could also help lend an insight into objects far out in our galaxy. Black holes, for example, are constantly rotating and as waves pass them, they are forced to twist in line with the black hole.

According to Tamburini, analysing the incoming waves from the supermassive black hole at the centre of the Milky Way, Sagittarius A,

could help astronomers obtain crucial information about the rotation of this "million-solar mass monster."

More information: "Encoding many channels on the same frequency through radio vorticity: first experimental test" Tamburini F et al 2012 *New J. Phys.* 14 033001 - iopscience.iop.org/1367-2630/14/3/033001/article

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