# Scientists find the only answer to laser chaos is quantum chaos

*by Colm Gorey*



*Image: VladGavriloff/Shutterstock*

**In an effort to make ultra-powerful, stable lasers, an international research team has brought ‘quantum chaos’ into the mix.**

Away from science fiction, lasers are a fundamental part of semiconductor technology, commonly used in materials processing, biomedical imaging and industrial research.

However, one of the biggest problems is that the emitted light they produce is affected by instabilities, making them ‘incoherent’.

These instabilities are caused by chaotic light structures that move randomly and change with time, called optical filaments.

Attempting to remove these instabilities has been the focus of many a physicist, but so far our best efforts mean we can either choose between a powerful semiconductor laser with poor output quality or a coherent, but much weaker, laser.

Now, however, an international team from Imperial College London (ICL), Yale University, Nanyang Technological University and Cardiff University has found a truly fantastic-sounding solution.

## Laser tornadoes

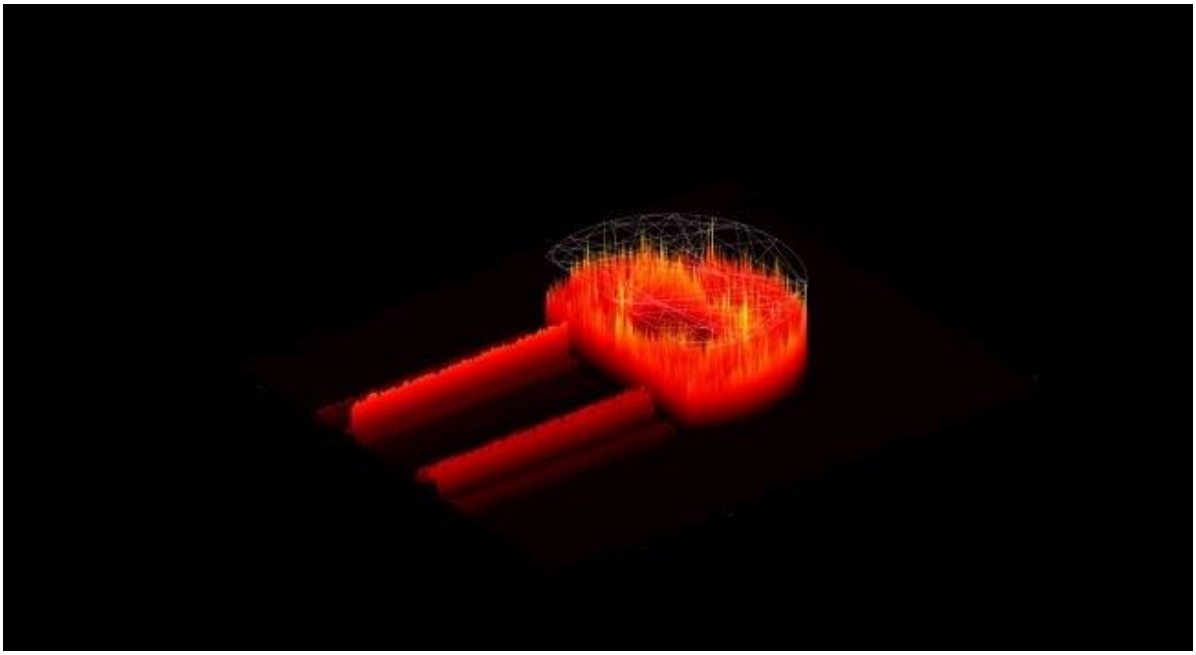
Publishing its findings in *Science*, the team described how it is able to prevent laser filaments using a technique called ‘quantum chaos’.

By overcoming laser chaos, scientists can create ultra-bright 3D laser cinemas, or have them as elements in extremely bright laser systems used in nuclear fusion reactors.

Rather than being the name of a new super-villain, quantum chaos can be compared somewhat to the erratic and destructive behaviour of tornadoes.

“Tornadoes are more likely to form and move about over flat country,” said Prof Ortwin Hess of ICL.

“For example, in America they form frequently in beautiful Oklahoma but not as often in hilly West Virginia. The hills appear to be a key difference; they prevent tornadoes from being able to form or move around.”



**The D-shaped cavity producing quantum chaos resulting in a more stable laser. Image: Bittner et al**

## Creating quantum chaos

With this in mind, by creating a ‘hilly’ optical landscape inside lasers using quantum chaos, the researchers can prevent the filaments from forming or getting out of control.

To achieve quantum chaos, the researchers had to alter how a typical laser amplifies, whereby it is bounced around a cuboid cavity.

The quantum chaos design meanwhile uses a D-shaped cavity, creating these optical ‘hills’ to dispel the optical ‘tornadoes’.

After the successful testing of the Singaporean-built laser system in the US, the team is now working to further explore and tailor the light emission, such as improving the directionality of the laser.

In the meantime, the team’s current work should allow semiconductor lasers to work at higher power with high emission quality, and the same idea could be applied to other types of lasers.