

Laser technique measures vast distances with nanometre precision

A new technique involving lasers can measure long distances more precisely than ever, which could be useful for space telescopes

By [Alex Wilkins](#) on January 13, 2025



Laser beams in a physics laboratory. Callum Fraser / Alamy Stock Photo

A new way to gauge distance using lasers can measure lengths of more than 100 kilometres to within a thousandth of the width of a human hair, and could be used to make better space telescopes.

In lab-settings, scientists can use lasers to measure distances with extreme precision, to within a few nanometres. But for longer distances of a kilometre or more, the precision of these techniques tends to be much lower, to within around a millimetre.

[Jian-Wei Pan](#) at the University of Science and Technology of China and his colleagues have developed a new technique that was able to measure a distance of 113 kilometres between two laboratories in Xinjiang with nanometre precision.

The technique involves a kind of laser called an [optical frequency comb](#), which contains many frequencies of light, regularly spaced across the spectrum. They act like a kind of ruler that you can compare other light beams against.

Pan and his team fired a pair of these lasers from one lab to the other, then used a third laser to interfere with the combs. When light waves interfere with each other, they create a pattern of brighter and darker sections. Measuring these patterns can reveal how much the frequencies in the comb's light have changed from when it was first produced, which can be used to calculate the distance the lasers have travelled.

The precision of the measurement depends on how long the interference pattern is measured for. In around a millisecond, the researchers could achieve a precision of around a hundredth of a millimetre. Over 20 seconds, they reached a precision of 82 nanometres, or millionths of a millimetre.

Pan and his team argue that this precision could improve space telescopes that are made up of different satellites working together, because they rely on accurate measurements of the distances between them.

"Looking at the precision that they get, it is impressive," says [Derryck Reid](#) at Heriot-Watt University in Edinburgh, UK. "It's very comparable to some of the best precisions over much shorter ranges."

However, having a very precise measurement tool doesn't necessarily mean it is accurate, says Reid. "Accuracy tells you how well you know the true distance between two objects. Precision just tells you about how repeatably you can measure that. So you could have terrible accuracy, but really high precision."

This could be problematic for uses like flying satellite telescopes in formation, though it is conceivable that they could work using just precision and their relative positions, says Reid.

Reference:

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