

Record-breaking laser link could provide test of Einstein's theory

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UWA's rooftop observatory. Credit: ICRAR

Scientists from the International Centre for Radio Astronomy Research (ICRAR) and the University of Western Australia (UWA) have set a world record for the most stable transmission of a laser signal through

the atmosphere.

In a study published today in the journal *Nature Communications*, Australian researchers teamed up with researchers from the French National Centre for Space Studies (CNES) and the French metrology lab Systèmes de Référence Temps-Espace (SYRTE) at Paris Observatory.

The team set the [world record](#) for the most stable [laser](#) transmission by combining the Aussies' phase stabilization technology with advanced self-guiding optical terminals. Together, these technologies allowed laser signals to be sent from one point to another without interference from the [atmosphere](#).

Lead author Benjamin Dix-Matthews, a Ph.D. student at ICRAR and UWA, said the technique effectively eliminates atmospheric turbulence. "We can correct for atmospheric turbulence in 3-D, that is, left-right, up-down and, critically, along the line of flight," he said. "It's as if the moving atmosphere has been removed and doesn't exist. It allows us to send highly stable laser signals through the atmosphere while retaining the quality of the original signal."

The result is the world's most precise method for comparing the flow of time between two separate locations using a laser system transmitted through the atmosphere.



One of the self-guiding optical terminals on its telescope mount on the roof of a building at the CNES campus in Toulouse. Credit: ICRAR/UWA

ICRAR-UWA senior researcher Dr. Sascha Schediwy said the research has exciting applications. "If you have one of these optical terminals on the ground and another on a satellite in space, then you can start to explore fundamental physics," he said. "Everything from testing Einstein's theory of general relativity more precisely than ever before, to discovering if fundamental physical constants change over time."

The technology's precise measurements also have practical uses in earth science and geophysics. "For instance, this technology could improve satellite-based studies of how the water table changes over time, or to look for ore deposits underground," Dr. Schediwy said.

There are further potential benefits for optical communications, an emerging field that uses light to carry information. Optical communications can securely transmit data between satellites and Earth with much higher data rates than current radio communications.

"Our technology could help us increase the data rate from satellites to ground by orders of magnitude," Dr. Schediwy said. "The next generation of big data-gathering satellites would be able to get critical information to the ground faster."

The phase stabilization technology behind the record-breaking link was originally developed to synchronize incoming signals for the Square Kilometer Array telescope. The multi-billion-dollar telescope is set to be built in Western Australia and South Africa from 2021.

More information: Benjamin P. Dix-Matthews et al. Point-to-point stabilized optical frequency transfer with active optics, *Nature Communications* (2021). [DOI: 10.1038/s41467-020-20591-5](https://doi.org/10.1038/s41467-020-20591-5)

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