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SWINBURNE UNIVERSITY OF TECHNOLOGY

Media Release

Measuring the Universe with a fine tooth comb

Using a Nobel Prize winning laser technique, an international team of researchers has vastly improved the precision of astronomy - it will even allow them to measure a star moving as slowly as a tortoise.

In an article published today in *Science,* the researchers demonstrated how a 'laser frequency comb' could be used to calibrate an astronomical telescope. This will enable astronomers to measure the spectral features of distant stars and galaxies with extreme precision.

"It looks as if we are on the way to fulfil the astronomer's dream of having a very precise calibration source for their spectrograph," said Theodor Hänsch, Nobel Prize winner for co-inventing the technique and one of the scientists who carried out the demonstration.

The laser frequency comb is considered an ideal reference point for scientists. It is a source of light emitted at a series of wavelengths, which are regularly spaced and known to extremely high accuracy because the whole laser system is controlled by an atomic clock. The technique has already revolutionised the way scientists take measurements in laboratories, however this is the first time it is has been used with an astronomical telescope - in this case to observe our own Sun.

Swinburne University's Dr Michael Murphy, also on the team, likens the frequency comb's teeth to the markers on a metre-long ruler.

"Previously, astronomers would have had a marker about every ten centimetres. And we didn't even know the exact position of those markers, so our measurements were a bit uncertain.

"When you use a frequency comb, it's like having instead a very fine density of markings - every millimetre in fact. We also know the exact location of those markers, just as accurately as we know the ticking rate of an atomic clock," he said. "So this really is a new standard of precision in astronomy."

Murphy expects the new technique will have a huge impact on astronomical research. It will enable astronomers to undertake new experiments, including the search for new planets similar to our Earth.

"In order to find Earth-sized planets orbiting around Sun-like stars, you need to track a star's motion to within a few centimetres per second over many years," he said. "The frequency comb technique promises to provide this level of accuracy."

Another application for the technique will be to look for variations in the fundamental constants of nature throughout the Universe.

"Frequency combs will allow astronomers to search for variations in the laws of nature on the other side of the Universe, as they will be able to detect very minute changes in the spectral features of distant galaxies," said Murphy.

However, perhaps the greatest benefits of this new technique are still unknown. According to Murphy, it could open the door to completely new experiments. "This could spark the beginning of whole new fields of astronomy, as the boundary of precision we have been facing for many years has finally been overcome."

Note: Observations were made at the Vacuum Tower Telescope operated by the Kiepenheuer Institute for Solar Physics in Germany. The team is composed of Constanza Araujo-Hauck, Antonio Manescau, Luca Pasquini, Hans Dekker and Sandro d'Odorico (European Southern Observatory, Germany), Thomas Udem, Tobias Wilken and Theodor Hänsch (Max-Planck Institute for Quantum Optics, Germany), Ronald Holzwarth and Tilo Steinmetz (Menlo Systems GmbH), and Michael Murphy (Swinburne University of Technology, Australia).

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Media Contact: Crystal Ladiges (03) 9214 5064 or 0416 174 880