Gravitational waves innovation could help unlock cosmic secrets

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New frontiers in the study of the universe—and gravitational waves—have been opened up following a breakthrough by University of the West of Scotland (UWS) researchers.

The groundbreaking development in thin film technology promises to enhance the sensitivity of current and future gravitational wave detectors. Developed by academics at UWS's Institute of Thin Films, Sensors and Imaging (ITFSI), the innovation could enhance the

understanding of the nature of the universe. The research is published in the journal *Applied Optics*.

Gravitational waves, first predicted by Albert Einstein's theory of general relativity, are ripples in the fabric of spacetime caused by the most energetic events in the cosmos, such as black hole mergers and neutron star collisions. Detecting and studying these waves provides invaluable insights into the fundamental nature of the universe.

Dr. Carlos Garcia Nuñez, lecturer at UWS's School of Computing, Engineering and Physical Sciences said, "At the Institute of Thin Films, Sensors and Imaging, we are working hard to push the limits of thin film materials, exploring new techniques to deposit them, controlling their properties in order to match the requirements of current and future sensing technology for the detection of gravitational waves."

"The development of high reflecting mirrors with low thermal noise opens a wide range of applications, which covers from the detection of gravitational waves from cosmological events, to the development of quantum computers."

The technique used in this work—originally developed and patented by Professor Des Gibson, Director of UWS's Institute of Thin Films, Sensors and Imaging—could enable the production of thin films that achieve low levels of "thermal noise." The reduction of this kind of noise in mirror coatings is essential to increase the sensitivity of current gravitational wave detectors—allowing the detection of a wider range of cosmological events—and could be deployed to enhance other high-precision devices, such as atomic clocks or quantum computers.

Professor Gibson said, "We are thrilled to unveil this cutting-edge thin film technology for gravitational wave detection. This breakthrough represents a significant step forward in our ability to explore the

universe and unlock its secrets through the study of gravitational waves. We believe this advancement will accelerate scientific progress in this field and open up new avenues for discovery."

"UWS's thin film technology has already undergone extensive testing and validation in collaboration with renowned scientists and research institutions. The results have been met with great enthusiasm, fueling anticipation for its future impact on the field of gravitational wave astronomy. The coating deposition technology is being commercialized by UWS spinout company, Albasense Ltd."

The development of coatings with low thermal noise will not only make future generation of gravitational wave detectors more precise and sensitive to cosmic events, but will also provide new solutions to atomic clocks and quantum mechanics, both highly relevant for the United Nations' Sustainable Development Goals 7, 9 and 11.

More information: Carlos Garcia Nuñez et al, Amorphous dielectric optical coatings deposited by plasma ion-assisted electron beam evaporation for gravitational wave detectors, *Applied Optics* (2023). DOI: 10.1364/AO.477186

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