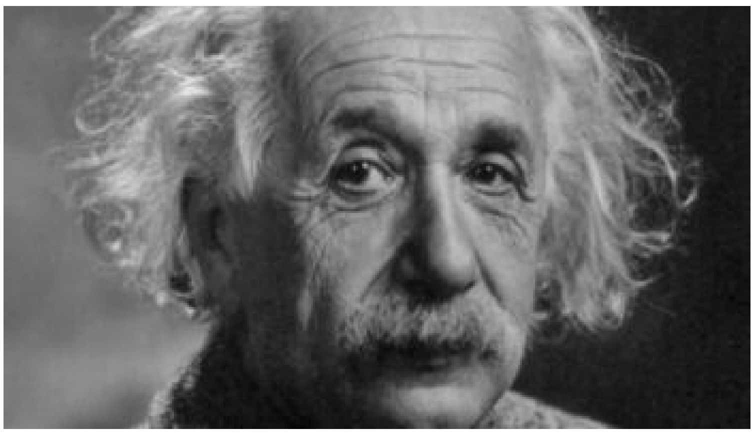
Researcher's work offers more proof of Einstein's general theory of relativity

November 17 2015



Albert Einstein

A Florida State University high-performance computing researcher has predicted a physical effect that would help physicists and astronomers provide fresh evidence of the correctness of Einstein's general theory of relativity.

Bin Chen, who works at the university's Research Computing Center, describes the yet-to-be-observed effect in the paper "Probing the Gravitational Faraday Rotation Using Quasar X-ray Microlensing," published today in the journal *Scientific Reports*.

"To be able to test general relativity is of crucial importance to physicists and astronomers," Chen said.

This testing is especially so in regions close to a black hole, according to Chen, because the current evidence for Einstein's general relativity—light bending by the sun, for example—mainly comes from regions where the gravitational field is very weak, or regions far away from a black hole.

Electromagnetism demonstrates that light is composed of oscillating electric and magnetic fields. Linearly polarized light is an electromagnetic wave whose electric and magnetic fields oscillate along fixed directions when the light travels through space.

The gravitational Faraday effect, first predicted in the 1950s, theorizes that when linearly polarized light travels close to a spinning black hole, the orientation of its polarization rotates according to Einstein's theory of general relativity. Currently, there is no practical way to detect gravitational Faraday rotation.

In the paper, Chen predicts a new effect that can be used to detect the gravitational Faraday effect. His proposed observation requires monitoring the X-ray emissions from gravitationally lensed quasars.

"This means that light from a cosmologically distant quasar will be deflected, or gravitationally lensed, by the intervening galaxy along the line of sight before arriving at an observer on the Earth," said Chen of the phenomenon of gravitational lensing, which was predicted by Einstein in 1936. More than 100 gravitational lenses have been discovered so far.

"Astronomers have recently found strong evidence showing that quasar X-ray emissions originate from regions very close to supermassive black holes, which are believed to reside at the center of many galaxies," Chen said. "Gravitational Faraday rotation should leave its fingerprints on such compact regions close to a black hole.

"Specifically, the observed X-ray polarization of a gravitationally microlensed quasar should vary rapidly with time if the gravitational Faraday effect indeed exists," he said. "Therefore, monitoring the X-ray polarization of a gravitationally lensed quasar over time could verify the time dependence and the existence of the gravitational Faraday effect."

If detected, Chen's effect—a derivative of the gravitational Faraday effect—would provide strong evidence of the correctness of Einstein's general relativity theory in the "strong-field regime," or an environment in close proximity to a black hole.

Chen generated a simulation for the paper on the FSU Research Computing Center's High-Performance Computing cluster—the second-largest computer cluster in Florida.

More information: Bin Chen. Probing the gravitational Faraday rotation using quasar X-ray microlensing, *Scientific Reports* (2015). DOI: 10.1038/srep16860

Provided by Florida State University