Scientists find evidence for light-by-light scattering, long standing prediction of the Standard Model

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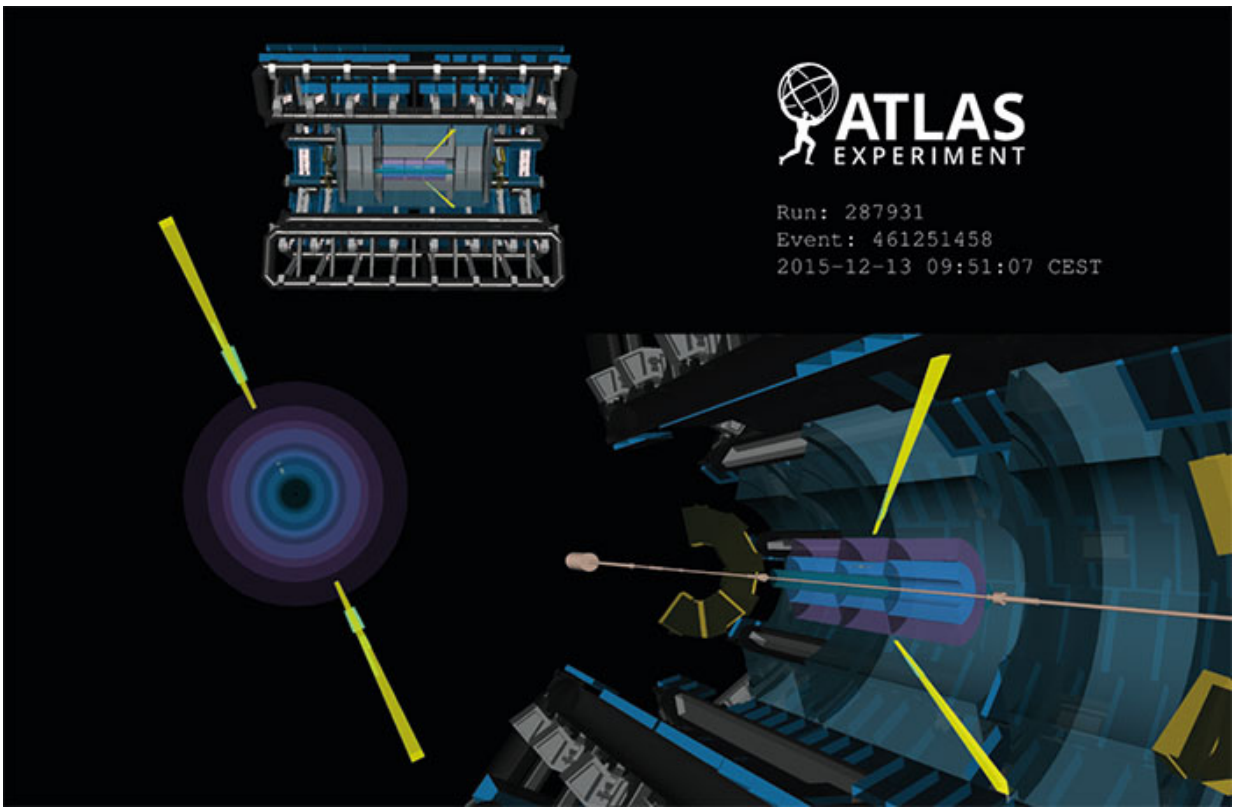

As the result of light-by-light scattering, two low-energy photons are observed in the ATLAS detector. Credit: CERN/ATLAS experiment

Scientists from the ATLAS collaboration at the LHC have found

evidence for light-by-light scattering, in which two photons interact and change their trajectory. Researchers from DESY, the Johannes Gutenberg University Mainz and the AGH University of Science and Technology in Krakow performed the study.

"According to classical electrodynamics, beams of light pass each other without being scattered. But if we take quantum physics into account, light can be scattered by light, even though this phenomenon seems very improbable", explains Mateusz Dyndal, a DESY scientist who played a major role in the data analysis. One of the oldest predictions of quantum electrodynamics says that photons, the carrier particles of the electromagnetic force, can interact and scatter off of each other. This process has been tested in different environments, but a direct observation of light-by-light scattering has not previously been achieved.

In 2012, physicists proposed that light-by-light scattering could be observed in collisions at the LHC. Protons that are accelerated to nearly the speed of light produce a very strong electromagnetic field. The generated field is even stronger when Lead ions are used rather than protons . When two such ions pass each other in a so-called ultra-peripheral collision, two photons can scatter off one another while the ions themselves stay intact. The scientists then observe two low-energy photons with specific kinematic properties and no additional activity in the detector. Based on the data taken in 2015 at the LHC, physicists at the ATLAS experiment conducted a search for light-by-light scattering and found 4.4σ evidence for the phenomenon. The σ-value describes the statistical significance of a scientific result. Physicists usually speak of a "discovery" if they find a 5σ result and call a 3σ result "evidence" for something new. Light-by-light scattering has a very small cross-section, which means that it happens very rarely. Thus in four billionanalysed events, only 13 candidates for such diphoton events were observed.

Because the scientists observed only a few events attributed to light-by-

light scattering, the statistical accuracy of their results is limited. When the next lead-lead run at the LHC starts (end of 2018), they hope to collect more data to test this phenomenon more precisely. Further studies could also provide an additional window into new physics at the LHC. "Maybe we can find evidence for physics beyond the standard model of particle physics, for example axion-like particles that are a possible candidate for dark matter. Different theoretical concepts predict that light-by-light scattering can be sensitive to such particles", says Dyndal.

More information: Evidence for light-by-light scattering in heavy-ion collisions with the ATLAS detector at the LHC. arxiv.org/pdf/1702.01625.pdf

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