В очередном номере электронного издания CERN Courier (Volume 61 Number 4 July/August 2021) опубликована заметка о поиске X-бозона в эксперименте NA64, руководителем которого является сотрудник ИЯИ РАН С.Н.Гниненко

'X' boson feels the squeeze at NA64

Recent measurements bolstering the longstanding tension between the experimental and theoretical values of the muon's anomalous magnetic moment generated a buzz in the community (*CERN Courier* May/June 2021 p5). Though with a much lower significance, a similar puzzle may also be emerging for the anomalous magnetic moment of the electron, a_e.

Depending on which of two recent independent measurements of the fine-structure constant is used in the theoretical calculation of a_e – one obtained at Berkeley in 2018 or the other at Kastler–Brossel Laboratory in Paris in 2020 – the Standard Model prediction stands 2.4σ higher or 1.6σ lower than the best experimental value, respectively. Motivated by this inconsistency, the NA64 collaboration at CERN set out to investigate whether new physics – in the form of a lightweight "X boson" – might be influencing the electron's behaviour.

Exploration *The NA64 set up is being used to search for new particles that might account for the electron g−2 and ATOMKI anomalies.*

The generic X boson could be a sub-GeV scalar, pseudoscalar, vector or axial-vector particle. Given experimental constraints on its decay modes involving Standard Model particles, it is presumed to decay predominantly invisibly, for example into dark-sector particles. NA64 searches for X bosons by directing 100 GeV electrons generated by the SPS onto a target, and looking for missing energy in the detector via electron–nuclei scattering $e^-Z \rightarrow e^-ZX$.

Analysing data collected in 2016, 2017 and 2018, corresponding to about 3×10^{11} electrons-on-target, the NA64 team found no evidence for such events. The result sets new bounds on the e–X interaction strength and, as a result, on the contributions of X bosons to a_e: X bosons with a mass below 1 GeV could contribute at most between one part in 10^{15} and one part in 10^{13}, depending on the X-boson type and mass. These contributions are too small to explain the current anomaly in the electron's anomalous magnetic moment, says NA64 spokesperson Sergei Gninenko. "But the fact that NA64 reached an experimental sensitivity that is better than the current accuracy of the direct measurements of a_e, and of recent high-precision measurements of the fine-structure constant, is amazing."

In a separate analysis, the NA64 team carried out a model-independent search for a particular pseudoscalar X boson with a mass of around 17 MeV. Coupling to electrons and decaying into e^+e^- pairs, the so-called "X17" has been proposed to explain an excess of e^+e^- pairs created during nuclear transitions of excited ^{8}Be and ^{4}He nuclei reported by the "ATOMKI" experiment in Hungary since 2015 (*CERN Courier* January/February 2020 p7).

The e–X17 coupling strength is constrained by data: too large and the X17 would contribute too much to a_e; too small and the X17 would decay too rarely and too far away from the ATOMKI target. In 2019, the NA64 team excluded a large range of couplings, although at large values, for a vector-like X17. More recently, they searched for a pseudoscalar X17, which has a lifetime about half that of the vector version for the same coupling strength. Re-analysing a sample of approximately 8.4×10^{10} electrons-on-target collected in 2017 and 2018 with 100 and 150 GeV electrons, respectively, the collaboration has now excluded couplings in the range $2.1–3.2 \times 10^{-4}$ for a 17 MeV X-boson.

"We plan to further improve the sensitivity to vector and pseudoscalar X17's after long shutdown 2, and also try to reconstruct the mass of X17, to be sure that if we see the signal it is the ATOMKI boson," says Gninenko.

Further reading

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