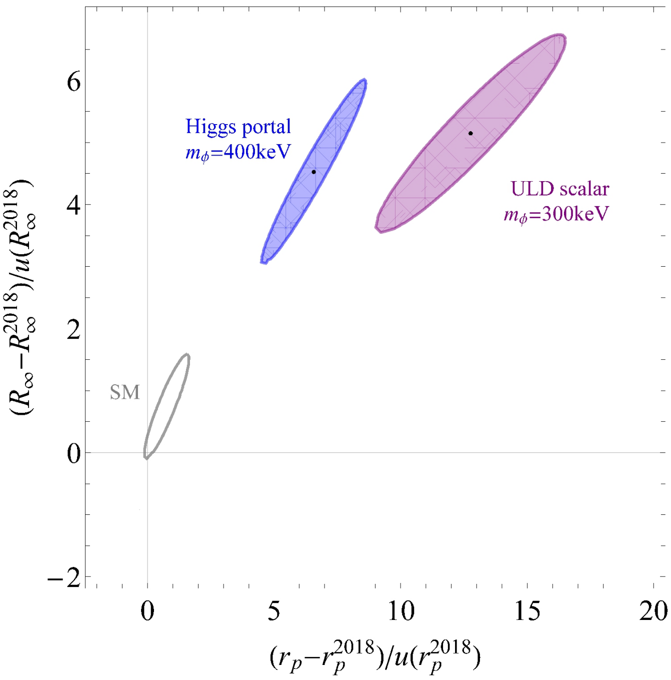


The values of fundamental constants of nature might be affected by new particles and unknown forces of nature, according to a study by an international group of researchers that includes Cédric Delaunay from LAPTh (Annecy) and Jean-Philippe Karr from LKB (Paris). The findings were published in the journal *Physical Review Letters* ( https://doi.org/10.1103/PhysRevLett.130.121801 ).

Scientists continuously strive to develop and refine theories that explain the world and the universe around us. One extremely successful theory has been the standard model of particle physics, which predicts how elementary particles behave, interact, and eventually form larger structures such as atomic nuclei, atoms, and molecules.

In many cases the predictions of the standard model are found to be in agreement with the results of very precise measurements on particles, atoms and molecules. However, the results of some recent experiments hint towards behavior that might be explained by some higher law of physics that has yet to be discovered. This has stimulated physicists to develop new theoretical models that could possibly describe the putative ‘new physics’.

Theoretical models – including the celebrated standard model – take the form of mathematical equations that reflect the laws of nature. Among the essential ingredients of these equations are the values of fundamental constants of nature, such as the mass of the electron and the speed of light. For example, if the mass of the electron were chosen slightly too large, the theoretical predictions would no longer agree with experimental results.

In fact, the values of fundamental constants are determined – or rather adjusted – such that theoretical predictions match experimental results as closely as possible. This adjustment of the values of fundamental constants is repeated every few years by CODATA, the Committee on Data for Science and Technology. It involves about one hundred results from different types of precision measurements, which are compared with theoretical predictions by the standard model for these measurements – everything under the assumption that the standard model by itself is valid.

The authors of the published work point out that this assumption is violated as soon as one contemplates hypothetical particles or forces that might exist beyond the standard model. So, one might argue whether it is correct to use these fundamental constants in combination with theoretical models that try to describe such new phenomena.

At the same time, recent CODATA adjustments revealed that – for unknown reasons – some experimental data are not fully consistent with the found fundamental constants. This problem was mitigated by increasing the uncertainty of these experimental data so that the inconsistency became insignificant.

But what if the inconsistency were due to new physical phenomena? The authors provide an answer to this question: they point out that instead of increasing uncertainties, one can also modify the theoretical predictions by adding the hypothetical effect of a new particle. The theory that describes this new particle is then characterized by its own fundamental constants, for example the mass of the new particle. And as the authors show, these new constants can be determined along with the known fundamental constants using the same adjustment procedure.

The authors have examined six possible new-physics models that postulate, for example, the existence of particles akin to the famed Higgs boson. Remarkably, in one of these models the introduction of a new particle made the inconsistencies disappear. The new particle also caused the values of some of the existing fundamental constants to change substantially from their present CODATA values.

Still, the authors stress that their results should not be construed as the discovery of a new particle. They point at measurement data from particle accelerator experiments that rule out some of the hypothetical models that they proposed. Nevertheless their work provides a novel, consistent way of incorporating fundamental constants in models that attempt to explain possible new physics, along with the insight that the hundred precision measurements that are now used to determine fundamental constants can also be used to search for new physics. As such their work might ultimately help answer the question what unknown physics lies beyond the standard model.