More precise measurements of the W boson

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(PhysOrg.com) -- "The W boson is one of the very few major building blocks of matter," Dmitri Denisov tells *PhysOrg.com*. "It is a member of a family of particles that is the most fundamental in nature. The W boson is responsible for weak interactions, which govern some of the most important processes in nature."

Denisov is a scientist at Fermilab in Batavia, Illinois, and he is one of around 500 physicists from 19 countries that have been collaborating on the effort to increase the precision of measurement with regard to the width of the W boson. Their group is known as the D0 Collaboration. Some of the results of the D0 collaboration are available in Physical Review Letters: "Direct Measurement of the W Boson Width."

“Particle physicists are working hard to improve our knowledge of the fundamental particles of nature. We want precision measurements of all these particles, since their properties are important to understand world around us and for calculations used in developing and testing new theories,” Denisov explains. “The W boson is one of those that is worth looking at, because if its role in weak interactions. We wanted to measure the width, because that is directly related to its lifetime.”

Denisov points out that the W boson’s lifetime is connected to the way it decays. And the W boson also influences the way nuclei decay. “The W boson is especially known for its role in nuclear decay,” he says. “Modern theory predicts how different W boson decays, but there might be modes we don’t know, and the width of the W boson would be influenced by these modes. So with these more precise measurements of the W boson, we can start looking for things that we don’t know yet.”

In order to produce these new measurements of W boson width, which have the highest precision to date, the D0 Collaboration used the Tevatron at Fermilab. They gathered data from a specific form of decay, and measured the spectrum of energy from the electrons that resulted. “The spectrum of energy in electrons is wider if it lifetime is shorter,” Denisov says. The scientists produced and then recorded a sample consisting of around half a million W bosons.

“The whole analysis process took about three years,” Denisov explains. “We had to collect data from the Tevatron, and then analyze it. Scientists worked on developing Monte Carlo simulations to describe the detector performance. As a result, we have been able to come up with a very precise measure of W boson width and lifetime that can be used to develop physics theories and for precision description of world around us.”

Going forward, Denisov expects that the D0 Collaboration will continue to work to improve the precision of their measurements. “We have a good data set, and we are collecting more and more data quite literally as we speak. At this point, our measurement does not show any new particles affecting W boson lifetime. However, as we continue to improve the accuracy of our measurements, it’s possible that we could see a deviation. In about a year, we are hoping that we will be able to reduce current uncertainty substantially.”

“This work,” Denisov continues, “is very important for fundamental physics. Quite a few people put years of their lives into this measurement, to gain a better understanding of the forces which governs our world.”

More information: D0 Collaboration, “Direct Measurement of the W Boson Width,” Physical Review Letters (2009). Available online: arxiv.org/abs/0909.4814