Faculty Research Profiles

K. Hatakeyama

Assistant Professor

Research Interests:

Experimental Elementary Particle Physics

The goal of elementary particle physics is to understand the nature of subatomic particles and their interactions at the most fundamental level. Presently, we have a theoretical model called the "Standard Model" which provides a very successful description of most of the experimental observations on elementary particles. Predicted quarks, leptons, and four force-carrier bosons have all been experimentally observed and the measured properties of those particles and four fundamental forces are consistent with what is expected from the Standard Model.

In spite of the success of the Standard Model, there are numerous important questions that are left unanswered in particle physics. For example, the mechanism of how elementary particles acquire masses is still not well understood. In addition, questions such as why we live in a matter-dominated world and what is the source of dark matter and dark energy are unanswered.

Dr. Hatakeyama has been working on two high energy particle physics experiments, the CDF experiment at Fermilab, IL and the CMS experiment at the Large Hadron Collider (LHC), CERN, Switzerland to find clues to some of these unanswered questions and to find "new physics" beyond the Standard Model. At the CDF experiment which has been collecting data for more than 20 years, while Dr. Dittmann has been searching for the Higgs boson which will explain the source of particle masses, Dr. Hatakeyama has searched for the sign of quark substructure, i.e., even smaller fundamental particles, and new massive particles which are expected from various theoretical models in proton-antiproton collisions including high energy "jets". Jets are clusters of particles originating from energetic quarks and Dr. Hatakeyama is an expert of this signature. Although these searches did not find a signal, they provided crucial information for better understanding Quantum Chromodynamics, the strong interaction sector of the Standard Model, and the structure of the proton.

Dr. Hatakeyama is now focused on a newer experiment, CMS, at the LHC. After many years of preparation, the LHC finally started to deliver proton-proton collisions at $\sqrt{s}$ = 7 TeV since March 2010, which is 3.5 times higher than the highest possible energy at the Fermilab Tevatron proton-antiproton collider. He has been searching for a signature of "Supersymmetry" in proton-proton collision events with multiple jets and "missing" energy. Supersymmetry is currently one of the most favored physics model beyond the Standard Model. The missing energy in a proton-proton collision is the sign of a very weakly interacting particle, and is the dark matter candidate. Supersymmetry not only offers the candidate of dark matter but also solves several unnatural issues present in the Standard Model. Dr. Hatakeyama was in charge of the data quality monitoring system for jets and missing energy in the CMS data, and since 2011 he lead the missing ET working group of CMS. These activities are critical not only for this Supersymmetry search, but also for all CMS data analyses using jets and/or missing energy. The initial Supersummetry searches using the 2010 data and 2011 data up to summer have not show a significant indication of the Supersymmetric particle production; however, these searches have already shown much higher sensitivities than the data analysis by the previous experiments. The CMS searches have just started, and there is a good discovery potential in the upcoming years.

He has also made a measurement on the internal structure of jets. This knowledge is critical in, for example, some of the Higgs searches at the LHC. He believes that the data from the LHC are going to give us very interesting physics results in coming years.

Recent Publications:

Search for new physics at CMS with jets and missing momentum. CMS Collaboration, *JHEP* **1108**, 155 (2011); arXiv:1106.4503.

Missing transverse energy performance of the CMS detector. CMS Collaboration, *JINST* **6**:P09001,2011; arXiv:1106.5048.

CMS Collaboration, "Searches for Dijet Resonances in 7 TeV pp Collisions at CMS," *Phys. Rev. Lett.* **105**, 211801 (2010).

T. Aaltonen, et al., CDF Collaboration, "Search for new particles decaying into dijets in proton-antiproton collisions at $\sqrt{s}$ = 1.96 TeV," *Phys. Rev. D* **79**, 112002 (2009).

T. Aaltonen, et al., CDF Collaboration, "Measurement of the inclusive jet cross section at the Fermilab Tevatron ppbar collider using a cone-based jet algorithm," *Phys. Rev. D* **78**, 052006 (2008).