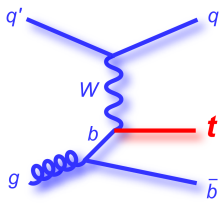
Particle Physics at SFU



Experimental Particle Physics (web site: http://hep.phys.sfu.ca)

The experimental particle physics group has played a leading role in both DZero and ATLAS. Dugan O'Neil is the founding spokesman of the Canadian DZero collaboration, while Mike Vetterli is the computing coordinator for ATLAS-Canada. Prof. Vetterli is also a founding principal investigator of WestGrid, a network of high-perfomance computing facilities in Western Canada and the project leader for the ATLAS Tier-1 data analysis center at TRIUMF, Canada's national laboratory for particle and nuclear physics. He was also recently elected as chair of the Worldwide LHC Computing Grid Collaboration Board. Bernd Stelzer, who is a new faculty member, plays a central role in top-quark and Higgs physics at CDF.

ATLAS at CERN

The ATLAS experiment at CERN in Geneva will study proton-proton collisions at the highest energy ever achieved in the laboratory. ATLAS is a general purpose experiment that will search for a wide variety of phenomena. The main goal is to discover the Higgs particle, which is central to electroweak symmetry breaking and hence to the mechanism by which subatomic particles attain mass. ATLAS will also search for physics "Beyond the Standard Model", such as Supersymmetry, extra dimensions, and quark substructure.

The SFU group's physics interests are currently in single top-quark production (in particular t-quark polarisation and top pair resonance searches), tau production, where we are applying advanced analysis techniques to improve the efficiency of tau detection, Supersymmetry, and quark substructure. The group is heavily involved in the computing for ATLAS. SFU led the proposal for the Tier-1 data analysis centre at TRIUMF, and the university hosts a Tier-2 centre where physicists will access the data. We are also participating in the liquid Argon calorimeter group, both on calibration and commissioning. Examples of our work can be found in:

- *"In-Situ Jet Calibration with γ + jet Events"*; D. Schouten & M. Vetterli;
  http://hep.phys.sfu.ca/~dschoute/CSCJetCalibNote.pdf
- *"Jet Calibration in ATLAS"*; Master's thesis, Doug Schouten;
  http://hep.phys.sfu.ca/theses/DougSchouten_msc.pdf
- *"Commissioning of the ATLAS Liquid Argon Calorimeters"*; Master's thesis, Erfan Rezaie;
  http://hep.phys.sfu.ca/theses/ErfanRezaie_msc.pdf

DZero and CDF at Fermilab

The group's activities on DZero and CDF have focused on top-quark physics, in particular "single-top quark" production. The DZero group at SFU led the analysis which produced the first observation of top-quarks produced by the electroweak interaction, or "single-top production". Previously, top quarks had been seen only in pairs, as they are produced by the strong interaction. The three central contributors to this discovery were honoured for their work: Dugan O'Neil was awarded the BC Innovation Council's Young Innovator prize, Yann Coadou (Res. Assoc.) received the Tollestrup Award from Fermilab, and Dag Gilberg (Grad Student) was selected to give a plenary talk at the Fermilab Users' Meeting.

Until recently, Bernd Stelzer was the convener of the single-top quark group at CDF. He was chosen to present CDF's single-top results, which are now the most precise, at the prestigious Moriond conference. In addition, SFU is participating in searches for the Higgs boson. CDF has set the most stringent limits

on low-mass Higgs production at the Tevatron.
Samples of SFU contributions to DZero and CDF can be found in:
- *"Evidence for production of single top quarks and first direct measurement of* $|V_{tb}|$*"*; Phys. Rev. Lett. 98, 181902 (2007)
- *"A Study of Jet Response in the D0 Calorimeters"*; SFU Master's thesis, Dag Gilberg; http://hep.phys.sfu.ca/theses/DagsMasters.pdf
- *"The CDF-II Production Farm"*; Instrum. Methods A, vol.572, pp. 399-401

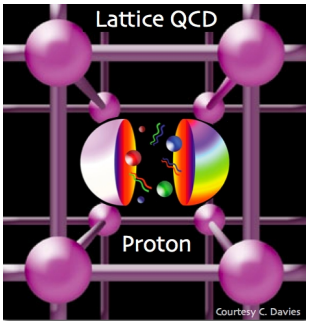
HEP Theory at SFU (web site: http://www.sfu.ca/~trottier)

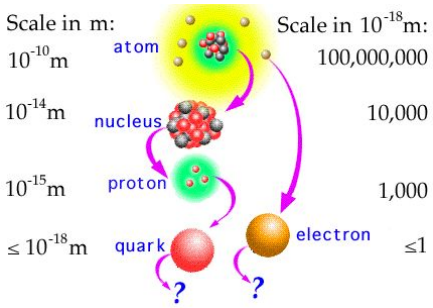
For the past several years Howard Trottier's theoretical work at SFU has been integral to the "High Precision QCD" Collaboration, a group of senior physicists, postdoctoral fellows, and graduate students, at a number of institutions in the US, the UK, and Canada, including: Cambridge, Cornell, Fermilab, Glasgow, Ohio State, SFU, and TRIUMF.

Trottier's current research work is centered on heavy-flavour physics, such as the leptonic and semileptonic decays of D and B mesons. The broad goal of this program, as part of the HPQCD Collaboration, is to provide calculations of hadronic matrix elements which are needed to extract fundamental parameters of the Standard Model from experiment. The results for B-meson decays may also have profound implications in the search for physics beyond the Standard Model, such as CP-violation and Supersymmetry. The HPQCD collaboration is focused on achieving an unprecedented level of theoretical precision for such quantities using the so-called lattice formulation of Quantum Chromodynamics. This work features strong connections to recent and future experiments at CLEOc, SLAC, and CERN.

Trottier's work relies on both analytical and numerical techniques in quantum field theories, and is suitable to both M.Sc. and Ph.D. students. Some examples of recent student theses under Trottier's supervision include:
- *Automated lattice perturbation theory for improved quark and gluon actions,* M. Nobes, Ph.D. 2004.
- *QCD topology and lattice perturbation theory from Monte Carlo simulations,* K. Wong, Ph.D. 2005.
- *A novel infrared regulator for matching lattice to continuum QCD,* S. Kautsky, M.Sc. 2006.
- *Perturbative improvement of lattice gauge action with staggered quarks,* Z. Hao, M.Sc. 2006.

Current and Possible Thesis Topics





Experiment:
- top-quark polarisation at the LHC
- Using Decision Trees to improve tau efficiency
- Effects of pile-up on ATLAS calorimetry
- Searching for Supersymmetry in inclusive channels
- Two-jet production at the LHC

Theory:
- Infrared matching calculations for high-precision lattice QCD phenomenology
- Radiative transitions of charmed mesons
- Precise determination of the bottom-quark mass