Statement of Research Interests

Mary Raafat Mikhail Bishai

Abstract

My general research interests are in heavy flavor and beyond the standard model physics at hadron colliders. In particular, I am interested in understanding and measuring the production properties of heavy flavor in hadron colliders. These measurements are precision tests of the predictions of Quantum Chromodynamics (QCD) and are sensitive to the presence of new physics beyond the standard model. For the past five years, I have had the unique opportunity to participate in Fermilab's exceptionally diverse hadron collider physics program as a member of the CDF collaboration. I have played a leading role in many aspects of Run II at the CDF detector, including the construction and commissioning of key components of the silicon vertex detector, its data acquisition system, and the completion of several key measurements of the B-physics analysis program. In addition to my experience at hadron colliders, my graduate work at the CLEO collaboration has afforded me a unique perspective on e^+e^- collider physics in the charm sector, where my thesis work was on parity violation in charm baryon decays - a powerful probe of the decay dynamics of heavy baryons. In addition, my thesis work with Microstrip Gas Chambers (MSGCs) at Purdue University has provided me with a unique experience working on general detector R&D with wide applicability to, not only high energy physics experiments, but also in the medical and industrial imaging fields.

1 Previous and Current Research

For the past five years, I have had the unique opportunity to participate in Fermilabs exceptionally diverse hadron collider physics program as a member of the CDF collaboration. During the first two years of data taking in CDF Run II (2002-2003), I lead a team of postdocs and graduate students to the completion of two key measurements in the B physics program at CDF: the **first measurement of the inclusive J/ψ and b-hadron cross-section at low transverse momenta** covering the range from 0 GeV/c to 20 GeV/c. This is the **first measurement of the total production cross-sections of J/ψ [1] and b-hadrons [2] in the central rapidity region produced in $p\bar{p}$ collisions**. Previous measurements of these cross-sections carried out during Run I of the Fermilab Tevatron collider (1992-1995) only probed 10% and 23% of the total inclusive J/ψ and b-hadron cross-sections respectively. These measurements are a crucial step towards understanding the production mechanisms of beauty and charm quarks in $p\bar{p}$ collisions. In addition to playing the leading role in the aforementioned measurements, I have also actively participated in the analysis efforts of two graduate students measuring the lifetime of the Λ_b beauty baryon using both the semileptonic decay mode $\Lambda_b \to \Lambda_c \ell \nu$ and hadronic decay mode $\Lambda_b \to J/\psi \Lambda$. The lifetime differences between bottom baryons and mesons test theoretical perturbative expansions in Heavy Quark Effective Theory (HQET) at the third order. **The measurement of the Λ_b lifetime in the mode $\Lambda_b \to J/\psi \Lambda$ is the first such measurement using a fully reconstructed final state [3].**

I have played a leading role in other activities of the B-physics analysis group at CDF, which is the largest of the five physics analysis groups: B, Top, Electroweak, Exotics and QCD. I was a **co-convener of**

the J/ψ B-Physics analysis sub-group from Fall '01 to Fall '02, and I am **currently co-convener of the B-Physics data validation group**. I am responsible for co-ordinating and supervising the validation of the processed data used for all charm and bottom analyses carried out by the B-Physics group. I am also serving on the CDF standing review committee, charged with monitoring the CDF RUN II Luminosity measurement. I have been an internal reviewer of the new CDF Run I exclusive B lifetime analysis which has already been published.

My experience with high energy physics analyses includes research at e^+e^- colliders operating at the $\Upsilon(4S)$, as well as hadron colliders. A large portion of my Ph.D dissertation was on physics analysis carried out at the CLEO detector at the Cornell Electron Storage Ring (CESR), an electron-positron collider operating at the $\Upsilon(4S)$ resonance. At CLEO, I chose to study the decay dynamics of charm baryons. I successfully reported on **evidence for the semileptonic decay of the doubly strange charm baryon, Ω_c^0, the first observation of the decay of this particle outside fixed target charm experiments**. To test the predictions of Heavy Quark Effective Theory (HQET) in heavy to light quark transitions, I studied and reported on the **first evidence for parity violation in the hadronic decay of the charm strange baryon Ξ_c^0**.

Besides my broad physics analysis expertise at $p\bar{p}$ and e^+e^- colliders, I also have a rich and extensive technical experience in HEP detector hardware and data acquisition systems. I have spent the first three years of my current tenure as a research associate at Fermilab commissioning the Silicon Vertex Detector (SVXII) of CDF Run II. In particular, I played a **leading role in commissioning the interface between the data acquisition system (DAQ) and the front-end silicon detector components**. I supervised the final stage of debugging and testing of the Compact Port Card (CPC) boards, **the principal component of the CDF Silicon vertex detector digital optical data acquisition system**. I co-lead the effort to assemble, test, install, and operate a working prototype of the CDF II Silicon system which was an integral part in the Fall '00 6 week engineering run of the Tevatron accelerator and the CDF Run II detector. I was a **key participant in the final installation of the silicon detector in the CDF Run II collision hall in May/June 2001** and in supervising its initial operation, leading other collaborators in the effort.

As a Purdue graduate student, my work with Microstrip Gas Chambers (MSGCs) has provided me with a **unique experience working on general detector R&D with wide applicability to not only High Energy Physics experiments, but also in the medical and industrial imaging fields.** When I first joined the Purdue Microstrip Gas Chamber (MSGC) research group in summer 1992, we were a small group just starting out in the field, comprised of my adviser and two graduate students including myself. Over the next two years I was an instrumental contributor in helping the group mature into a leading U.S. MSGC research group, particularly in the development of MSGCs printed on plastic substrates.

2 Previous Teaching Experience

In addition to my rich research experience, I have had the oppurtunity to gain experience teaching at both the undergraduate and graduate levels. As a teaching assistant at Purdue University during my graduate studies, I taught several physics undergraduate labs and recitations for freshman level pre-med. students and sophomore level engineering students. I also graded graduate level quantum mechanics and was praised by both students and professor for my diligence and insightful comments. **At CDF, two of the graduate students in whose analyses I played a key role have now successfully completed their Ph.D. dissertations [3], [4].**

3 Future Directions

In summary, I am interested in taking a **leading role in research in heavy flavor and beyond the standard model physics at hadron colliders, particularly LHC**, as an extension of my current work at the Fermilab Tevatron. During my tenure at CDF, I have been actively involved in a supervisory role in the research efforts of several graduate students, postdoctoral fellows and technical personnel from different institutions and I hope to expand that role by **leading my own HEP research team**. In addition to my research interest in physics analyses, I have worked extensively in hardware development for high energy physics and my goal is to continue pursing a leading role in High Energy Physics collider detector design, development and construction. I am particularly interested in **pursuing detector technologies that have multidisciplinary applications**.

In the longer term, I hope to pursue my lifetime interest in particle astrophysics by becoming involved in high energy astrophysics experiments and **exploring the intersections between particle physics and astrophysics**.

The capability to effectively communicate the excitement and complexity of current physics knowledge is an integral part of an academic career. I am looking for an opportunity to develop my own teaching curricula at both the undergraduate and graduate levels at an institute committed to both academic and research excellence as well as direct the research efforts of my own graduate students.

References

[1] The results of this measurement were first presented publicly at the 2003 American Physical Society meeting (APS) and can be found at the following web page: http://www-cdf.fnal.gov/physics/new/bottom/030327.blessed-jpsixsec/xsec_html/index.html

[2] The measurement of the b-hadron inclusive cross-section was presented publicly at the International Workshop on Heavy Quarkonium September 20-22, 2003 at FermiLab.

[3] R. Madrak, "Measurement of the Λ_b Lifetime in the Decay Mode $\Lambda_b \to J/\psi\Lambda$", a thesis presented to The Department of Physics, Harvard University in partial fullfillment of the requirements for the degree of Doctor of Philosophy, September 2003.

[4] S. Waschke, "Measurement of the $B \to J/\psi X$ Inclusive Cross-section at the Collider Detector at Fermilab", University of Glasgow, Department of Physics and Astronomy, A thesis submitted to the Physical Sciences Graduate School for the degree of Doctor of Philosophy, September 2003.