Symmetry in High Energy Physics

Thesis submitted for the degree of Doctor of Philosophy in physics to

Physics Department
University College of Women's for Arts, Science and Education,
Ain Shams University

By Hayam Yassin Sayed Hassanien
M.SC. (2006)

Under Supervision of:

1- **Prof. Hala Mahmoud Khalil**, Assistant Professor of theoretical physics, Physics department, University College of Women's for Arts, Science and Education, Ain Shams university.

2- **Dr. Tarek Mohamed Abdel Hamid Awwad** , Lecturer of theoretical physics, Physics department, University College of Women's for Arts, Science and Education, Ain Shams university.

3- **Dr. Gaber Younes Mohamed Faisel**, Lecturer of theoretical physics, Meteorological Authority.

Physics Department
University College of Women's for Arts, Science and Education,
Ain Shams University
(2010)

Symmetry in high energy physics

Name of the student: Hayam Yassin Sayed Hassanien

Under Supervision of:

1- Prof. Hala Mahmoud Khalil, Assistant Professor of theoretical physics, Physics department, University College of Women's for Arts, Science and Education, Ain Shams university.

2- Dr. Tarek Mohamed Abdel Hamid Awwad , Lecturer of theoretical physics, Physics department, University College of Women's for Arts, Science and Education, Ain Shams university.

3- Dr. Gaber Younes Mohamed Faisel, Lecturer of theoretical physics, Meteorological Authority.

Physics Department
University College of Women's for Arts, Science and Education,
Ain Shams University
(2010)

Contents

List of Figures

List of Tables

Acknowledgements

Acknowledgements

I am thankful to Allah, by the grace of whom the progress of this work was possible. I wish also to express my gratefulness to Prof. Amira, Head of Physics Department for her support to facilitate the regulations and her encouragement and guidance.

I would like to express deep thanks to my supervisor Prof. Hala Mahmoud Khalil for suggesting the problem, stimulating discussion and valuable encouragement during the course of this work.

I would like to express my sincere gratefulness to Prof. Mostafa Shalaby, for his time and scientific guidance during the course of this thesis.

My Sincere thanks to my supervisor Dr. Tarek Awwad for his support, his advice, guidance.

My Sincere thanks to my supervisor Dr. Gaber Faisel for assisting the knowledge I need for this work, for his support, his guidance.

I wish also to express my gratefulness for the members of the Physics Department.

My gratitude and thanks to my husband who offered me the advice, help, hope and support to establish this work. Of course, I am most grateful to my parents for their patience, support and encouragement. Also, my heartfelt thanks are to my sister, my brother and all my friends for supporting me whenever i needed some support.

Last but not least, I would also like to thank my twins for their love and hope in my life.

Summary

Summary

During the twentieth century, remarkable progress was made in particle physics both experimentally and theoretically, which led to a great triumph "The Standard Model" (SM). However, we consider the Standard Model as an approximation of a more fundamental theory at low energies, since there are so many unexplained issues in SM, as charge conjugation parity (CP) violation.

Supersymmetry (SUSY) is one of the most interesting candidates for physics beyond the SM. In supersymmetric extensions of the SM there are additional sources of CP violation. We studied the CP violation in the mesonic(B) decay processes. we analyze the SM and supersymmetric contributions to CP-averaged branching fractions and the direct asymmetry of $B \to \pi\pi$ and $B \to KK$ processes within the framework of soft collinear effective theory (SCET). SCET provides a systematic and rigorous approach to deal with the processes where several energy scales are exist.

For branching ratios of $B \to \pi\pi$ processes we found that:
(i) In the frame work of SM, there is an agreement with the experimental range.

For CP-averaged branching fractions of $B \to \pi\pi$ processes we found that:
(i) Within the scenario S4 of quantun chromodynamics factorization (QCDF) and the SCET formalism, the predicted $R_{+-}^{\pi\pi}$ are in agreement with the experimental range.

(ii) Within the scenario S4 of QCDF and the SCET formalism, the predicted $R_{00}^{\pi\pi}$ are still much lower than the data. On the other hand, the perturbative quantum chromodynamics (pQCD) predictions are even worse no matter the next-leading order (NLO) corrections are included or not.

(iii) Motivated by the small prediction of the SM to the branching ratios, we study SUSY contribution to $R_{00}^{\pi\pi}$ using SCET formalism considering two scenarios. SUSY contributions can enhance $R_{00}^{\pi\pi}$ to be in the experimental range.

For direct asymmetry of $B \to \pi\pi$ processes we found that:
(i)In the framework of SM, the predicted CP asymmetry are still much lower than the data for $B \to \pi^+\pi^-$ and $B \to \pi^0\pi^0$ processes. But their is no prediction of the CP asymmetry of $B \to \pi^-\pi^0$. This can be attributed to the absence of the charm penguin contribution to $B \to \pi^-\pi^0$ which is the source of the strong phase at the leading order in α_s expansion.

(ii) Motivated by the small prediction of the SM to the CP asymmetries, we study SUSY contribution to the CP asymmetries using SCET formalism. we find the values of the two asymmetries exceed their values in the SM. It should be noted also that the asymmetries in the case of SUSY still not satisfy the experimental measured asymmetries.

For branching ratios of $B \to KK$ processes we found that:
(i)In the framework of SM, there is an agreement with the experimental range for $B \to K^+K^-$ process. But for $B \to K^0\bar{K}^0$ process, still there is not an experimental value measured for this process yet. It is expected that, within the running of the large hadron collider, these

quantities will be measured.

(ii) Including SUSY contributions of $B \to K^+K^-$ and $B \to K^0\bar{K}^0$ processes, SUSY contributions can enhance the branching ratio to be larger than prediction in the SM.

For direct asymmetry of $B \to KK$ processes we found that:
(i)In the framework of SM, we get the values of them but their values are not yet measured experimentally. It is expected that, within the running of the large hadron collider, these quantities will be measured.

(ii) Including SUSY contributions of $B \to K^+K^-$ and $B \to K^0\bar{K}^0$ processes, SUSY contributions can enhance the direct asymmetry to be larger than prediction in the SM.

In Conclusion, SUSY contributions can enhance both branching ratios and direct CP asymmetries.

Abstract

Abstract

Minkowski is the first who put the basis of the symmetry in high energy physics, which add the time coordinate dimension to the three place coordinates dimensions. Lorentz transformation is the mathematical formula for the special theory of relativity which was asymmetric with respect to the time and the place.

Minkowski used matrix 4×4 to explain the transformation from the inertial reference frame to another one and all of these frames move with constant speed with respect to each other.

Group theory is the mathematical tool to describe the symmetry. $U(1) \otimes SU(2) \otimes SU(3)$ is the suitable description to the Standard Model (SM). CP violation plays a privileged role in our quest for new physics beyond the electroweak Standard Model (SM).

Supersymmetry (SUSY) is one of the most interesting candidates for physics beyond the SM. In supersymmetric extensions of the SM there are additional sources of CP violation. We studied the charge conjugation parity (CP) violation in the mesonic(B) decay processes. we analyze the SM and supersymmetric contributions to CP-averaged branching fractions and the direct asymmetry of $B \to \pi\pi$ and $B \to K^0 \bar{K}^0$ processes within the framework of soft collinear effective theory (SCET). SCET provides a systematic and rigorous approach to deal with the processes where several energy scales are exist.