Advanced Topics on Flavor Physics

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1 Purpose

Flavor physics is entering an exciting era. The accumulation of data has stimulated abundant theoretical studies of flavor dynamics within and beyond the standard model. Experiments have confirmed the patten of quark flavor mixing, the mixing of different flavors of neutrinos, and that neutrinos have nonzero masses. However, the origin of quark and lepton masses and of their mixing is still not understood. The two running B-factories, BaBar and Belle, have made precision measurement of B-meson decays possible, and cast a challenge to current models of heavy-flavor dynamics. Tevatron has provided useful information on formation of heavy-flavor hadrons and their decays. Many new excited and "exotic" hadronic states with open or close charm are discovered by BaBar, Belle and CLEO. Besides the operating colliders, those facilities under construction and upgrade, such as LHC, BEPC2 with BES3, and DaYa Bay neutrino project, or in planing, such as Super B-factories, will provide more decisive information to the important subjects in flavor physics.

Motivated by the above experimental and theoretical progresses, we propose a KITPC-program with the title "Advanced Topics on Flavor Physics", which aims at a more advanced understanding of flavor dynamics. The program will be held at KITP in China. Active international and domestic researchers in this field will be invited to station at KITPC for some time, so that they can exchange expertise and have discussions intensively, through which collaborations at different scales and levels on interesting projects will be stimulated. It is worthwhile to mention that there is a large fraction of particle physicists in China (including Taiwan) working on flavor physics. The proposal, if approved, will strengthen the interaction among the researchers within and outside this region, and benefit both the particle-physics communities across the strait. The main subjects of the program are outlined below.

2 Subjects

It has been a challenge to understand the different patterns of direct CP asymmetries in neutral and charged B meson decays. The data of direct CP asymmetries of many modes are getting precise, with which confrontation of theoretical predictions will likely reveal new physics signal. The weak phase can be extracted from the measurement of mixing-induced CP asymmetries in either tree-dominated or penguin-dominated decays. The current data, however, indicate a significant discrepancy between the two extractions, which is believed to be the most potential hint for new physics. The longitudinal polarization fractions in B meson decays into two light vector mesons are expected to be close to units, according to naive factorization assumption. The measurements of the $B \to \phi K^*$, ρK^* decays have shown obvious deviation from the above naive expectation. It is necessary to clarify whether the deviation is attributed to QCD corrections to the naive expectation, or to new physics effects. B_s and B_c meson decays measured at LHCb will provide more channels to study heavy flavor dynamics. It is about time to study these decays in a systematic way.

Final-state interaction (FSI) is supposed to be more prominent in the charm sector due to the small energy release in charm decays and to an abundant spectrum of resonances existing at energies close to the mass of the charmed meson. A careful study of FSI is necessary in order to gain a complete understanding of charm decays. The Dalitz plot analysis of three-body decays provides a rich information on meson production in charm decays. Especially, the examination of D to light scalars such as σ, κ, $a_0(980)$ and $f_0(980)$ will provide information on the two-quark and four-quark pictures of the light scalars. Experimentally and theoretically, it is important to identify the quantum numbers of the new excited charmed states and understand their properties. The observation of the D^0-$\bar{D}^0$ mixing may provide not only a clue of new physics, but also an essential element in searches for CP violation. It will be interesting to undertake dedicated searches for CP asymmetries in charm decays where the SM predicts very small effect smaller than 10^{-3}. Hence, significant large values would signal new physics.

Current neutrino oscillation experiments have provided some quantitative information about two neutrino mass-squared differences and three neutrino mixing angles, but the absolute neutrino mass scale and the leptonic CP-violating phase(s) are entirely unrestricted. On the theoretical side, new flavor symmetries and (or) unified lepton-quark pictures deserve much more speculation and attention in model building at either low or super-high energy scales. It is desirable to deeply understand how small θ_{13} may be and where CP violation originates. Given the well-known seesaw mechanism for the origin of neutrino masses, the observed cosmological matter-antimatter asymmetry can be interpreted via the leptogenesis scenario. The presence of neutrinos is crucial in the Big Bang nucleosynthesis, cosmic microwave background and large scale structure. More efforts should be made towards better understanding of the distant astrophysical sources and their production mechanisms for neutrinos.

3 Program's size, duration, and preferred time

Size: the number of physicists stationing at Beijing will be maintained at 20 to 30 during the execution of the program. There will be more participants, when schools, workshops and conferences are organized.
Duration: 3 months
Preferred time: May 15-August 15, 2008.

Prof. G. Kane, who will coordinate another KITPC-program on "New Physics", is welcome to join the organization of the program on "Advanced Topics on Flavor Physics", since many overlaps of invited participants and activities are expected between the two programs.

4 Possible Participants

Scientists from Oversea:

A. Ali, C. Bauer, I.I. Bigi, F. Borzumati, M. Beneke, G. Buchalla, J.W. Chen, H.Y. Cheng, C.W. Chiang, T.W. Chiu, M. Ciuchini, Th. Feldmann, S. Fleming, C.Q. Geng, K. Hagiwara, S. Hashimoto, X.G. He, S.K. Kang, T.K. Lee, C.S. Kim, O. Kong, M. Gronau, G.L. Lin, D.

London, Th. Mannel, S. Mishima, M. Neubert, S. Oh, Y. Okada, T. Onogi, J.L. Rosner, C.T. Sachrajda, A.I. Sanda, L. Silvestrini, A. Soni, and I. Stewart...............

Scientists from Mainland of China:

Y.B. Dai, C.R. Qin, C. Liu, C.H. Chang, C.S. Huang, X.Y. Li, Y. L. Wu, T. Huang, D. S. Du, C.D. Lü, Z.Z. Xing, M.Z. Yang, Y. Jia, H.Y. Jin, G.H. Zhu, C.F. Qiao, D.S. Yang, D.X. Zhang, M.X. Luo, Z.J. Xiao, Y.D.Yang, Q. Wang, Y.P. Kuang, M.L. Yan, Q.Y. Liu, D.N. Gao, Z.T. Liang, Z.G. Si, S.Y. Li, X.Q. Li, Z.T. Wei,...............

+ over 10 post-doctors and students.

5 Organization committee

to be determined.