

### Research Work carried out during Ph.D. :

- 1. Investigating non-Fritzsch-like texture specific quark mass matrices:** A detailed investigation of all possible textures of Fritzsch-like and non-Fritzsch-like, 144 for texture 6 zero and 432 for texture 5 zero mass matrices, was carried out to ascertain their compatibility with the existing quark mixing data. It was observed that all the texture 6 zero possibilities were completely ruled out whereas in case of texture 5 zero mass matrices there was one unique Fritzsch-like combination which showed limited viability depending upon the light quark masses used as input.
- 2. Implications of CP asymmetry parameter  $\sin 2\beta$  on structural features of texture specific mass matrices:** In the context of Fritzsch-like texture 4 zero Hermitian quark mass matrices, analytical expressions for the various CKM matrix elements were obtained up to next to leading order terms using the assumption of weak hierarchy among the elements of mass matrices. These relations provided detailed insight on the dependence of CKM matrix elements and  $\sin 2\beta$  on the quark masses, hierarchy of quark mass matrices as well as the phases involved in these. The expression showed a vast improvement over the usual expression based on strong hierarchy of the elements of the mass matrices. Further, the expression provided a detailed insight into the phase structure of the elements of the mass matrices.
- 3. Exploring the parameter space of texture four-zero quark mass matrices:** Attempt was made to extend the parameter space of the elements of the texture four-zero Hermitian quark mass matrices, to include the case of 'weak hierarchy' amongst them along with the usually considered 'strong hierarchy' case. It was found that not only are the weakly hierarchical mass matrices able to reproduce the strongly hierarchical mixing angles but also both the phases, having their origin in the mass matrices, have to be non-zero to achieve compatibility of these matrices with recent quark mixing data.
- 4. Implications of additional elements in Weak Basis Texture 2 zero hermitian mass matrices for fermion mixing data:** After exactly diagonalizing the Weak Basis texture 2 zero hermitian mass matrices, attempt was made to explore the implications of the additional 11 elements of the 2 zero Weak Basis mass matrices for fermion mixing parameters, when the condition of naturalness is imposed on these matrices. It was observed that the additional (1,1) elements in these texture 2-zero mass matrices do not contribute significantly to fermion mixing parameters, which can be attributed to the condition of 'naturalness' imposed on the elements of these mass matrices indicating that for the purpose of reproducing the mixing data, the Fritzsch like 4 zero mass matrices can be considered to be the most general ones.
- 5. Implications of  $\theta_{13}$  on Fritzsch-like lepton mass matrices:** Implications of the lepton mixing angles, in particular of  $\theta_{13}$ , have been investigated for minimal as well as non-minimal Fritzsch-like textures for the case of Majorana neutrinos. Both, in minimal texture (texture 6 zero lepton mass matrices) and non-minimal textures (two cases of texture 5 zero lepton mass matrices), inverted hierarchy and degenerate scenario of neutrino masses have been ruled out. The implications of  $\theta_{13}$  were investigated on the lightest neutrino mass  $m_{\nu 1}$  as well as the effective Majorana mass  $\langle m_{ee} \rangle$ .

6. **Texture specific mass matrices with Dirac neutrinos and their implications:** Considering Dirac neutrinos and Fritzsch-like texture six zero and five zero mass matrices, detailed predictions for cases pertaining to normal/inverted hierarchy as well as degenerate scenario of neutrino masses were carried out. All the cases pertaining to inverted hierarchy and degenerate scenario of neutrino masses were observed to be ruled out by the existing data. For the normal hierarchy cases, it was observed that the lower limit of  $m_{\nu 1}$  and of  $s_{13}$  as well as the range of Dirac-like CP violating phase  $\delta_1$  would have implications for the texture specific cases.
7. **Revisiting the possibility of New Physics in the  $K-\bar{K}$  and  $B_d-\bar{B}_d$  systems:** Recently several developments have taken place in the lattice QCD calculations of hadronic factors in the case of  $K-\bar{K}$  and  $B_d-\bar{B}_d$  mixings along with contribution of the long distance effects in the  $K-\bar{K}$  system. These have led some authors to point towards the possibility of New Physics (NP) in these systems to the tune of 20% or so. However, the analysis, based on essentially NP free inputs and incorporating constraints of unitarity, showed that in case the NP effects are there in the parameters associated with these systems, e.g.  $\text{Sin}2\beta$ ,  $V_{td}$ ,  $\epsilon_K$ , etc., these seemed to be only at a few percent level.
8. **Compatibility of Fritzsch-Like texture 4 zero hermitian mass matrices with SO(10) based mass matrices:** Attempt was made to study the compatibility of texture 4 zero Fritzsch like mass matrices with SO(10) inspired mass matrices using 10, 120 and 126 Higgses and it was observed that the anti-symmetric 120 couplings play a vital role in explaining the current data.