Summary of Ph.D. thesis "Lepton Flavour Violation in the extensions of the Standard Model" by Saereh Najjari

The Standard Model (SM) of elementary particle interactions successfully explains the particle phenomenology at the energy scale currently reachable in the experiments. However, various theoretical problems and cosmological observations that cannot be explained in the frame of SM lead to the believe that it is only an effective approximation of some more fundamental theory. The promising area to search for New Physics phenomena is the lepton flavour phenomenology. In particular within SM lepton flavor violating (LFV) and CP-violating (CPV) effects in the charged lepton sector are very strongly suppressed, and so far have not been observed in any experiment. Any such observation would immediately signal some phenomena going beyond the SM.

In my thesis I discuss possible size of lepton flavor- and CP-violating effects in the charged lepton sector of the SM extensions. I use model-independent parametrization of New Physics effects, where the SM is extended by the full basis of the dimension-5 and -6 operators constructed of the SM fields and preserving its gauge symmetries. Assuming barion number conservation, there is a unique operator of dimension-5 and 59 types of independent operators of dimension-6. However, as discussed in the thesis, after all simplification in general only 9 types operators can give significant contributions to charged LFV processes, usually less if one particular process is considered.

With my collaborators I performed, at the tree and 1-loop level, calculations of several experimentally best constrained LFV and CPV observables expressing the final formulae for them in terms of Wilson coefficients multiplying the effective operators. Such expressions simplify significantly a comparison of various specific New Physics models with the experimental results, as now only the values Wilson coefficients of new operators need to be calculated within a given model - the remaining part of analysis discussed in the thesis is model-independent.

In my dissertation for introduction I summarize the predictions for radiative and three body decays charged lepton decays in the SM extended with massive neutrinos. Then I describe how to parametrize the general extensions of the SM in terms higher dimension operators and discuss which types of such operators can contribute to LFV in the charged lepton sector. Further, I calculate in terms of the Wilson coefficients of the following observables: the decay rates of the radiative lepton flavor violating decays $\ell_i \to \ell_f \gamma$, related to

them magnitudes of the charged lepton Electric Dipole Moments and Anomalous Magnetic Moments, decay rates of the three-body charged lepton flavor violating decays $\ell_i \to \ell_j \ell_k \ell_l$ and Z-boson decays into pair of leptons of different flavors. The final formulae are compact and simple and are presented in the form allowing for easy comparison with the experimental bounds. Finally, I discuss several examples of how combining bounds from various measurements could help finding correlation between different LFV couplings. Such correlation could be potentially very important for designing new experiments.

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