Long and short distance contributions to the weak $D \to V l^+ l^-$ decays

S. Fajfer[a], S. Prelovšek[a] and P. Singer[b]

a) J. Stefan Institute, Jamova 39, P. O. Box 300, 1001 Ljubljana, Slovenia

b) Department of Physics, Technion - Israel Institute of Technology, Haifa 32000, Israel

ABSTRACT

We analyse the long and short distance contributions to $D \to V l^+ l^-$ decays using the model, which combines heavy quark symmetry and chiral perturbation theory. We divide the long distance contribution in the resonant part, which arises from the intermediate light vector meson V_0 exchange ($D \to V V_0 \to V\gamma \to V l^+ l^-$, V_0 is ρ^0, ω or ϕ)), and the nonresonant part, which arises from the direct photon emission ($D \to V\gamma \to V l^+ l^-$). In addition, there is a short distance contribution in the Cabibbo suppressed decays, due to the $c \to u l^+ l^-$ transition. The most frequent decays into a muon-antimuon pair are the Cabibbo allowed decays $D^0 \to \bar{K}^{*0}\mu^+\mu^-$ and $D_s^+ \to \rho^+\mu^+\mu^-$, which are expected to occur with the sizable branching ratios $\sim 2 \cdot 10^{-6}$ and $\sim 3 \cdot 10^{-5}$, respectively, and are driven by the long distance dynamics. The short distance dynamics with the possible signal of new physics can be in principle observed in the Cabibbo suppressed decays. We find that in all the Cabibbo suppressed decays the short distance contribution is well masked in the standard model by the resonant long distance contribution. In the case of $D^0 \to \rho^0(\omega) l^+ l^-$ decays, however, the short distance contribution is of comparable size as the nonresonant long distance part. The Cabibbo suppressed decays are typically expected at $[3-7] \cdot 10^{-7}$ range for $D^0 \to \rho^0(\omega)\mu^+\mu^-$ and $D_s^+ \to K^{*+}\mu^+\mu^-$ decays and in the 10^{-6} range for the decay $D^+ \to \rho^+\mu^+\mu^-$. Accordingly, branching ratios well above 10^{-7} for Cabibbo suppressed decays could signal new physics.