HIGGS DECAY TO CHARMONIA AND THE CHARM-QUARK YUKAWA COUPLING

With the discovery of the Higgs boson at the CERN Large Hadron Collider (LHC), the particle spectrum of the Standard Model (SM) is complete. The next target at the energy frontier will be to study the Higgs properties and to search for the next scale beyond the SM. Experimentally, the $H \to c\bar{c}$ channel would be extremely difficult to dig out because of both the weak Yukawa coupling and the daunting SM di-jet background. We propose to test the charm-quark Yukawa coupling at the LHC and future hadron colliders with the Higgs boson decay to J/ψ via the charm-quark fragmentation. Using the non-relativistic quantum chromodynamics (NRQCD), we study the Higgs decay channel $H \to c\,\bar{c} + J/\psi(\text{or } \eta_c)$, where both the color-singlet and color-octet contributions are considered. The decay rates are governed by the charm-quark Yukawa coupling, unlike the decay $H \to J/\psi + \gamma$, which is dominated by the γ^*-J/ψ mixing. Our result opens another door to improve determinations at the LHC of the Higgs Yukawa couplings: the final state from this decay mode is quite distinctive with $J/\psi \to e^+e^-$, $\mu^+\mu^-$ and the branching fraction is enhanced by the charm-quark fragmentation mechanism.