Title: Studies of B_d^0 meson properties with the ATLAS experiment

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Abstract: A precision measurement of the effective lifetime of the B_d^0 meson $\tau_{B_d^0}$ with the ATLAS detector is presented. The decay channel $B_d^0 \to J/\psi K^{*0}$ is used with a dataset corresponding to an integrated luminosity of 140.1 fb^{-1} of proton–proton collisions at $\sqrt{s} = 13$ TeV, recorded during Run 2 of the LHC. A two-dimensional unbinned maximum likelihood fit to the invariant mass and proper decay time distributions is employed to separate signal and background components and to extract the effective lifetime of the B_d^0 meson. The analysis incorporates advanced statistical techniques, including per-event proper decay time uncertainties and the ${}_s\mathit{Plot}$ technique. The average decay width Γ_d is also extracted using external inputs. Furthermore, the ratio Γ_d/Γ_s is determined as well combining with the previous ATLAS measurement of Γ_s. The measured values are:

$$\tau_{B_d^0} = 1.5053 \pm 0.0012\ (\text{stat}) \pm 0.0035\ (\text{syst})\ \text{ps},$$

$$\Gamma_d = 0.6639 \pm 0.0005\ (\text{stat.}) \pm 0.0016\ (\text{syst.}) \pm 0.0038\ (\text{ext.})\ \text{ps}^{-1},$$

$$\Gamma_d/\Gamma_s = 0.9905 \pm 0.0022\ (\text{stat.}) \pm 0.0036\ (\text{syst.}) \pm 0.0057\ (\text{ext.}).$$

These results are consistent with Standard Model predictions and represent the most precise determination of $\tau_{B_d^0}$ in this decay mode to date. They provide a test of the Heavy Quark Expansion framework and Lattice QCD and offer sensitivity to possible new physics contributions through deviations in lifetime ratios.

Keywords: decay width, lifetime, b quark, B meson, ATLAS, LHC