Belle II results on charmless hadronic B-decays and prospects

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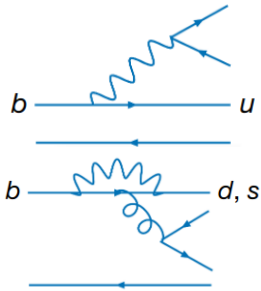
Charmless B Decays

- Hadronic B decays, where $b \to u, d, s$ but not $b \to c$;
- Cabbibo-suppressed $b \to u$ trees;
- Non-negligible contribution from $b \to d, s$ penguins.
  - Highly sensitive to non-SM physics;
  - Probe non-SM dynamics in all three CKM angles.



Exp. challenges: $\mathcal{B} \approx \mathcal{O}(10^{-5})$, large contribution from $e^+e^- \to q\bar{q}$ background

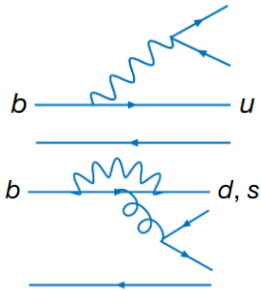
Belle II charmless program:

- Test Standard Model using isospin sum rules;
- Investigate localized CP asymmetries in Dalitz plot of three-body decays;
- Improve precision on CKM angle ϕ_2 (α).

Today, showing the result of two analyses using 190 fb^{-1} data

$B^+ \to \rho^+\rho^0$ Motivation

- CKM angle ϕ_2 (α) accessible in $B^0 \to \rho^+\rho^-$;
- Measured angle is shifted: $\phi_2^{\text{meas.}} = \phi_2 + \delta\phi_2$;
- Need $B^0 \to \rho^0\rho^0$, $B^+ \to \rho^+(\to \pi^+\pi^0)\rho^0(\to \pi^+\pi^-)$ to 'remove' shift.



Belle II provides a clean environment with constrained kinematics:

Unique place to measure all three!

$B^+ \to \rho^+\rho^0$ Experimental Challenges

Large background from $e^+e^- \to q\bar{q}$ background:

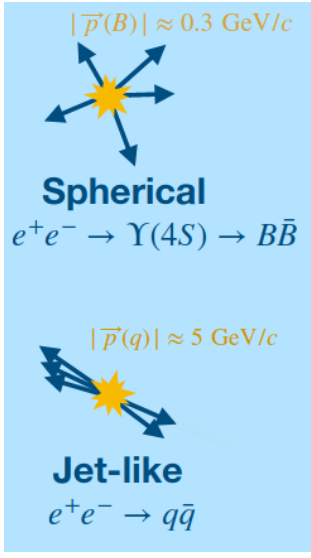
- Reduced using multivariate algorithm.

Intermediate ρ is a vector meson:

- Fit distribution of helicity angles of the π^+ to obtain longitudinal polarization fraction f_L.

Broad ρ mass peak:

- 6D template fit to discriminate signal and background.



$B^+ \to \rho^+\rho^0$ Result

Results:

Branching fraction:

- $\mathcal{B} =$

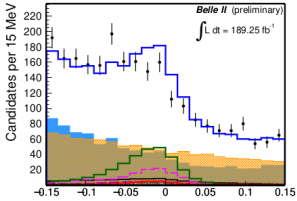
Longitudinal polarization:

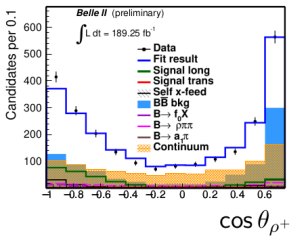
- $f_L =$

Direct CP violation ($B^+ \to \rho^+\rho^0$ vs $B^- \to \rho^-\rho^0$):

- $A_{CP} =$

World average: $A_{CP} = -0.05 \pm 0.05$



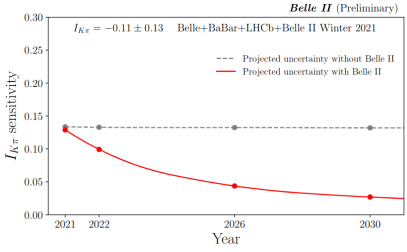


$B^0 \to K^0\pi^0$ Motivation

$B^0 \to K^0\pi^0$ is sensitive to New Physics. In particular, test of Isospin sum rule,

$$2A_{CP}(B_0 \to K^0\pi^0) - A_{CP}(B^+ \to K^0\pi^+) + 2A_{CP}(B^+ \to K^+\pi^0) \approx 0$$

- Uncertainty dominated by $A_{CP}(B_0 \to K^0\pi^0)$;
- Experimentally very challenging
  $\to$ only feasible at Belle II;
- If current central value holds, sum rule will be violated with 3σ with 15 ab^{-1}.

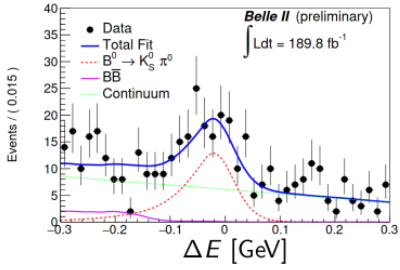


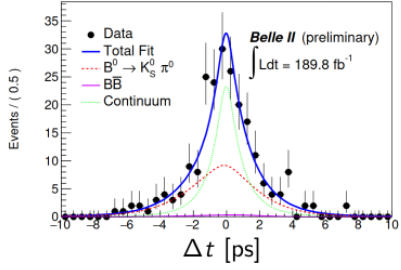
$B^0 \to K^0\pi^0$ Measurement

- Perform 4D fit including ΔE, Δt;
- Details on TDCPV presented earlier;
- τ^0_B, Δm_d and S_{CP} constrained to world average to maximize precision on A_{CP}.

Results:

- $\mathcal{B} =$
- $A_{\mathrm{CP}} =$





Conclusion and Prospects

Belle II continues to prove its unique ability to measure decays with neutrals in the final state.

More to come soon from Belle II charmless group:

- Dalitz analyses with 3-body charmless modes;
- Improved results for $B \to \pi\pi$.