

Erratum to

LHCb Collaboration; Aaij, R.; Adeva, B.; Adinolfi, M.; Affolder, A.; Ajaltouni, Z.; Akar, S.; Albrecht, J.; Alessio, F.; Alexander, M.; Ali, S.; Alkhazov, G.; Alvarez Cartelle, P.; Alves, A. A.; Amato, S.; Amerio, S.; Amhis, Y.; An, L.; Anderlini, L.; Anderson, J.

DOI:

[10.1007/JHEP09\(2018\)145](https://doi.org/10.1007/JHEP09(2018)145)

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Document Version

Publisher's PDF, also known as Version of record

Citation for published version (Harvard):

LHCb Collaboration, Aaij, R, Adeva, B, Adinolfi, M, Affolder, A, Ajaltouni, Z, Akar, S, Albrecht, J, Alessio, F, Alexander, M, Ali, S, Alkhazov, G, Alvarez Cartelle, P, Alves, AA, Amato, S, Amerio, S, Amhis, Y, An, L, Anderlini, L, Anderson, J, Andreotti, M, Andrews, JE, Appleby, RB, Aquines Gutierrez, O, Archilli, F, Artamonov, A, Artuso, M, Aslanides, E, Auriemma, G, Baalouch, M, Bachmann, S, Back, JJ, Badalov, A, Baesso, C, Baldini, W, Barlow, RJ, Barschel, C, Barsuk, S, Barter, W, Batozskaya, V, Battista, V, Bay, A, Bifani, S, Farley, N, Griffith, P, Kenyon, IR, Lazzeroni, C, Mazurov, A, McCarthy, J, Pescatore, L & Watson, NK 2018, 'Erratum to: differential branching fraction and angular analysis of b_0^+ decays', *Journal of High Energy Physics*, vol. 2018, no. 9, 145. [https://doi.org/10.1007/JHEP09\(2018\)145](https://doi.org/10.1007/JHEP09(2018)145)

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Checked for eligibility: 16/01/2018

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RECEIVED: August 17, 2018

ACCEPTED: September 12, 2018

PUBLISHED: September 26, 2018

Erratum: Differential branching fraction and angular analysis of $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ decays



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ERRATUM TO: [JHEP06\(2015\)115](#)

ARXIV EPRINT: [1503.07138](#)

The angular distribution of the dimuon system of the decays $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ and $\bar{\Lambda}_b^0 \rightarrow \bar{\Lambda} \mu^+ \mu^-$ can be described by

$$\frac{d\Gamma}{d \cos \theta_\ell} = \frac{3}{8}(1 + \cos^2 \theta_\ell)(1 - f_L) + A_{\text{FB}}^\ell \cos \theta_\ell + \frac{3}{4}f_L \sin^2 \theta_\ell, \quad (1)$$

where A_{FB}^ℓ is the forward-backward asymmetry of the dimuon system and f_L is its longitudinal polarisation fraction. For the Λ_b^0 decay, the angle θ_ℓ is calculated as the angle between the direction of the μ^+ lepton, in the rest frame of the dimuon pair, and the direction of the dimuon pair, in the rest frame of the Λ_b^0 decay. The forward-backward asymmetry of the lepton pair, A_{FB}^ℓ , is “odd” under CP conjugation and changes in sign between the Λ_b^0 and $\bar{\Lambda}_b^0$ decays. To compensate for this sign, the angle θ_ℓ is usually calculated from the μ^- lepton rather than the μ^+ lepton such that A_{FB}^ℓ can be calculated from the combined sample. This was the intended approach of this paper. Unfortunately, A_{FB}^ℓ was determined using the μ^+ lepton when determining θ_ℓ for both the Λ_b^0 and the $\bar{\Lambda}_b^0$ decays. Consequently, the value of A_{FB}^ℓ in this paper corresponds to a difference $A(A_{\text{FB}}^\ell)$ in asymmetries between the Λ_b^0 and $\bar{\Lambda}_b^0$ decays rather than a proper average and is expected to be zero if CP is conserved. The result quoted as A_{FB}^ℓ in this paper should therefore be interpreted as

$$A(A_{\text{FB}}^\ell) = -0.05 \pm 0.09 \text{ (stat)} \pm 0.03 \text{ (syst)}, \quad (2)$$

and is indeed consistent with the Standard Model expectation that CP violating effects should be small in the decay $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$. This is in itself a useful result. A measurement of A_{FB}^ℓ has since been presented in ref. [1]. The results in ref. [1] supersede the corresponding results in this paper. Note, the mistake in the angular definition only affects the value of A_{FB}^ℓ presented in the paper. The values of f_L , A_{FB}^h and the differential branching fraction are unchanged, due to the symmetry of the efficiency model in $\cos \theta_\ell$.

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References

- [1] LHCb collaboration, *Angular moments of the decay $\Lambda_b^0 \rightarrow \Lambda \mu^+ \mu^-$ at low hadronic recoil*, *JHEP* **09** (2018) 146 [[arXiv:1808.00264](https://arxiv.org/abs/1808.00264)] [[INSPIRE](https://inspirehep.net/literature/1808002)].

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