Eur. Phys. J. C (2021) 81:219
https://doi.org/10.1140/epjc/s10052-021-08998-w

THE EUROPEAN PHYSICAL JOURNAL C

Erratum

Erratum to: The new physics reach of null tests with $D \to \pi\ell\ell$ and $D_s \to K\ell\ell$ decays

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Received: 1 February 2021 / Accepted: 22 February 2021 / Published online: 5 March 2021

Erratum to: Eur. Phys. J. C (2020) 80:65
https://doi.org/10.1140/epjc/s10052-020-7621-7

In this Erratum we correct terms involving finite m_ℓ and C_T in $D \to \pi\ell\ell$ distributions. We further adapt the q^2 integration limits corresponding to the LHCb analysis [1]. We give the modifications regarding these two points, as well as further corrections. Note, further numerics of the article are unaffected and the conclusion remains unchanged.

$D \to \pi\ell\ell$ distributions Errors in Eqs. (7), (17), (18) and (21) involving C_T and finite m_ℓ-terms have been fixed. The corrected distributions are in agreement with Ref. [2], and therefore footnote 1 has been removed. The correct expressions read

$$
\begin{aligned}
\frac{\mathrm{d}\Gamma}{\mathrm{d}q^2} = {} & \frac{G_F^2\alpha_e^2}{1024\pi^5 m_D^3}\sqrt{\lambda_{DP}\left(1-\frac{4m_\ell^2}{q^2}\right)} \\
& \times \left\{\frac{2}{3}\left|C_9+C_9^R+C_7\frac{2m_c}{m_D+m_P}\frac{f_T}{f_+}\right|^2\right. \\
& \times \left(1+\frac{2m_\ell^2}{q^2}\right)\lambda_{DP} f_+^2 \\
& + |C_{10}|^2\left[\frac{2}{3}\left(1-\frac{4m_\ell^2}{q^2}\right)\lambda_{DP} f_+^2\right. \\
& \left. + \frac{4m_\ell^2}{q^2}(m_D^2-m_P^2)^2 f_0^2\right] \\
& + \left[|C_S|^2\left(1-\frac{4m_\ell^2}{q^2}\right)+|C_P+C_P^R|^2\right] \\
& \times \frac{q^2}{m_c^2}(m_D^2-m_P^2)^2 f_0^2 \\
& + \frac{4}{3}\left[|C_T|^2+|C_{T5}|^2\right]\left(1-\frac{4m_\ell^2}{q^2}\right)\frac{q^2\lambda_{DP} f_T^2}{(m_D+m_P)^2} \\
& + 8\,\mathrm{Re}\left[\left(C_9+C_9^R+C_7\frac{2m_c}{m_D+m_P}\frac{f_T}{f_+}\right)C_T^*\right] \\
& \times \frac{m_\ell}{m_D+m_P}\lambda_{DP} f_+ f_T \\
& + 4\,\mathrm{Re}\left[C_{10}\left(C_P+C_P^R\right)^*\right]\frac{m_\ell}{m_c}(m_D^2-m_P^2)^2 f_0^2 \\
& \left. + 16\,|C_T|^2\frac{m_\ell^2}{(m_D+m_P)^2}\lambda_{DP} f_T^2\right\},
\end{aligned}
\tag{7}
$$

$$
\begin{aligned}
A_{\mathrm{FB}}(q^2) = {} & \frac{1}{\Gamma}\left[\int_0^1-\int_{-1}^0\right]\frac{\mathrm{d}^2\Gamma}{\mathrm{d}q^2\mathrm{d}\cos\theta}\mathrm{d}\cos\theta = \frac{b(q^2)}{\Gamma} \\
= {} & \frac{1}{\Gamma}\frac{G_F^2\alpha_e^2}{512\pi^5 m_D^3}\lambda_{DP}\left(1-\frac{4m_\ell^2}{q^2}\right) \\
& \times \left\{\mathrm{Re}\left[\left(C_9+C_9^R+C_7\frac{2m_c}{m_D+m_P}\frac{f_T}{f_+}\right)C_S^*\right]\right. \\
& \times \frac{m_\ell}{m_c} f_+ \\
& + 2\mathrm{Re}\left[C_{10}C_{T5}^*\right]\frac{m_\ell}{m_D+m_P} f_T \\
& + \mathrm{Re}\left[C_S C_T^* + \left(C_P+C_P^R\right)C_{T5}^*\right] \\
& \left. \times \frac{q^2}{m_c(m_D+m_P)} f_T\right\}(m_D^2-m_P^2) f_0,
\end{aligned}
\tag{17}
$$

$$
\begin{aligned}
F_H(q^2) = {} & \frac{2}{\Gamma}[a(q^2)+c(q^2)] \\
= {} & \frac{1}{\Gamma}\frac{G_F^2\alpha_e^2}{1024\pi^5 m_D^3}\sqrt{\lambda_{DP}\left(1-\frac{4m_\ell^2}{q^2}\right)}
\end{aligned}
$$

The original article can be found online at https://doi.org/10.1140/epjc/s10052-020-7621-7.

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$$
\begin{aligned}
&\times \left\{ \left| C_9 + C_9^R + C_7 \frac{2m_c}{m_D + m_P} \frac{f_T}{f_+} \right|^2 \frac{4m_\ell^2}{q^2} \lambda_{DP} f_+^2 \right. \\
&+ |C_{10}|^2 \frac{4m_\ell^2}{q^2} (m_D^2 - m_P^2)^2 f_0^2 \\
&+ \left[|C_S|^2 \left(1 - \frac{4m_\ell^2}{q^2}\right) + |C_P + C_P^R|^2 \right] \\
&\times \frac{q^2}{m_c^2} (m_D^2 - m_P^2)^2 f_0^2 \\
&+ 4 \left[|C_T|^2 + |C_{T5}|^2 \right] \left(1 - \frac{4m_\ell^2}{q^2}\right) \\
&\times \frac{q^2}{(m_D + m_P)^2} \lambda_{DP} f_T^2 \\
&+ 8\,\mathrm{Re}\left[\left(C_9 + C_9^R + C_7 \frac{2m_c}{m_D + m_P} \frac{f_T}{f_+} \right) C_T^* \right] \\
&\frac{m_\ell}{m_D + m_P} \lambda_{DP} f_+ f_T \\
&+ 4\,\mathrm{Re}\left[C_{10} \left(C_P + C_P^R \right)^* \right] \frac{m_\ell}{m_c} (m_D^2 - m_P^2)^2 f_0^2 \\
&\left. + 16\,|C_T|^2 \frac{m_\ell^2}{(m_D + m_P)^2} \lambda_{DP} f_T^2 \right\},
\end{aligned} \tag{18}
$$

$$
\begin{aligned}
\frac{\mathrm{d}\Gamma}{\mathrm{d}q^2} - \frac{\mathrm{d}\overline{\Gamma}}{\mathrm{d}q^2} &= \frac{G_F^2 \alpha_e^2}{256\pi^5 m_D^3} \sqrt{\lambda_{DP}\left(1 - \frac{4m_\ell^2}{q^2}\right)} \\
&\times \left\{ \frac{2}{3}\,\mathrm{Im}\left[C_9 + 2C_7 \frac{m_c}{m_D + m_P} \frac{f_T}{f_+} \right] \right. \\
&\times \mathrm{Im}\left[C_9^R\right] \left(1 + \frac{2m_\ell^2}{q^2}\right) \lambda_{DP} f_+^2 \\
&+ \mathrm{Im}\,[C_P]\,\mathrm{Im}\left[C_P^R\right] \frac{q^2}{m_c^2} (m_D^2 - m_P^2)^2 f_0^2 \\
&+ 4\,\mathrm{Im}\,[C_T]\,\mathrm{Im}\left[C_9^R\right] \\
&\times \frac{m_\ell}{m_D + m_P} \lambda_{DP} f_+ f_T \\
&\left. + 2\,\mathrm{Im}\,[C_{10}]\,\mathrm{Im}\left[C_P^R\right] \frac{m_\ell}{m_c} (m_D^2 - m_P^2)^2 f_0^2 \right\}.
\end{aligned} \tag{21}
$$

LHCb and constraints on Wilson coefficients We correct the integration limits of the full q^2–region according to [1] and add a footnote to Eq. (9). The bounds on Wilson coefficients are changed accordingly. The paragraph is changed to the following:

Using the experimental limits on the branching fraction of $D^+ \to \pi^+\mu^+\mu^-$ in high and full q^2–regions at 90% CL [1][1],

$$
\begin{aligned}
&\mathcal{B}(D^+ \to \pi^+\mu^+\mu^-)|_{\text{full } q^2} < 7.3 \times 10^{-8} \\
&\quad \left(250\,\text{MeV} \le \sqrt{q^2} \le m_{D^+} - m_{\pi^+}\right), \\
&\mathcal{B}(D^+ \to \pi^+\mu^+\mu^-)|_{\text{high } q^2} < 2.6 \times 10^{-8} \\
&\quad \left(\sqrt{q^2} \ge 1.25\ \text{GeV}\right),
\end{aligned} \tag{9}
$$

and neglecting the SM contributions, we obtain the following constraints on the BSM Wilson coefficients in the full q^2-region,

$$
\begin{aligned}
&1.2|C_7|^2 + 1.2|C_9|^2 + 1.2|C_{10}|^2 + 2.4|C_S|^2 \\
&\quad + 2.5|C_P|^2 + 0.4|C_T|^2 + 0.3|C_{T5}|^2 \\
&\quad + 0.3\,\mathrm{Re}[C_9 C_T^*] + 1.0\,\mathrm{Re}[C_{10} C_P^*] + 2.4\,\mathrm{Re}[C_7 C_9^*] \\
&\quad + 0.6\,\mathrm{Re}[C_7 C_T^*] \lesssim 1.
\end{aligned} \tag{10}
$$

and in the high q^2–region,

$$
\begin{aligned}
&0.6|C_7|^2 + 0.7|C_9|^2 + 0.8|C_{10}|^2 + 4.4|C_S|^2 \\
&\quad + 4.5|C_P|^2 + 0.4|C_T|^2 + 0.4|C_{T5}|^2 \\
&\quad + 0.3\,\mathrm{Re}[C_9 C_T^*] + 1.1\,\mathrm{Re}[C_{10} C_P^*] + 1.4\,\mathrm{Re}[C_7 C_9^*] \\
&\quad + 0.3\,\mathrm{Re}[C_7 C_T^*] \lesssim 1,
\end{aligned} \tag{11}
$$

Further corrections Updated values for the integrated branching fractions of $D^+ \to \pi^+\mu^+\mu^-$ are given in Table 2.

The lifetime factor τ_D in Eq. (13) is added on the right hand side.

We correct Eq. (25).[2] It reads

$$
\begin{aligned}
&1.3\left(|K_9|^2 + |K_{10}|^2\right) + 2.6\left(|K_S|^2 + |K_P|^2\right) \\
&+ 0.4\left(|K_T|^2 + \left|K_{T5}\right|^2\right) \\
&+ 0.5\,\mathrm{Re}\left[K_{10} K_P^* \pm K_9 K_S^*\right] \\
&+ 0.3\,\mathrm{Re}\left[K_9 K_T^* \pm K_{10} K_{T5}^*\right] \lesssim 50.
\end{aligned} \tag{25}
$$

The corrected version of the article is available at arXiv:1909.11108v3.

[1] We use the full q^2–region as given in Eq. (9) in order to present the strongest upper limit on the Wilson coefficients in Eq. (10). Since an actual measurement is only performed within $\sqrt{q^2} \in [250, 525]$ MeV and $\sqrt{q^2} \ge 1.25$ GeV and extrapolated in [1] in between, we prefer to use the bounds from the high q^2-region given in Eq. (11).

[2] We thank Xinshuai Yan for pointing this out.

Table 2 Integrated branching fractions in the high q^2–bin ($\sqrt{q^2} \geq 1.25$ GeV) in the SM and in the NP benchmark scenarios as in Fig. 3. In the third to sixth column, upper entries correspond to NP-only branching ratios while for the lower entries the resonance contributions are taken into account

$\mathcal{B}\|_{\text{high}\,q^2} \times 10^9$	SM	$C_{9\,(10)} = 0.5$	$C_{S\,(P)} = 0.1$	$C_{T\,(T5)} = 0.5$	$C_9 = \pm C_{10} = 0.5$
$D^+ \to \pi^+\mu^+\mu^-$	$0.3\ldots3.0$	4.5 ± 0.3	1.1 ± 0.1	2.6 ± 0.4	9.4 ± 0.6
		7.8 ± 7.4	2.9 ± 1.4	5.0 ± 2.9	12.6 ± 7.7
$D_s^+ \to K^+\mu^+\mu^-$	$0.03\ldots0.3$	0.40 ± 0.05	0.15 ± 0.07	0.15 ± 0.05	0.8 ± 0.1
		0.8 ± 0.7	0.3 ± 0.2	0.4 ± 0.3	1.2 ± 0.8

Data Availability Statement This manuscript has no associated data or the data will not be deposited. [Authors' comment: There are no data because this is theoretical works.]

Funded by SCOAP[3].

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