Fitting methods

The methods to fit the experimental data in different figures (Figs. 3 – 6) can be described as follows. In each figure, the values of adjustable parameters with standard errors were determined by least-squares fittings to the experimental data.

Figure 3. Using Eq. (3) and with two adjustable parameters \( r_0 \) and \( F_S \), the experimental data of Uemura et al. [6] on force dependence of stepping ratio at saturating ATP can be fitted (Fig. 3a). Using Eq. (5), with fixed parameters \( r_0 \) and \( F_S \) determined above and with two adjustable parameters \( k_D^{(+)} \) and \( k_D^{(-)} \), the experimental data of Uemura et al. [6] on force dependence of velocity at saturating ATP (1 mM) can be fitted (Fig. 3b, black line). Using Eq. (16), with fixed parameters \( r_0, F_S, k_D^{(+)} \) and \( k_D^{(-)} \) determined above and with two adjustable parameters \( k_b \) and \( C_D \), the experimental data of Uemura et al. [6] on force dependence of velocity at non-saturating ATP (1 \( \mu \)M) can be fitted (Fig. 3b, red line). Using Eq. (6) and with parameters \( r_0, F_S, k_D^{(+)} \) and \( k_D^{(-)} \) determined above, the theoretical results on force dependence of dwell time at saturating ATP can be calculated (Fig. 3c, black line). Using Eq. (17) and with parameters \( r_0, F_S, k_D^{(+)} \), \( k_D^{(-)} \), \( k_b \) and \( C_D \) determined above, the theoretical results on force dependence of dwell time at 1 \( \mu \)M ATP can be calculated (Fig. 3c, red line).

Figure 4. Using Eq. (21), with the same values of parameters \( r_0, F_S \) and \( C_D \) as those given in Fig. 3 and with adjustable parameters \( k_D^{(+)} \), \( k_D^{(-)} \), \( k_b \), \( k_s^{(-)} \), \( k_s^{(+)} \) and \( F_d \), the experimental data of Gebhardt et al. [9] on force dependence of velocity at 1
μM ATP can be fitted (Fig. 4a). Using Eq. (21) and with the parameters determined above, the theoretical results on dependence of velocity upon ATP concentration under different forces can be calculated (Fig. 4b and c).

**Figure 5.** Using Eqs. (7) and (16) for $P_{E_1} = 1$ and $P_{E_2} = 1$ (i.e., $P_{EF} = 1$ and $P_{EB} = 0$) under $F = 0$ and with two adjustable parameters $k_D^{(+)}$ and $k_b$, the experimental data of Zhang et al. [7] on dependence of velocity upon ATP concentration under $F = 0$ can be fitted (Fig. 5a). Using Eqs. (7), (16) and (25) – (30), with fixed parameters $k_D^{(+)}$ and $k_b$ determined above and with two adjustable parameters $k_P$ and $\varepsilon_{s0}$, the experimental data of Zhang et al. [7] on dependence of run length upon ATP concentration under $F = 0$ can be fitted (Fig. 5b, solid black line). The dashed red line in Fig. 5b was calculated by taking $\varepsilon_{s0} = 0$. Using Eqs. (25) – (29) and with the parameters determined above, the theoretical results on dependence of unbinding rate upon ATP concentration under $F = 0$ can be calculated (Fig. 5c, solid black line). The dashed red line in Fig. 5c was calculated by taking $\varepsilon_{s0} = 0$.

**Figure 6.** Using Eq. (5) and with adjustable parameters $r_0, F_S, k_D^{(+)}$ and $k_D^{(-)}$, the experimental data of Clemen et al. [8] on force dependence of velocity at saturating ATP can be fitted (Fig. 6a). Using Eq. (5), (23) – (25) and (28) – (30), with fixed parameters $r_0, F_S, k_D^{(+)}$ and $k_D^{(-)}$ determined above, with fixed parameters $F_d$ and $\varepsilon_{s0}$ as given in Figs. 4 and 5, respectively, and with one adjustable parameter $k_P$, the experimental data of Clemen et al. [8] on force dependence of run length at saturating ATP can be fitted (Fig. 6b, solid black line). The dashed red line in Fig. 6b was calculated by taking $\varepsilon_{s0} = 0$. Using Eq. (5) and (25) – (29) and with the parameters determined above, the theoretical results on force dependence of unbinding rate can be calculated (Fig. 6c, solid black line). The dashed red line in Fig. 6c was calculated by taking $\varepsilon_{s0} = 0$. 