Supplementary Information: New tricks for old dogs: Improving accuracy of biomolecular force fields by pair-specific corrections to non-bonded interactions

Jejoong Yoo and Aleksei Aksimentiev*

Center for the Physics of Living Cells, Department of Physics, University of Illinois at Urbana–Champaign, 1110 West Green Street, Urbana, Illinois 61801

E-mail: aksiment@illinois.edu

*To whom correspondence should be addressed

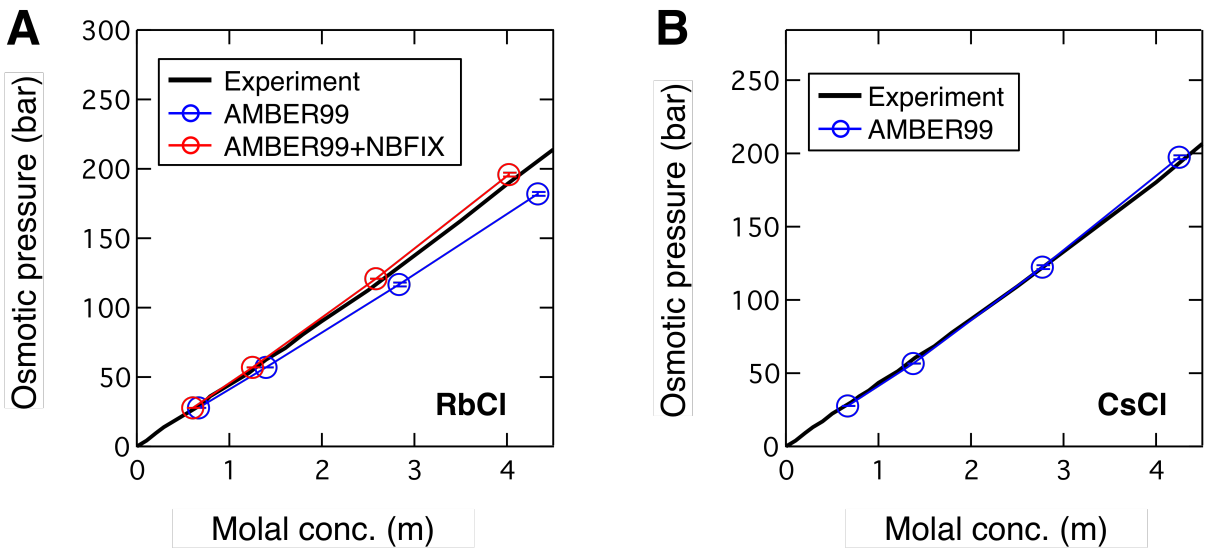

Figure S1: Validation and calibration of Rb^+–Cl^- (A) and Cs^+–Cl^- (B) ion pair interactions for the AMBER ff99 force fields using osmotic pressure simulations. Standard ion parameters optimized for the TIP3P water were taken from Joung and Cheatham.[1] The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones σ parameters for cation–anion atom pairs. Experimental data were taken from Ref. 4. See Table 3 for the changes in σ parameters.

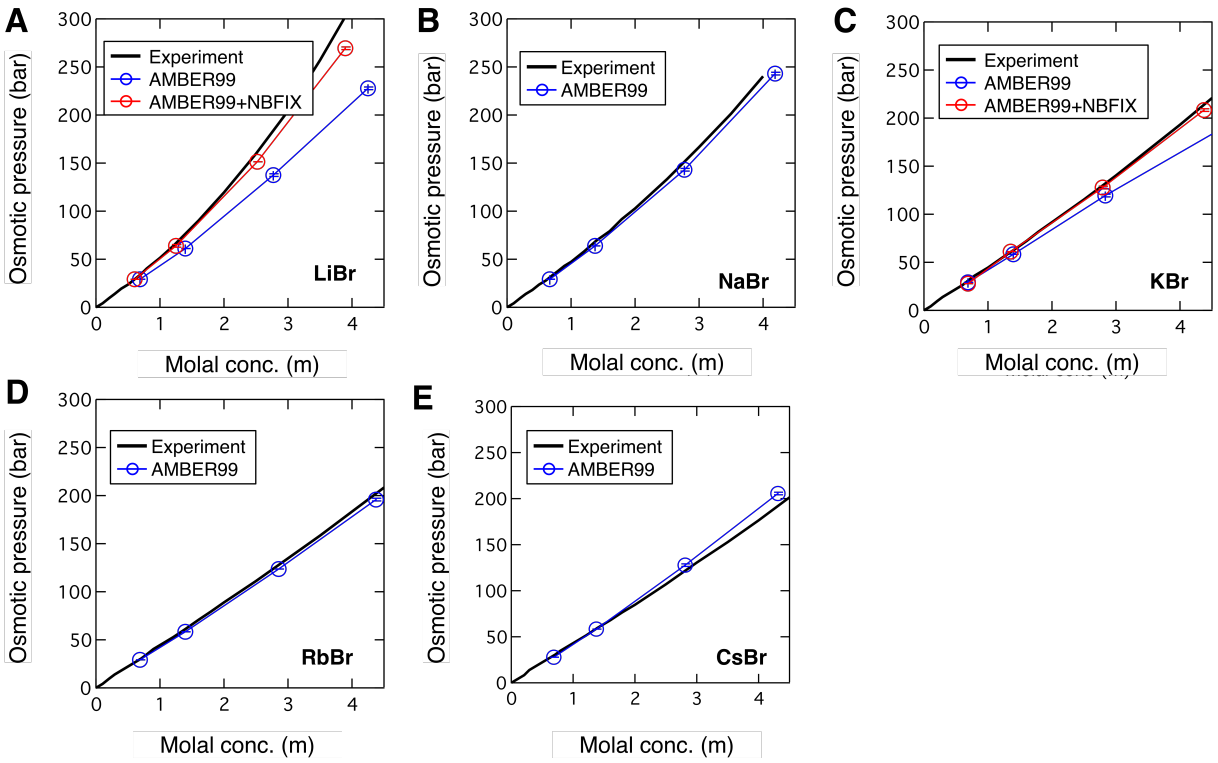

Figure S2: Validation and calibration of Li^+–Br^- (A), Na^+–Br^- (B), K^+–Br^- (C), Rb^+–Br^- (D), and Cs^+–Br^- (E) ion pair interactions for the AMBER ff99 force fields using osmotic pressure simulations. Standard ion parameters optimized for the TIP3P water were taken from Joung and Cheatham.[1] The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones σ parameters for cation–anion atom pairs. Experimental data were taken from Ref. 4. See Table 3 for the changes in σ parameters.

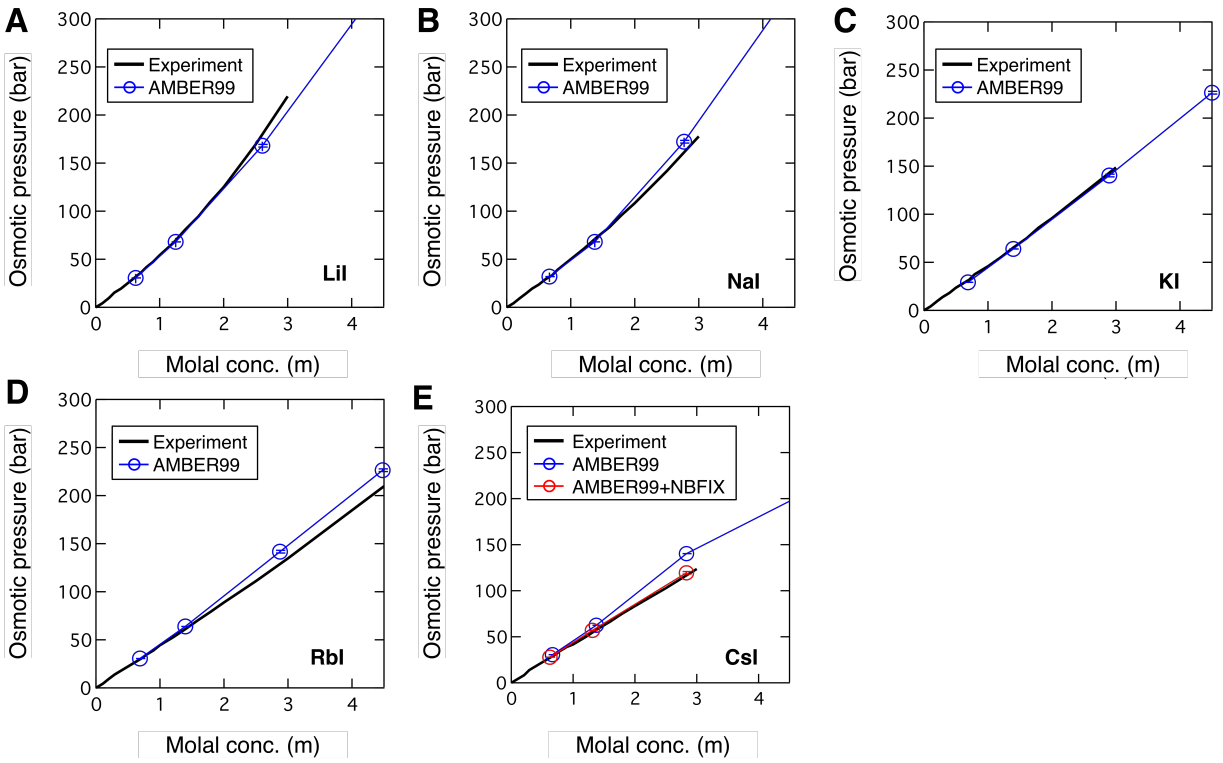

Figure S3: Validation and calibration of Li^+–I^- (A), Na^+–I^- (B), K^+–I^- (C), Rb^+–I^- (D), and Cs^+–I^- (E) ion pair interactions for the AMBER ff99 force fields using osmotic pressure simulations. Standard ion parameters optimized for the TIP3P water were taken from Joung and Cheatham.[1] The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones σ parameters for cation–anion atom pairs. Experimental data were taken from Ref. 4. See Table 3 for the changes in σ parameters.

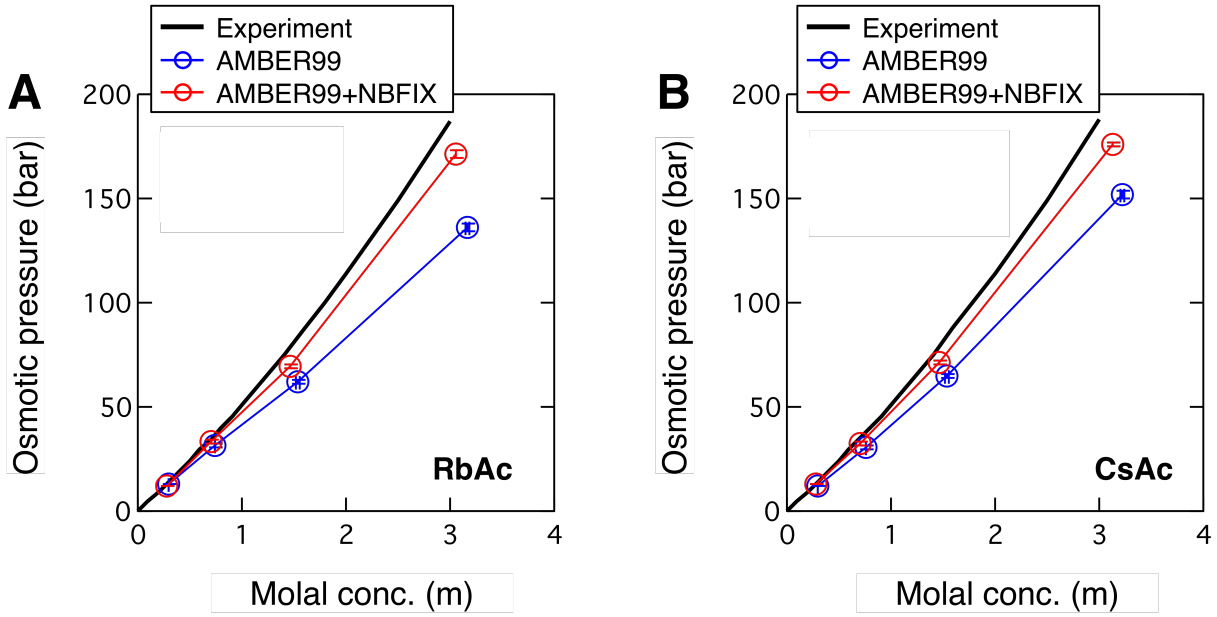

Figure S4: Validation and calibration of Rb^+–Ac^- (A) and Cs^+–Ac^- (B) ion pair interactions for the AMBER ff99 force fields using osmotic pressure simulations. Standard ion parameters optimized for the TIP3P water were taken from Joung and Cheatham.[1] Standard parameters for acetate were taken from AMBER ff99. The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones σ parameters for cation–acetate oxygen atom pairs. Experimental data were taken from Ref. 4. See Table 3 for the changes in σ parameters.

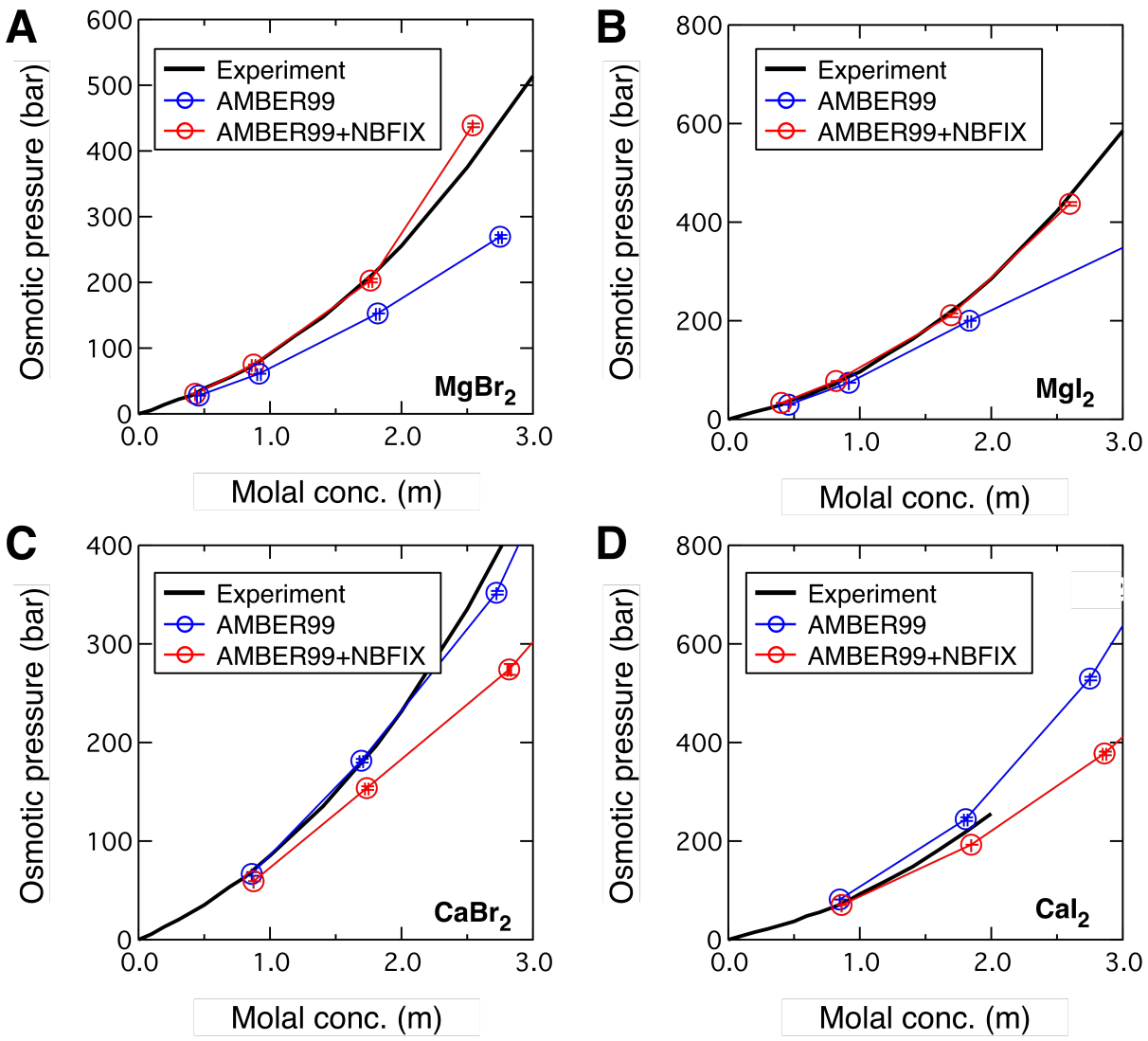

Figure S5: Validation and calibration of Mg^{2+}–Br^- (A), Mg^{2+}–I^- (B), Ca^{2+}–Br^- (C), and Ca^{2+}–I^- (D) ion pair interactions for the AMBER ff99 force fields using osmotic pressure simulations. Standard parameters for Mg^{2+} and Ca^{2+} were taken from the CHARMM36 force field.[5] In all calibration simulations that used NBFIX, Mg^{2+} and Ca^{2+} ions were in the hexahydrate and heptahydrate forms, respectively; the dipole moment of the water molecules forming hexa- and heptahydrates was adjusted to account for the polarization effect.[2] Standard parameters for Br^- and I^- were taken from Joung and Cheatham.[1] The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones $R_{\min}$ parameter of the hexa- or heptahydrate water oxygen – anion atom pairs. Experimental data were taken from Ref. 4. See Table 3 for the changes in σ parameters.

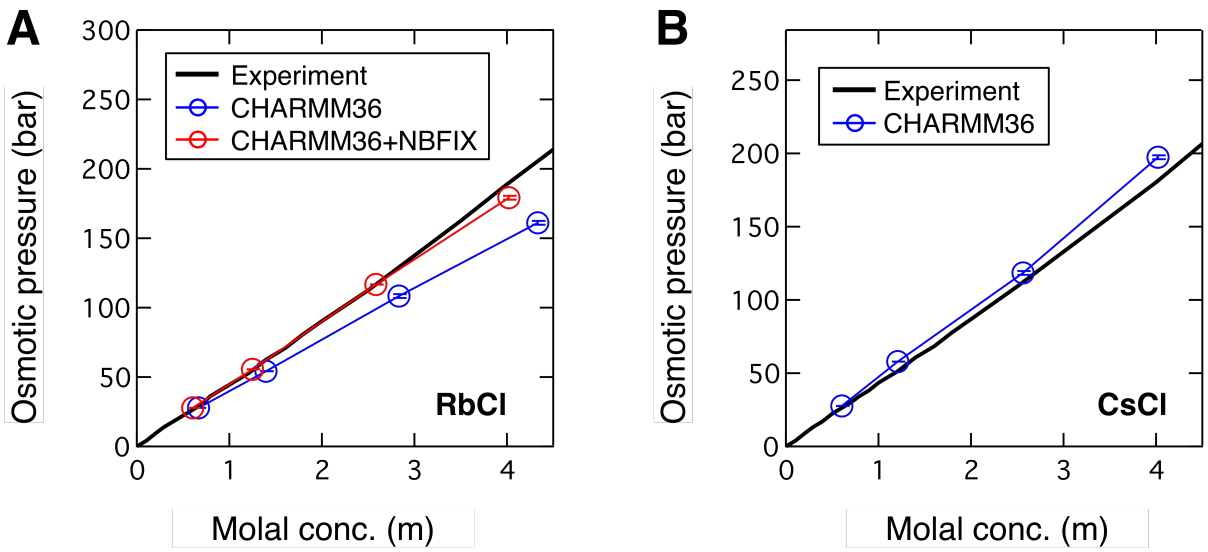

Figure S6: Validation and calibration of Rb^+–Cl^- (A) and Cs^+–Cl^- (B) ion pair interactions for the CHARMM36 force field using osmotic pressure simulations. The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones $R_{\min}$ parameters for cation–anion atom pairs. Experimental data were taken from Ref. 4. See Table 4 for the changes in $R_{\min}$ parameters.

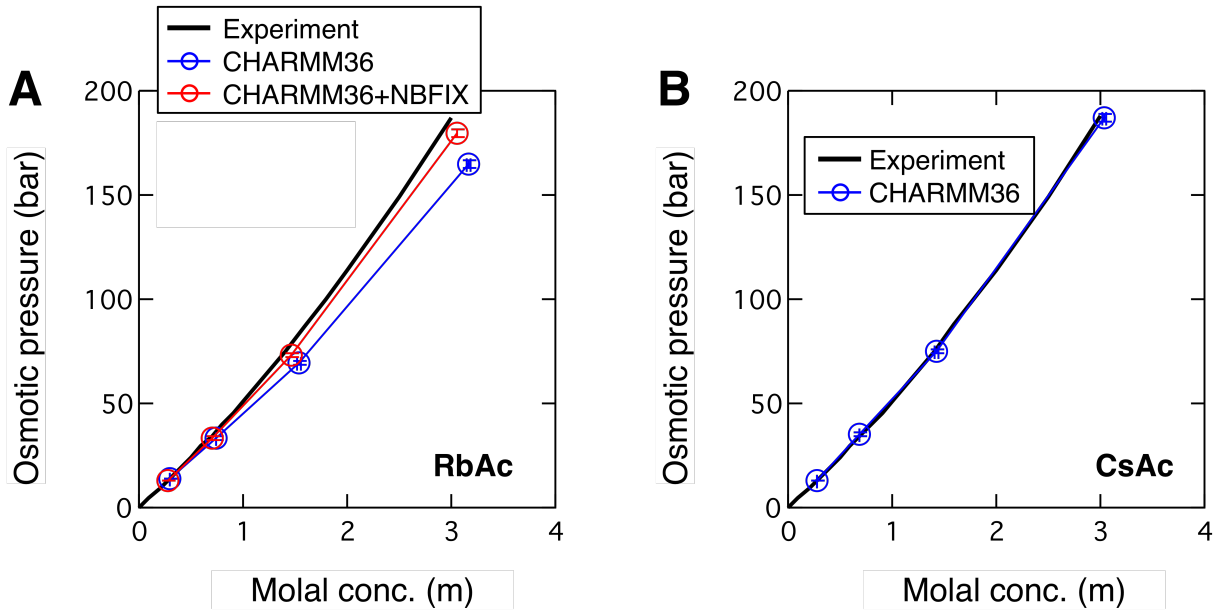

Figure S7: Validation and calibration of Rb^+–Ac^- (A) and Cs^+–Ac^- (B) ion pair interactions for the CHARMM36 force field using osmotic pressure simulations. The simulation method for computing osmotic pressure was similar to that used in Ref. 2 and 3. NBFIX corrections, if necessary, were applied to the Lennard-Jones $R_{\min}$ parameters for cation–acetate oxygen atom pairs. Experimental data were taken from Ref. 4. See Table 4 for the changes in $R_{\min}$ parameters.

References

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(3) Yoo, J.; Aksimentiev, A. Improved Parameterization of Amine–Carboxylate and Amine–Phosphate Interactions for Molecular Dynamics Simulations Using the CHARMM and AMBER Force Fields. *J. Chem. Theory Comput.* **2016**, *12*, 430–443.

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