

# Supplemental materials of [Net Motion of a Charged Macromolecule in a Ratchet-Slit]

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## 1 The effect of counter-ions

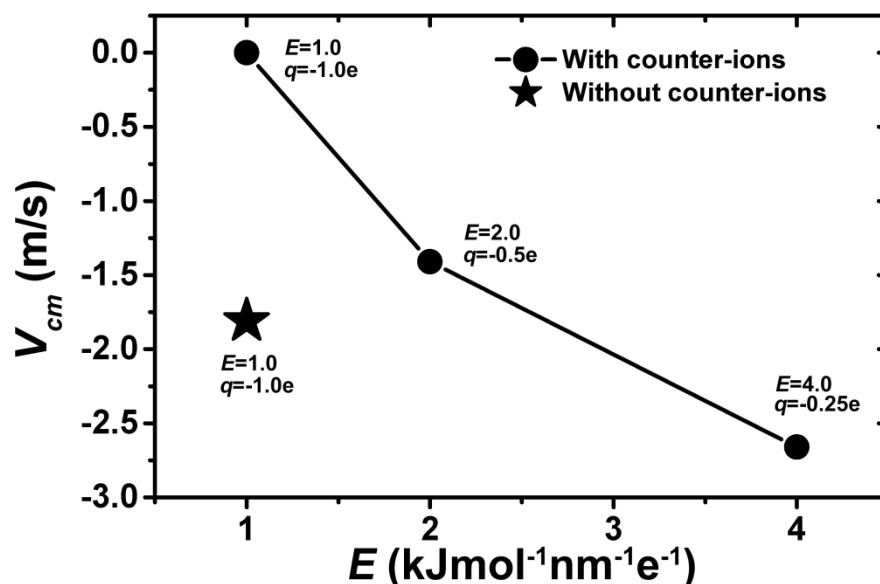


Fig. s1 Centre of mass velocity ( $V_{cm}$ ) of the C type macromolecule in the ratchet slit system with  $g=1.44\text{nm}$  and  $f=2.5\text{GHz}$  with and without counter-ions. See the text for details.

The counter-ions play important roles in the transport of charged macromolecules in aqueous solution which should maintain electrical neutrality. In order to evaluate the influence of counter-ions on the macromolecular transport in the ratchet slit system, we perform a simple test. In our test, each charged unit in the macromolecule is neutralized by one counter-ion with the same amount of opposite charges. Particularly, within the electric field, we kept the electric driving force on each charged unit as  $F=1.0\text{ kJ mol}^{-1}\text{ nm}^{-1}$ . By changing the intensity of the external electric field as  $E=1, 2$ , and  $4$  and the charge on each charge unit as  $q=1e, 0.5e$ , and  $0.25e$ , the attraction between ions-pair become gradually weak. We measure the centre-of-mass velocity ( $V_{cm}$ ) of the macromolecule (see solid circle dot Fig. 1s,) in the ratchet slit system with  $g=1.44\text{nm}$  and  $f=2.5\text{GHz}$ . From Fig. 1s, it is found that when the electric field is small compared with the interaction between ions-pair, the net motion is greatly reduced because the driving force on the ions-pair is a balance force. When the electric field is strong enough to separate the ions-pair, the charged macromolecule will move forward and backward, then the net motion become obvious. As a comparison, we also provide the system without counter-ions, where the net motion of the macromolecule becomes obvious at relatively weak electric field. Since our research target in this article is to explore the interplay between macromolecule and solvent in ratchet system, in our main text, we ignore the counter-ions for simplicity and clarity. A more detailed investigation about the transport behavior of charged macromolecule influenced by counter-ions in the ratchet slit system is on-going now.