One-way rotation of a single molecule-rotor

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Passing through a molecule-motor, the tunneling current shot noise can drive the one-way rotation of its rotor [1,2,3]. Here the local quantum access to the vibronic modes of its first excited states is delivering minute energy to this rotor using the very local tunneling inelastic effect induced by the STM tip with a precision better that 10 pm [4,5]. We demonstrate that a ratchet-like ground state rotation potential energy curve is not necessary for the rotation to occur and anyway the micro-reversibility principle forbid the existence of such a ground state [6]. We will show that a relative shift in energy between the maxima of this ground state and the minima of the employed excited states is necessary to reach a unidirectional rotation. The rotor speed of rotation and its rotation direction are both controlled by this shift [6], pointing out the necessity of a careful design of both the ground and excited states of the next generation of molecule-motors to be able to generate a motive power at the atomic scale.

References

[1] U.G.E. Perera, F. Ample, H. Kersell, Y. Zhang, G. Vives, J. Echeverria, M. Grisolia, G. Rapenne, C. Joachim and S.-W. Hla, Nature Nano, 8, 46 (2013).
[2] P. Mishra, J.P. Hiel, S. Vijayaraghavam, W.V. Rossom, S. Yoshizawa, M. Grisolia, J. Echeveria, T. Ono, K. Ariga, T. Nakayama, C. Joachim and T. Uchihashi, NanoLett., 15, 4793 (2015).
[3] R. Ohmann, J. Meyer, A. Nickel, J. Echevaria, C. Joachim, F. Moresco and G. Cuniberti, ACS Nano, 9, 8394 (2015).
[4] M. Lastapis, M. Martin, D. Riedel, L. Hellner, G. Comtet, and G. Dujardin, Science, 308, 1000 (2005).
[5] F. Eisenhut, C. Durand, F. Moresco, J.P. Launay and C. Joachim Eup. Phys. Journ. AP, 76, 10001 (2016).
[6] J. Echevaria, S. Monturet and C. Joachim, Nanoscale, 6, 2793 (2014).