Conveyor belts on a nanometer scale

By Sherri Carmody

Researchers have uncovered a new way to control the motion of submicroscopic particles in artificial nanodevices and biological systems. The technique may deliver medications to specific cells or replace wires in molecular-sized electronic devices

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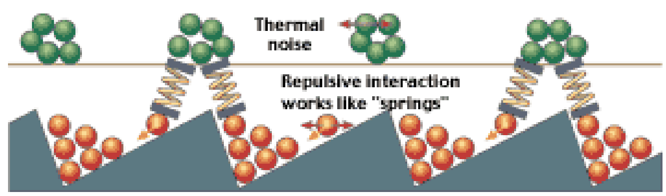
The idea, devised by a University of Michigan physicist and other researchers, is to add auxiliary particles that interact with the primary target particles. This makes it easier to control and manage how particles of interest flow. Ratchets, or asymmetrically shaped sawtooth substrates, can then make particles (ions or molecules) flow in one direction instead of wandering randomly.

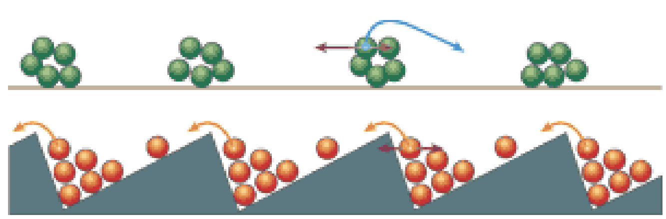
For example, if one species of particle repels the other, the two will drift in opposite directions. However, if they attract each other, the more active species will drag the passive one along. This indirect rectification of particle motion could be used to deliver or remove passive ingredients from a cell or from an artificial molecular-scale device. These tiny shuttles or microscopic conveyor belts might also act as new types of wires, replacing standard wires in nanodevices.

According to the team, injecting an appropriate density of passive particles can control the velocity of active particles, and vice versa.

How it works



At low temperatures, thermal noise is too weak to overcome the barriers. The red particles move toward the bottom of the grooves, pushing the green particles toward the substrate peaks.



At high temperatures, thermal noise shakes the particles strongly enough to make them jump over the barriers. The opposite spatial asymmetry for red and green balls pumps them in different directions.