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(G*) High-performance information engine.

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Information engines are the modern realization of the Maxwell demon, a thought experiment that revealed that information is also a thermodynamic quantity. We build and study a simple information-to-work engine, which consists of a heavy bead, in a water bath, trapped by optical tweezers. The bead undergoes Brownian motion due to the thermal fluctuations in the bath. The position of the bead is tracked at a high sampling rate (50 kHz) using a quadrant photodiode. Occasionally, when the bead fluctuates "up,"the position of the trap is also raised, thus converting information about the system's position into stored energy. The engine can also be designed to produce directed motion. Optimizing the feedback parameters, we found that maximum performance is obtained for continuous ratcheting. Also, the velocity is maximized for small bead diameters, whereas stored power is maximized for large bead diameters. Increasing the trap stiffness increases both. These observations are well explained by a recently developed theory based on mean first-passage times. By optimizing the feedback algorithm and experimental parameters, we have observed rates of energy storage of 1000 k_{B}T/s and directed velocities of 190 μm/s, numbers that are comparable to those observed in biological systems such as bacteria.

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