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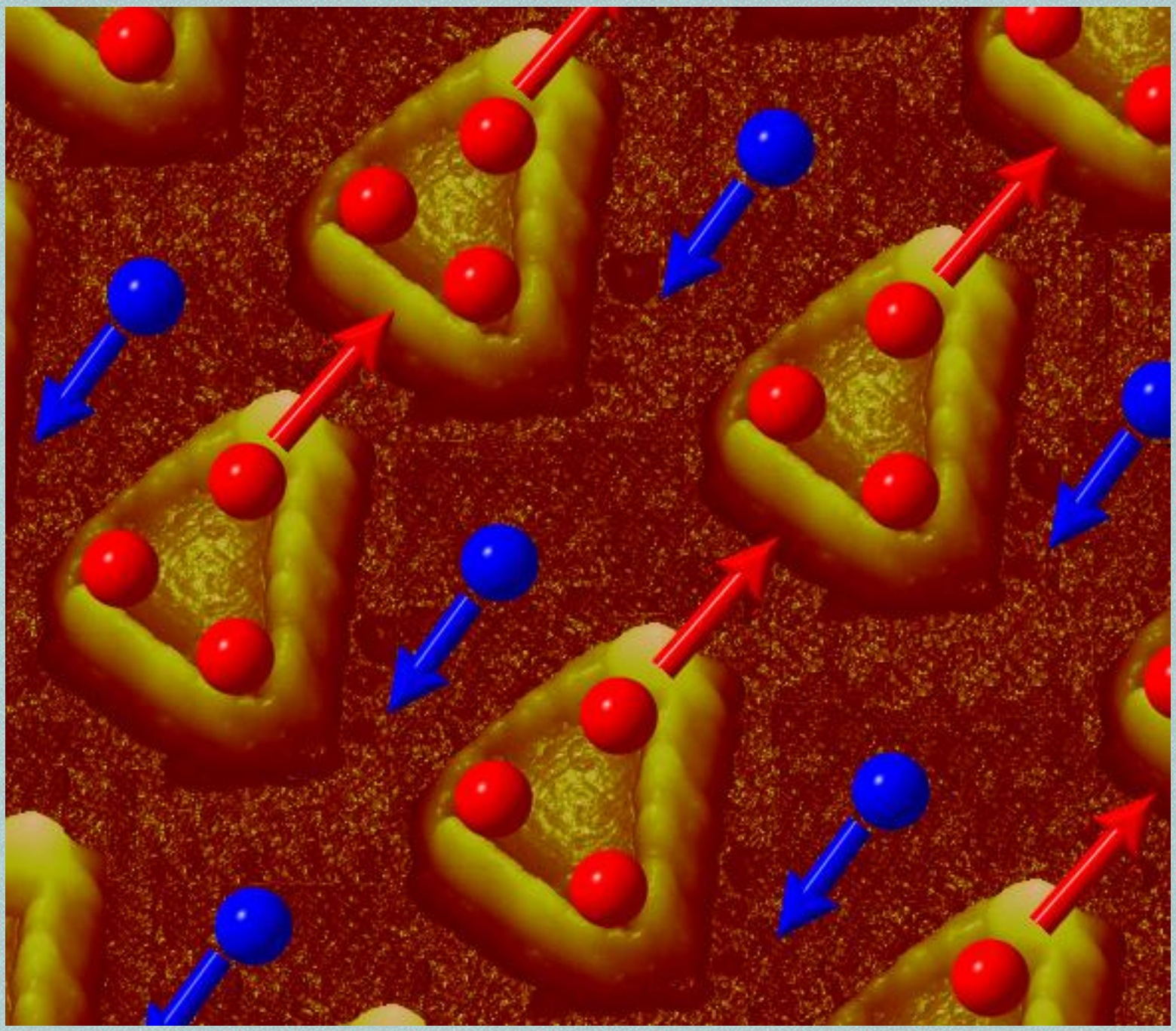

Magnetic Flux Quanta Reversible Rectifier

Source: Jose Luis Vicent and Franco Nori

References:

J.E. Villegas, Sergey Savel'ev, Franco Nori, E.M. Gonzalez, J.V. Anguita, R. García, J.L. Vicent , "Reversible Rectifier that Controls the Motion of Magnetic Flux Quanta in Superconductors,"
Science **302**, 1188 (Nov. 14, 2003)

Description:

We fabricated a device that controls the motion of flux quanta in a Niobium superconducting film grown on an array of nanoscale triangular pinning potentials. The controllable rectification of the vortex motion is due to the asymmetry of the fabricated magnetic pinning centers. The reversal in the direction of the vortex flow is explained by the interaction between the vortices trapped on the magnetic nanostructures and the interstitial vortices. The applied magnetic field and input current strength can tune both the polarity and magnitude of the rectified vortex flow. Our ratchet system is explained and modeled theoretically considering the interactions between particles.

The control of the motion of vortices using asymmetric pinning can be useful for applications in superconductivity, including field-dependent reversible vortex diodes and the removal of unwanted trapped flux in devices. Several different ways of using asymmetric pinning in superconductors to control vortex motion have been recently proposed. However experiments in this area have been difficult to control.

Our device allows a versatile control of the motion of vortices in superconducting films. Simple modifications and extensions of it would allow the pile up (magnetic "lensing"), shaping, or "sculpting" of micro-magnetic profiles inside superconductors. Thus, vortex lenses made of oppositely-oriented triangles would provide a strong local increase of the vortex density at its "focus" regions. Thus, extensions of these type of systems should open new avenues for motion control of flux quanta and provide a first step towards a new generation of devices based on the flow of magnetic flux quanta.

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