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## Laws of Nature survive attack by Nano Demon

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### A devilishly clever idea has been turned into reality by scientists, reports Roger Highfield

The bold vision of a 19th century scientific pioneer has at last been realised by scientists to put a law of nature to the test.

James Clerk Maxwell, who is ranked alongside Newton and Einstein for his contributions to physics, imagined an atom-sized creature- known as Maxwell's Demon - that could trap molecules as they moved in a specific direction to see if he could challenge the Second Law of Thermodynamics, which says entropy (disorder) always increases and, as a consequence, bans perpetual motion machines.

Maxwell reasoned that if the Demon could be summoned up, he would need energy to work, otherwise the Demon could convert the random heat motion of molecules into useful work - for instance to drive a molecular machine forward - and thwart the Second Law.

Now scientists at the University of Edinburgh, inspired by Maxwell's thought experiment in 1867, have been able to create such a "nanomachine" for the first time with their own "demon" inside it to ensnare the molecules as they move. The work is published in the journal Nature by Professor David Leigh, of the University of Edinburgh's School of Chemistry.

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"Last year was the 175th anniversary of James Clerk Maxwell's birth in Edinburgh, so it is fitting that advances in science mean that we can finally create a machine like the hypothetical one he pondered over so long ago," he said.

The molecular incarnation of the demon is a rotaxane - a molecular ring threaded onto a central axle on the nanoscale (80,000 times smaller than a hair's breadth). "Our machine has a device - or 'demon' if you like - inside it that traps molecule-sized particles as they move in a certain direction," he said.

But it needs energy, in the form of light, to do work. Thus the Second Law lives to see another day and confirms what the great science populariser Sir Arthur Eddington wrote in 1927: "If your theory is found to be against the second law of thermodynamics, I can give you no hope; there is nothing for it but to collapse in deepest humiliation. "

Applications of the nanotechnology machine could include trapping molecules to generate a force in front of an object using a laser pen. By shining the pen in the direction you want the object to move, the force of the molecules could be harnessed to push the object along.

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