MagnetIsing : Non-linear wave phenomena and illustration of the Ising model in a chain of magnetic oscillators.

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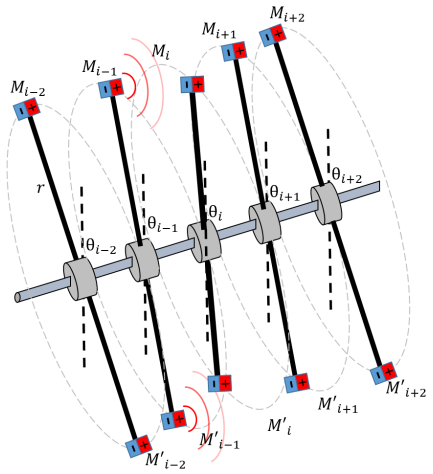

Figure 1. Our system consists of 1D chain of rods coupled together with magnets.

We investigate the physics of a series of coupled oscillators consisting of two magnets arranged symmetrically on rotating rods. The oscillators are coupled to each other by the magnetic fields allowing for an perturbation to propagate on the chain. The magnetic field allows coupling beyond the nearest neighbors making the system highly non-linear. In addition, for specific configurations with magnets of different strength on each rod there exists a lower energy state of the chain, creating a parallel to the Ising model. The setup was built using 3D printing materials. Using a stepper motor, a controllable excitation is sent and a camera tracks the movement of the oscillators to acquire the dispersion relation. It resembles the dispersion relation of a monoatomic chain [1] only partially matching analytical calculations which gives a non-linear wave equation. In the future, we want to try other configurations to enhance the second neighbor coupling in order to find unusual dispersion relations[2] such as a roton-like behavior [3]. Finally, we wish to develop the spin analogy with this mechanical system which has already achieved using coupled pendulums [4]. With this system, we hope to build a versatile experimental system with a "frugal/low-tech science" approach for both research in the field of wave physics, complex systems, statistical physics or spintronics and educational purposes to illustrate concepts to master level students that normally require expensive experiments.

Références

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4. V Leroy, J-C Bacri, T Hocquet and M Devaud, Simulating a one-half spin with two coupled pendula : the free Larmor precession, , Eur. J. Phys. 27 13632006, 10.1088/0143-0807/27/6/011