2D Claytronics Atom
Claytronics Atom Design Goals

• Large groups of units able to form arbitrary shapes
• Each unit capable of relative movement to others
• Units are externally powered
• Passive holding mechanism - units hold position in absence on external power
• Units capable of local communication with other units and possibly global communication
• Units can display at least one pixel of color
2D Design Specifications

• Cylindrical base made of multiple stacked plates
  ➔ Space efficiency in plane
• Electromagnetically controlled soft magnets
  ➔ Active relative motion
  ➔ Passive hold state in case of power loss.
• Specially constructed planar surface
  ➔ External power bus
  ➔ Communications
Controller Module

- 12 independent H-bridges for electromagnet control
- PIC 16F877 Microcontroller for high/low level interface
- Passthrough signal/control bus
Locomotion Module

- 12 Soft Magnets surrounded by electromagnetic coils
- Passthrough signal/control bus
Power Storage Module

- High Capacity Capacitor Bank
- Passthrough signal/control bus
Initial Prototype

Can it move?
How it works

Electromagnetic coils around AlNiCo magnets

High current discharge through the coil induces a large electromagnetic field, strong enough to permanently reverse magnet

Duration of discharge less than 1 millisecond! AlNiCo magnets in particular are both strong and very easy to reverse
Start of rotation
Field reversal, movement
Final state
Test setup

- Computer
  Keyboard interface
- Cerebellum Microcontroller
  Low level PIC-based controller
- Mosfet-based H-bridges
  High efficiency, scales down to small size
- Gauss Meter
  Field readings, outputs to scope
- Oscilloscope
  Monitors voltage, current, and gauss
- Prototype Catoms
  Guinea pigs
Rough numbers from current test setup

- Magnet Field Strength: 800 G
- Power required for field reversal:
  3A @ 15V for 10 ms (ten 1ms pulses)

Larger current $\rightarrow$ Higher field strength
Lower voltage $\rightarrow$ Easier to store onboard
Important Next Steps

• Mechanical measurements (force, torque)
• Planar surface & interface stack layer
• Maximize field while minimizing power
  – Coil construction
  – Different magnet geometry
• Create prototype stacks
• 3D!