Testing the Fundamental Symmetries Between Matter and Antimatter

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$$E = \pm mc^2$$
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All elementary particles have antiparticles
  ▶ Charge conjugation

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- All atoms can have antiatoms (p,n,e−|¯p¯n¯e+)
Antihydrogen Laser PHysics Apparatus

- (1928) Paul Dirac theorizes existence of the positron
- All elementary particles have antiparticles
  - Charge conjugation
- All atoms can have antiatoms ($p,n,e^-|\bar{p}\bar{n}e^+$)
- There should be matter-antimatter symmetry in the universe
- CPT Theorem and the Standard Model
  - Matter-antimatter asymmetry problem

**Dirac Equation**

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\[ E = \pm mc^2 \]
Antihydrogen Laser PHysics Apparatus

- Designed to build and trap cold antihydrogen
- Make precise spectroscopic comparison of H and $\bar{H}$
  - Ground state hyperfine splitting
- Determine inertial/gravitational mass
- Currently building the all new ALPHAg apparatus

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My Project: Serial Multiplexer

- Improve upon an existing piece of equipment (Serial Multiplexer)
  - Reduces the number of fiber cables between equipment
  - Helps to create a buffer between noisy equipment and the apparatus
My Project: Attacking the Problem

- Built around the Arduino Microcontroller
- Tested the limitations of the Arduino to maximize outputs and minimize transmission time
- Coding to manipulate port registers
My Project: Attacking the Problem

- Design the circuit and printed circuit board using Altium Designer

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My Project: Attacking the Problem
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My Project: Results

- Improvements I made:
  - Each board now has 18 i/o’s respectively, previously 8
  - Each box holds 2 boards, previously 1
  - Made opening for USB port for easily upgrading firmware and software
  - Fixed a reset problem found in previous version
Final Thoughts

- Met some really great down to Earth physicists
- Look forward to hearing about the results from the ALPHAg experiment this fall
- Why did I come here? What did I find?

I ❤ Experimental Physics
Special Thanks

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