Development of the General Antiparticle Spectrometer

- A Balloon-Based Search for Dark Matter -

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What is Dark Matter?

Supersymmetry
- Neutralino
  - Lightest Supersymmetric Particle (LSP)
  - Interacts with matter very weakly
  - Stable in cosmic time scale
  - Majorana particle
  - Is its own antiparticle and can co-annihilate

Universal Extra Dimension
- Right-Handed Neutrino (LZP)
- Kaluza-Klein Particle (LKP)

Direct Search
- Underground detection of nuclear recoils

Indirect Search
- Detect annihilation products

3rd generation experiments
- ~ 1 ton targets

Why Antideuteron?

Background Free at Low Energy!

Probe Unique SUSY Space

Detect Atomic X-rays and Pions
- A time of flight (TOF) system tags candidate events and records velocity & angle
- The antiparticle slows down & stops in a target material, forming an excited exotic atom
- De-excitation X-rays provide signature
- Nuclear annihilation produces Pions

GAPS Detector
- 13 layers composed of Si(Li) wafers
  - Relatively low Z material, 2mm thick
  - Segmented into 8 strip
  - 3D particle tracking
  - Timing: ~50 ns
  - Energy resolution: ~2 keV
  - Proven technology dating from the 1960s

Surrounded by Plastic TOF
- Identify incoming charged particles
- Dual channel electronics

Si(Li) Fabrication
- Active Area: 69.4 cm
- Ø = 102 mm
- Ø = 94 mm
- 2.5 mm thick
- 5-200 keV: X-rays
- 0.1-200 MeV: charged particle

P-bar/D-bar Identification Technique
- TOF stops sooner
- Pion Multiplicity
- D-bar produces twice of pions as P-bar

Flight Schedule

2011: Prototype flight from Hokkaido, Japan
- Install ~10 commercial (SEMIKON) and a few of our in-house homemade Si(Li)
- Demonstrate:
  - Stable, low noise Si(Li) with polymer coating at float altitude & ambient pressure
  - Basic functionality and operation of the TOF system
  - Si(Li) cooling approach & deployable sun shades (Verify thermal model)
  - Measure incoherent background level in a flight-like configuration

2014: LDB flight from Antarctica