Dark Matter Programs at UCLA

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UCLA Dark Matter Programs

- **Direct Search**
  - *David Cline, Katsushi Arisaka, Hanguo Wang*
    - $\text{Xe} : \text{ZEPLIN-II} \rightarrow \text{XENON100} \rightarrow \text{XENON 1Ton}$
    - $\text{Ar} : \text{DarkSide50} \rightarrow \text{DarkSide 5Ton}$
    - $\text{G3} : \text{MAX, XAX}$

- **Indirect Search**
  - *Rene Ong*
    - VERITAS $\rightarrow$ GAPS
  - *Vladimir Vassiliev*
    - VERITAS $\rightarrow$ CTA
  - *David Saltzberg*
    - ANITA

- **Theory**
  - *Graciela Gelmini*
    - DAMA/CoGeNT
  - *Alex Kusenko*
    - Sterile Neutrino
XENON100 Detector

162 kg
(48 kg)
90% CL Limits of SI Cross Section

100 days, 48 kg, 3 events
QUPID (QUartz Photon Intensifying Detector)

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10 m x 10 m water shield
active muon veto

XENON1T

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ICARUS

XENON1T

LNGS Hall B

WARp

2.5 t Active LXe

3” QUPID
(121 top, 121 bottom)

Titanium Vessels
(5 mm x 2, 400 kg)
DarkSide 50 kg $\rightarrow$ 5 Ton

Hanguo Wang

CTF Water Tank

Liquid Scintillator

3" QUPID (19 top + 19 bottom)

Depleted Ar (50 kg)
90% CL Limits of SI Cross Section

WIMP Mass [GeV/c²]

WIMP-Nucleon Cross Section [cm²]

DAMA/Na
CoGeNT
CDMS
EDELWEISS
ZEPLIN III

Buchmueller et al.

DAMA/I

XENON100 (2010)
XENON100 (2011)
XENON100 (2012)

Argon 5 ton-year
Xenon 1 ton-year
Xenon 10 ton-year

Argon 50 ton-year
DarkSide-50 0.1 ton-year

G1
G2
G3
Indirect WIMP Detection

Rene Ong, Vladimir Vassiliev

WIMP Annihilation (e.g. GC)

Telescopes

\( \gamma \) VERITAS, HESS, Fermi ...

\( \nu \) IceCube

Cosmic Ray Expts

\( e^- \) ATIC, Fermi ...

\( e^+ \) Pamela, AMS

\( p \) HEAT, Pamela, AMS

\( d \) GAPS

decreasing background

VERITAS, HESS, Fermi ...

IceCube

ATIC, Fermi ...

Pamela, AMS

HEAT, Pamela, AMS

GAPS

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VERITAS

12m reflector, f1.0 optics
350 Mirror Facets
500 pixel Camera

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Cherenkov Telescope Array

Vladimir Vassiliev

Low-energy section
energy threshold
of 20-30 GeV
~24m telescopes

Medium Energies:
mCrab sensitivity
100 GeV–10 TeV
12m telescopes

High-energy section
10 km² area at
multi-TeV energies
~5m telescopes
GAPS consists of two detectors (acceptance ~2.7 m$^2$sr):

**Si(Li) Detector (target and tracker):**
- Si(Li) tracker: 13 layers of Si(Li) wafers
- relatively low Z material
- good X-ray resolution
- circular modules segmented into 8 strips
  - 3D particle tracking
- 270 per layer (total: ~3500)
- timing: ~50 ns
- dual channel electronics
  - 5-200 keV: X-rays (resolution:~2 keV)
  - 0.1-200 MeV: charged particle

**Time of flight and anticoincidence shield:**
- plastic scintillator with PMTs surrounds tracker
- track charged particles, dE/dX
- velocity measurement
- anticoincidence for charged particles

LD Balloon flight in 2015?
Production **color coded** by "**warmness** vs **coldness**":

- **Neutrino oscillations off resonance** [Dodelson, Widrow] No prerequisites; production determined by the mixing angle alone; no way to turn off this channel, except for low-reheat scenarios [Gelmini et al.]

- **Resonant neutrino oscillations** [Shi, Fuller] Pre-requisite: sizable lepton asymmetry of the universe. (The latter may be generated by the decay of heavier sterile neutrinos [Laine, Shaposhnikov])

- **Higgs decays** [AK, Petraki] Assumes the Majorana mass is due to Higgs mechanism. **Sterile miracle:** abundance a "natural" consequence of singlet at the electroweak scale

- **Split seesaw** [AK, Takahashi, Yanagida] Two production mechanisms, **cold** and even **colder**.
Compatibility of DAMA/LIBRA with Xe100 and Xe10

If $L_{\text{eff}}$ extrapolated as a constant or zero below 4 keVnr (band: shows how the 90%CL bound changes with 1σ change in $L_{\text{eff}}$) (Savage, Gelmini, Gondolo, Freese 1006.0972)

Graph showing the compatibility of DAMA/LIBRA with Xe100 and Xe10.
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