

Dark Matter Direct Detection and Phase Velocity Distribution

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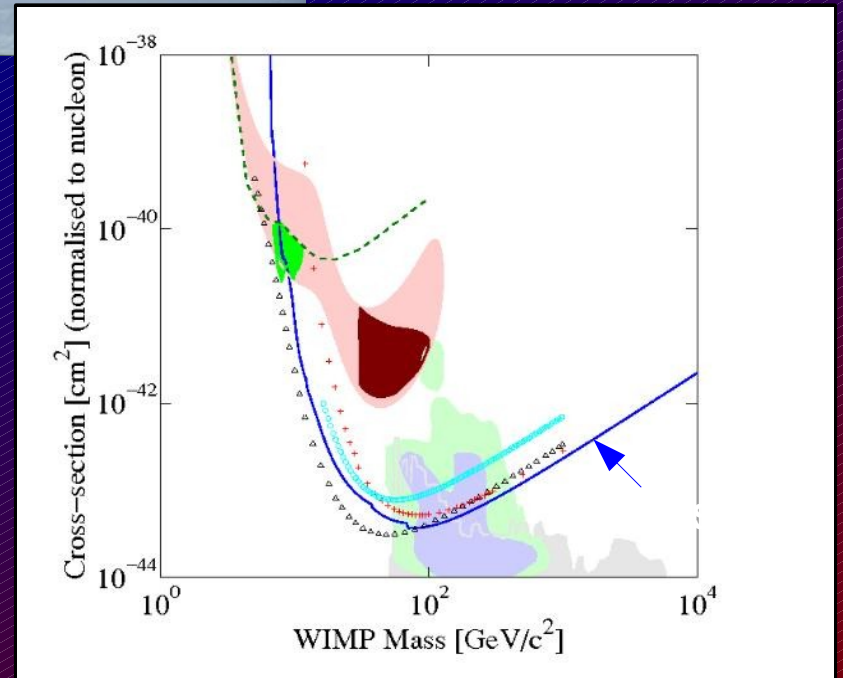
Cryogenic
Dark
Matter
Search
Experiment

physics@berkeley



“What's CDMS?”*

- Direct Detection of WIMPs
- Best limit on WIMP masses above 44 GeV/c^2
- Additional expected signatures: Modulation & Directionality



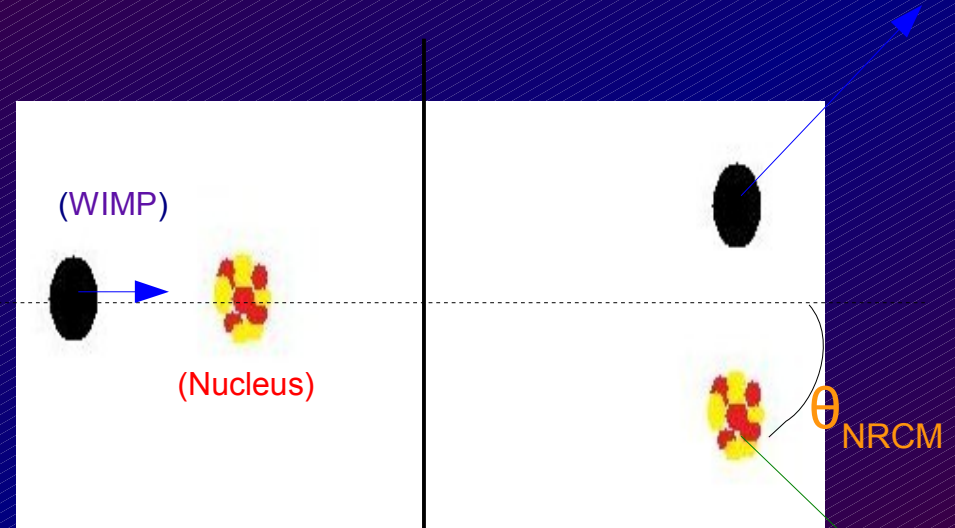
*See talk by T. Doughty, “The Cryogenic Dark Matter Search Experiment”, Session V.

Motivation

Standard Models

- Maxwellian velocity distributions
- Sharp cutoff at escape velocity
- Elastic Scattering of WIMPs from nuclei

Reasonable, but possibly oversimplified



Motivation

I. DAMA: Possible Reconciliation?

Excited dark matter:
Inelastic scattering

$$\chi \rightarrow \chi^*$$

$$\delta < \frac{\beta^2 m_\chi m_N}{2(m_\chi + m_N)}$$

Scattering
threshold
proportional
to velocity

Varies with m_N
(Ge vs. NaI vs.
Xe, etc.)

II. Possible Detection of Streams?

- *Do they exist?*
- *Steps in distribution?*
Anisotropies in angular distribution?
- *Sensitivity?*

Implementation

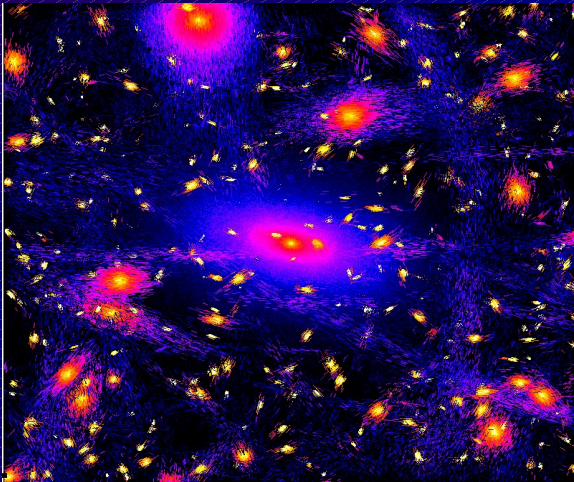
- MC Integration of velocities
- Metropolis rejection implementation of form factor

Testing

- Maxwell Distribution
- Elastic Scattering

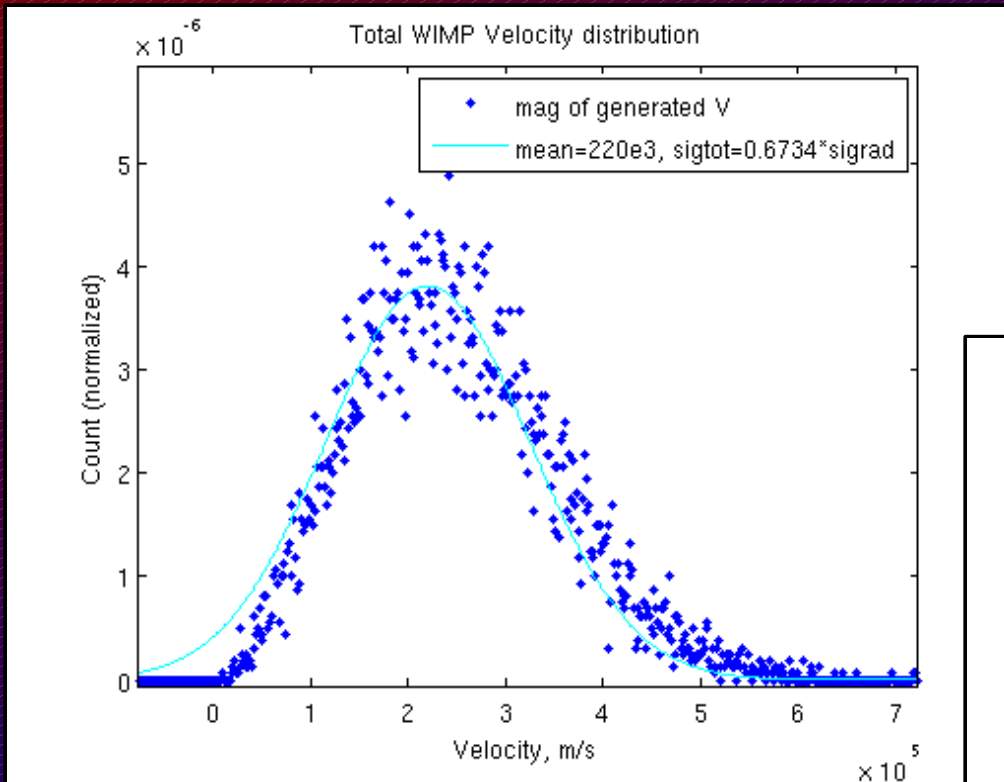
$$E_N = m_N \frac{m_l^2 v_l^2}{(m_l + m_N)^2} (1 - \cos\theta_{NRCM})$$

Next steps: *Simulation Distributions & More*

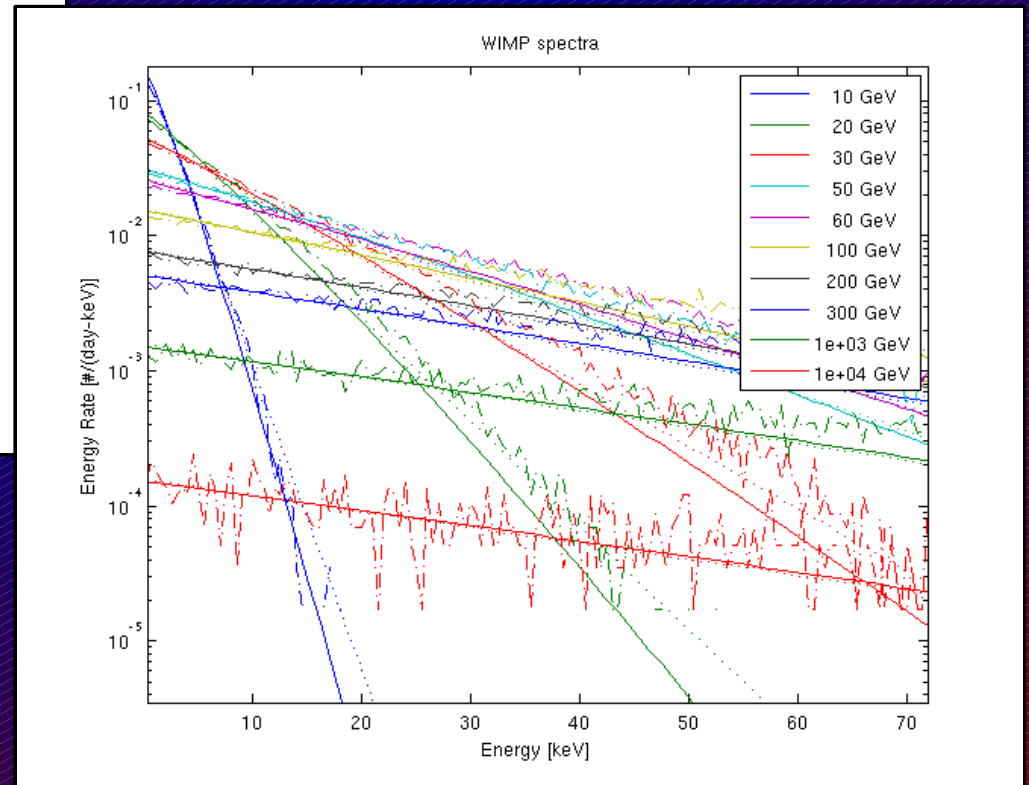


- Via Lactea II (Kuhlen et al; left)
- Aquarius (Vogelsberger et al)

Preliminary...

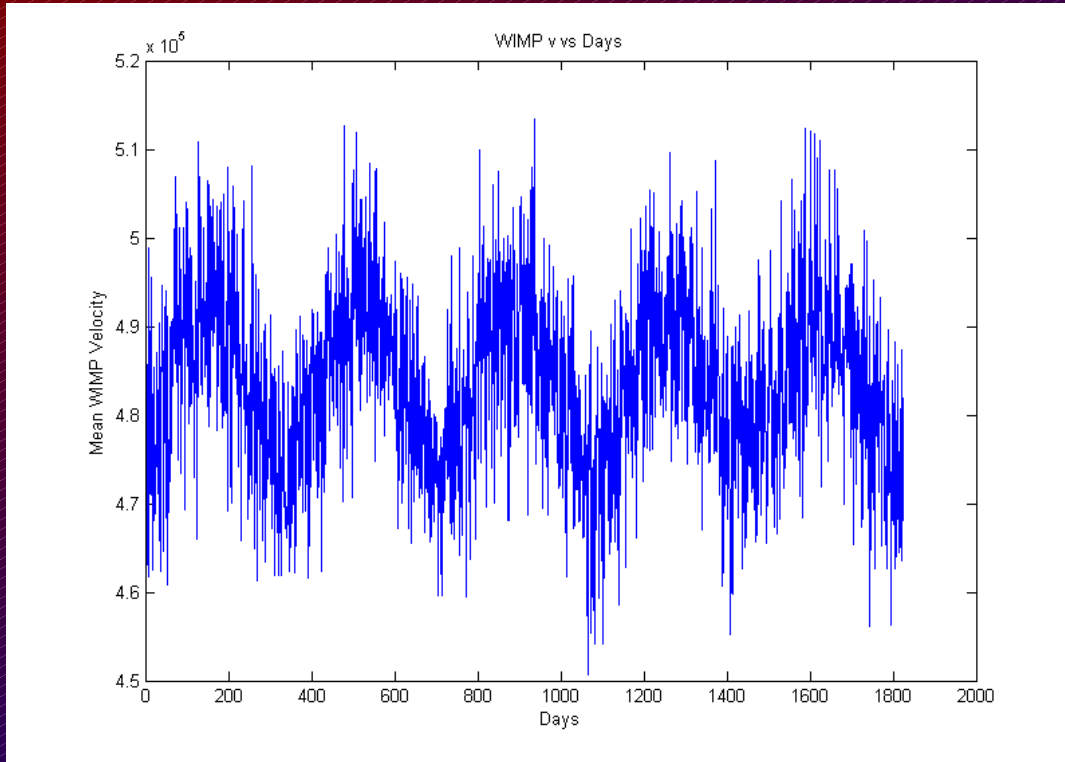


Sample Test distribution:



Wimp Spectra: rate vs. recoil energy (for several WIMP masses):

modulation:



Periodic change in WIMP rate
over time; period ~ 1 year

- FUTURE:
- Rotation of earth
 - Streams?



:directionality

In Short...

- Currently:
 - Maxwell distributions
 - Sharp cutoffs
- More sophisticated analysis may shed light on
 - expected rates; possibility of detecting streams
 - resolution of conflict of DAMA results with other dark matter searches
- Simulated distributions + direct detection → information on expected rates, modulation, directionality
- Work in Progress!