Implications of CoGeNT's New Results For Dark Matter

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Original CoGeNT Excess

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The Dark Matter Interpretation

- Approximately 100 events above known backgrounds over 56 days of data
- Data is well fit well by elastically scattering dark matter plus backgrounds (2 L-shell peaks + constant)
- Dashed line is the dark matter signal alone
CoGeNT excess in the mass, cross-section plane

Within the standard halo model, the elastic cross section is constrained within an order of magnitude.

There is a region that could produce both the CoGeNT excess and the DAMA modulation.
Our Prediction: CoGeNT after 1 year

CoGeNT (projected)
- $m_{DM}=8.0$ GeV
- $\sigma_{DM-N}=1.0 \times 10^{-4}$ pb
- $v_0=250$ km/s
- $v_{esc}=550$ km/s
A little more than one year of CoGeNT data

Still consistent with DAMA modulation for a large quenching factor

Well fit by 7 GeV WIMP with $\sigma_n = 1.2 \times 10^{-40} \text{ cm}^2$
Dark Matter Should Have Annual Modulation

http://www.hep.shef.ac.uk/research/dm/intro.php
Velocity Distribution of Dark Matter

Prediction for CoGeNT after 1 year: Annual Modulation

These confidence levels normalize the winter rate to 100 events in 56 days
Modulation in the data

- We find modulation of $16\pm5\%$ at the 2.7 sigma level
- The best fit to the peak is found to be at April $18\pm16$ days
- DAMA peak is May $16\pm7$ (2-4 keVee range) or May $26\pm7$ (2-6 keVee range)
- N-body simulations of galaxy formation find 68% of models have a peak within 20 days of late May/early June
More Modulation Than Expected

The grey contours give our prediction of the percentage modulation at CoGeNT for the given mass and cross section. The solid and dashed regions are the 90 and 99% preferred regions for the excess for the given halo parameters.
There is more modulation at higher energies than predicted in the standard halo model.
Tension with current limits

\[ \sigma_{\text{DM-N}} \text{ (cm}^2\text{)} \]

- $v_0 = 220 \text{ km/s}$
- $v_{\text{esc}} = 544 \text{ km/s}$

Diagram showing a contour plot with labels for experimental data points such as XENON100 and CDMS.
What would this particle look like at other detectors?

Preliminary CRESST results

COUPP, Winter
- $m=7$ GeV
- $\sigma=1.2\times10^{-40}$ cm$^2$

COUPP, Summer
- $m=7$ GeV
- $\sigma=1.2\times10^{-40}$ cm$^2$

CRESST (Oxygen)
- $m_{\text{DM}}=6.8$ GeV
- $\sigma_{\text{DM-N}}=1.58\times10^{-4}$ pb

Events (per day)

Counts/keV

Recoil Energy Threshold (keV)
C4 Detector

\[ \sigma_{\text{DM-N}} \text{ (pb)} \]

\[ \text{v}_0 = 320, 250, 180 \text{ km/s} \]

\[ v_{\text{esc}} = 460–640 \text{ km/s} \]

2.5 kg CoGeNT (99% CL)

\[ m_{\text{DM}} \text{ (GeV)} \]

\[ \text{Percentage Modulation} \]

CoGeNT (2.5 kg–years, projected)

\[ m_{\text{DM}} = 8.0 \text{ GeV} \]

\[ \sigma_{\text{DM-N}} = 1.0 \times 10^{-4} \text{ pb} \]

\[ v_0 = 250 \text{ km/s} \]

\[ v_{\text{esc}} = 550 \text{ km/s} \]

\[ E \text{ (keVee)} \]
Future Outlook

- Although many questions still exist, the dark matter interpretation of the CoGeNT excess is still viable
- CoGeNT is continuing to take data and understand more about their detector. We look forward to seeing if the modulation signal continues to increase in significance
- First C4 detector to be constructed soon
- We are very excited to learn about the CRESST Results at TAUP (Sep. 6)