Dark Matter Searches

Andrew Wagner

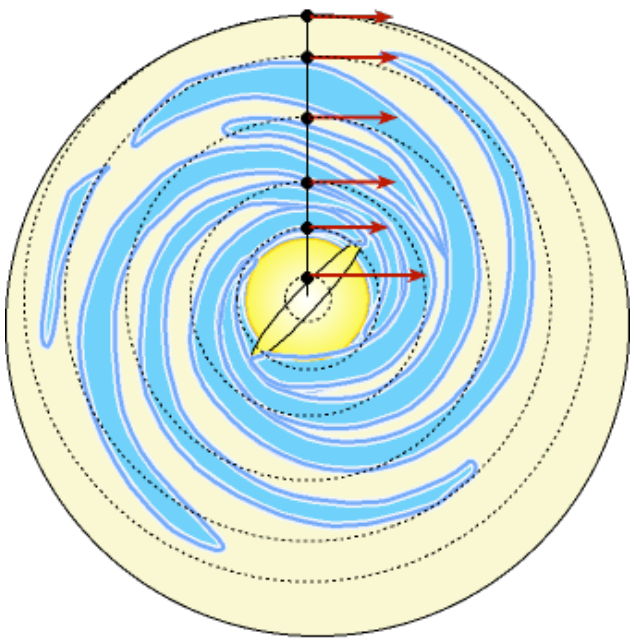
SASS Presentation

April 8, 2009

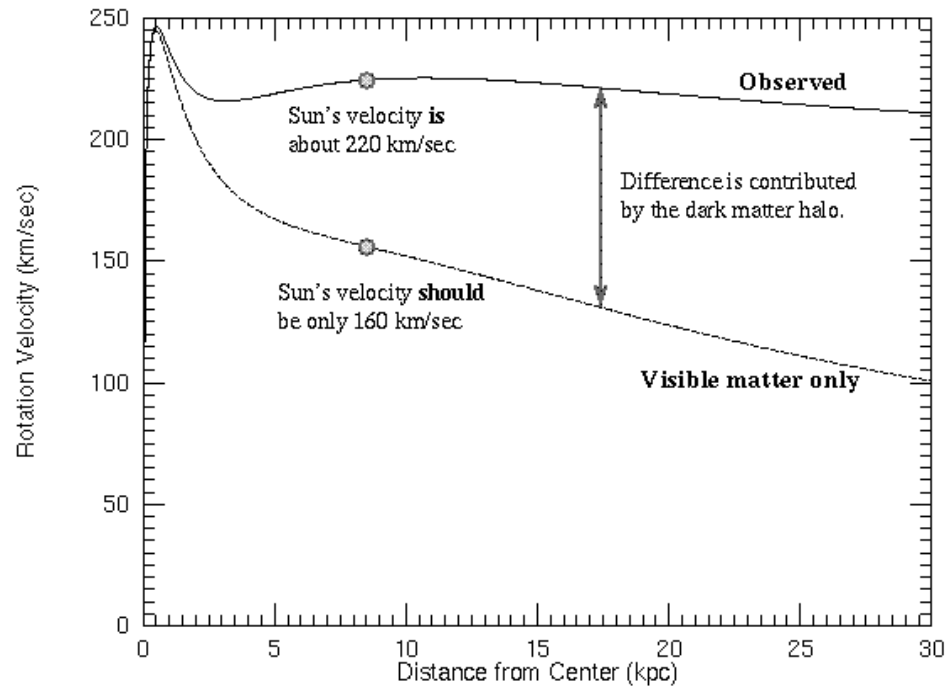
Outline

- If its Dark how do we know its there?
- What could it be? (What is it?)
- How could it be directly detected?
- What are present limits set by two experiments.
- What will we know in the next few years.

Pin Wheel, Pin Wheel Spinning Around ...



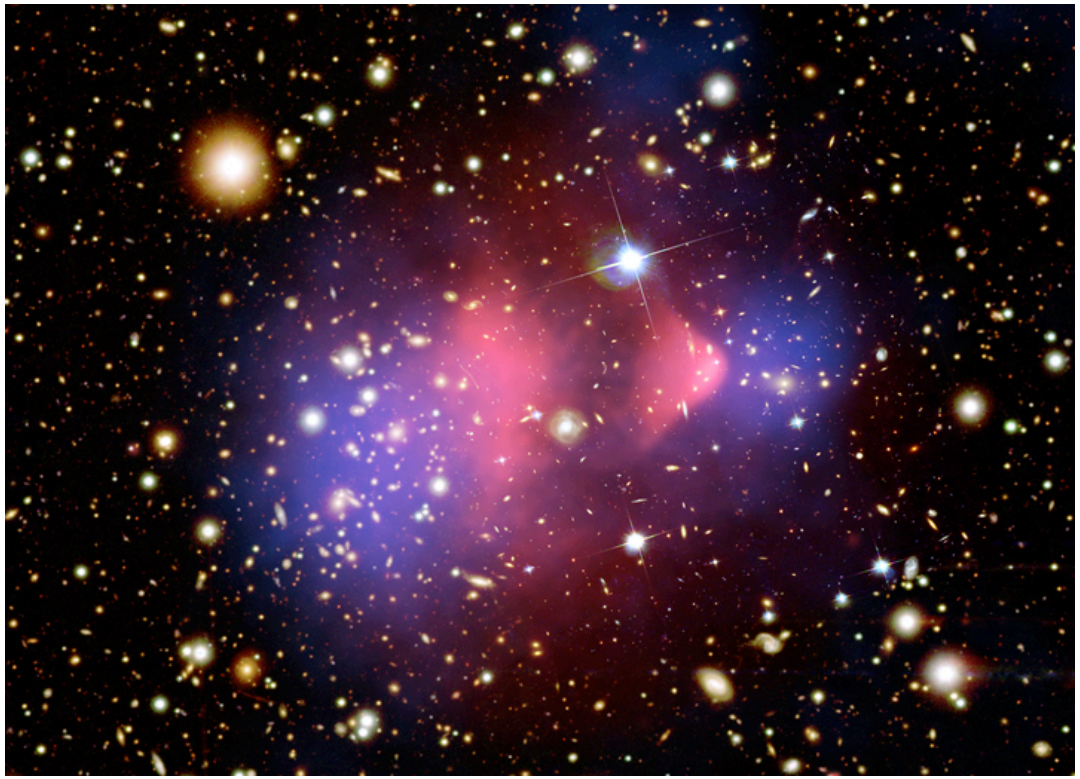
The mass inside an orbit can be found using the size of the orbit and the orbital speed. The arrows show the speeds for certain points on the **rotation curve** for this galaxy.



The gravity of the visible matter in the Galaxy is not enough to explain the high orbital speeds of stars in the Galaxy. For example, the Sun is moving about 60 km/sec too fast. The part of the rotation curve contributed by the visible matter only is the bottom curve. The discrepancy between the two curves is evidence for a **dark matter halo.**

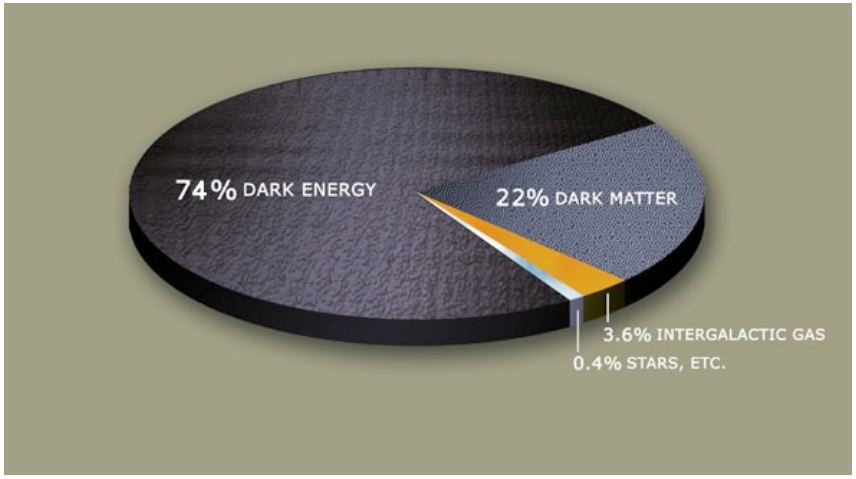
This page was copied from Nick Strobel's Astronomy Notes. Go to his site at www.astronomynotes.com for the updated and corrected version.

Double Vision



Hot Gas (X-ray)

Inferred Distribution of matter from lensing



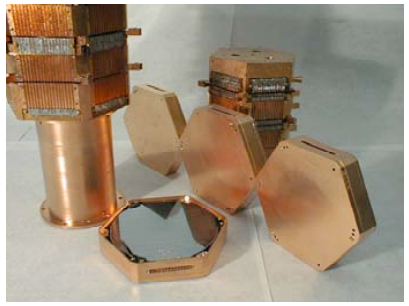
What could it be...

- Massive Compact Halo Objects (MACHOS): Brown Dwarfs, 100M Black holes ...
- Axions: Needed to solve Strong CP problem could be massive enough to explain dark matter
- Lightest Particles: Under R or K parity conservation the lightest SUSY or KK particle would be stable and only weakly interacting. Collectively these are known as WIMPS (weakly interacting massive particles)

A tale of two technologies

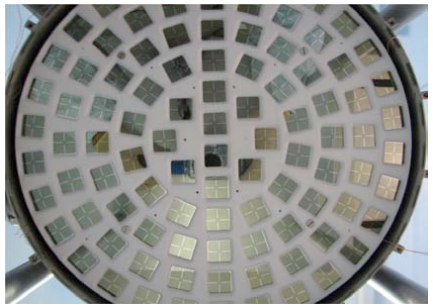
CDMS
EDELWEISS

Ge, Si



Bolometers: Semiconducting crystals which detect lattice vibrations (phonons) from WIMP interactions.

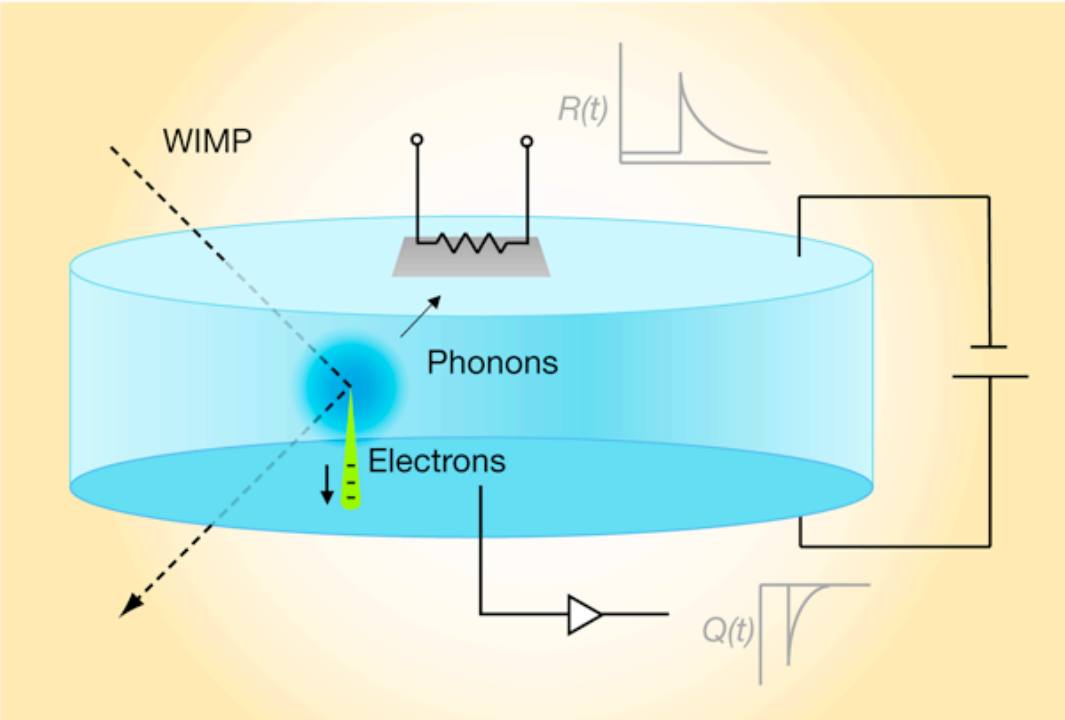
Noble Liquid Scintillators: Tanks of noble liquids which detect scintillation (photons) from WIMP interactions.

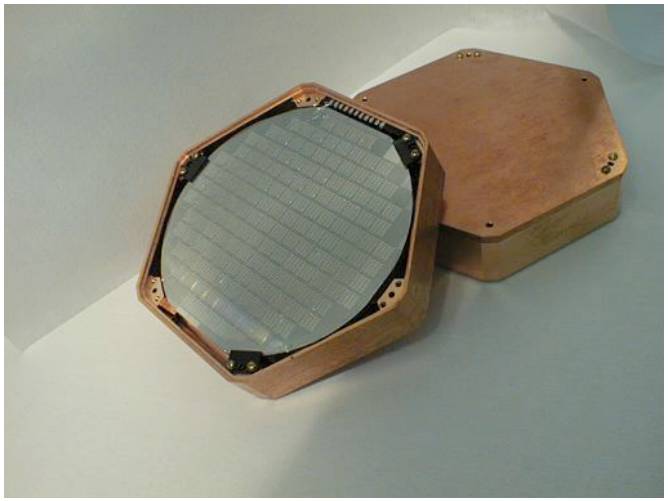


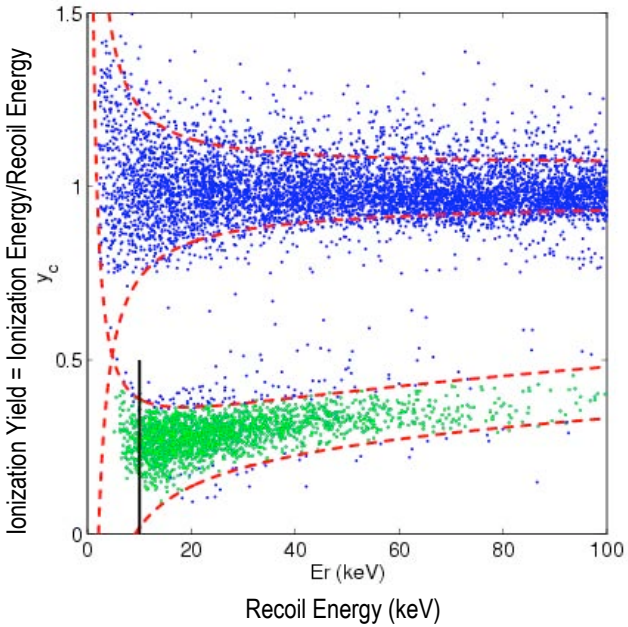
ZEPLIN, XENON,
WArP, ArDM

Xe, Ar

Bolometers



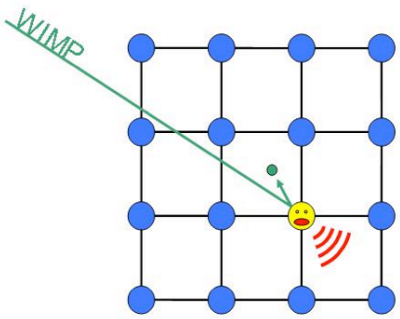




Gamma Calibration Ba(133)

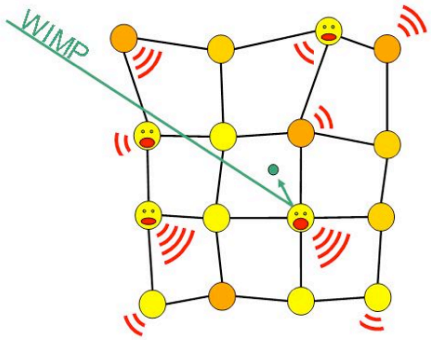
Neutron Calibration Cf(252)

Bolometers....brrrr



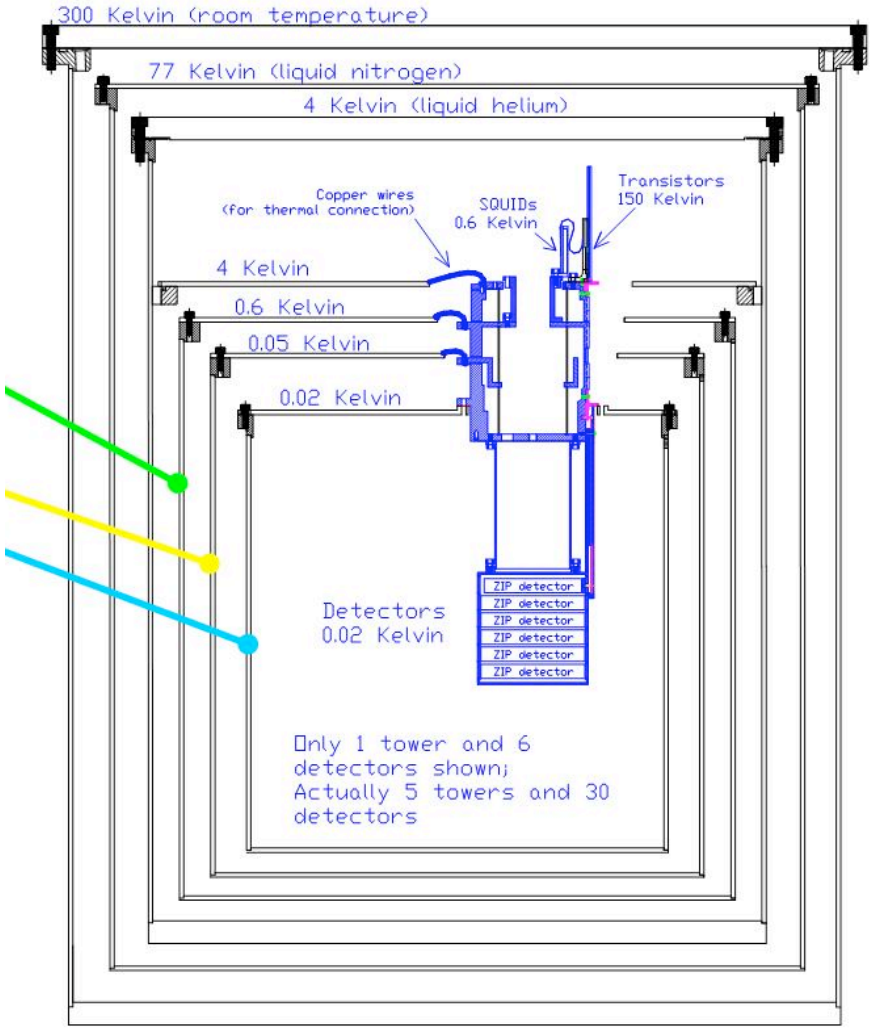
COLD
DETECTOR

It is possible to measure collisional signals when detectors are cold enough.



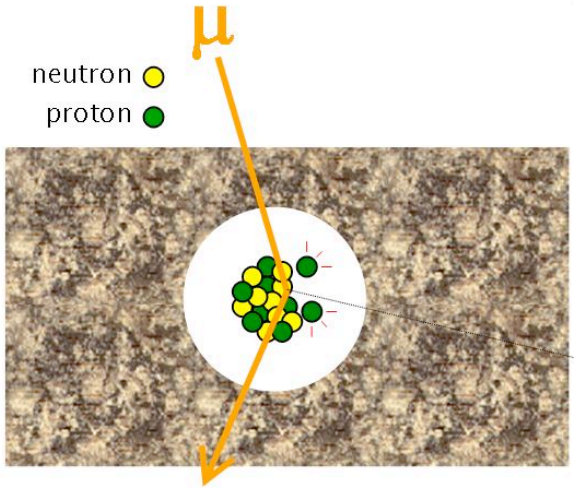
WARM
DETECTOR

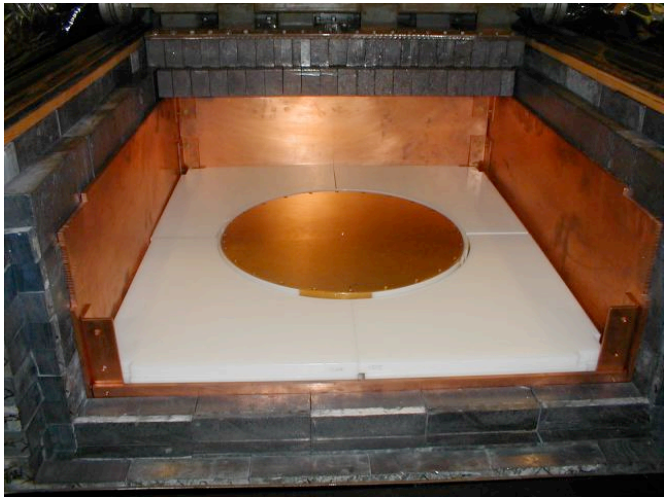
When detectors are warm, thermal vibrations drown out signals.



Oh' my darling... Oh' my darling

A muon can collide with a nucleus in the rock, busting up the nucleus and thereby liberating neutrons. A neutron can fake the signature of a dark matter particle.

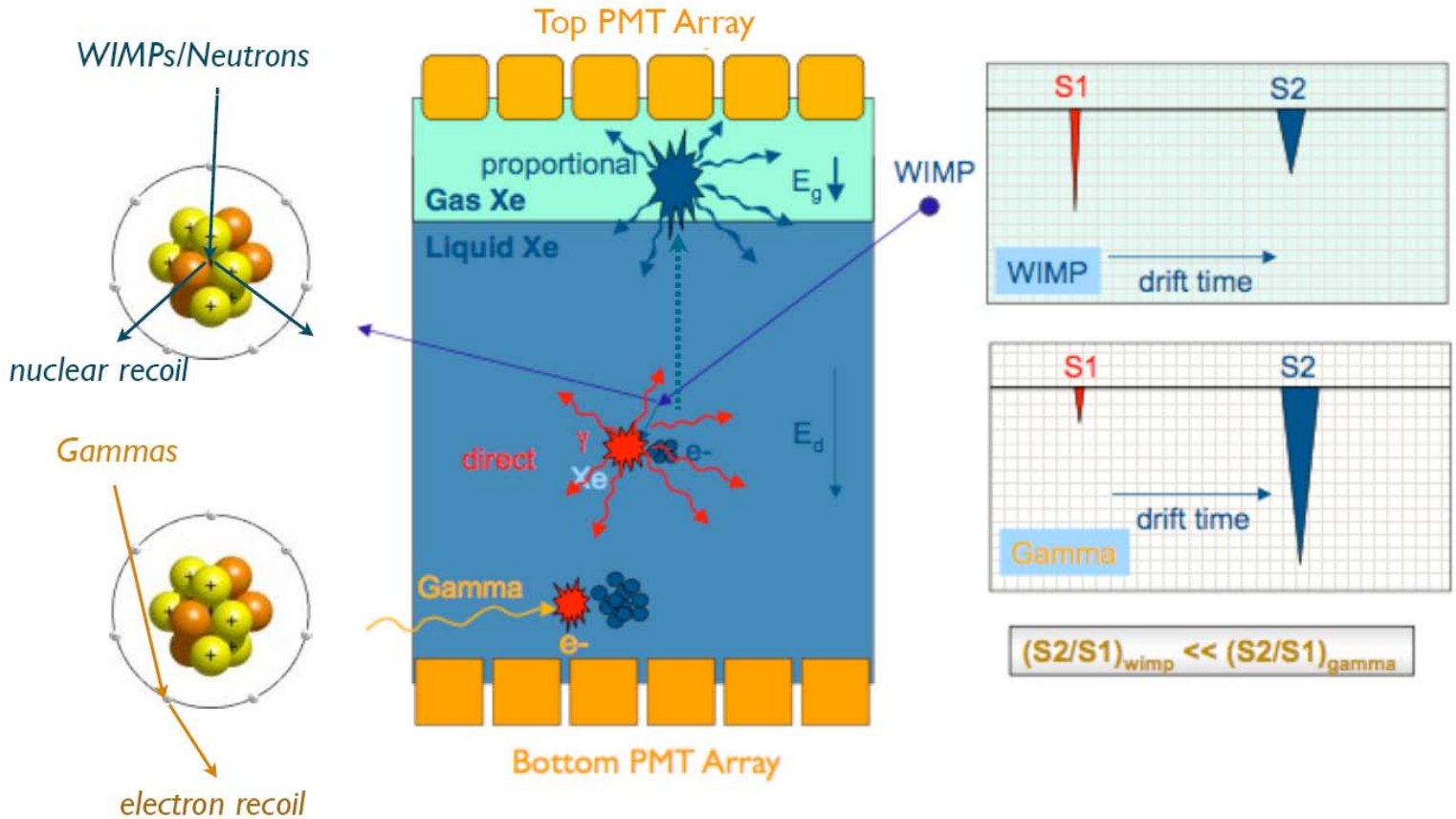




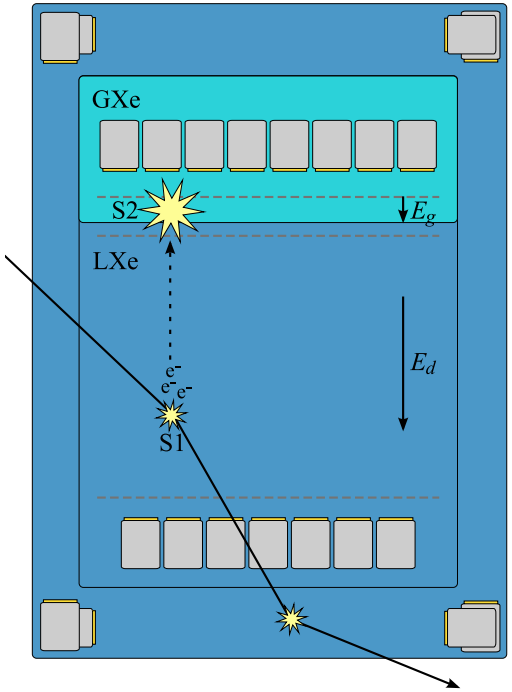
It's a Gas! ... and a Liquid!

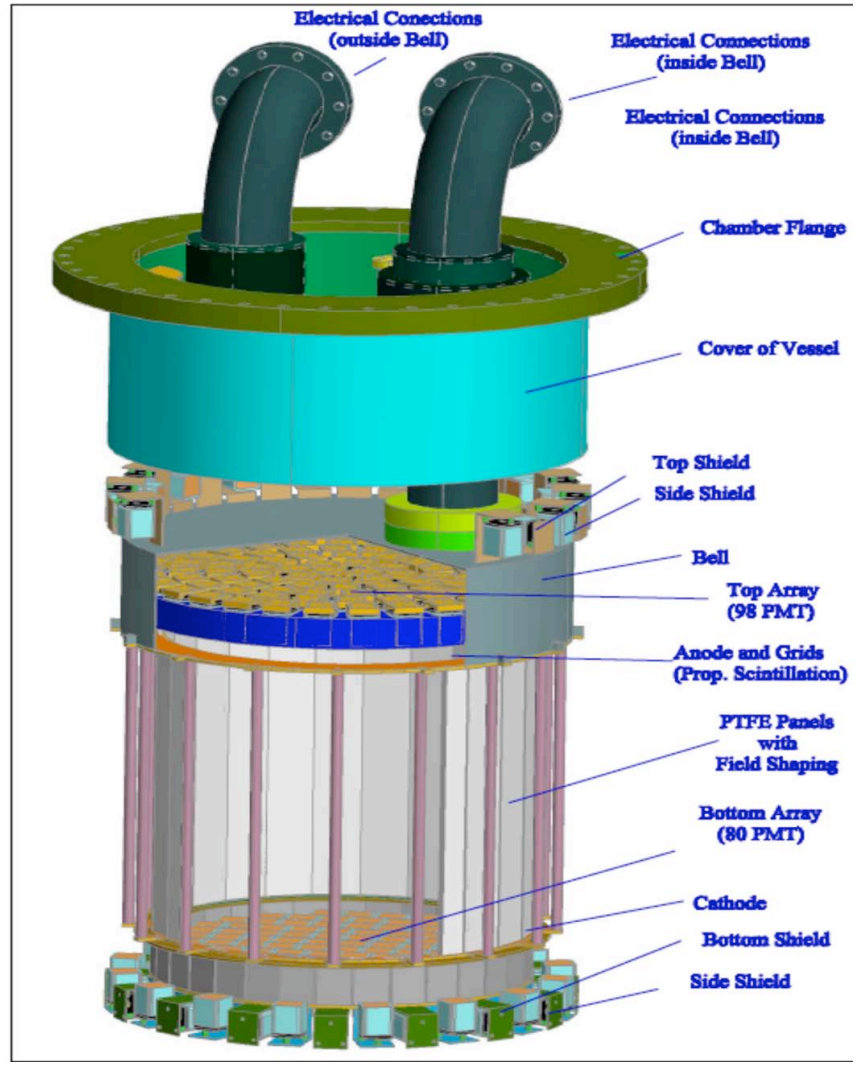
Two Phase Xe/Ar Time Projection Chamber

(XENON,ZEPLIN,WArP,ArDM)

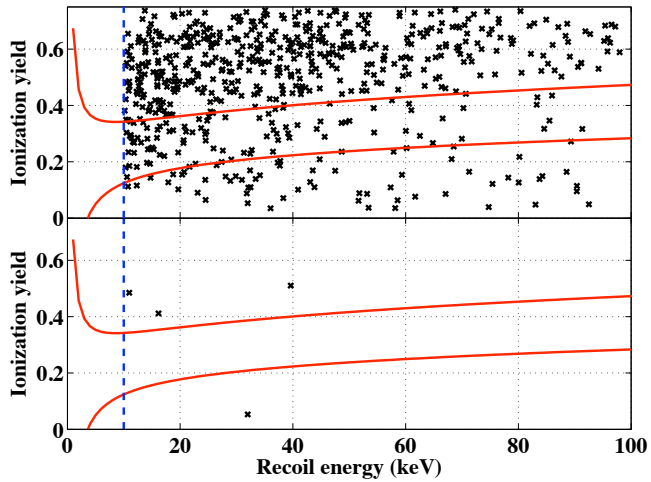


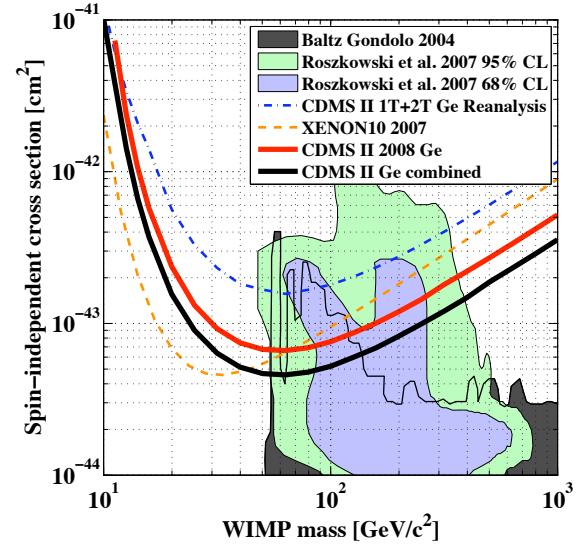
A Veto ... Actively

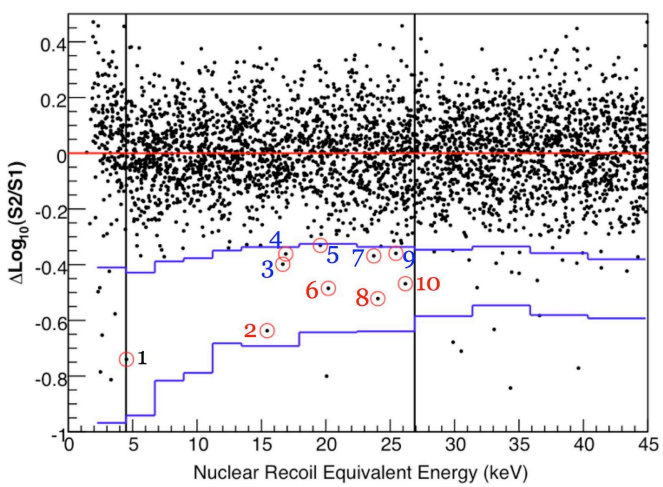


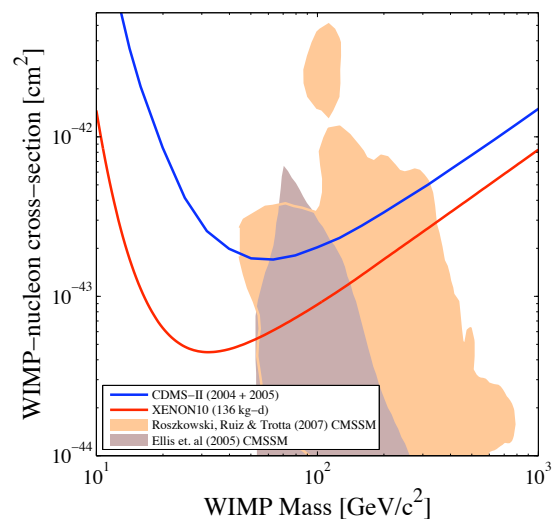


The Amazing Race









Back to the Future