The DarkSide Experiment at LNGS

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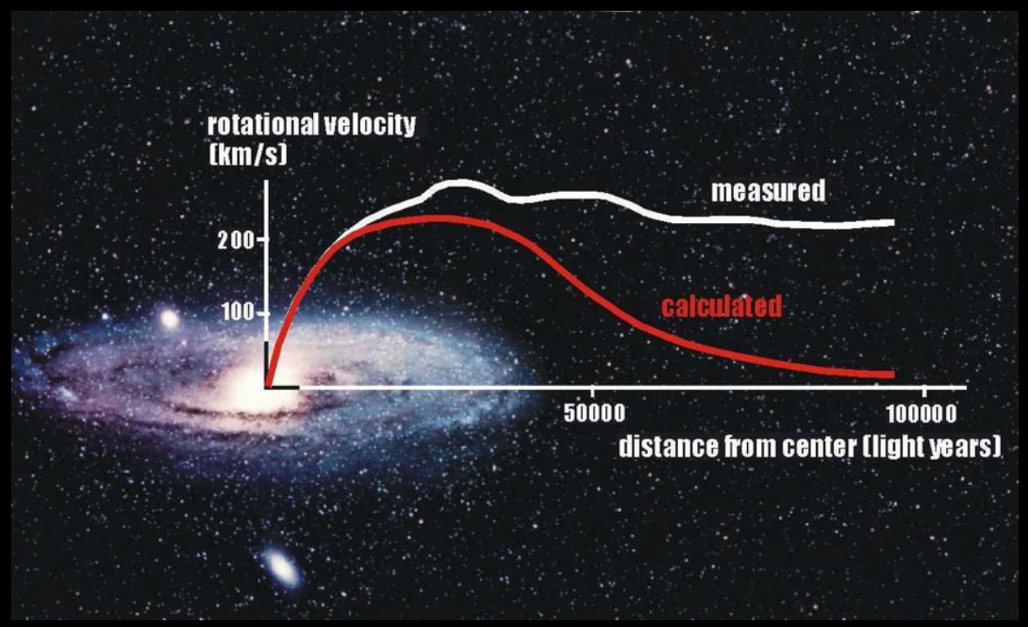
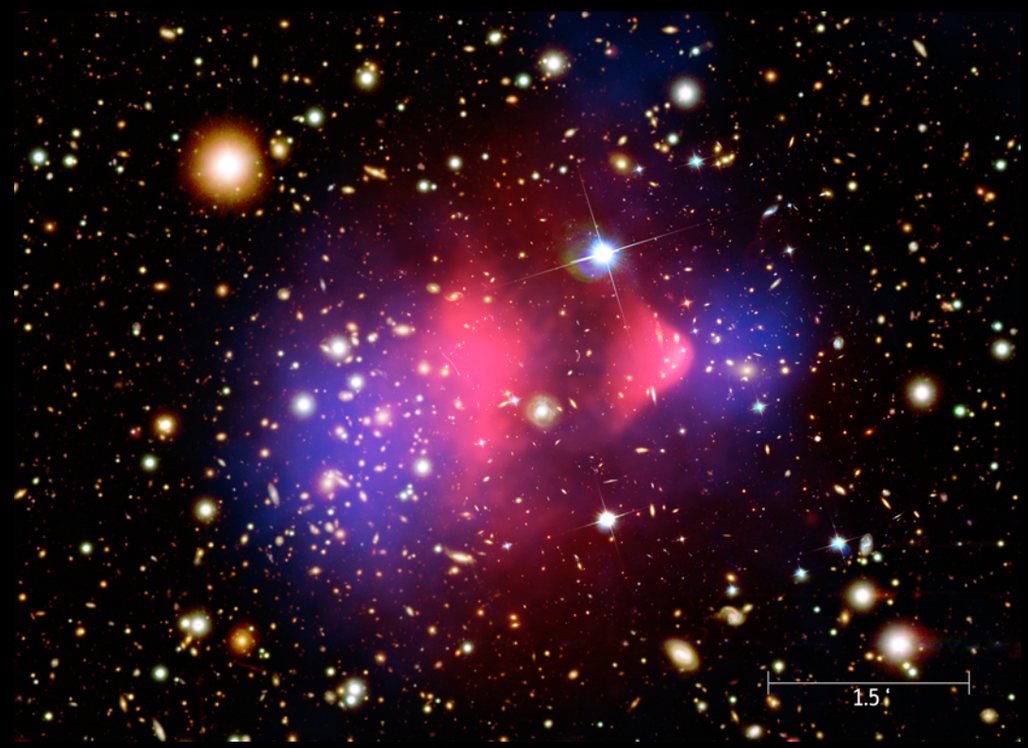
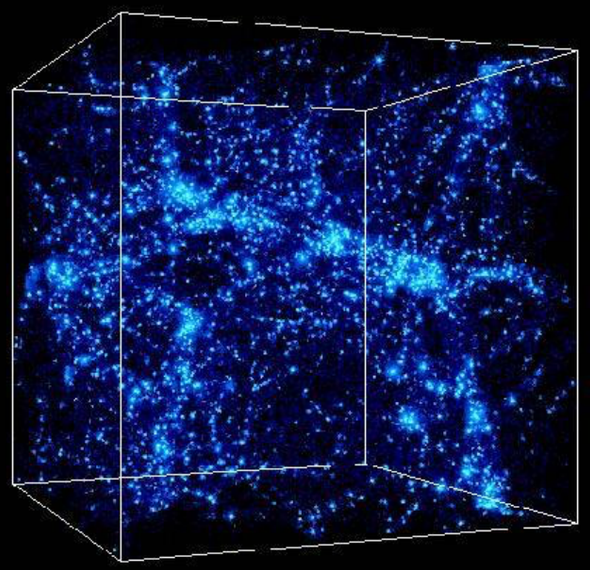
IASP@ Gran Sasso - Particle & Astroparticle Physics Spring Event

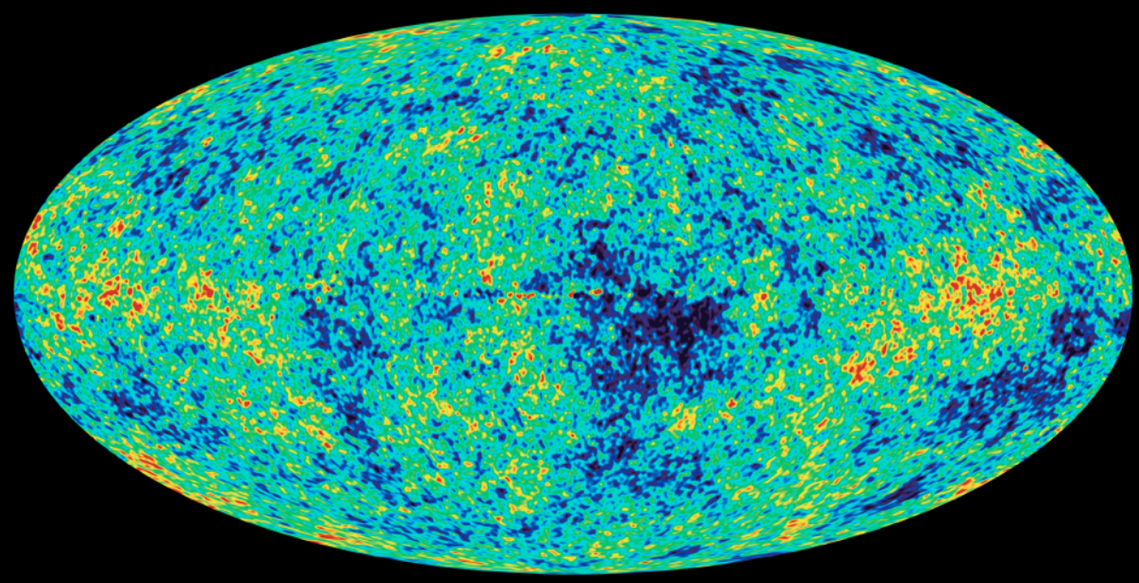
LNGS, May 7th, 2015

evidences of dark matter

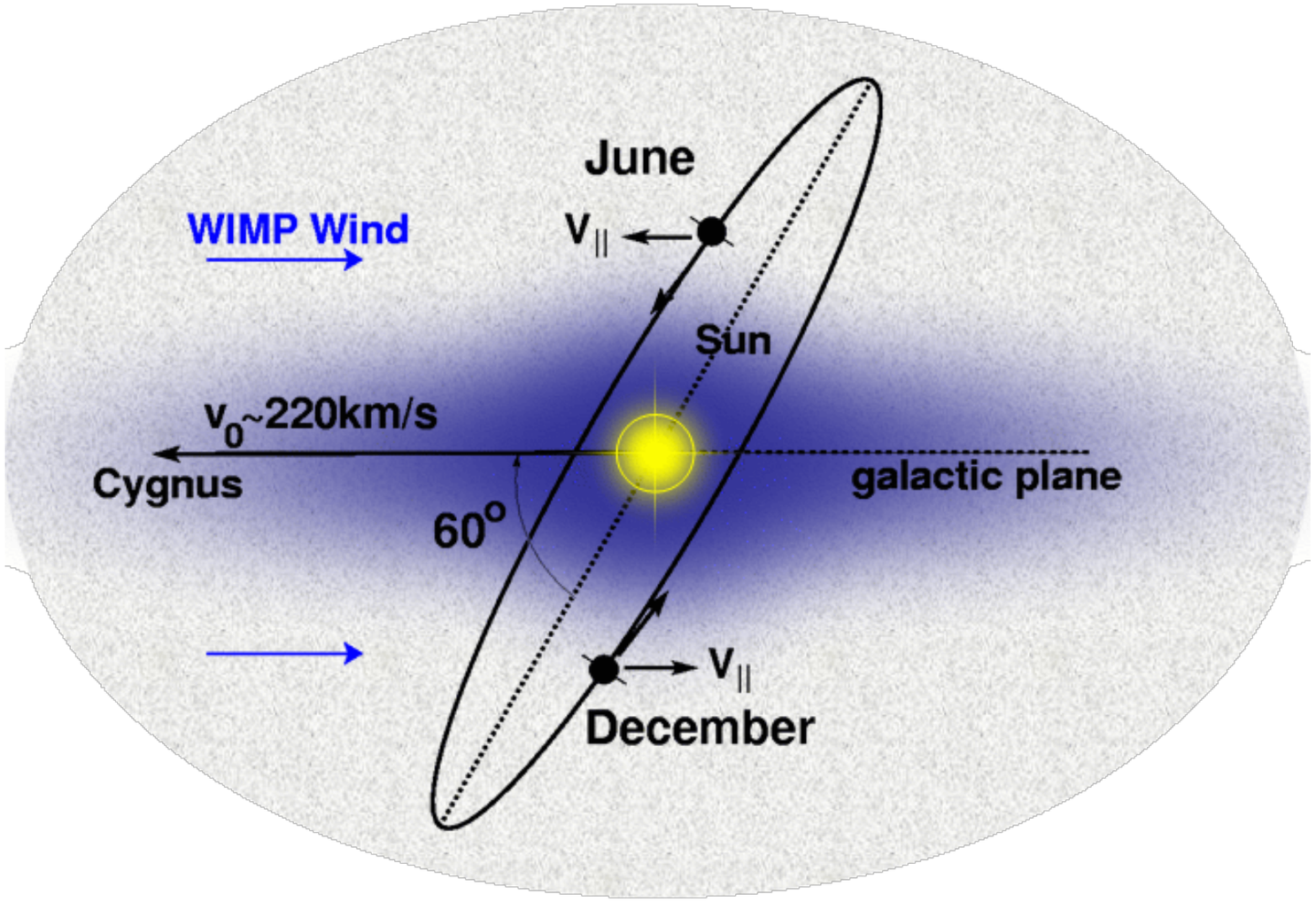




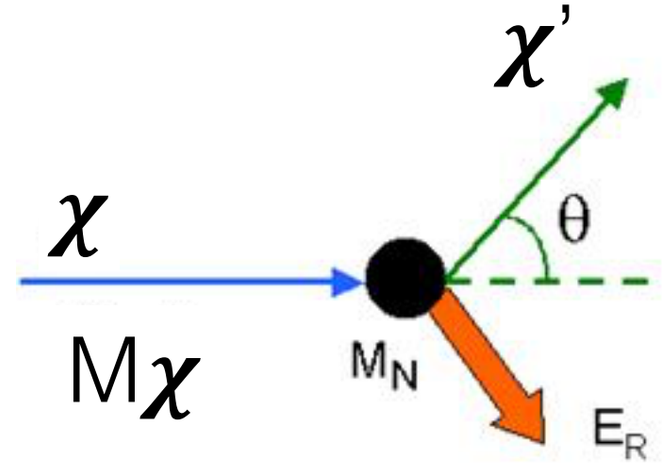




WIMP wind and recoil



Elastic scatter on nuclei
Recoil of nucleus (E_R < 100 keV)

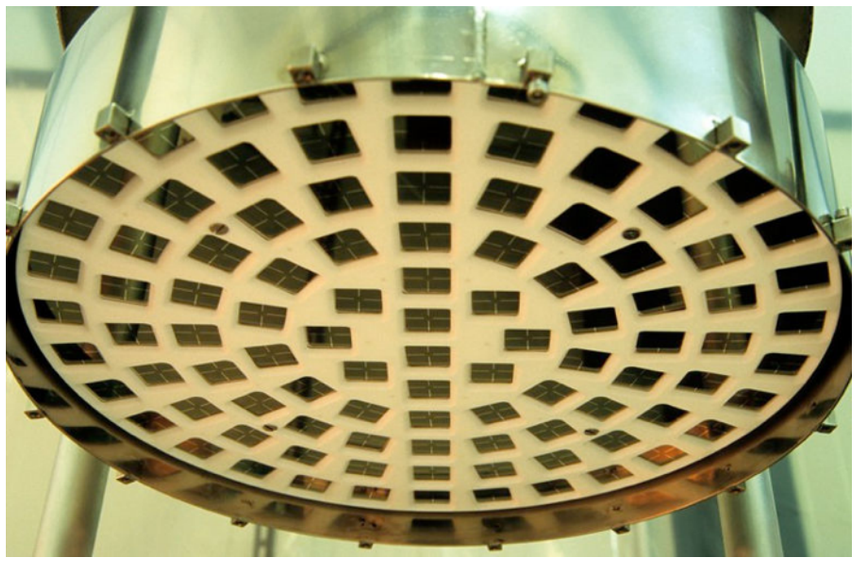


Exercise

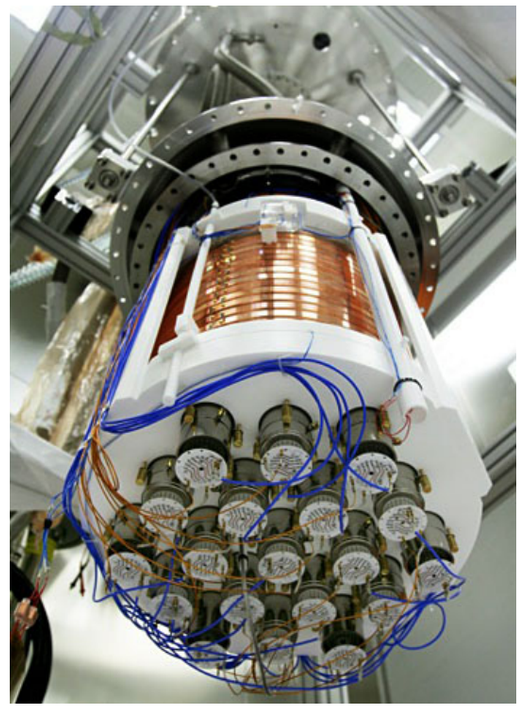
compute the kinetic energy of the recoiled nucleus
as function of Eχ and the scattering angle in the c. o. m. frame

Noble Gas TPC as dark matter detector

Among WIMP detectors
double phase **Ar**gon and **Xe**non **T**ime **P**rojection **C**hambers
play a substantial role



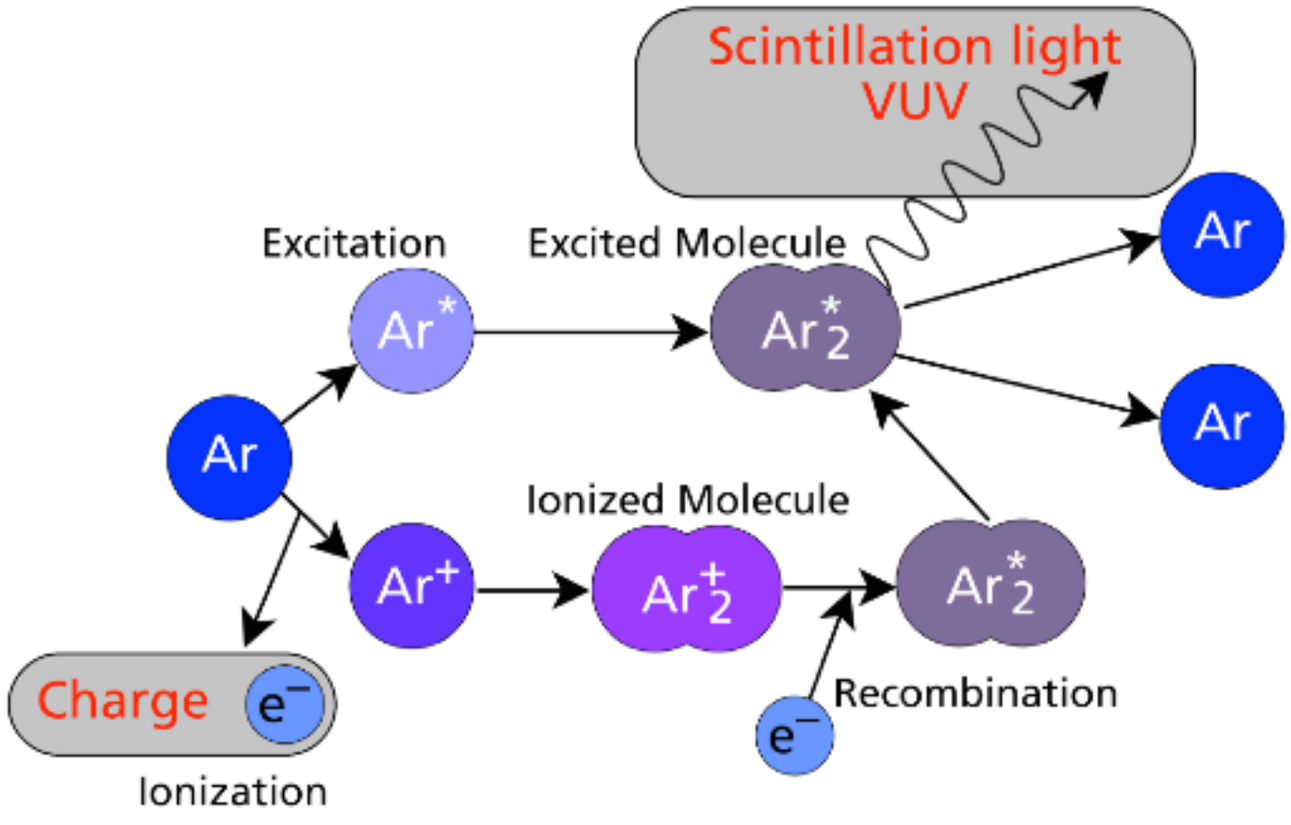
Xenon-100 (**Xe**)

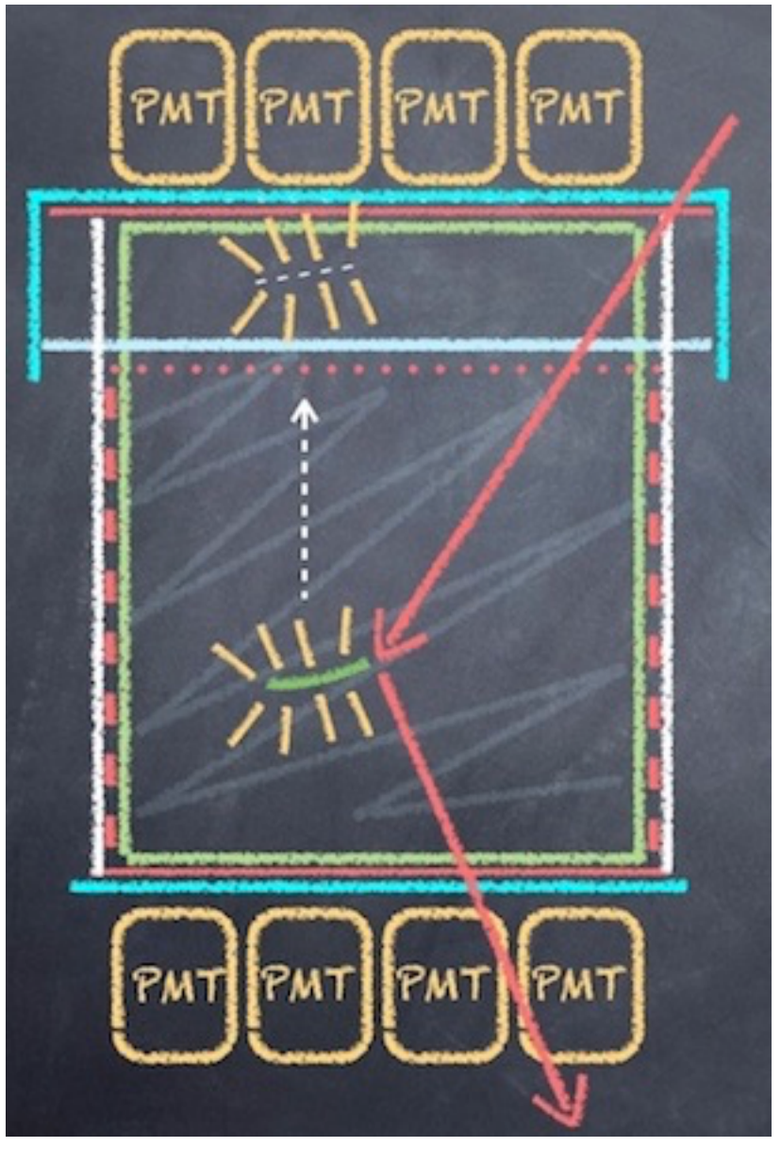


DarkSide-50 (**Ar**)

Key Concept
scintillation

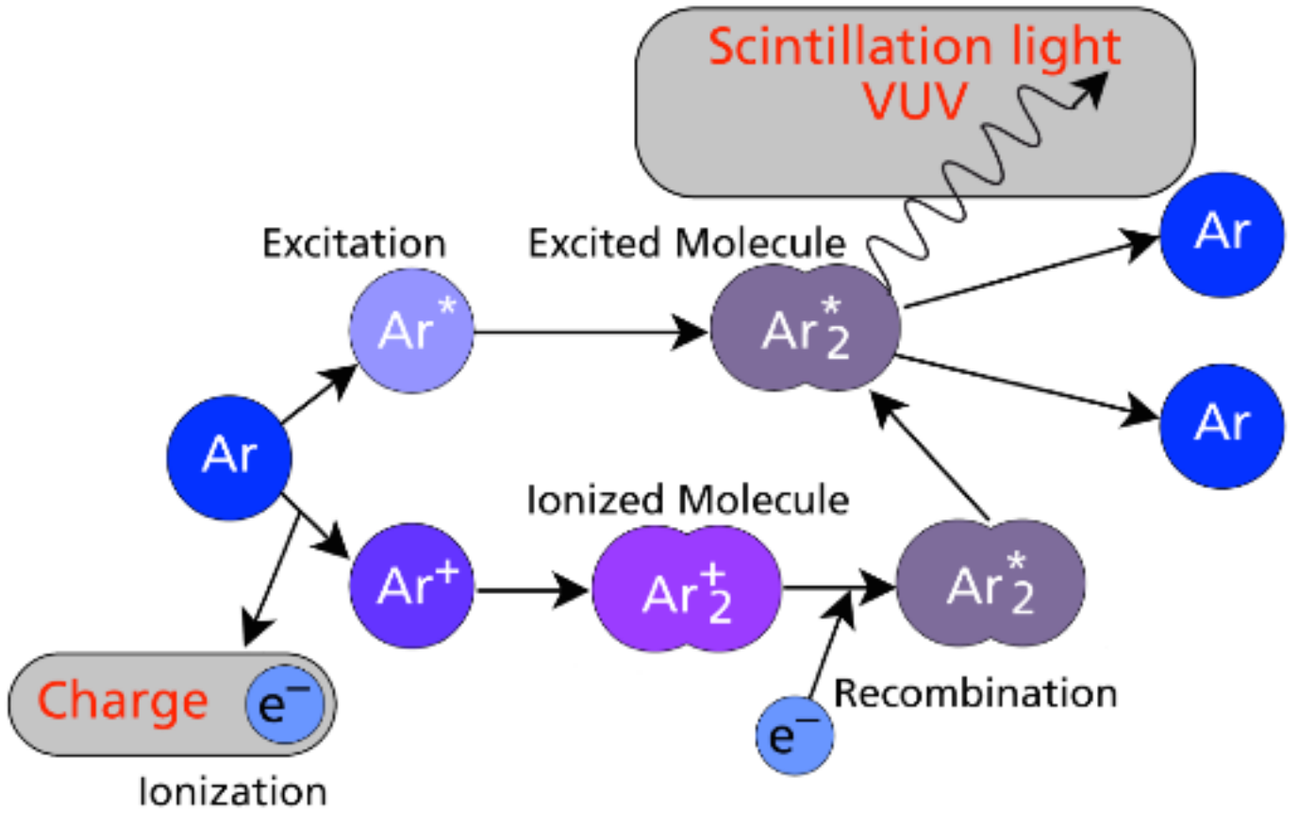
Scintillation is a flash of light produced in a transparent material
by the passage of a particle (an electron, an alpha particle, an ion, or a high-energy photon)

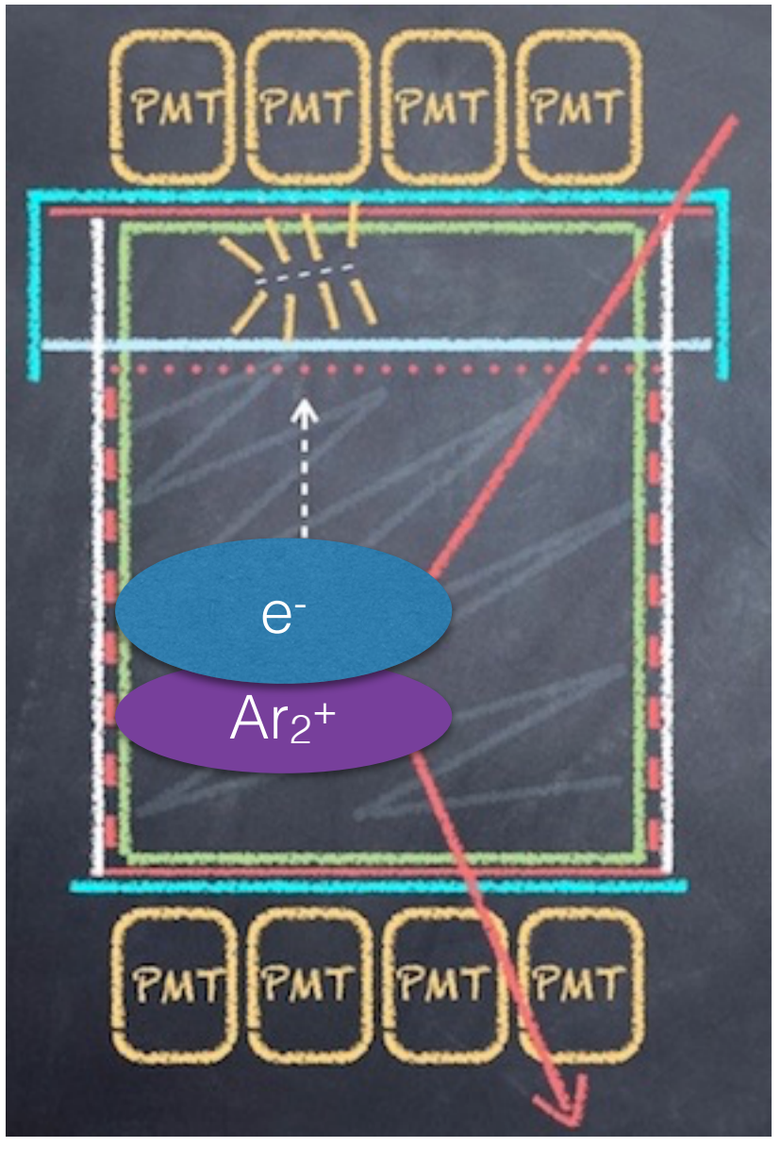




Key Concept ionization

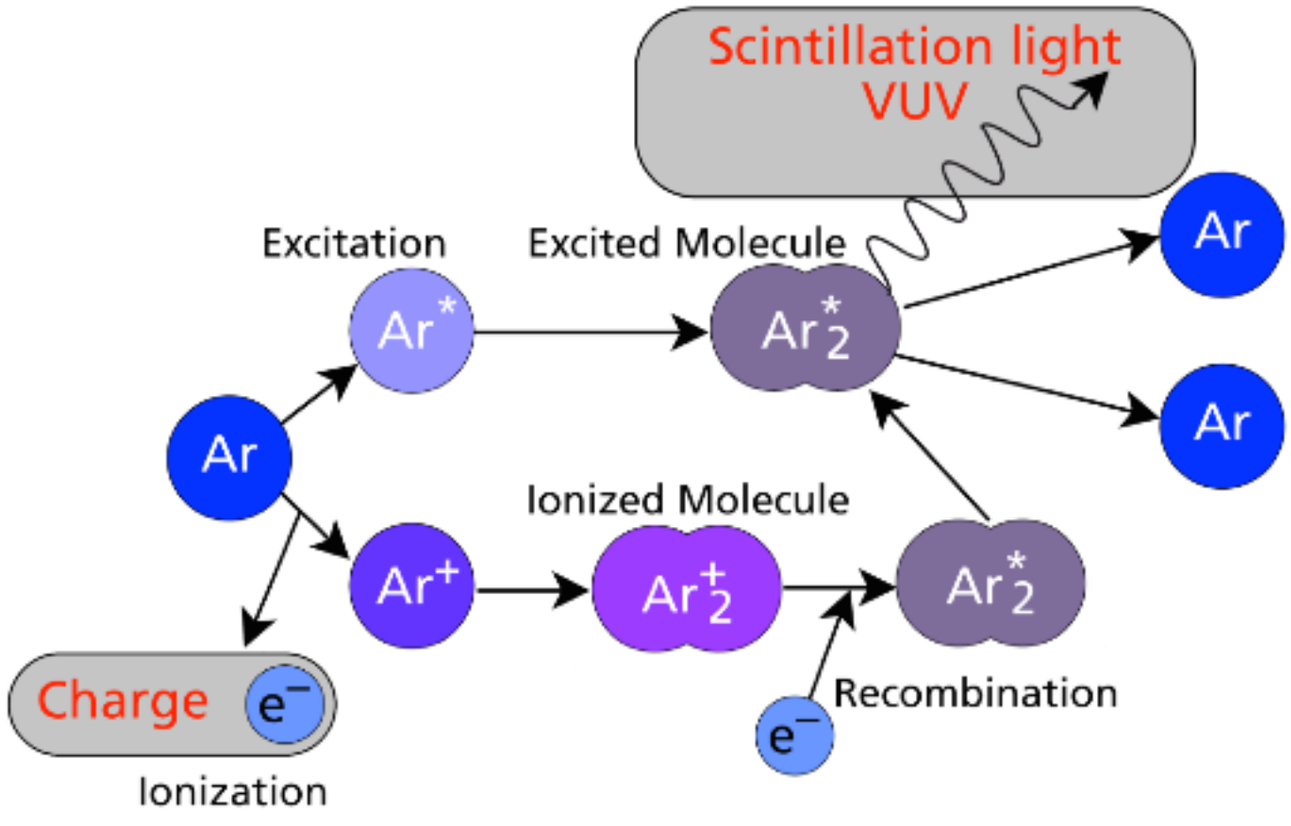
Ion and electron pairs produced by the passage of the ionizing particle

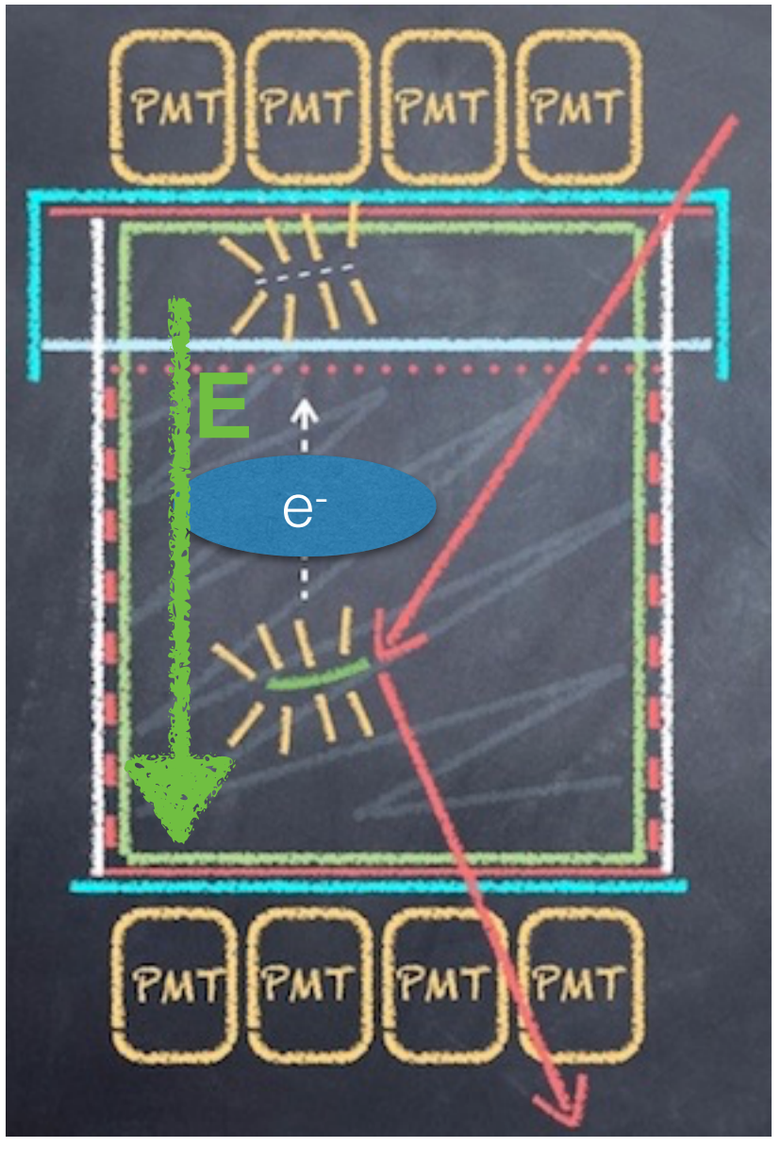




Key Concept electric fields

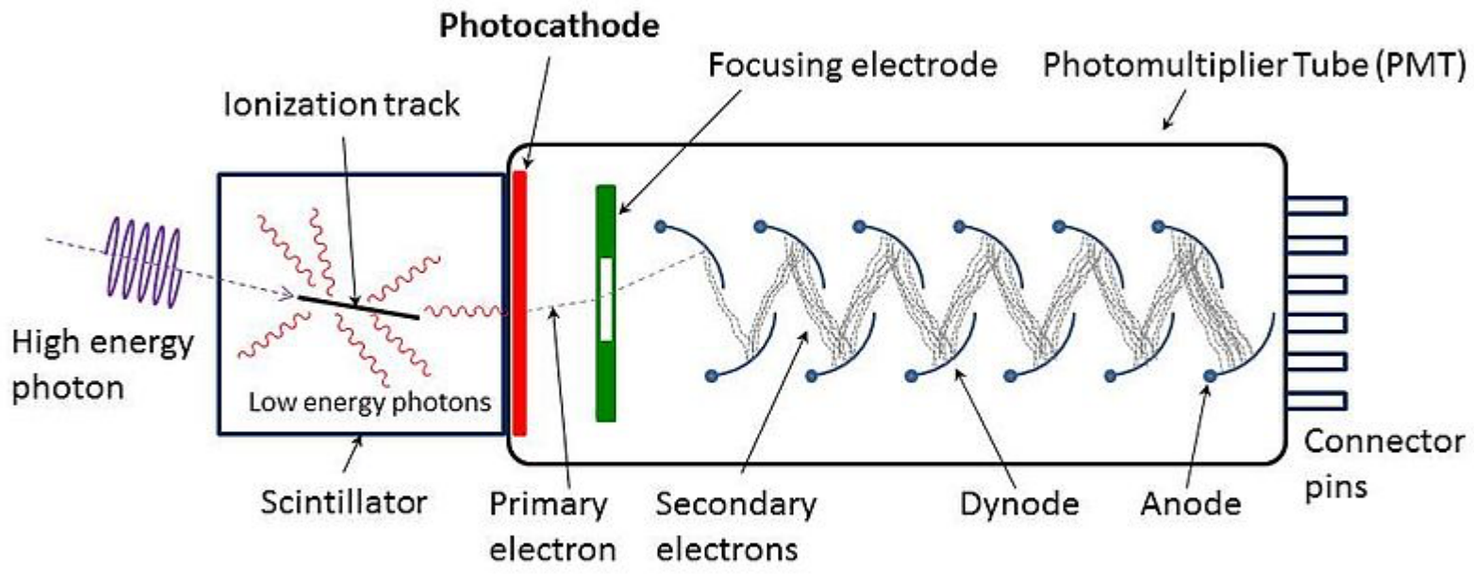
Electrons drifted by electric field
Additional pulse of light in the gas phase



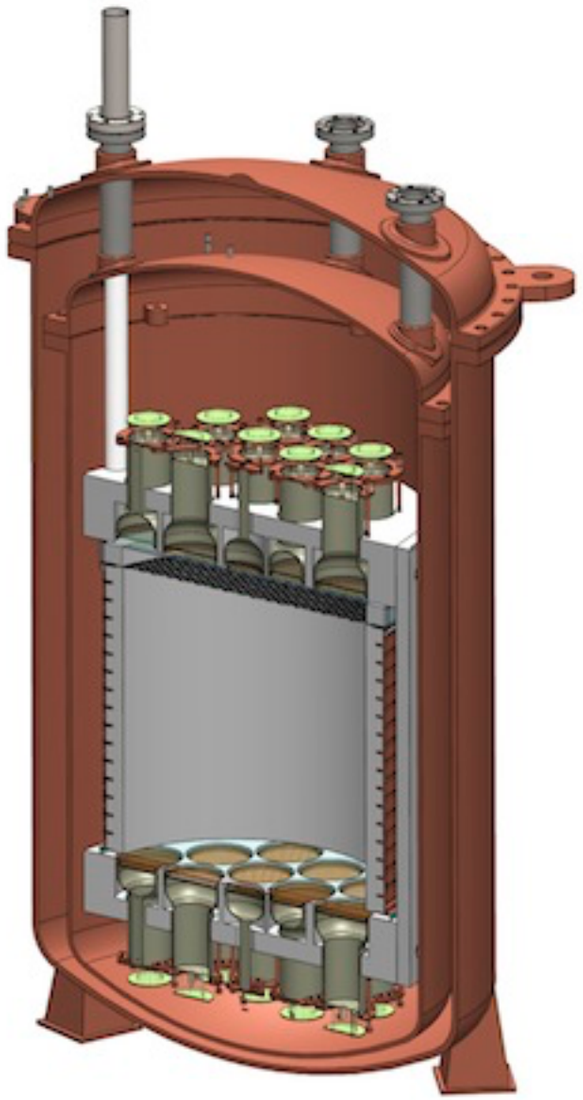


Key Concept photosensors

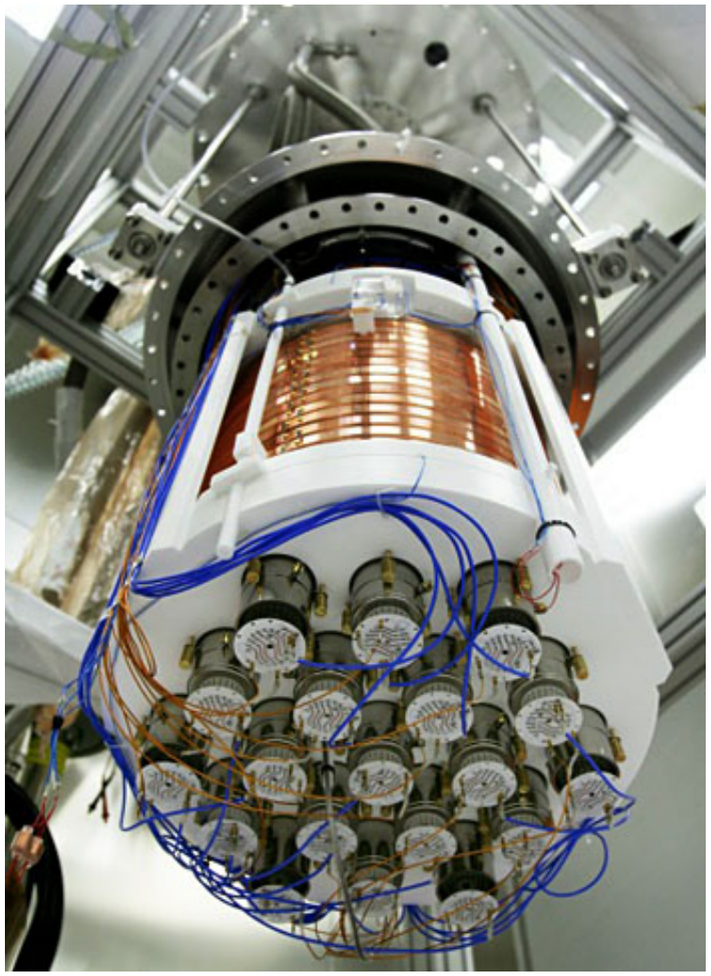
Photo**M**ultiplier **T**ube (PMT)



DarkSide-50 detector



Double Phase
Liquid Argon
Time Projection Chamber

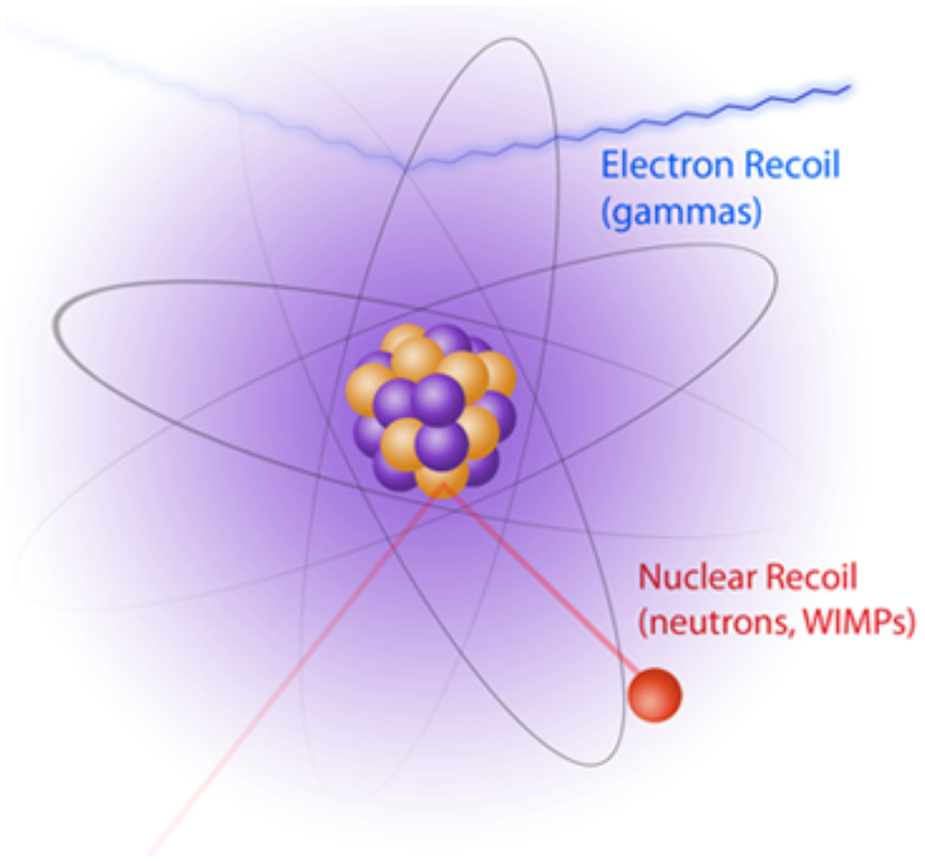


P. Agnes et al. "First results from the DarkSide-50 dark matter experiment at Laboratori Nazionali del Gran Sasso."
***Physics Letters B*, 743 (2015): 456-466**
[arXiv: 1410.0653]

Key Concept background

Any localised energy deposit in the detector can **mimic** WIMP interaction

radioactive decays (α, β, γ)
recoils due to **neutron** scattering



Key Concept
background rejection

nuclear recoils (due to neutrons and WIMPs)
deposit more localized energy
than electron recoils (due to β, γ decays)

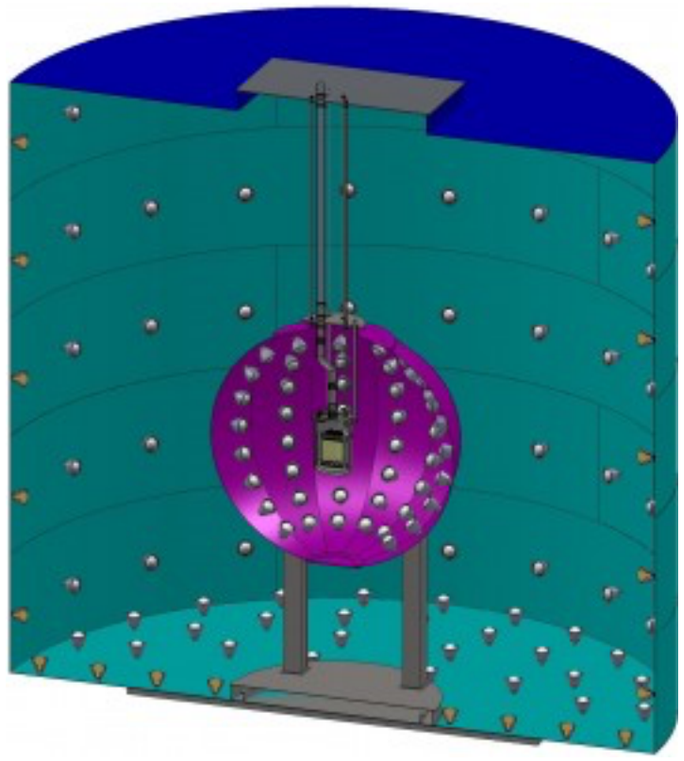
(see Bethe formula: http://en.wikipedia.org/wiki/Bethe_formula)

in Ar TPC one can **discriminate** the two classes of recoils with

scintillation/ionization ratio
time distribution of the scintillation **(pulse shape)**

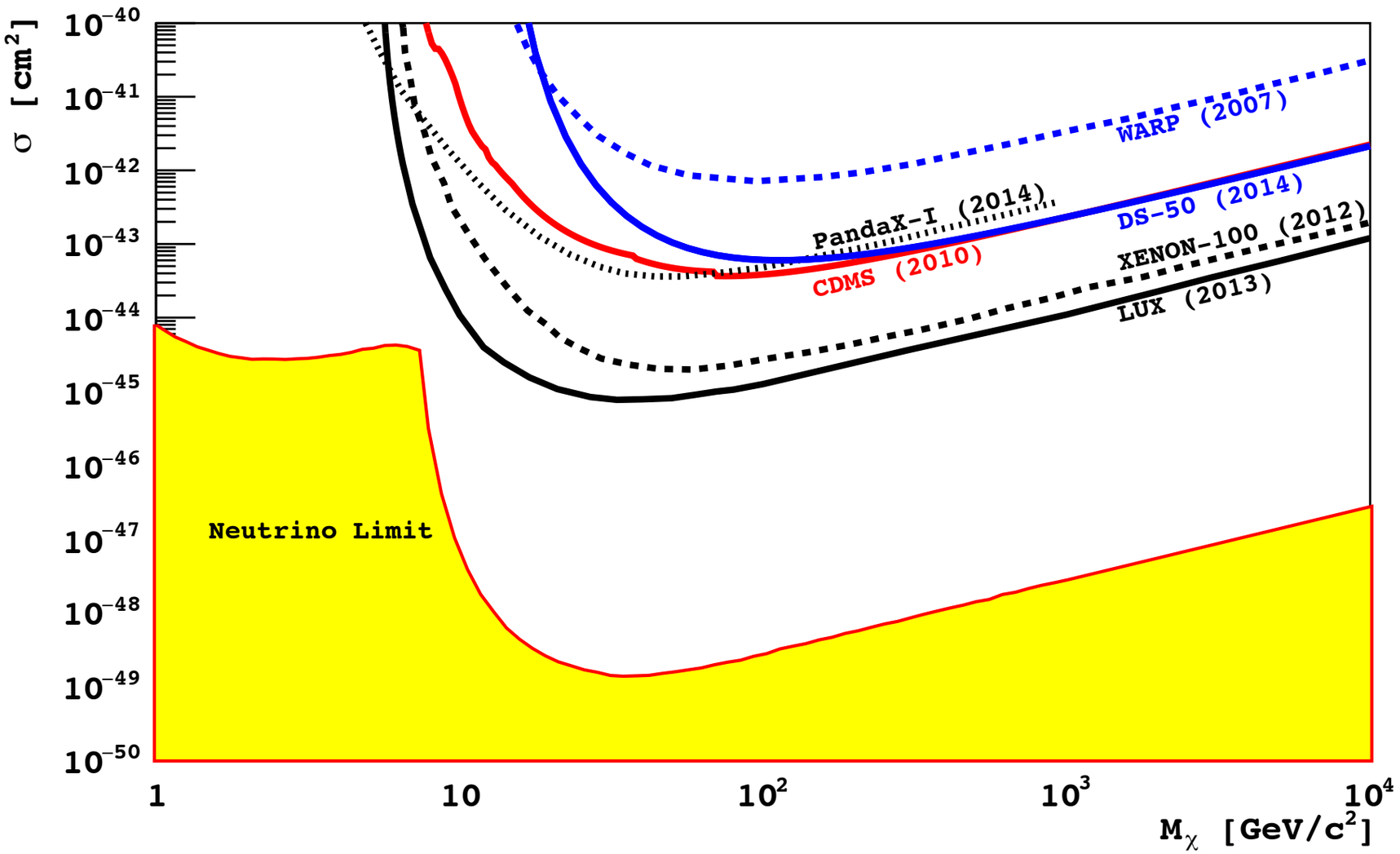
DarkSide-50 can reject all backgrounds due to β, γ decays

Key Concept
neutron rejection



DS-50 TPC inside a
Liquid **S**cintillator detector doped with ^{10}B
neutrons are captured efficiently and vetoed

DarkSide-50 results



no WIMPs detected so far in DS-50 …

limits in WIMP cross section and mass

Conclusions and Outlook

- Double phase noble element TPCs play a key role in WIMP searches

- DarkSide demonstrated the background rejection power of Liquid Argon TPC and of its neutron veto

- But no WIMPs detected in DarkSide-50 so far …

- New run of DarkSide-50 with Argon extracted from underground sources (very low amount of β-radioactive ^{39}Ar)