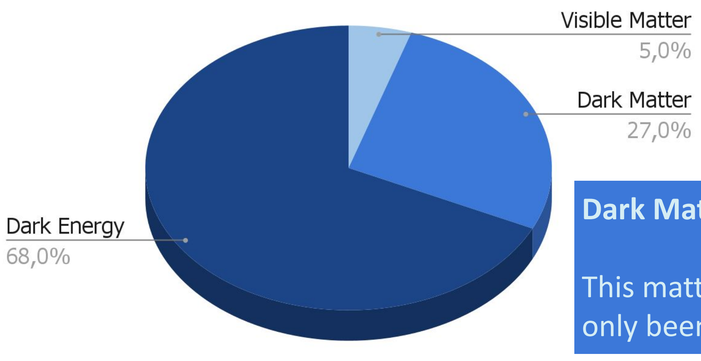
INFN Sezione di Roma 1 - Open Day

Istituto Nazionale di Fisica Nucleare
SEZIONE DI ROMA

# The puzzle of Dark Matter

Our Universe contains only about 5% of ordinary **Visible Matter**, or atoms, the building blocks of stars and planets.




**Dark Matter** comprises 26.8% of the universe.

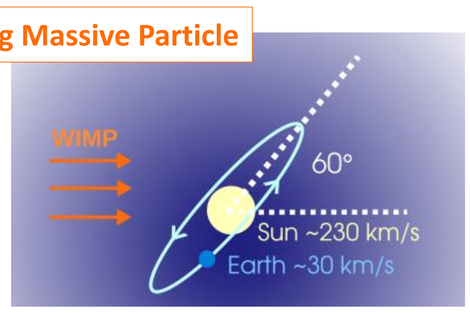
This matter does not emit or absorb light. It has only been detected indirectly by its gravity.

68.3% of the universe, is composed of **Dark Energy,** that acts as a sort of anti-gravity and is responsible for the present-day acceleration of the Universe expansion.

- If **Dark Matter** is made of yet unknown particles, they would form a halo embedding our Galaxy.
- We can detect their presence by searching for signals produced by DM particles scattering off atomic nuclei in a detector.
- The type of signal, the energy, the rate, they all depend on the **nature of the DM particle** and on the characteristics of the detector.

**WIMP = Weakly Interacting Massive Particle**

- Due to the Earth's orbital motion around the Sun, the expected interaction rate from DM particles in a detector varies along the year
- This **annual modulation** is a distinctive signature of DM particles in our Galaxy.



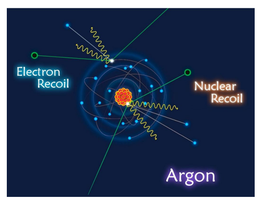

DARKSIDE

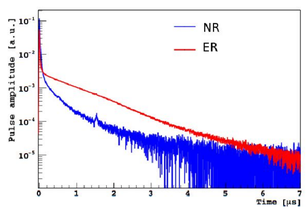
**DarkSide-20k** is a dual-phase liquid argon time projection chamber (**LArTPC)** detector for the **direct detection of dark matter** particles that is under construction in Hall C of the **Laboratori Nazionali Del Gran Sasso** (Italy).

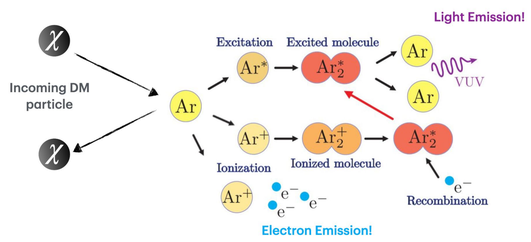
The LArTPC will contain 51.1 tons of LAr, derived from underground sources (UAr), equipped to detect the light resulting from an elastic scattering of a **WIMP** with argon nuclei.

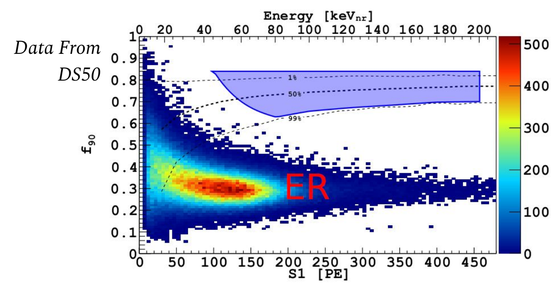
We look

- Single **nuclear recoil (NR)**
- Region of interest **(ROI): [30,200] keV$_{nr}$**

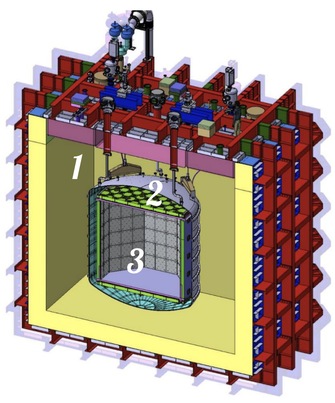


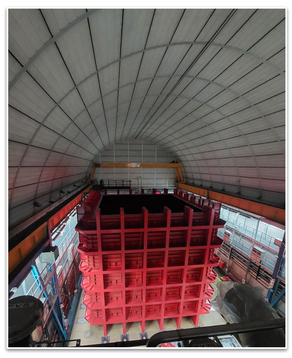




## The DarkSide-20k Detector




1. Outer **cosmic veto** filled with 700 t atmospheric Ar (AAr) = shield for muons and their shower products.
2. **Neutron veto** buffer between TPC and a stainless-steel vessel, filled with 32 t UAr
3. TPC instrumented with **528** SiPM-based photodetection units (**PDUs**), covering a sensible surface area of **21 m²**

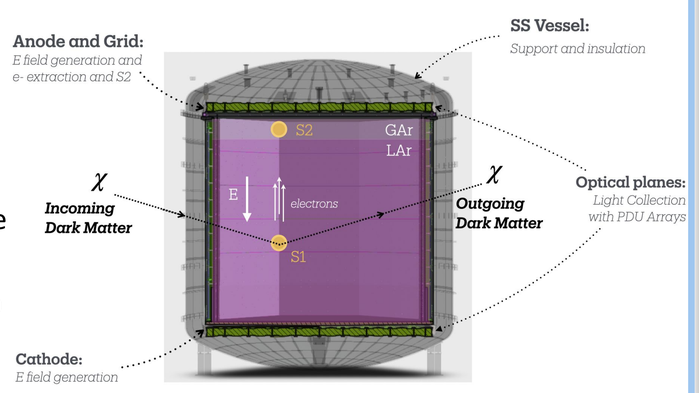


*DarkSide-20k Cryostat (Hall C)*

## Light Collection in a LArTPC

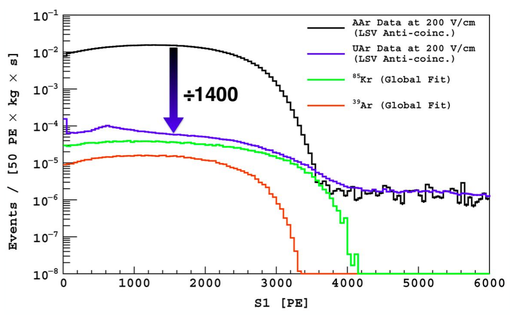
**S1**: primary scintillation in **LAr** (energy information and electron/nuclear recoil discrimination).

**S2**: delayed signals produced from **electroluminescence** in a gas layer at the top, where electrons are drifted by an electric field (energy information and 3D position reconstruction).

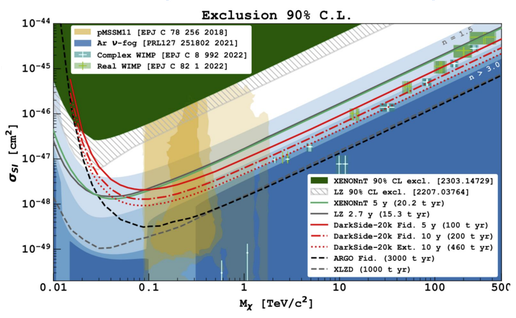



## Underground Argon:

TPC and veto use underground argon (UAr) to reduce **39Ar** content ( cosmogenic & beta emitter).




## Projected sensitivity




*DarkSide-20k physics reach: high mass WIMP*

**Information and thesis opportunities:**

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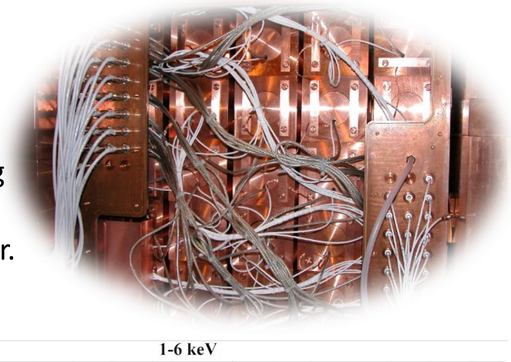
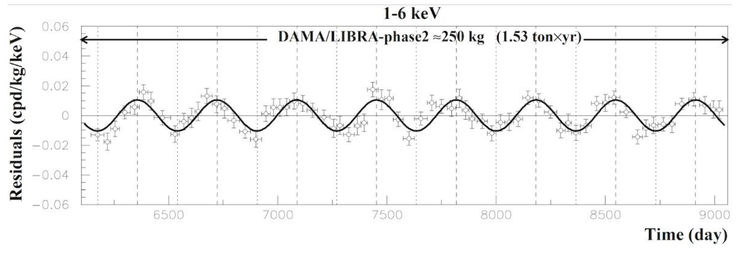
The **DAMA** project develops and uses low radioactive scintillators. It is located deep underground in the Gran Sasso National Laboratory (LNGS) of INFN, where several low background setups are operative and many different kinds of measurements are carried out.

The main aim of the project is the investigation of **Dark Matter** particles in the galactic halo.
The main experiment is **DAMA/LIBRA** (**L**arge sodium **I**odide **B**ulk for **RA**re processes), exploiting the model independent annual modulation signature to point out the presence of Dark Matter.



**DAMA/LIBRA-phase2**, with the previous DAMA/NaI and DAMA/LIBRA-phase1, confirmed the evidence of a signal that meets all the requirements of the model independent Dark Matter annual modulation signature at high C.L.

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SABRE

The goal of the SABRE experiment is to search for dark matter through the **annual modulation** signature with an array of NaI(Tl) scintillating crystals.

**Feature - Double Location in the Northern and Southern hemisphere**

- SABRE North at Laboratori Nazionali del Gran Sasso (LNGS) in Italy
- SABRE South at Stawell Underground Physics Laboratory (SUPL) in Australia


**R&D - Development of ultra radio-pure NaI powder and NaI(Tl) crystals**

- the radio-purity drives the background level and ultimately the sensitivity of the experiment
- several SABRE crystals tested and characterized with underground measurements at LNGS

**Outfitting ow new SABRE experimental area @ LNGS ongoing**

JOIN US !

**Information and thesis opportunities:**
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