

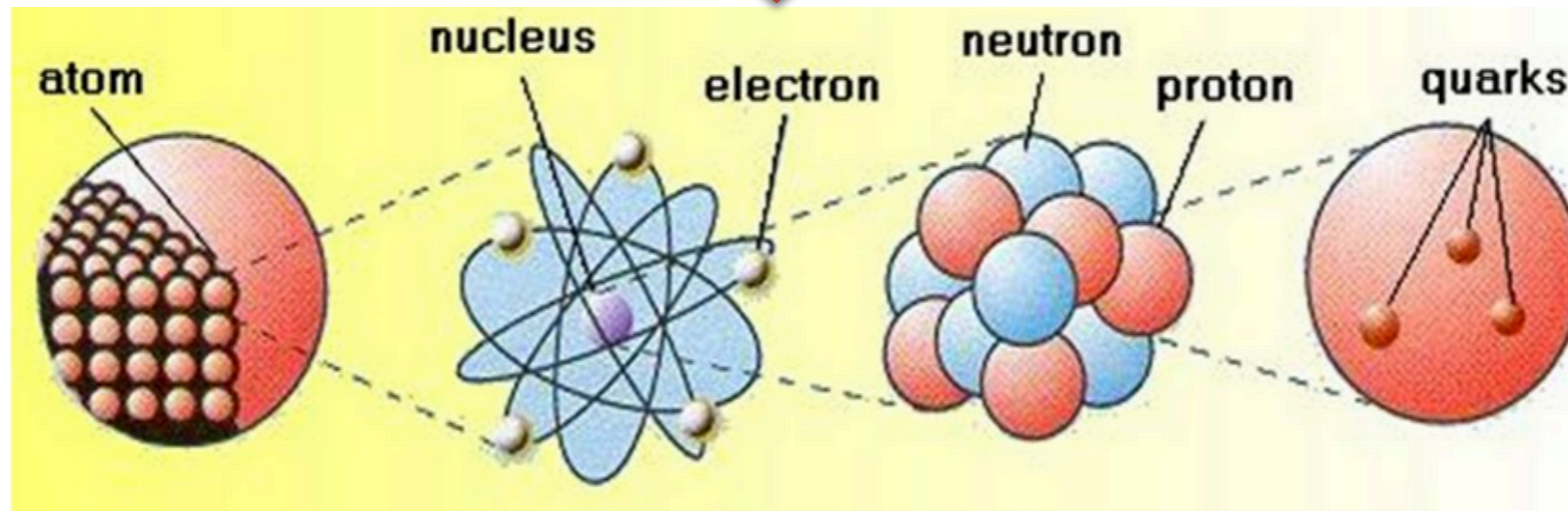
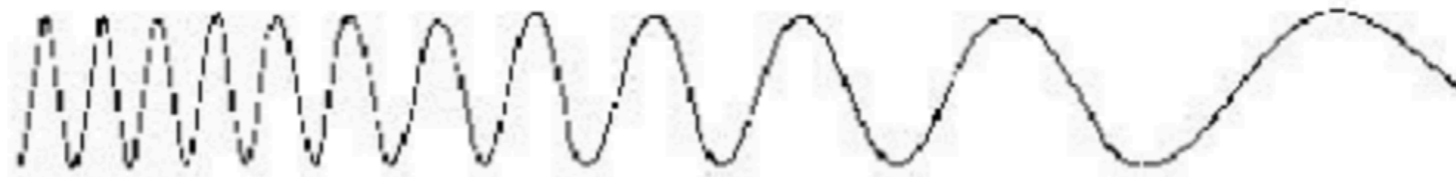
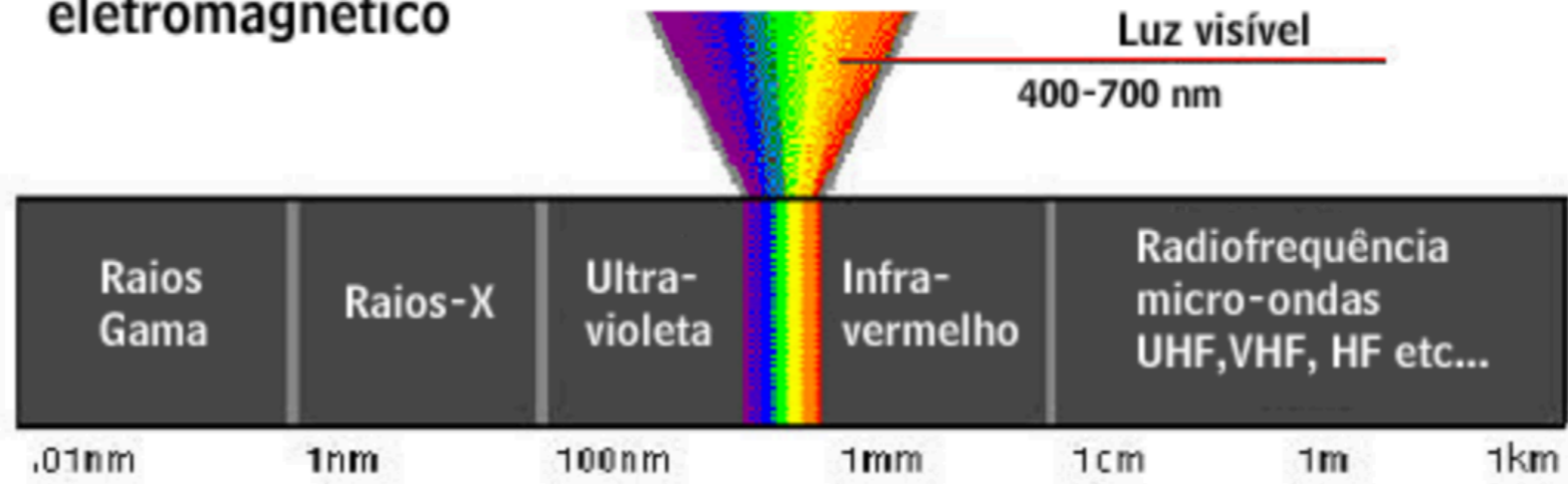
○ Que é a Matéria Escura do Universo?

Ivone Freire Mota Albuquerque
IFUSP

Física ao Vivo - SBFísica - Junho/2020



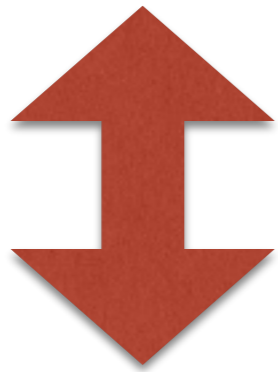
Espectro eletromagnético



Matéria Conhecida Interage Eletromagneticamente



LUMINOSIDADE

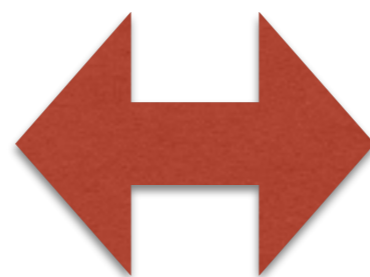


Massa da Galáxias





ROTAÇÃO

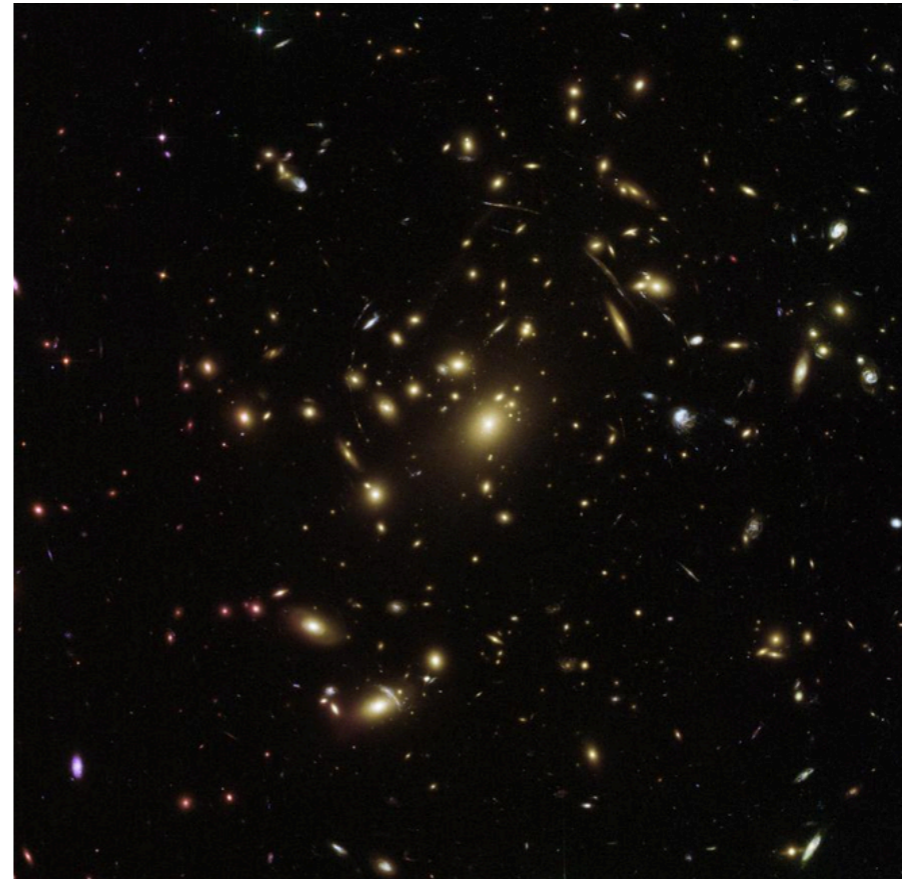


MASSA



Fritz Zwicky

**COMA
AGLOMERADO DE GALÁXIAS (1930)**



**Galáxias têm velocidades muito altas
para ser contida apenas pela massa
visível!!**

**Maior fração da matéria não interage com a luz
Não sabemos do que é composta!**

Matéria Escura!!



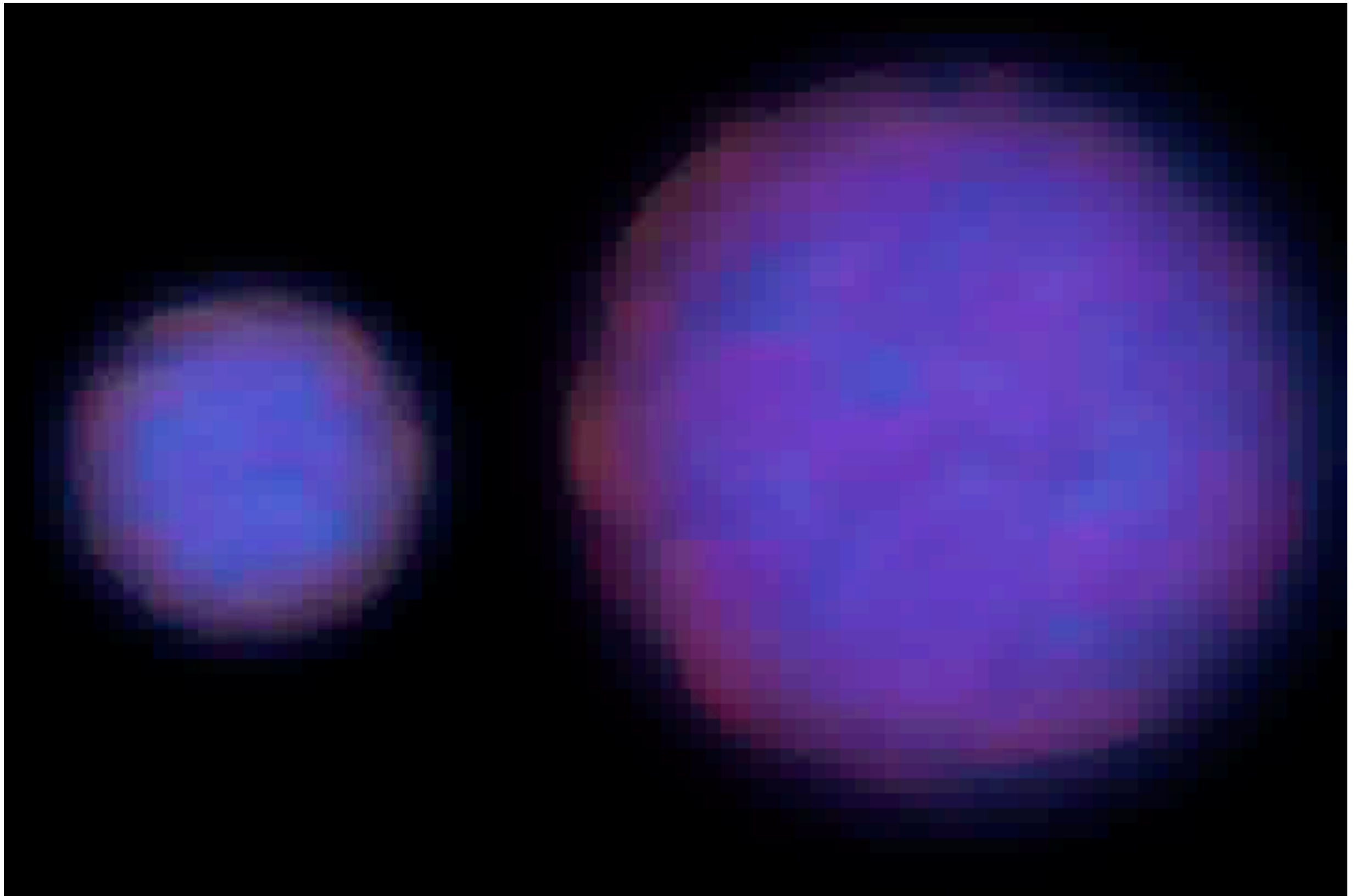
Vera Rubin (1970's)

Confirma presença da matéria escura com a medida da velocidade de rotação das galáxias

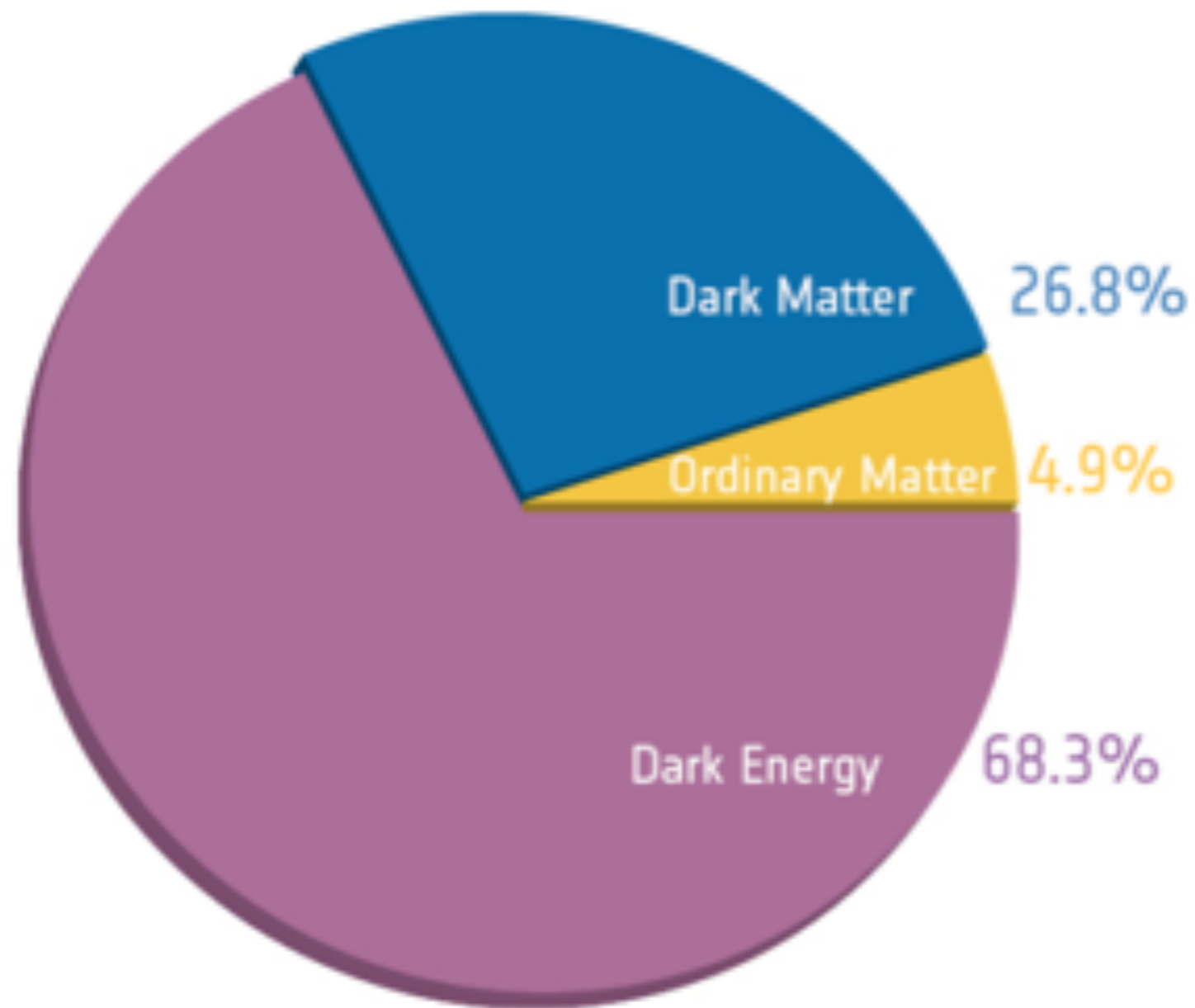
85% da matéria do Universo é desconhecida e não interage eletromagneticamente

LENTES GRAVITACIONAIS





Evidência Direta da Existência de ME



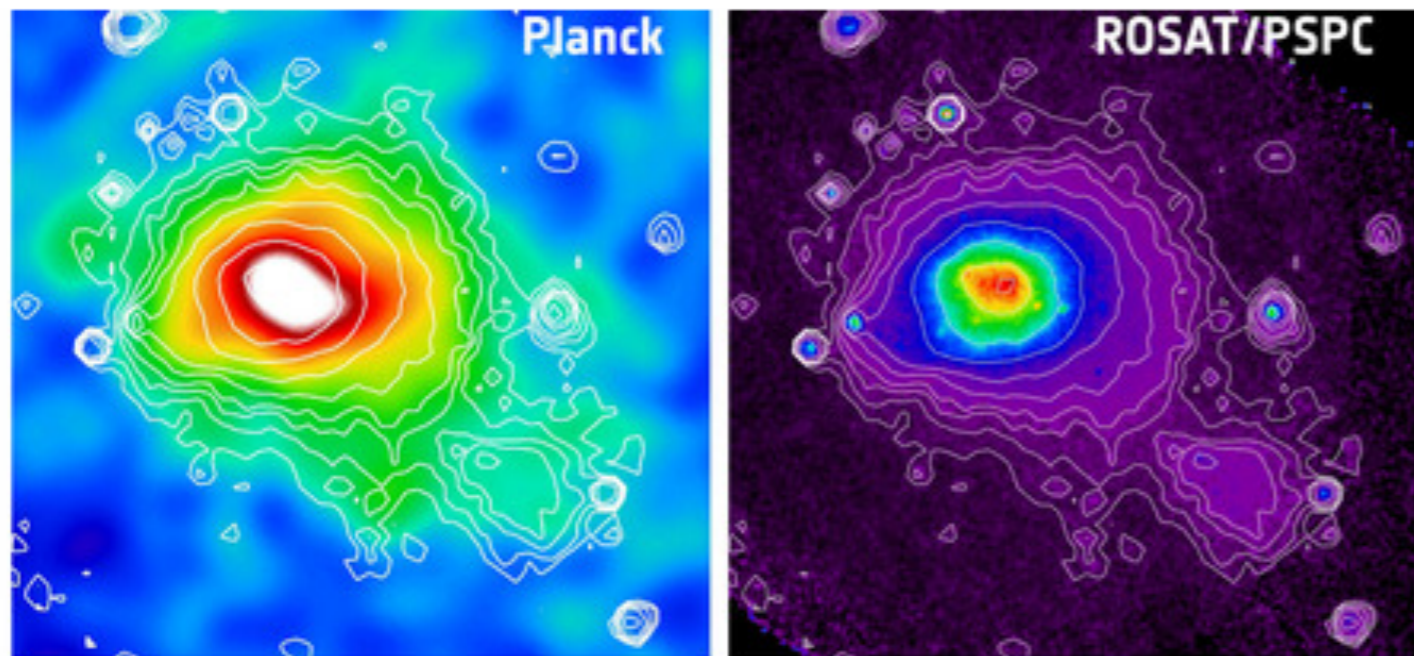
After Planck

The cosmic pie, before and after Planck. The size of the slices changed a little bit, but it's barely noticeable.

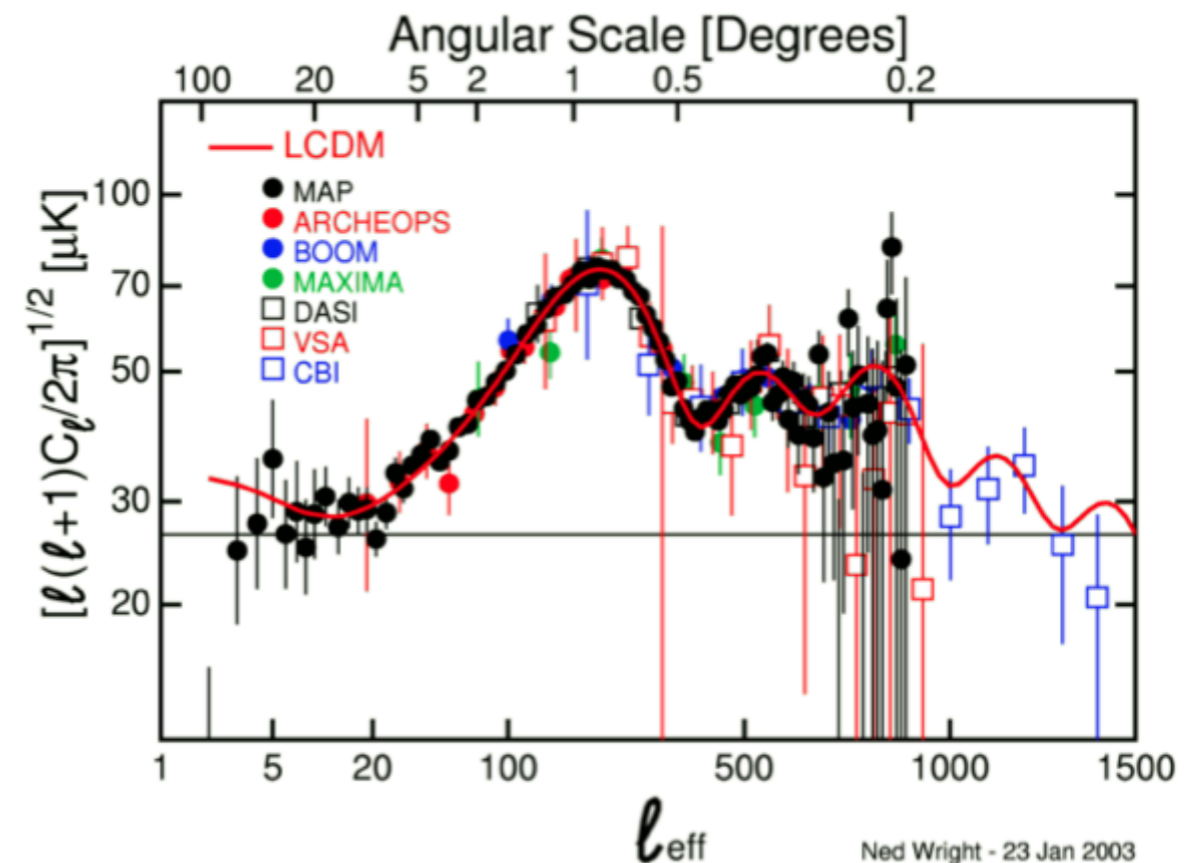
[Credit: [ESA/Planck Collaboration](#)]

O QUE SABEMOS SOBRE A MATÉRIA ESCURA??

Todas evidências vêm da interação gravitacional!

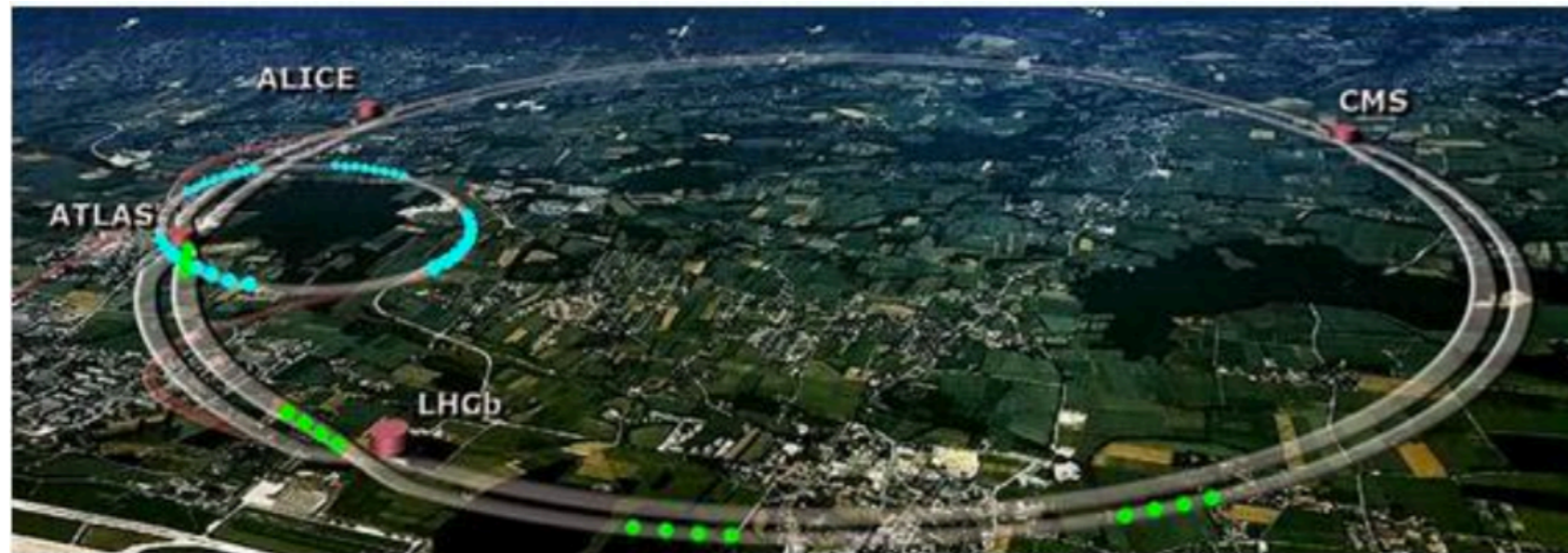


Gás no centro da galáxia (visível em Raios X)



Nenhuma das partículas conhecidas constituem a matéria escura!!

Enquanto isto na Terra:



CERN - LHC

Standard Model of Elementary Particles

	three generations of matter (fermions)			interactions / force carriers (bosons)	
	I	II	III		
mass	$\approx 2.2 \text{ MeV}/c^2$	$\approx 1.28 \text{ GeV}/c^2$	$\approx 173.1 \text{ GeV}/c^2$	0	$\approx 124.97 \text{ GeV}/c^2$
charge	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0	0
spin	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	0
QUARKS	u up	c charm	t top	g gluon	H higgs
	$\approx 4.7 \text{ MeV}/c^2$	$\approx 96 \text{ MeV}/c^2$	$\approx 4.18 \text{ GeV}/c^2$	0	
	$-\frac{1}{3}$	$-\frac{1}{3}$	$-\frac{1}{3}$	0	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
	d down	s strange	b bottom	γ photon	
	$\approx 0.511 \text{ MeV}/c^2$	$\approx 105.66 \text{ MeV}/c^2$	$\approx 1.7768 \text{ GeV}/c^2$	$\approx 91.19 \text{ GeV}/c^2$	
	-1	-1	-1	0	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
LEPTONS	e electron	μ muon	τ tau	Z Z boson	
	$< 1.0 \text{ eV}/c^2$	$< 0.17 \text{ MeV}/c^2$	$< 18.2 \text{ MeV}/c^2$	$\approx 80.39 \text{ GeV}/c^2$	
	0	0	0	± 1	
	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	
	ν_e electron neutrino	ν_μ muon neutrino	ν_τ tau neutrino	W W boson	

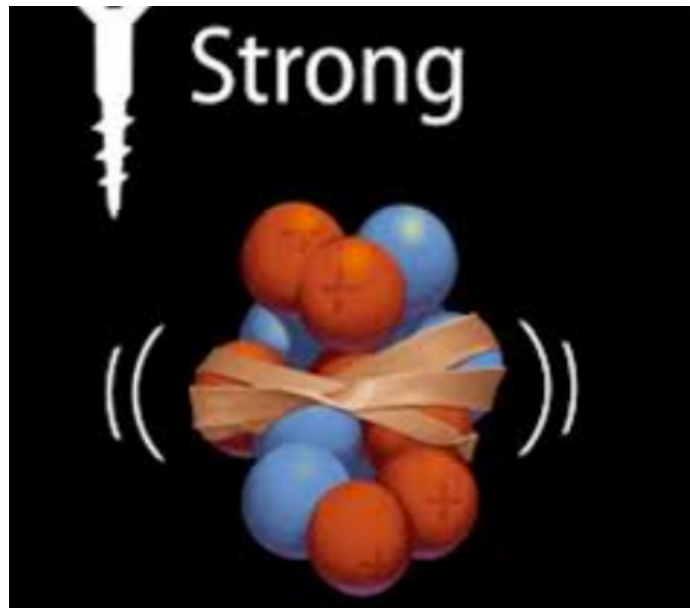
GAUGE BOSONS
VECTOR BOSONS
SCALAR BOSONS

Busca de novas partículas: a matéria escura entre elas

Cosmologia: observa os efeitos da matéria escura

Extensão da física de partículas: oferece candidatos

FORÇAS da NATUREZA



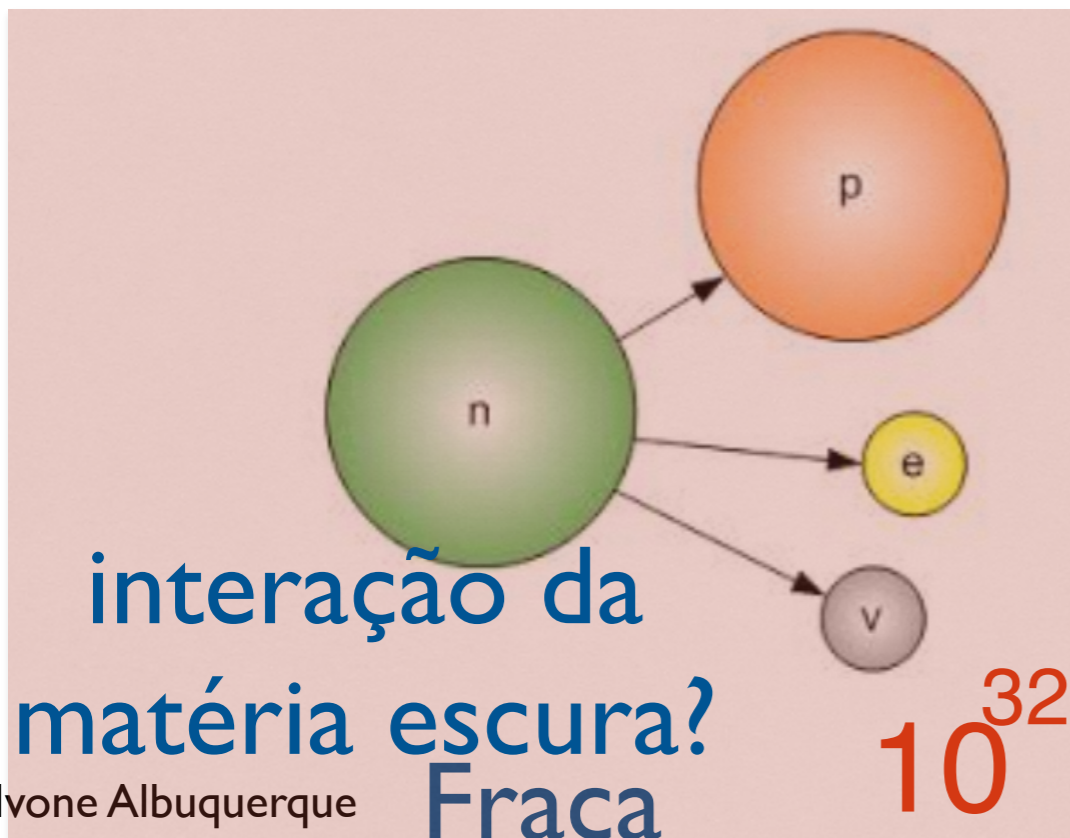
10^{38}

Forte

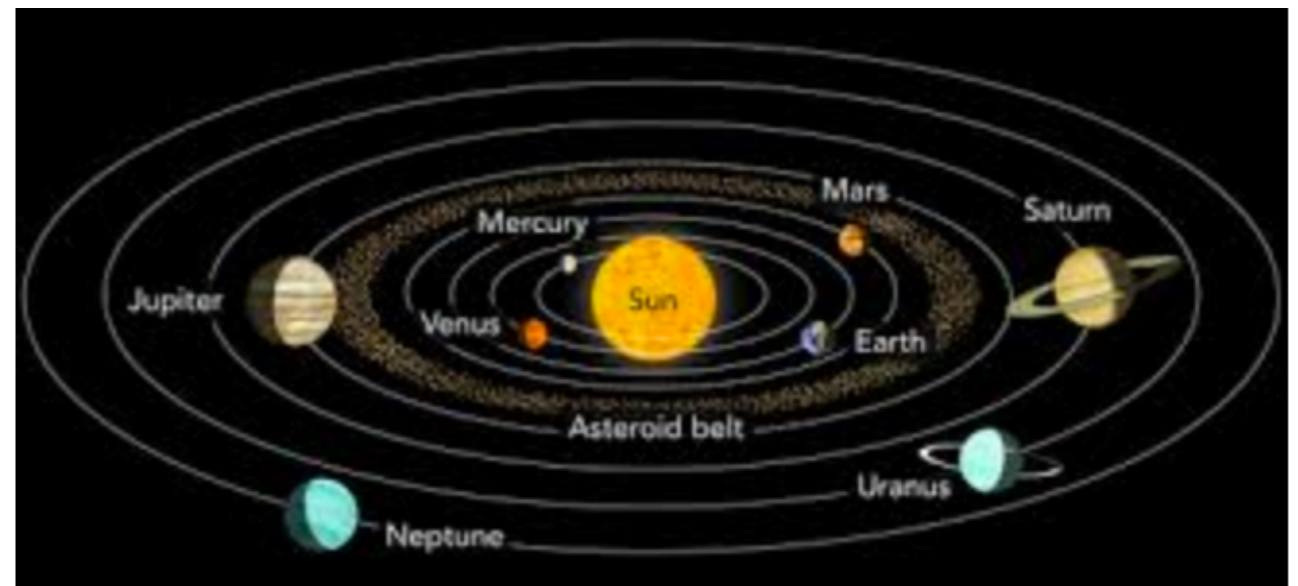


10^{36}

Eletromagnética

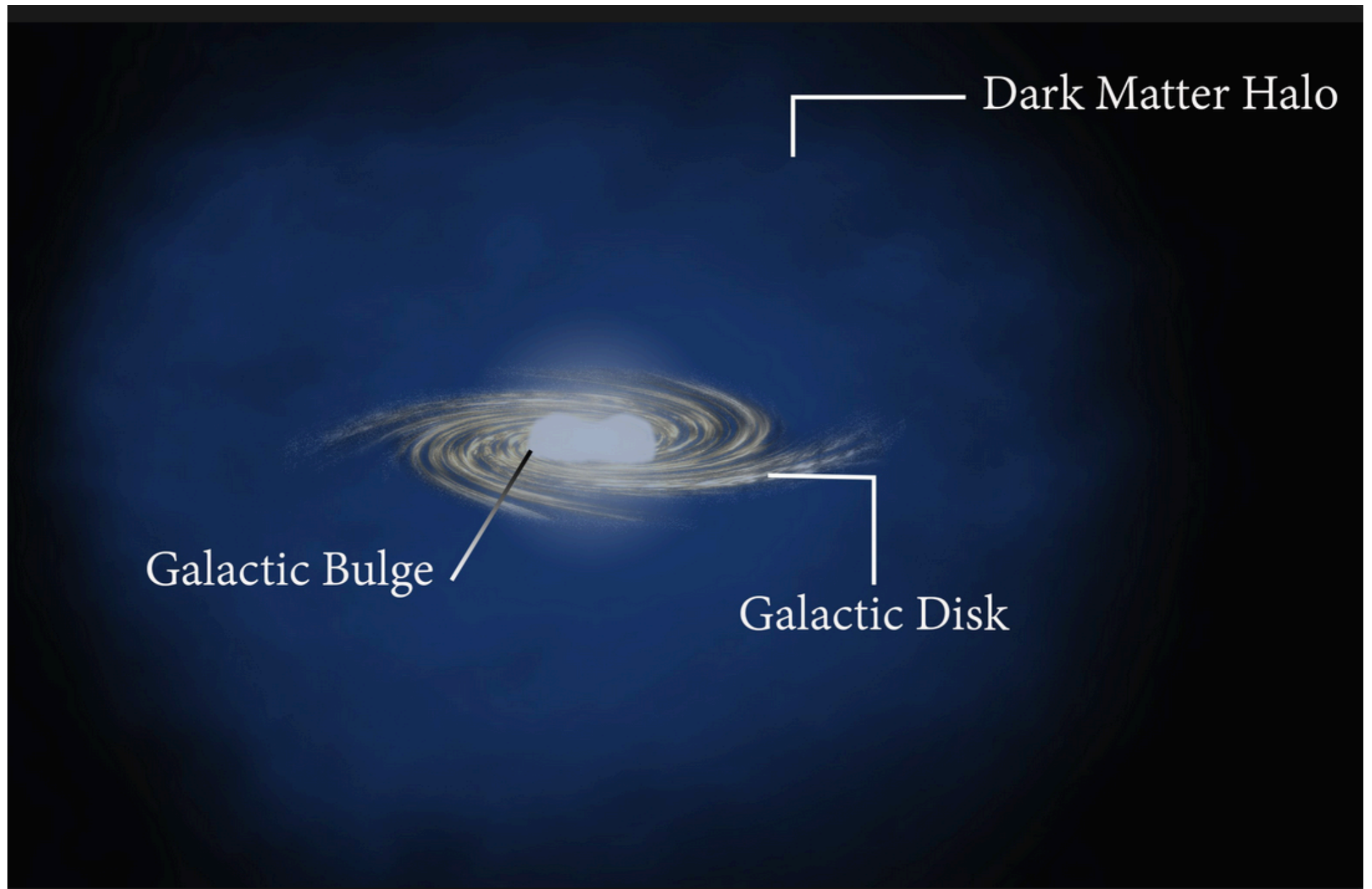


10^{32}

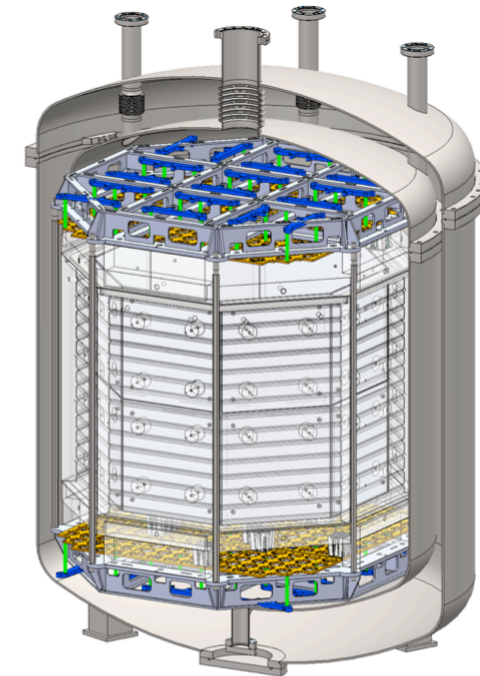


Gravitacional 1

DETECÇÃO



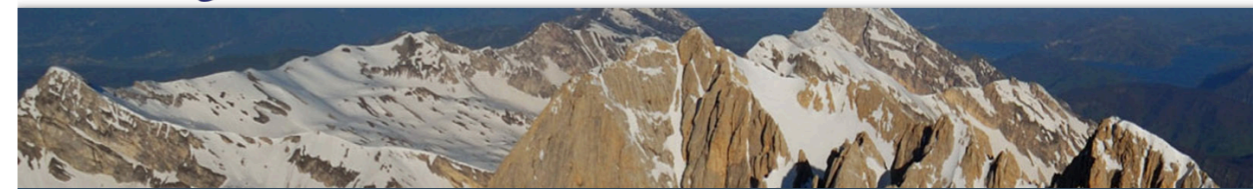
DETECÇÃO DIRETA



58 cm

DS-Proto-1
(2020–2021)
175 kg active
Scaled-down of
DS-20k TPC

 **Laboratori Nazionali del Gran Sasso**



DARKSIDE

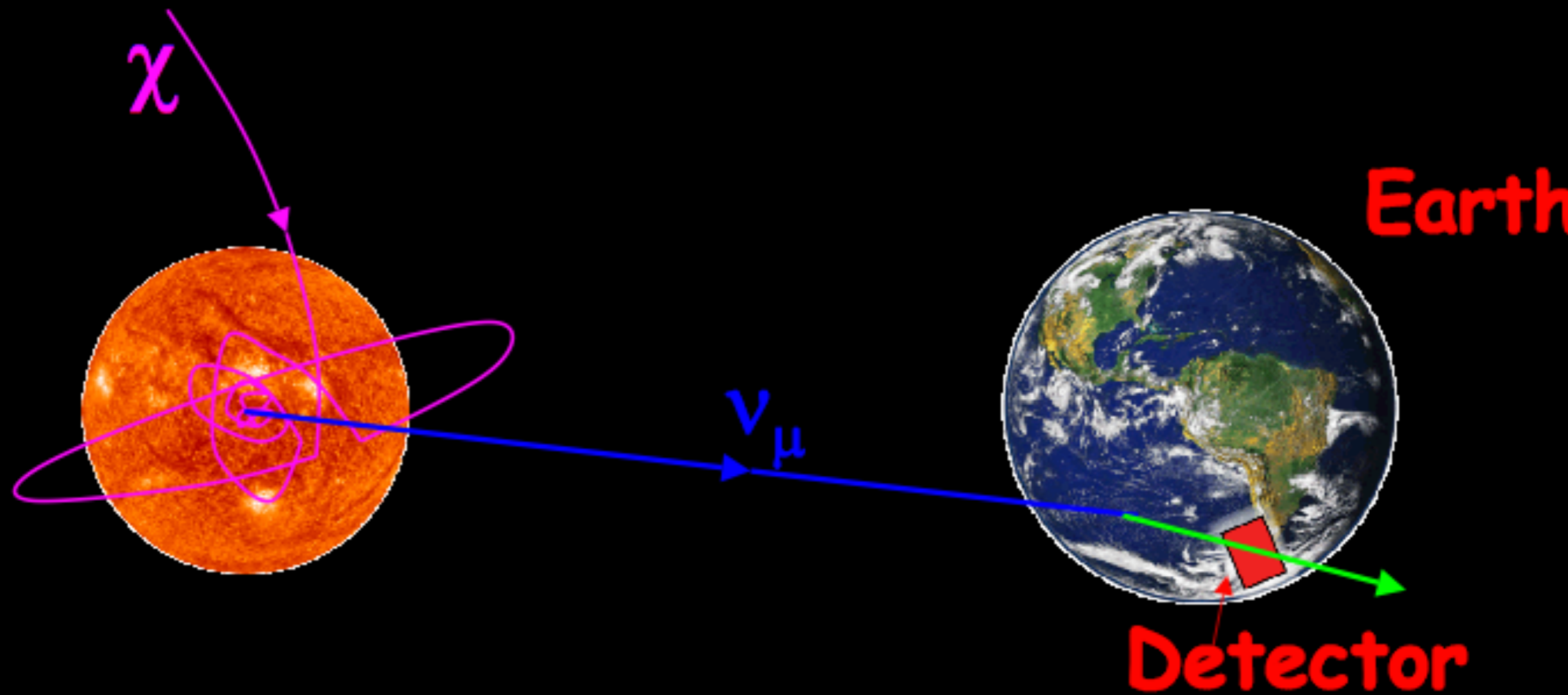
Experimentos de ME no Mundo



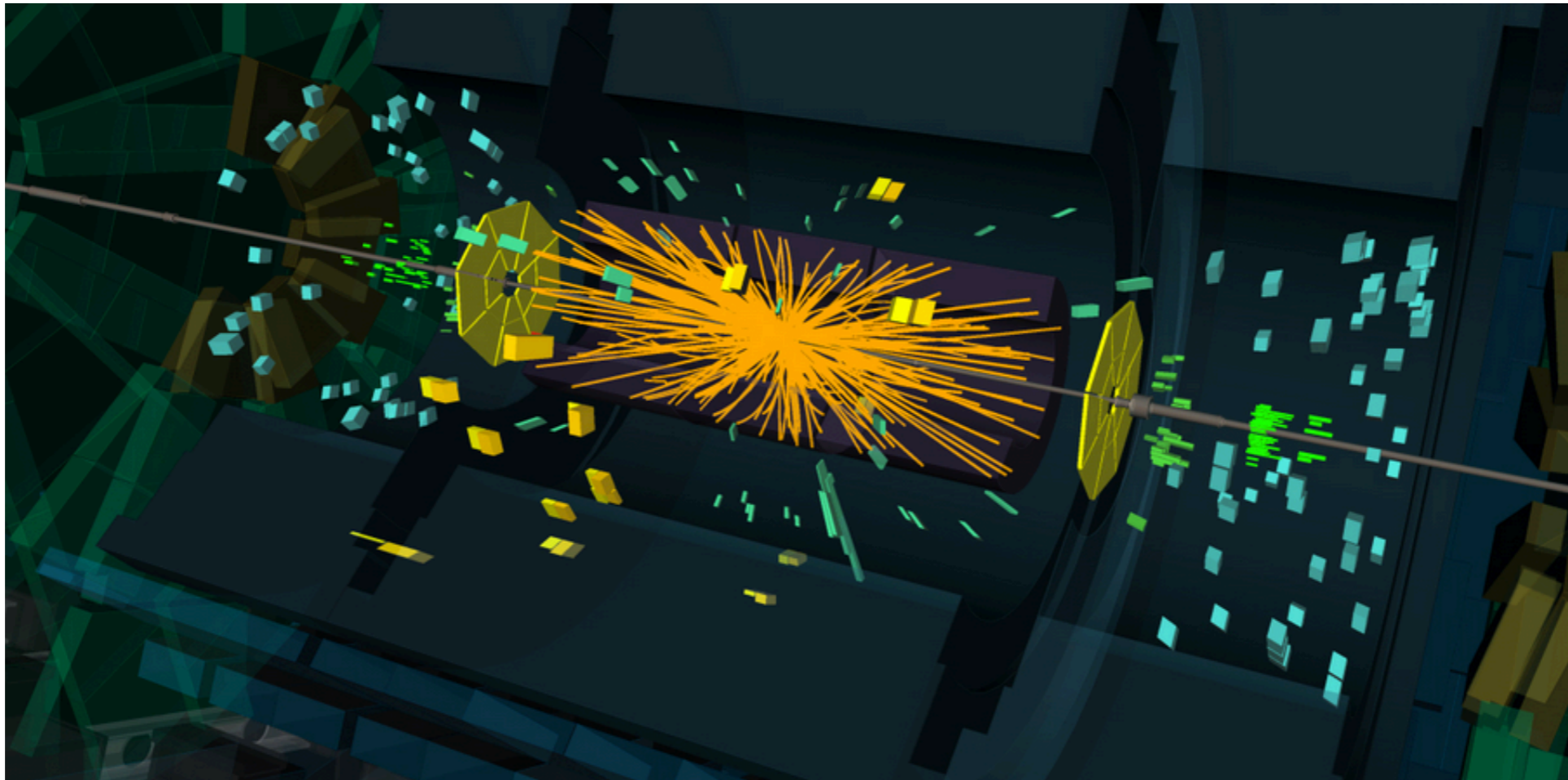
Tecnologia de Ponta em desenvolvimento constante!

DETECÇÃO INDIRETA

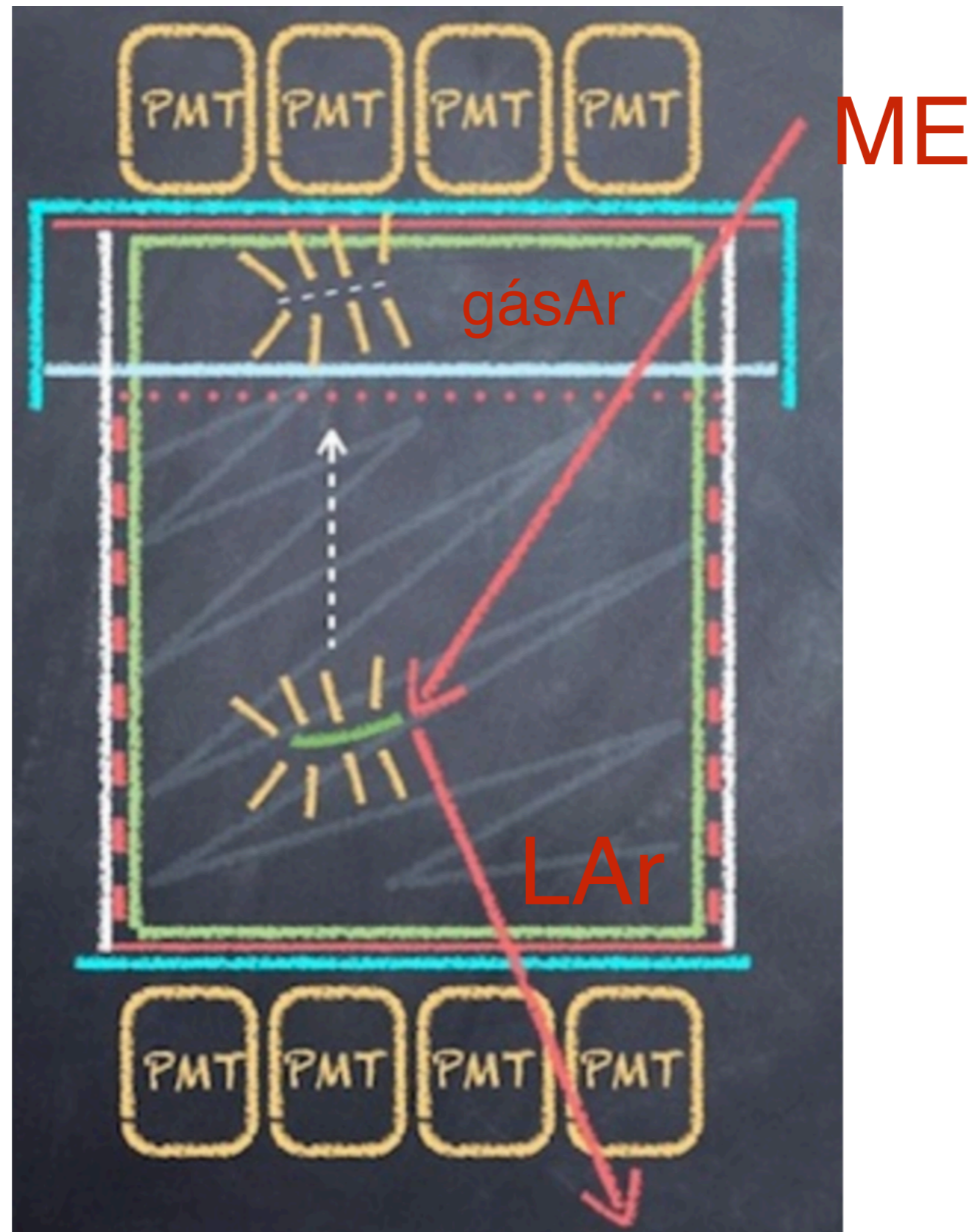
WIMP capture and annihilation



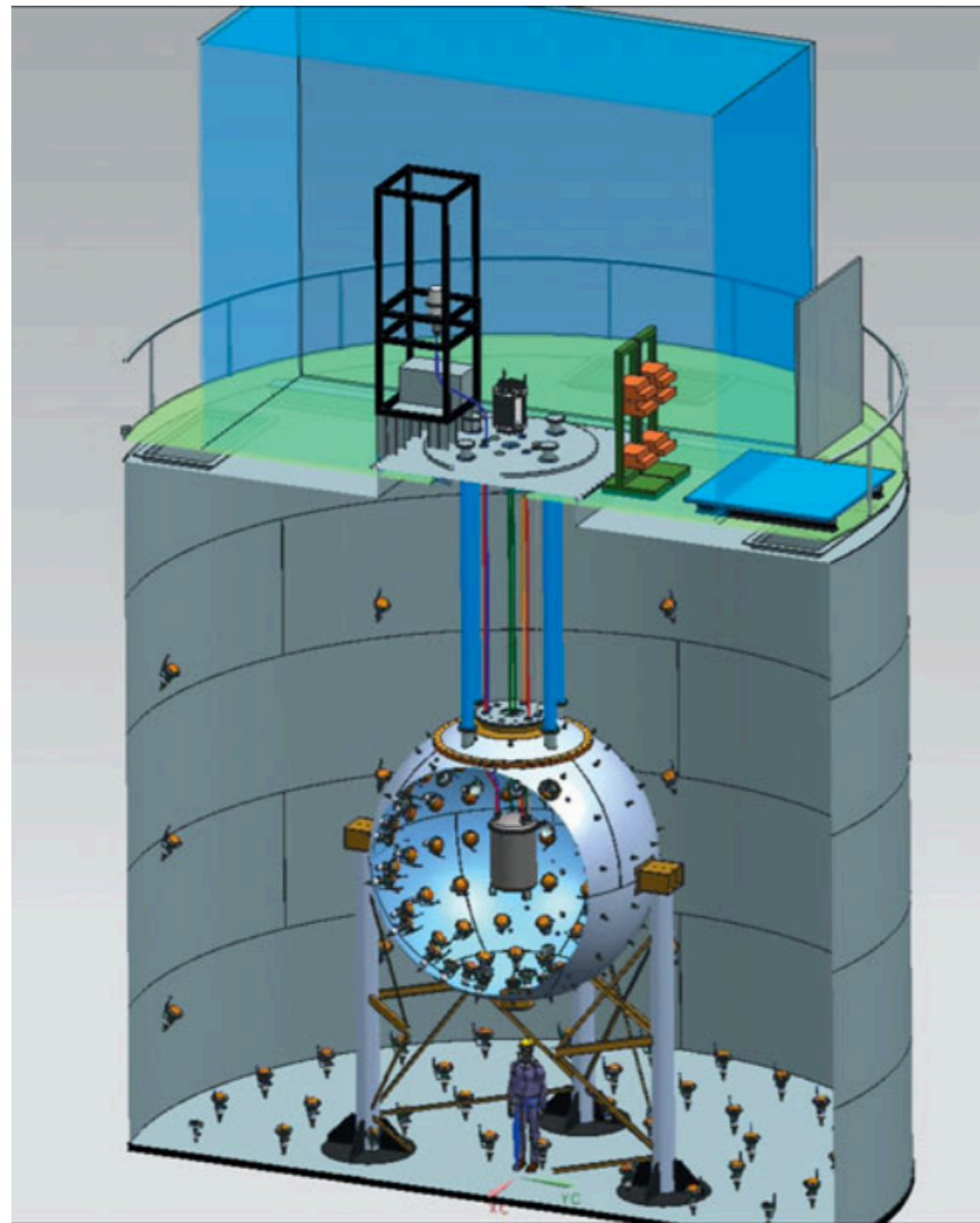
PRODUÇÃO E DETECÇÃO NO LHC - CERN



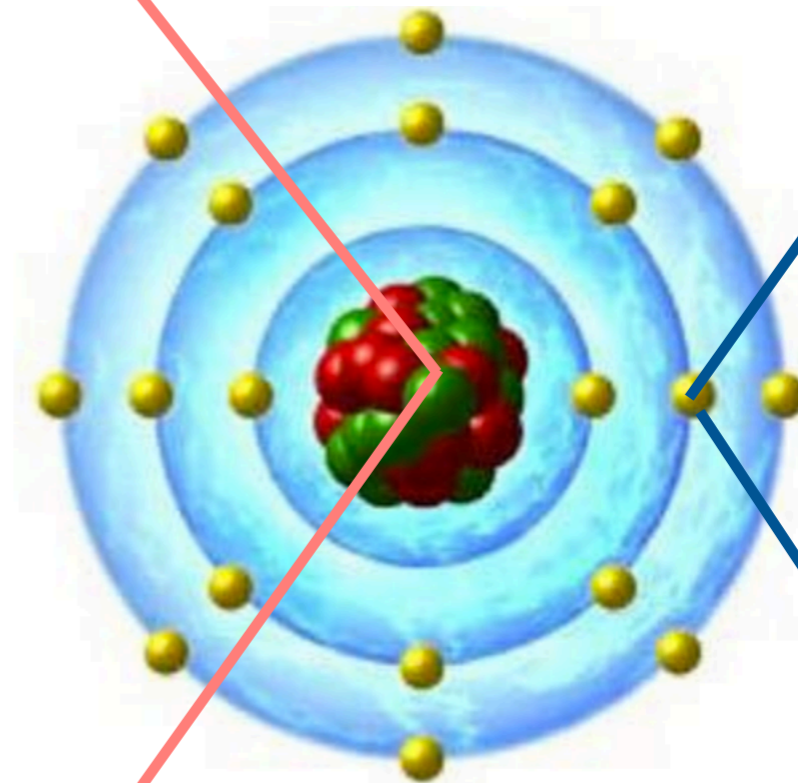
Princípio da Detecção Direta



Detector DarkSide



Recuos Eletrônicos
elétrons + gammas

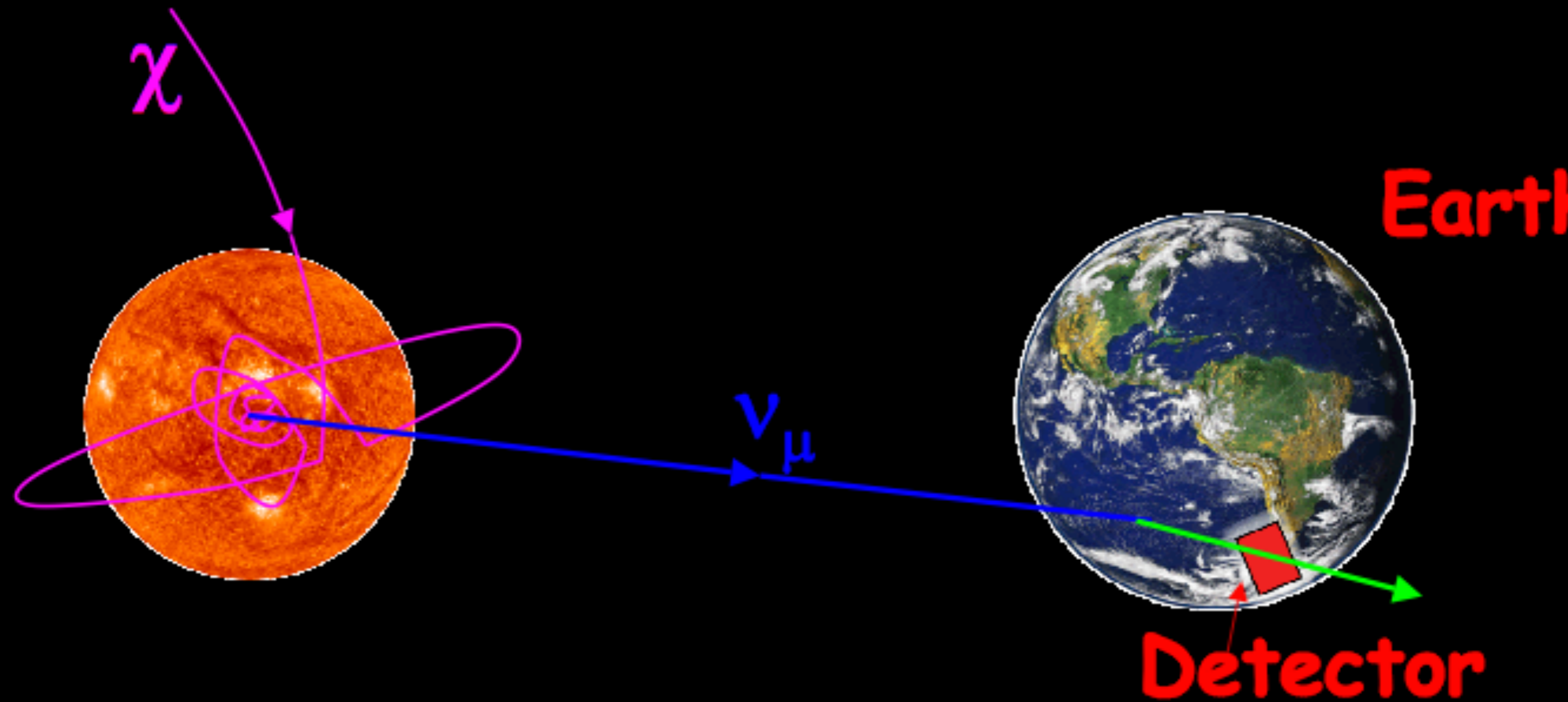


Recuos
Nucleares

neutrons

Matéria Escura

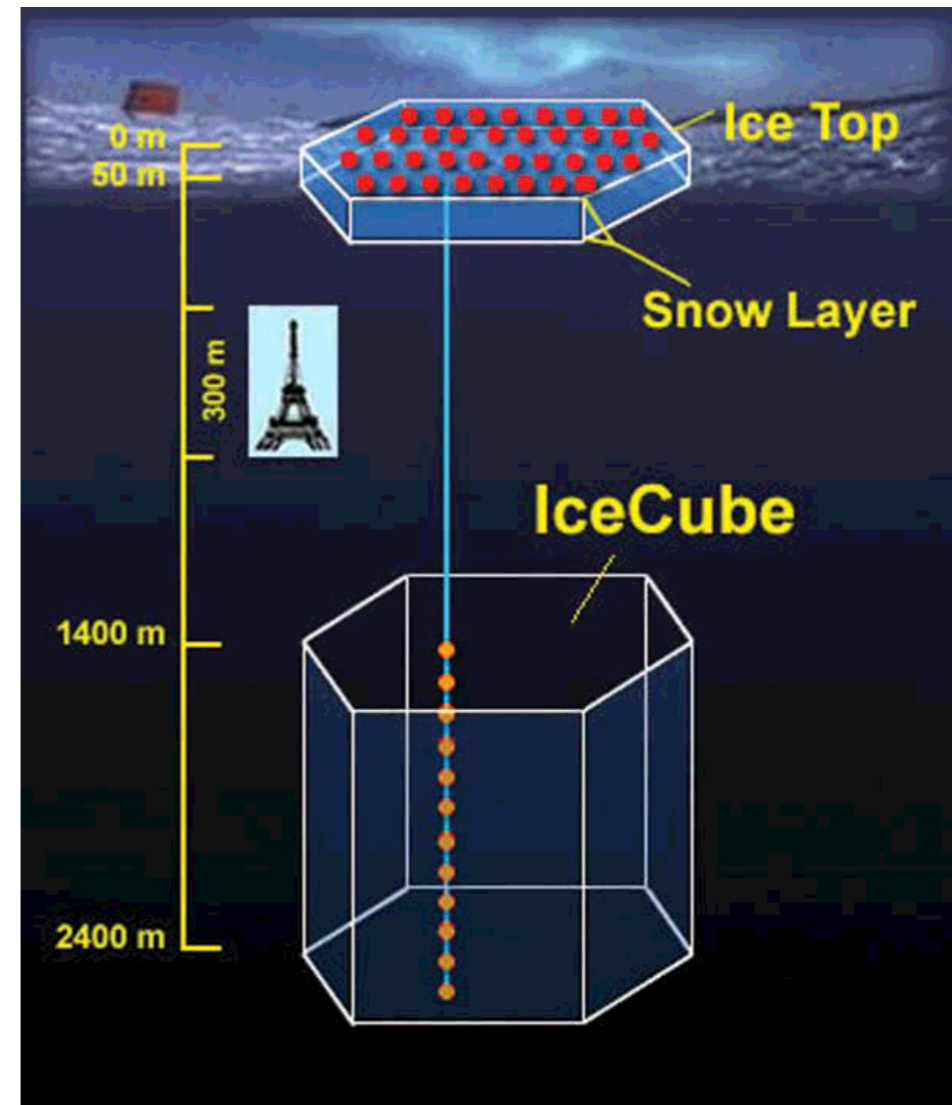
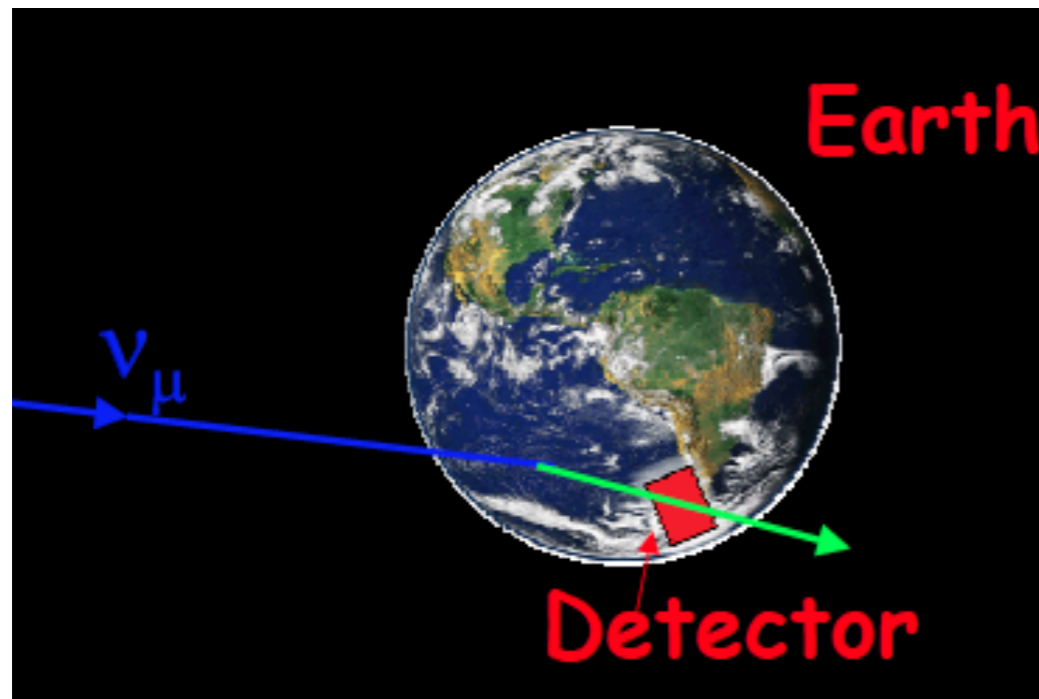
WIMP capture and annihilation



Detecção Indireta - IceCube



Detector IceCube



IceCube will occupy a volume of one cubic kilometer. Here we depict one of the 80 strings of optical modules (number and size not to scale). IceTop located at the surface, comprises an array of sensors to detect air showers. It will be used to calibrate IceCube and to conduct research on high-energy cosmic rays.

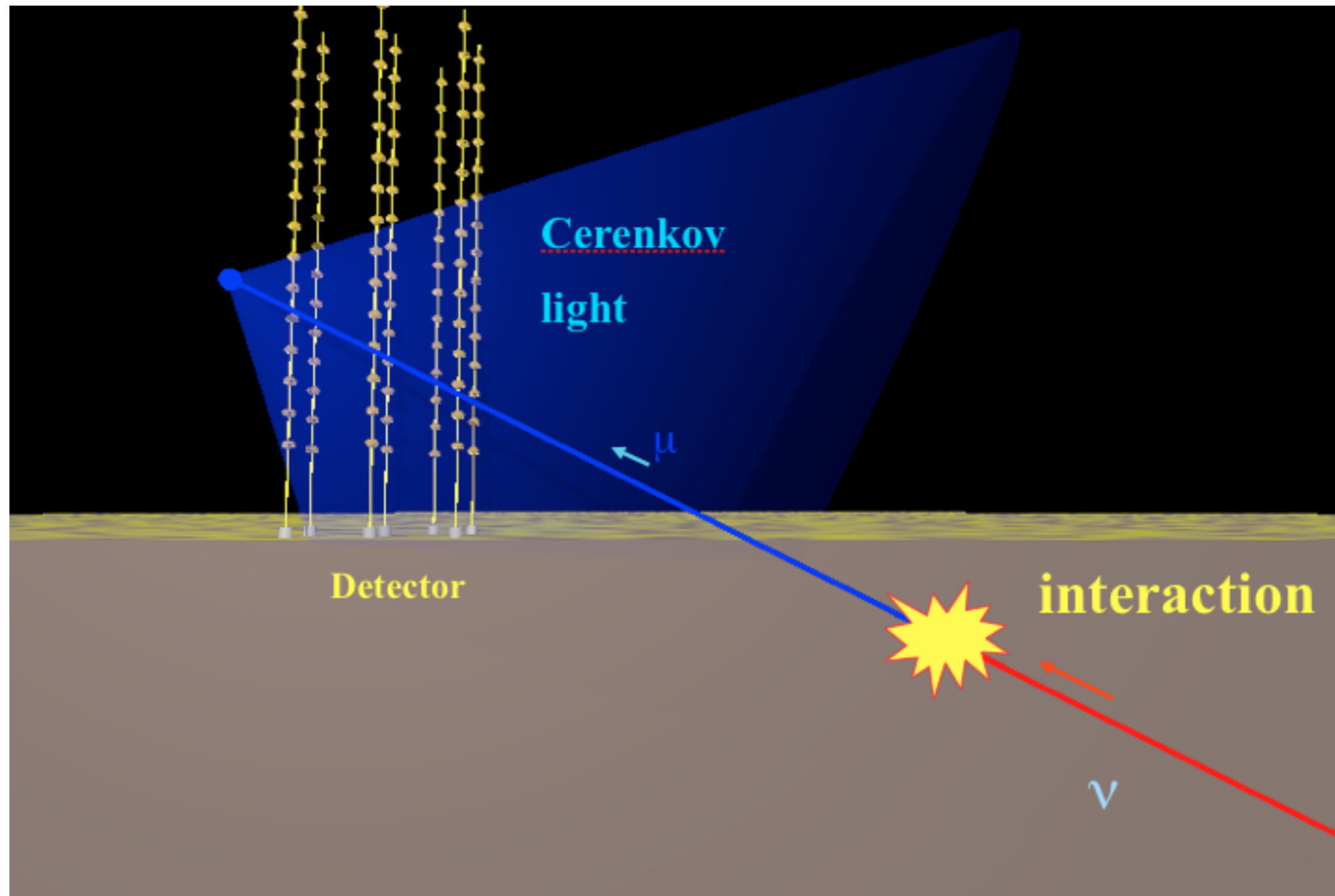
Filename: schema1-300.jpg

Image by: Darwin Rianto

Original Image

Last updated April 15, 2004 by IceCube Webmaster

Detecção de Luz Cherenkov



Cabos no Gelo



- Buraco é feito com água quente
→ cabo leva detectores de luz

Perspectivas

