

Ciaran O'Hare

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The cosmic pint

Q: What's in a pint of the Universe...

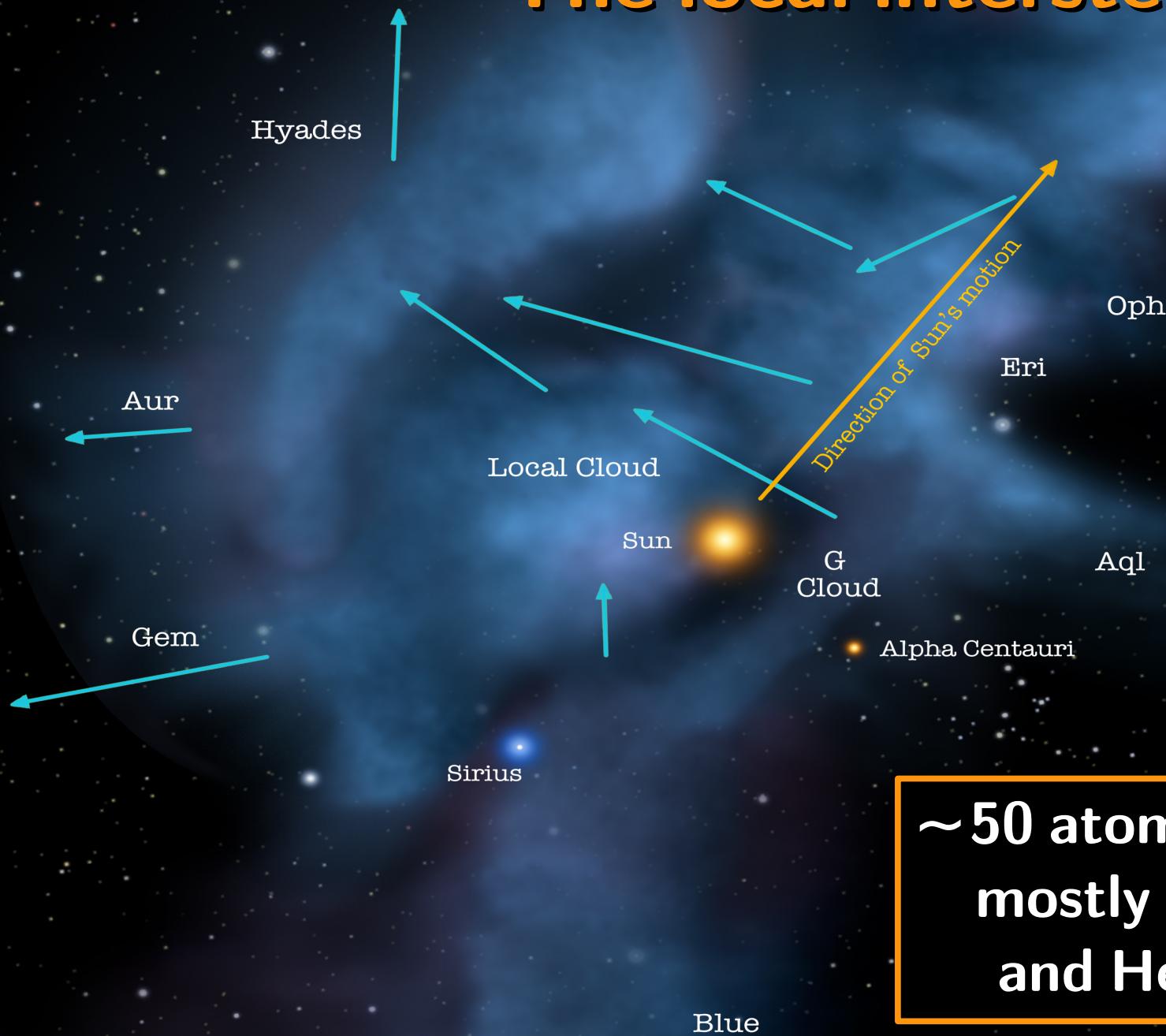


Ground rules:

- Get rid of the beer somehow
- ...and the rest of the Earth
- Assume we're out in space, not inside a star or a black hole

$$1 \text{ pint (approx.)} = 0.00057 \text{ m}^3 = 570 \text{ cm}^3$$

The local interstellar cloud



~50 atoms per pint,
mostly Hydrogen
and Helium gas

Cosmic rays

~ 100 cosmic ray particles passing through your pint every second, travelling at nearly the speed of light

Protons

p^+

Antiprotons

p^-

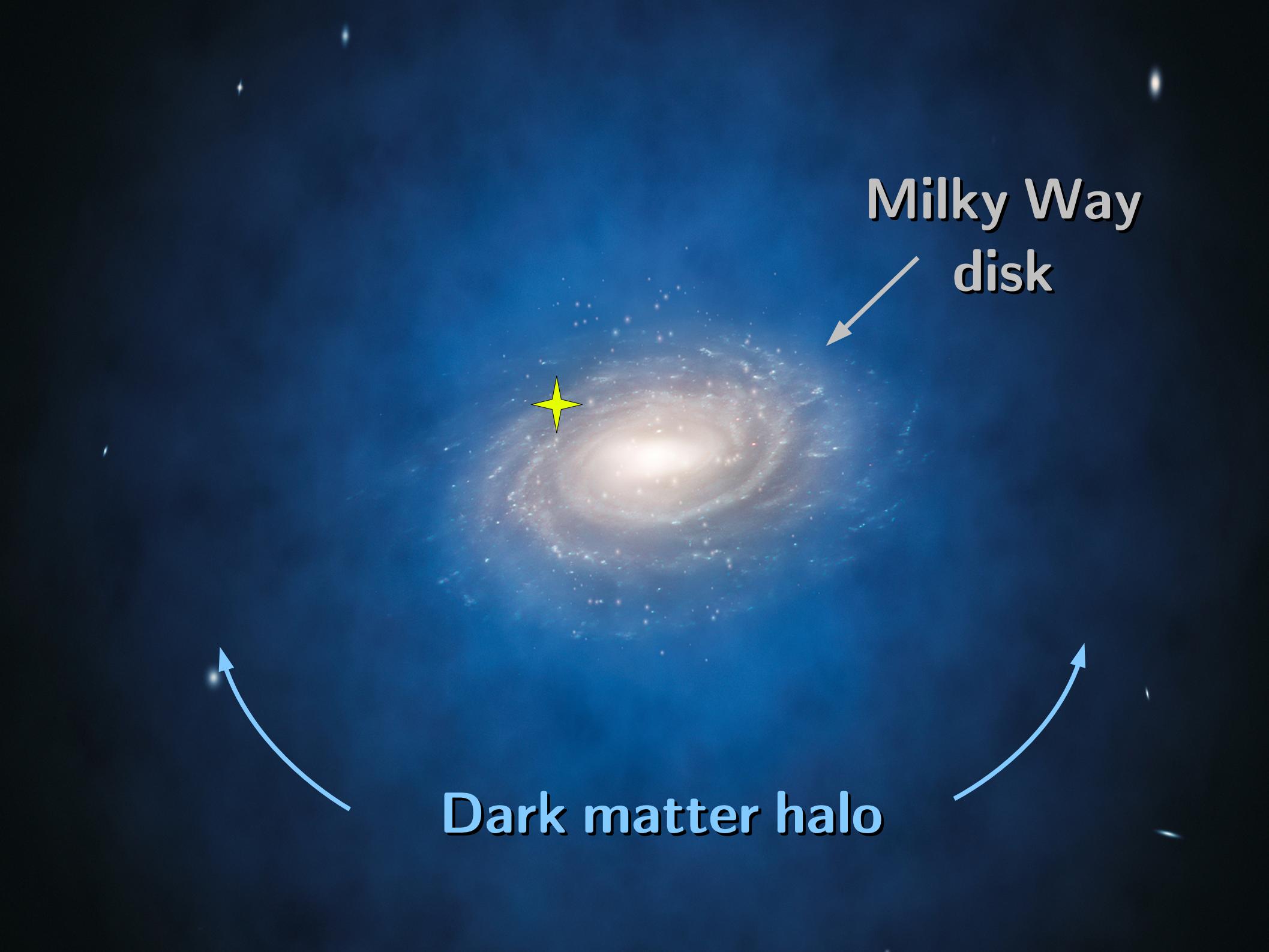
Electrons

e^-

Positrons

e^+



A photograph of a spiral galaxy with a yellow star and two blue arrows.

Milky Way
disk

Dark matter halo

The cosmic web

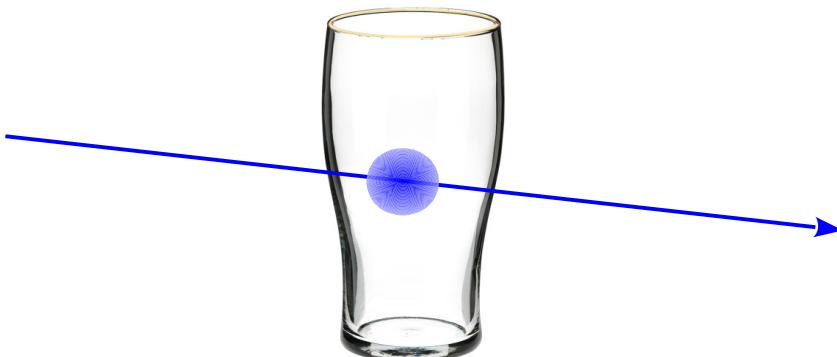
Distribution of dark matter in the Universe

What is dark matter?

We currently have two big ideas:

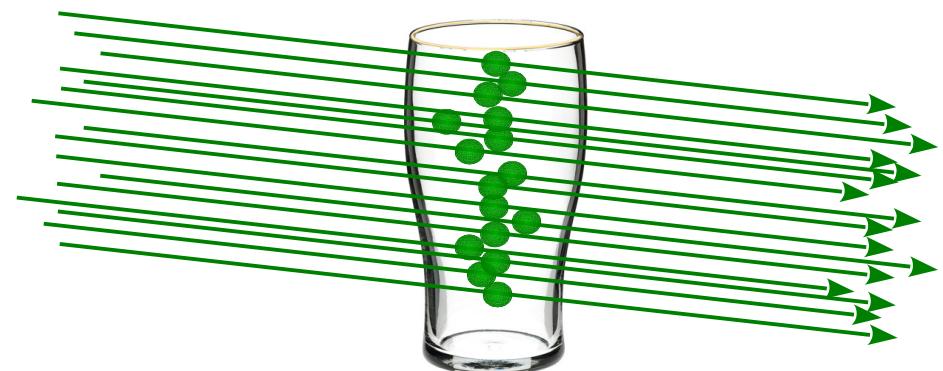
WIMPs

**Weakly Interacting
Massive Particles**



Very heavy
~ 1 WIMP per pint

Axions

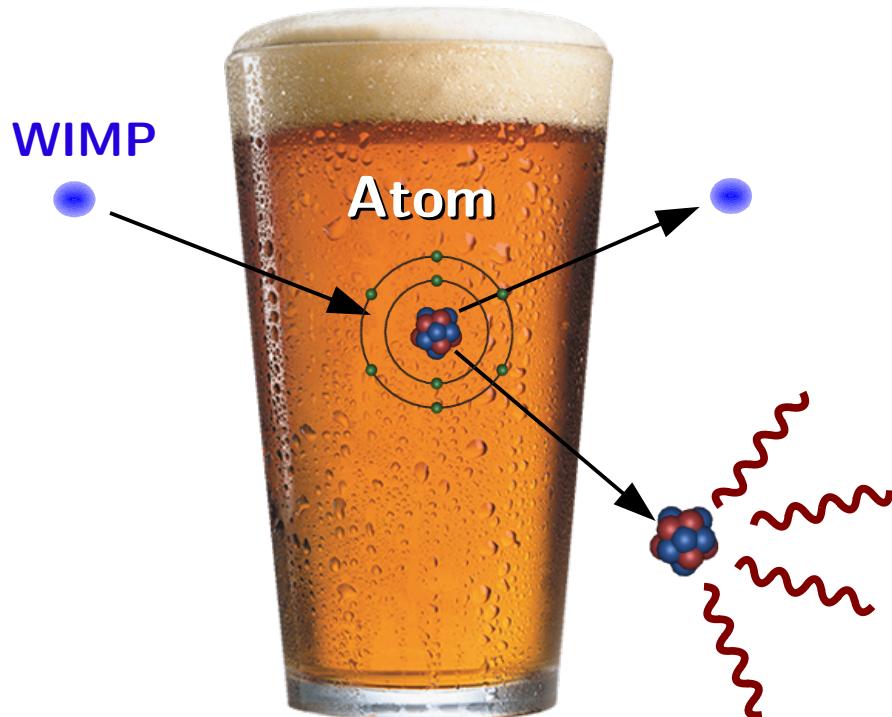


Extremely light
~ 10^{17} per pint

How to detect dark matter with your pint..

WIMPs

Fill your pint with some atoms e.g. beer

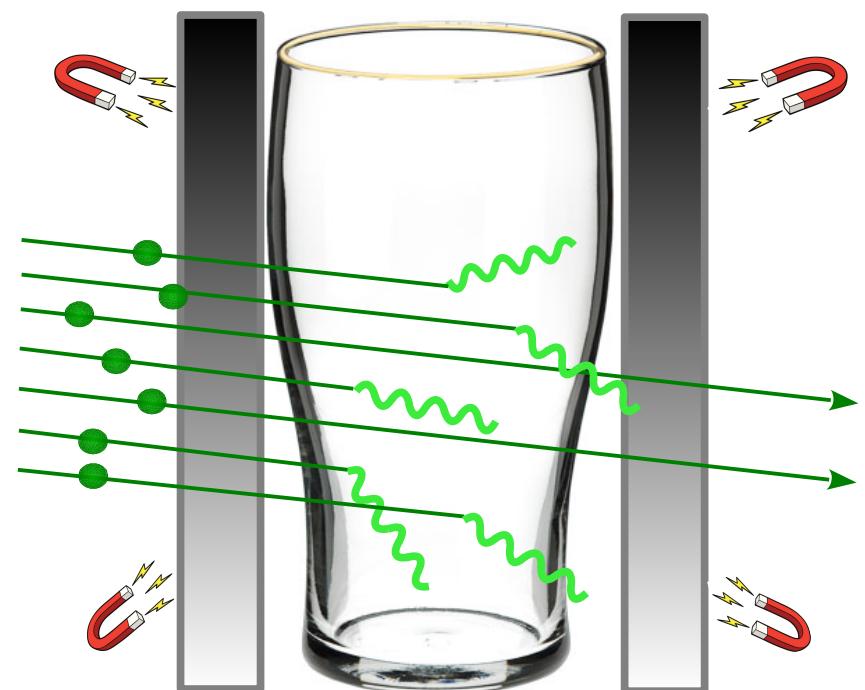


→ recoiling nuclei

~ once every 1000 years

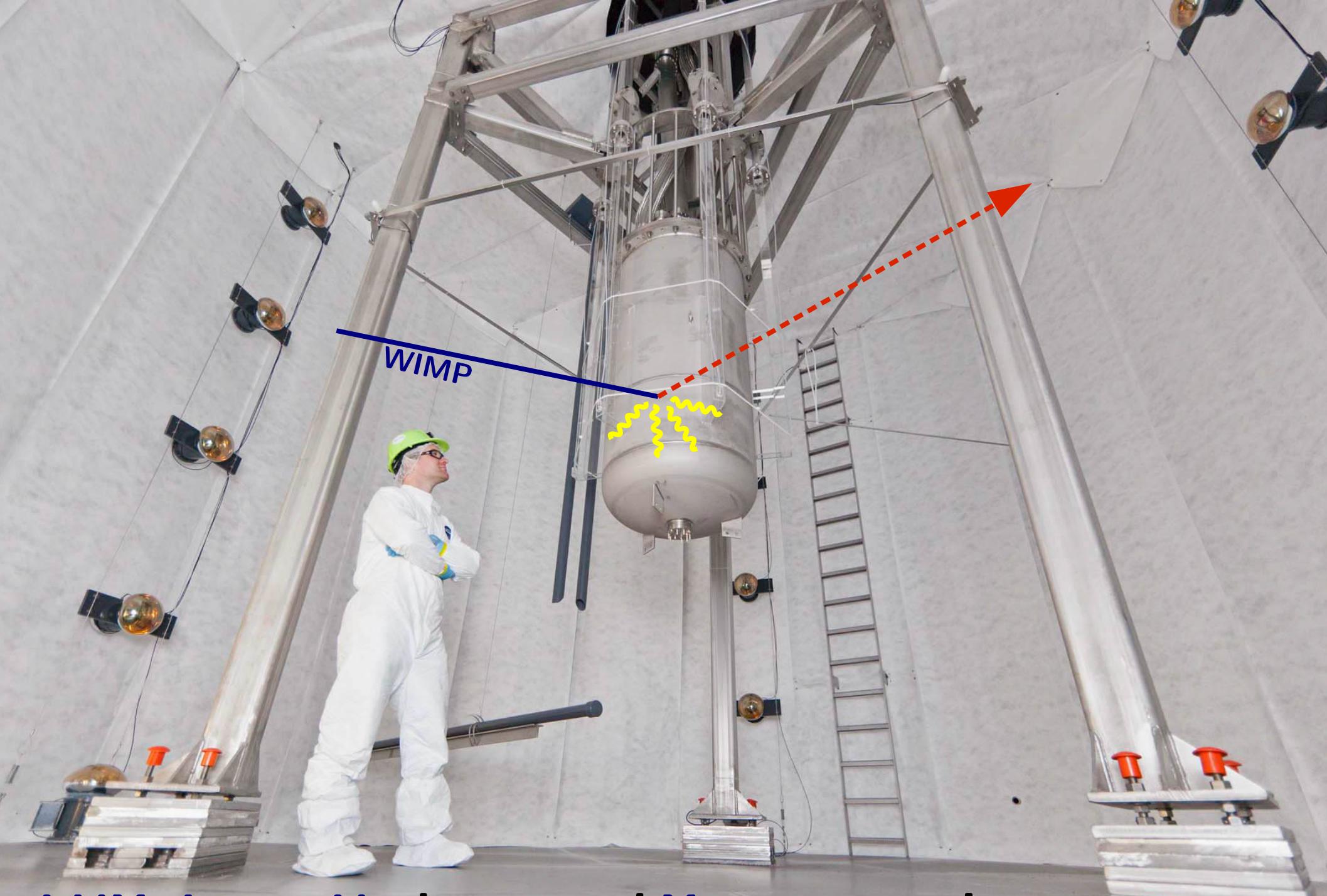
Axions

Fill your pint with a magnetic field



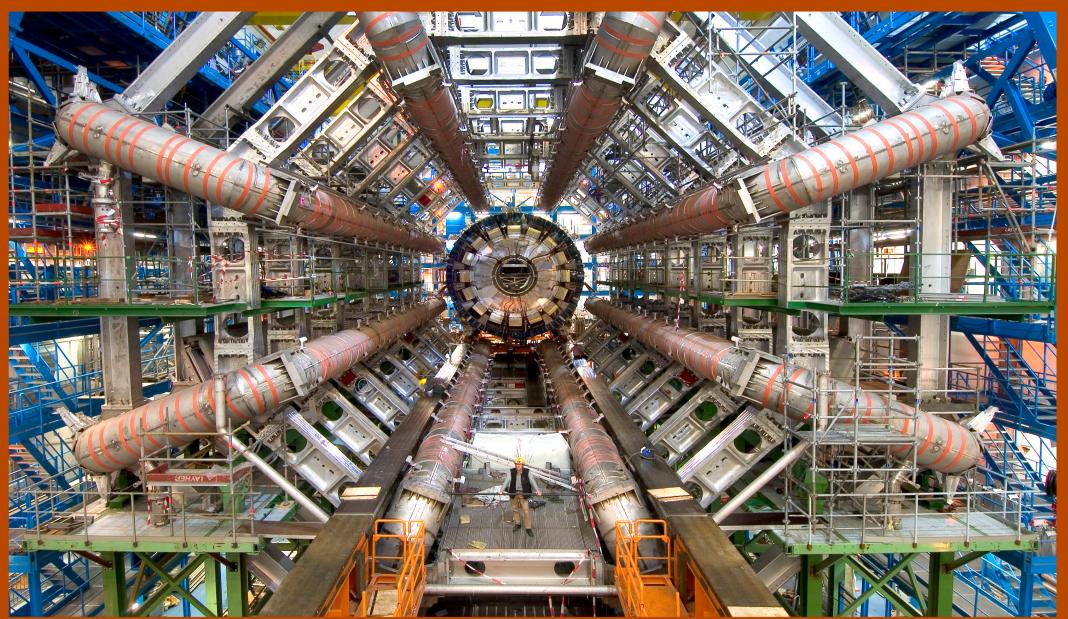
→ electromagnetic field

~ 30 W bulb located on Mars



LUX: Large Underground Xenon experiment

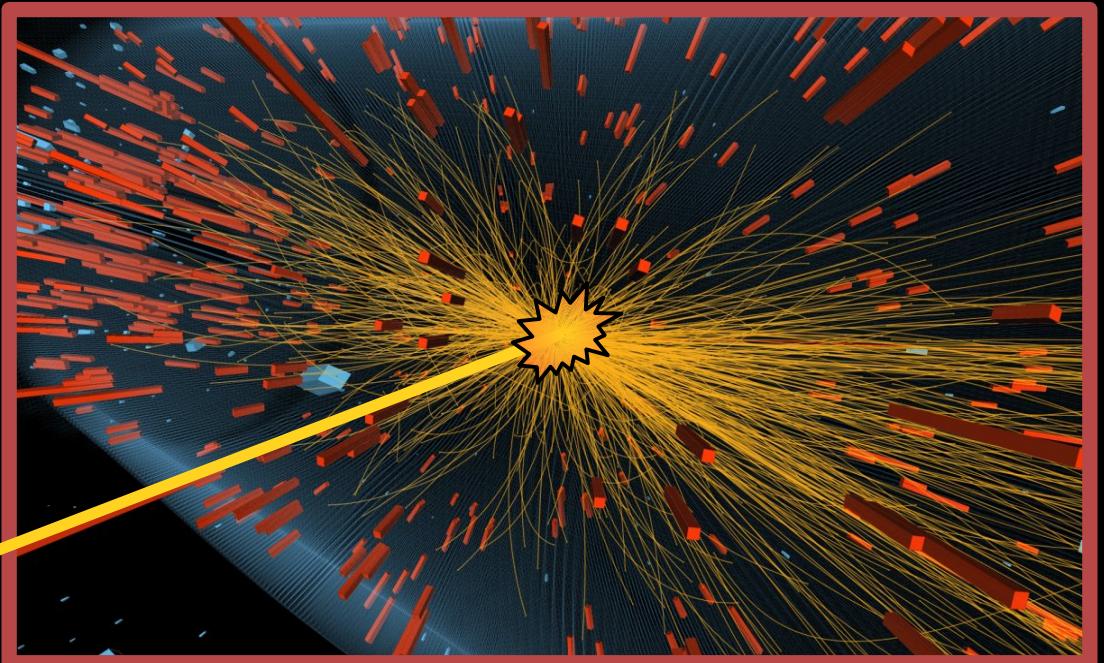
(uses 340 kg of liquid Xenon, equivalent to around 5000 pints of beer)



We are trying to *make*
dark matter at the
Large Hadron Collider
(LHC)

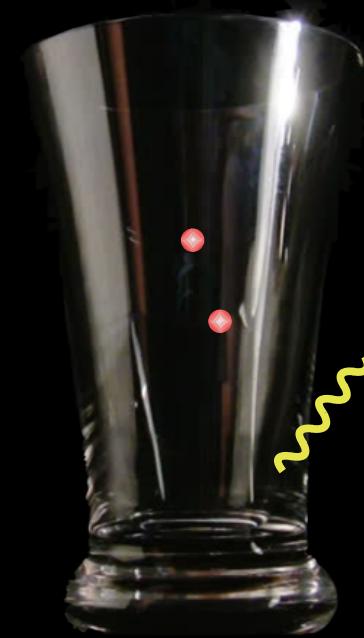
It escapes undetected,
so we must look for
missing energy

Dark matter



But what if we get rid of
all the galaxies and all the
dark matter?

Relics from the Big Bang



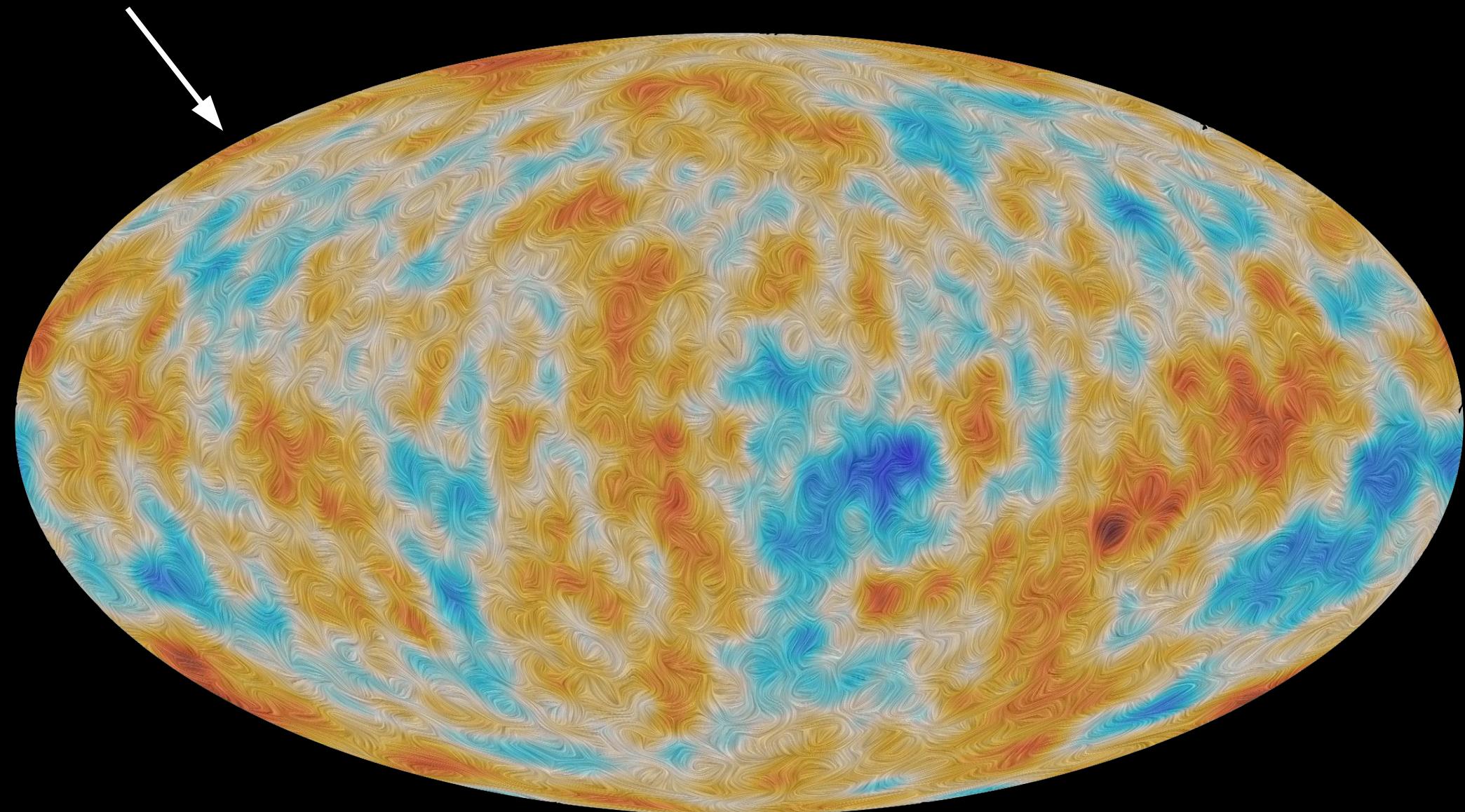
How much in a pint?

Microwave photons $\sim 210,000$

• Neutrinos $\sim 190,000$

Relics from the Big Bang

Hot and cold spots in the “Cosmic Microwave Background”



Polarisation map measured by the Planck satellite

Dark energy 68.3%

Dark matter
26.8%

Ordinary
matter 4.9%

Relics <0.001%

Dark energy

→ Causes the expansion of the Universe to accelerate

How much dark energy in a pint?

About the energy of your eardrums while listening to a whisper for 1 second



Particle Cosmology

The Universe on the largest scales



The interactions of fundamental particles

The Cosmic Pint

Always show your working...

→ Go to my twitter for a link to the full details of my calculations, as well as these slides

 @cajohare

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