Indirect Dark Matter search in dwarf spheroidal galaxies

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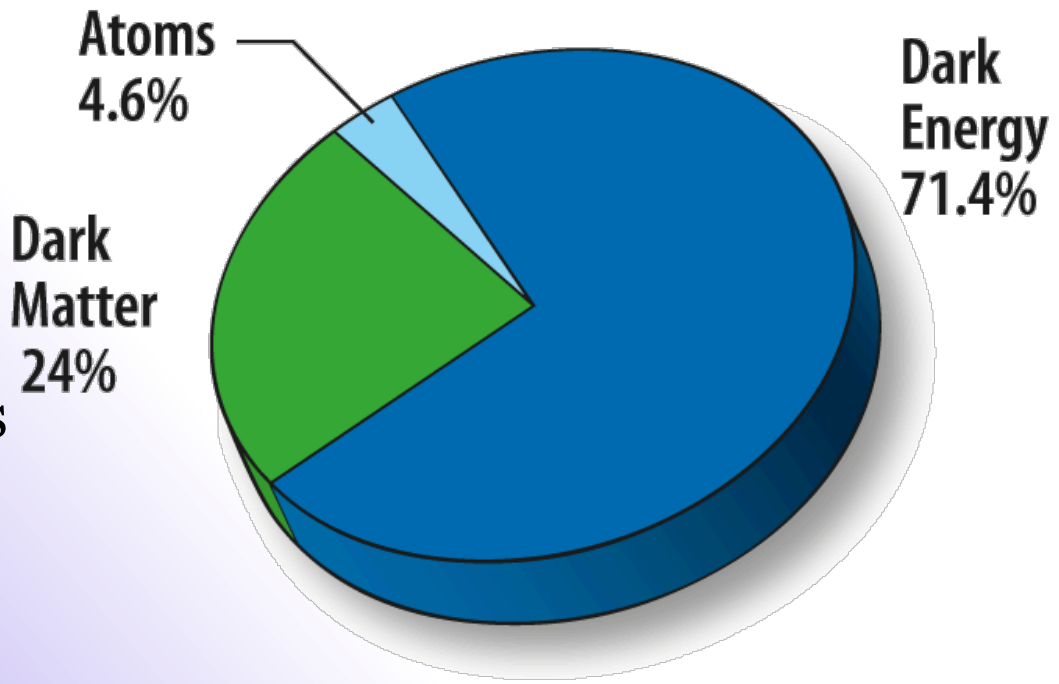
Introduction

Observational evidence indicates that dark matter is:

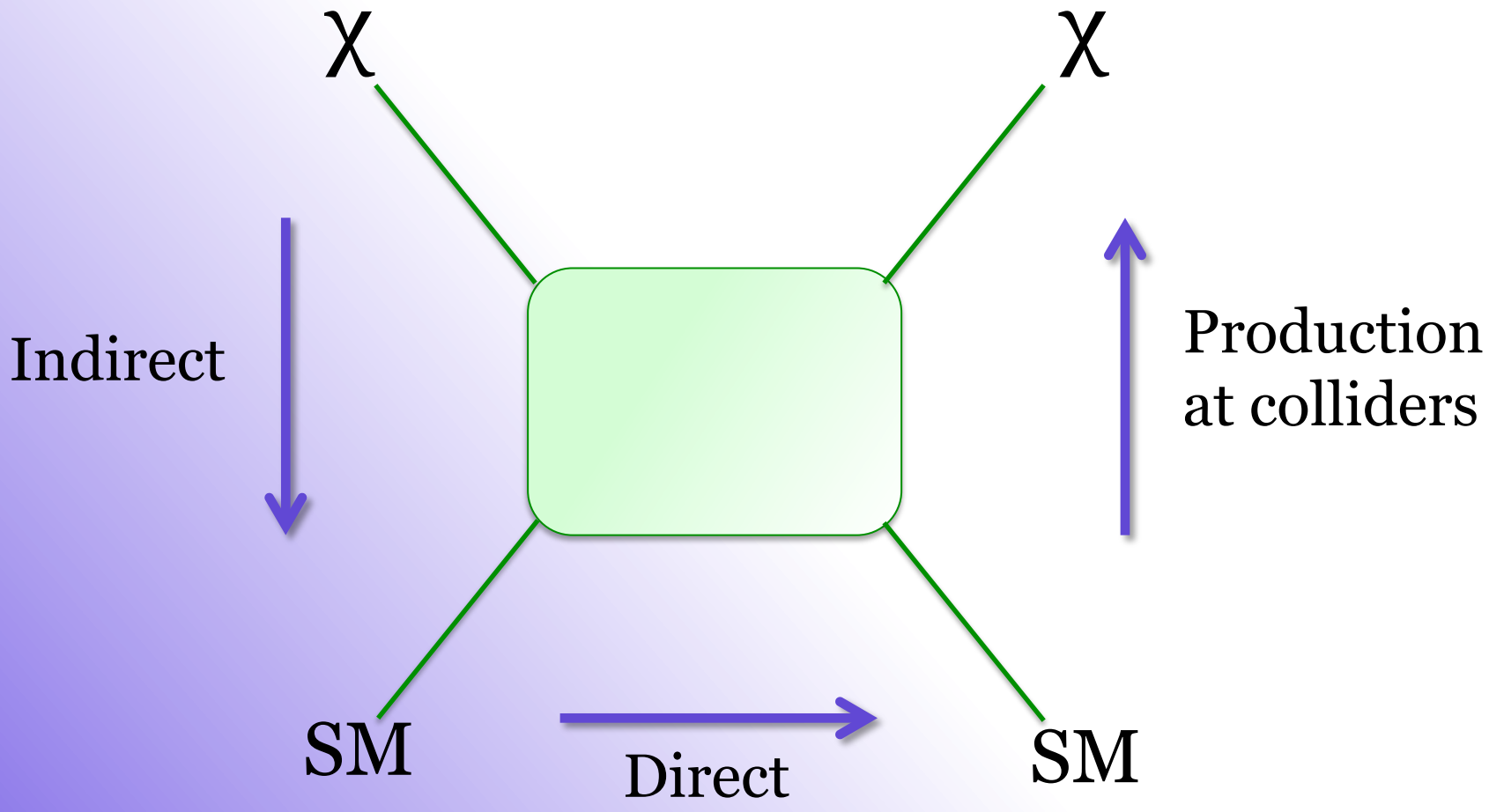
- Non-baryonic
- Cold (non-relativistic)
- Neutral
- Interacts only via gravitatonal and weak forces
- Massive
- Stable

→ WIMPs



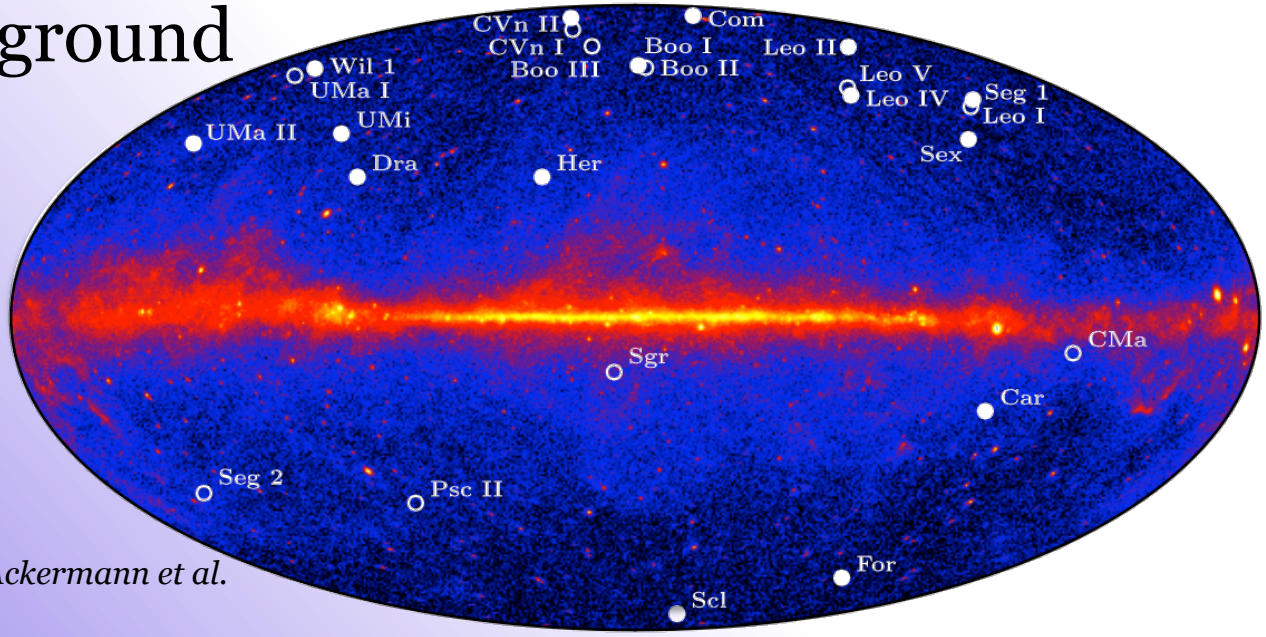
NASA/WMAP Science Team

DM searches



Dwarf spheroidal galaxies

- Satellite galaxies of the Milky Way (and M31)
- Largest galactic substructures
- Most dark matter dominated objects in the Universe
- Very low background



Ackermann et al.

Flux from DM annihilation

Expected γ-ray flux:

$$\phi_{\mathrm{WIMP}}(E, \Delta\Omega) = J(\Delta\Omega) \times \Phi^{\mathrm{PP}}(E)$$

Particle physics factor:

$$\Phi^{\mathrm{PP}}(E) = \frac{1}{2}\frac{\langle\sigma v\rangle}{4\pi m^2_{\mathrm{WIMP}}} \sum_f \frac{dN_f}{dE} B_f$$

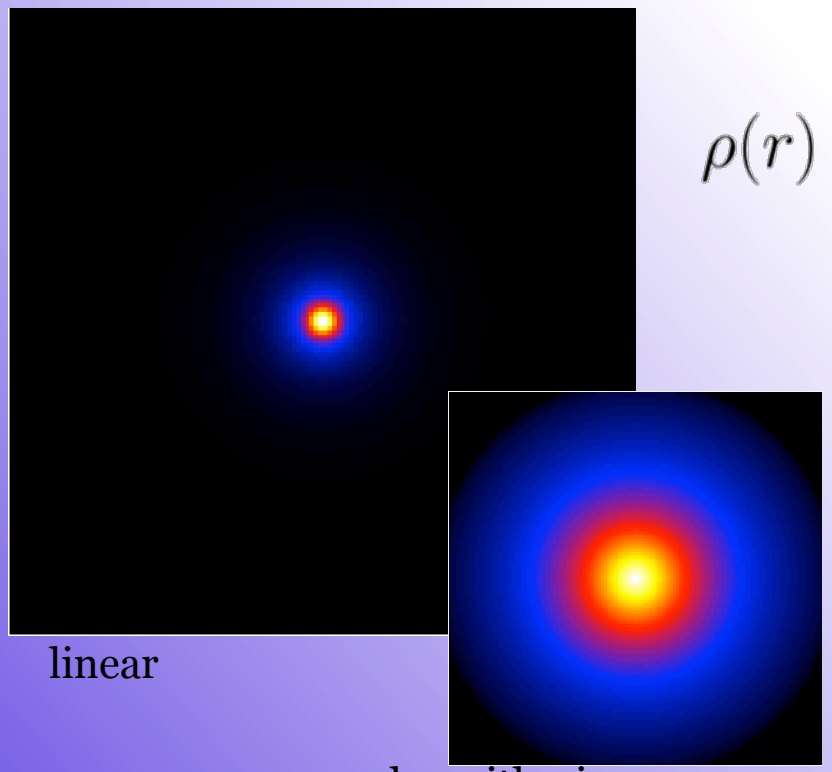
Astrophysical factor:

$$J(\Delta\Omega) = \int_{\Delta\Omega}\int_{\mathrm{l.o.s}} \rho^2(l)\mathrm{d}l\,\mathrm{d}\Omega$$

Astrophysical J-factor

$$J(\Delta\Omega) = \int_{\Delta\Omega} \int_{\text{l.o.s}} \rho^2(l) \mathrm{d}l \, \mathrm{d}\Omega$$

Dark matter distribution (NFW density profile):



linear

logarithmic

$$\rho(r) = \begin{cases} \frac{\rho_s r_s^3}{r(r_s+r)^2} & \text{for } r < r_t \\ 0 & \text{for } r \geq r_t \end{cases}$$

→ Spatial model

Diffuse DM background

Extragalactic γ-ray intensity produced in DM annihilations:

$$I_{\rm DM} \sim \frac{\langle \sigma v \rangle c}{8\pi} \left(\frac{\Omega_{DM} \rho_c}{m_{\rm DM}} \right)^2 \frac{{\rm d}N}{{\rm d}E} \xi$$

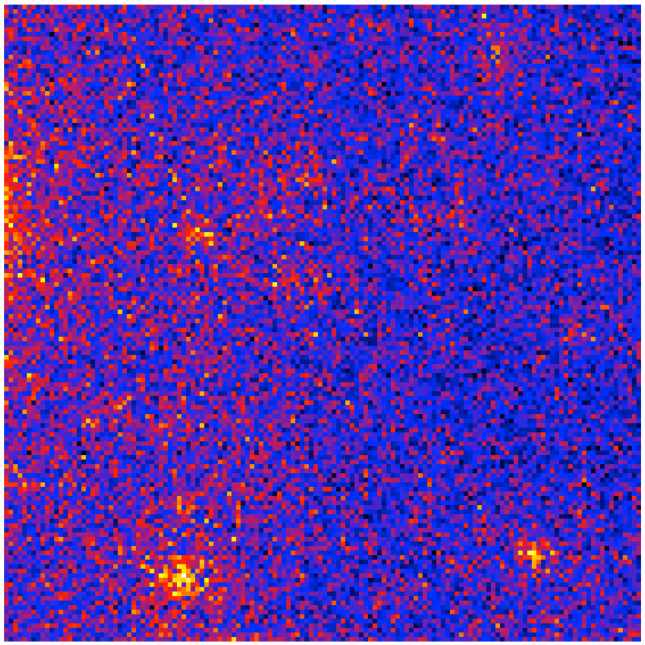
$$\xi = \int^z \frac{H_o}{H(z)} (1+z)^3 \underbrace{\langle \delta^2(z) \rangle}$$

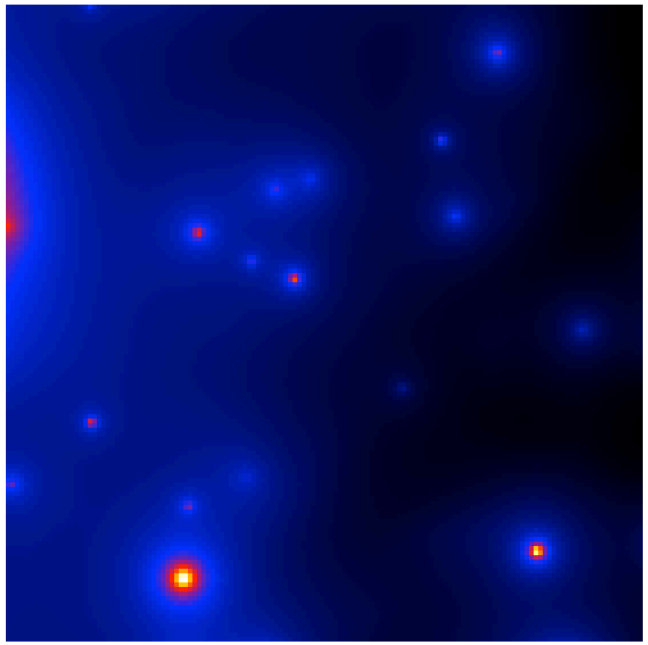
Flux multiplier: related to the variance of DM density in the Universe

→ Take $\langle \sigma v \rangle \xi$ as a combined free parameter.

~~Results~~

Work in progress





Summary

- ~80% of the matter in the Universe consists of DM
- Dwarf spheroidal galaxies are attractive targets for indirect DM search
- No detected excess so far

→ constraints on cross section