Dark matter detection on the Galactic scale

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Dark matter searches at neutrino telescopes

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Cosmological abundance

* Chemical equilibrium as long as T>m
* Non-relativistic when x=m/T>1 => Boltzmann suppression of codensity
* Freeze-out when annihilation rate < expansion rate
* Thermal equilibrium as long as interaction rate > expansion rate

=> Relevant quantities: Expansion rate (<=> relativistic degrees of freedom)

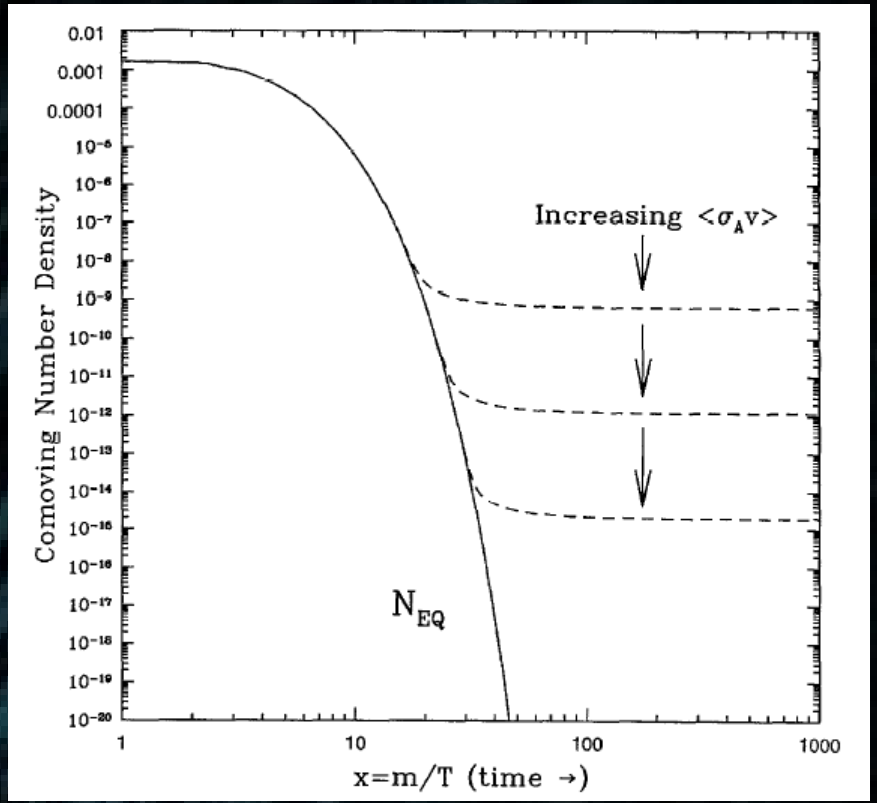
$$\frac{dY}{dx} = -\frac{1}{3H}\frac{ds}{dx}\frac{m_\chi}{x^2}\langle\sigma v\rangle\left(Y^2 - Y_{\rm eq}^2\right) = -\sqrt{\frac{\pi}{45}}\frac{M_p m_\chi}{x^2} g_\star^{1/2}\langle\sigma v\rangle\left(Y^2 - Y_{\rm eq}^2\right),$$

$$H^2 = \frac{8\pi G}{3}\rho$$

$$\rho = \frac{\pi^2}{30} g_{\rm eff}(T) T^4,$$

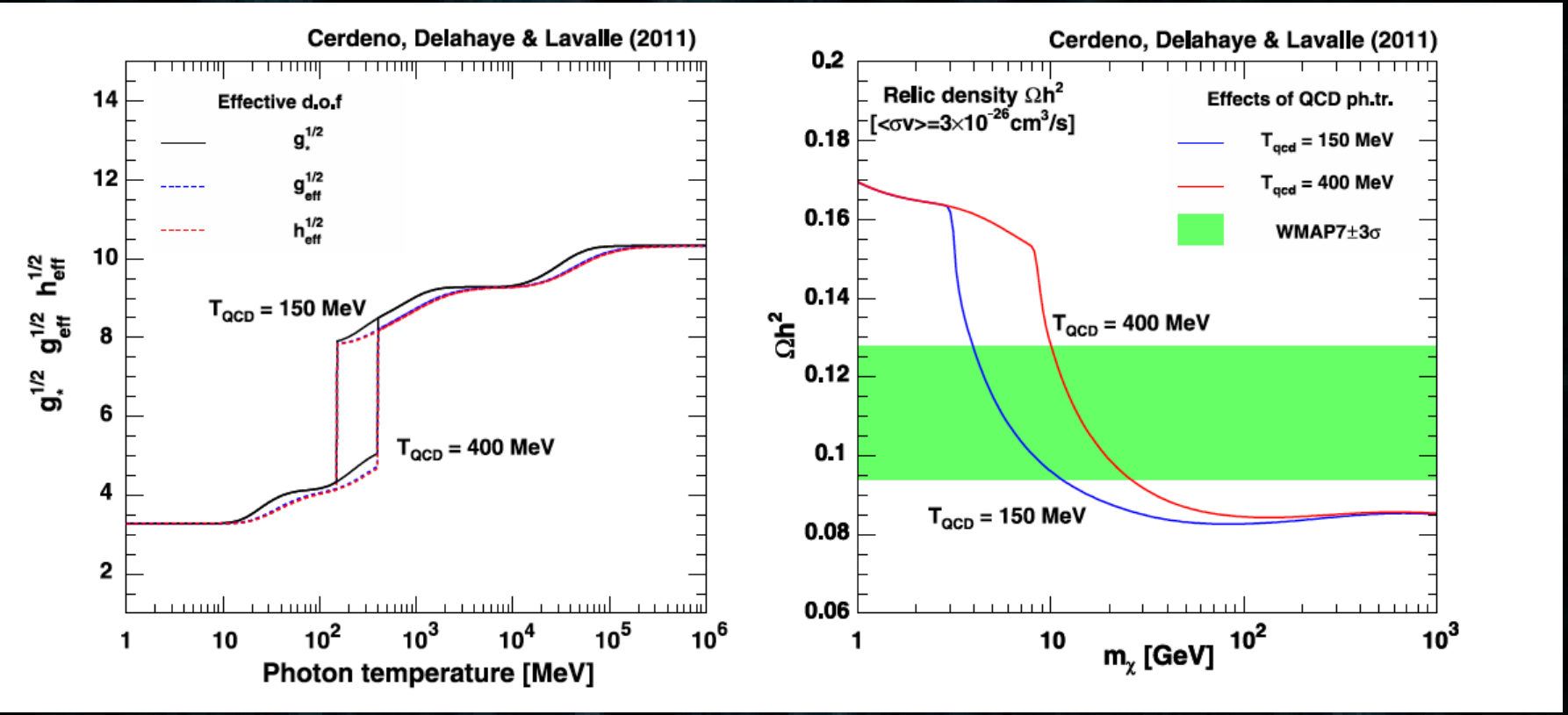
$$s = \frac{2\pi^2}{45} h_{\rm eff}(T) T^3,$$

$$g_\star^{1/2} = \frac{h_{\rm eff}}{\sqrt{g_{\rm eff}}}\left[1 + \frac{T}{3h_{\rm eff}}\frac{dh_{\rm eff}}{dT}\right].$$



Jungman et al, 96

Relics of WIMPs



$$\langle \sigma v \rangle \approx a + b/\{x \equiv m_\chi/T\}$$

Relic density set by full annihilation cross section
Indirect detection sensitive to S-wave only
In the Sun, WIMP capture set by **elastic scattering**
=> check sensitivity to P-wave scenarios (capture equation)

Dark matter in the Galaxy and around here

arXiv:0907.0018v2

A novel determination of the local dark matter density

Riccardo Catena[a]
Piero Ullio[b]

$$\rho_\odot \approx 0.4\,\mathrm{GeV/cm^3}$$

The dark matter density at the Sun's location

Paolo Salucci[1], Fabrizio Nesti[2], Gianfranco Gentile[3], Christiane Frigerio Martins[4]

Mon. Not. R. Astron. Soc. (2011) doi:10.1111/j.1365-2966.2011.18564.x

Mass models of the Milky Way

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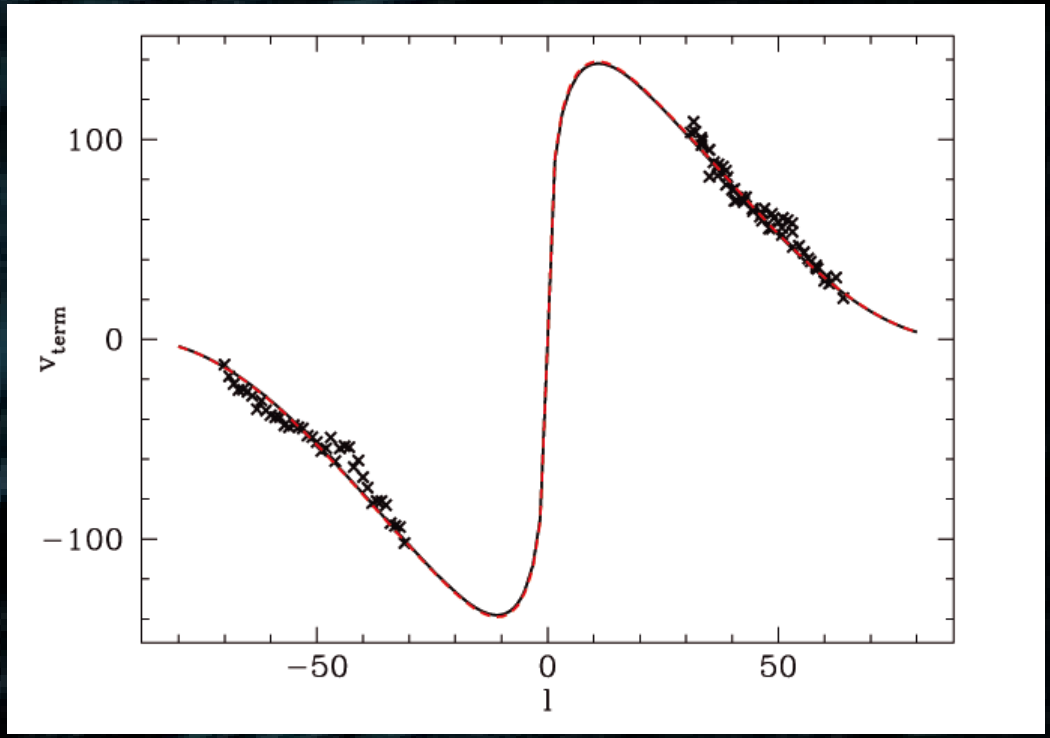


arXiv:1111.3556v1

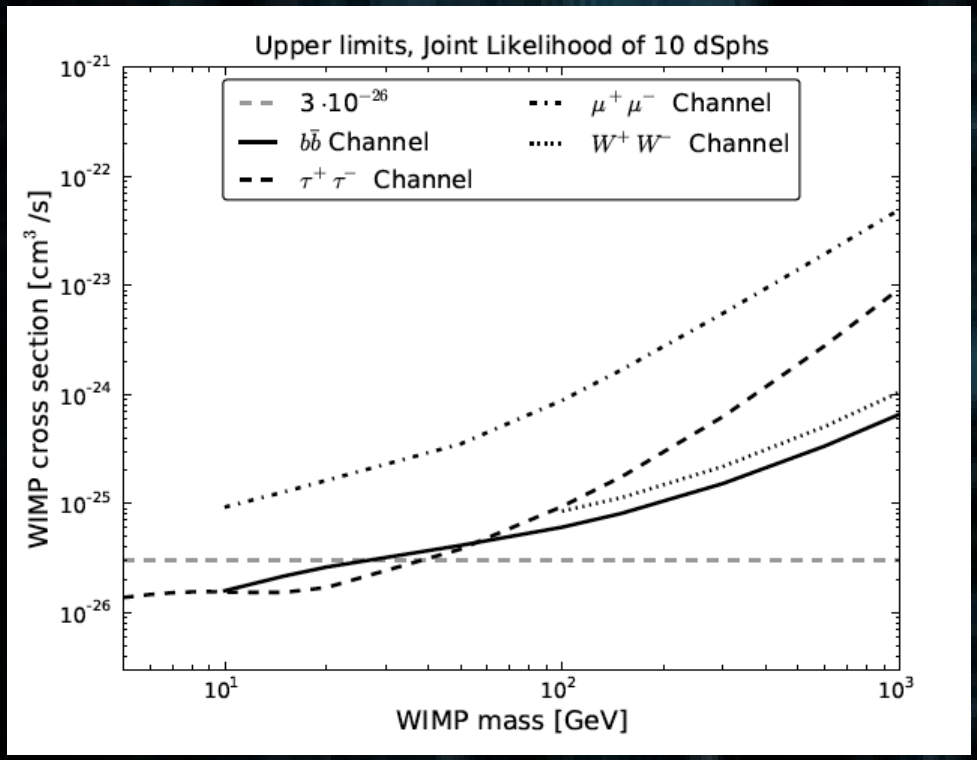
The local dark matter phase-space density and impact on WIMP direct detection

Riccardo Catena[a] and Piero Ullio[b]

those for light dark matter particles and for particles scattering inelastically. As a general trend, regardless of the assumed profile, when adopting a self-consistent phase-space density, we find that rates are larger, and hence exclusion limits stronger, than with the standard Maxwell-Boltzmann approximation. Tools for applying our result on the local dark matter phase-space density to other dark matter candidates or experimental setups are provided.

Complementarity with gamma-rays

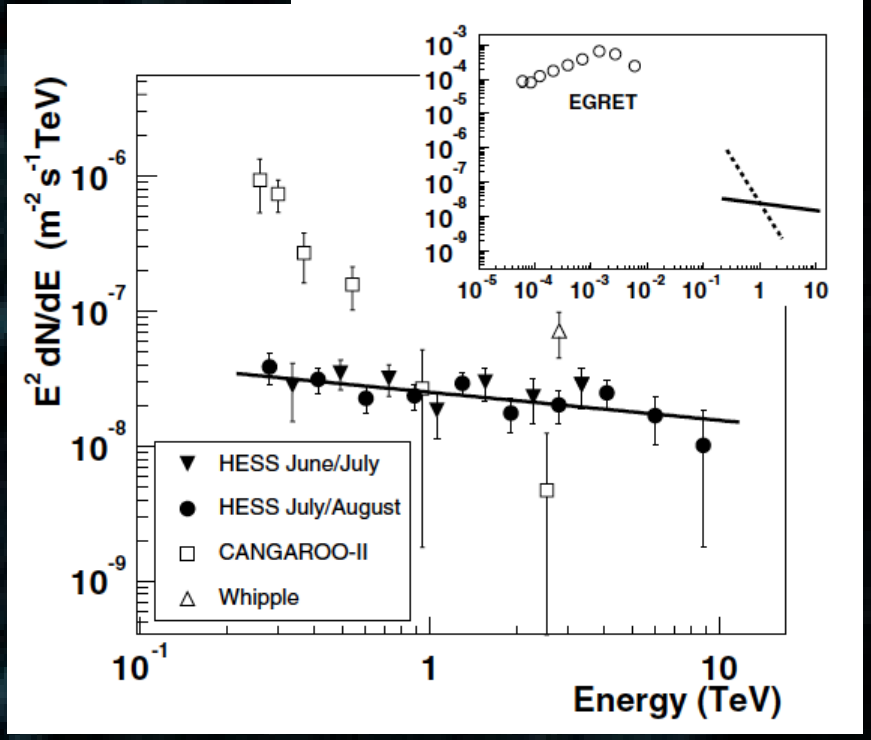
Fermi, 11

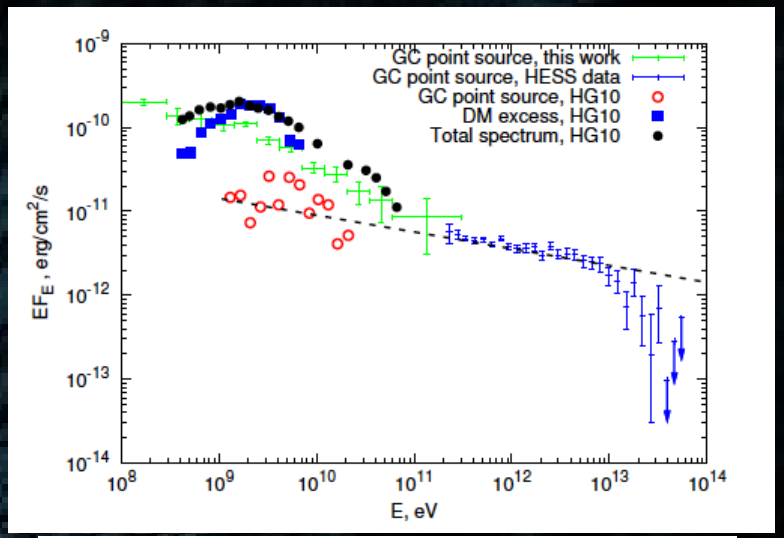


Name	l deg.	b deg.	d kpc	$\overline{\log_{10}(J)}$ $\log_{10}[\mathrm{GeV^2cm^{-5}}]$	σ	ref.
Bootes I	358.08	69.62	60	17.7	0.34	[17]
Carina	260.11	−22.22	101	18.0	0.13	[18]
Coma Berenices	241.9	83.6	44	19.0	0.37	[19]
Draco	86.37	34.72	80	18.8	0.13	[18]
Fornax	237.1	−65.7	138	17.7	0.23	[18]
Sculptor	287.15	−83.16	80	18.4	0.13	[18]
Segue 1	220.48	50.42	23	19.6	0.53	[14]
Sextans	243.4	42.2	86	17.8	0.23	[18]
Ursa Major II	152.46	37.44	32	19.6	0.40	[19]
Ursa Minor	104.95	44.80	66	18.5	0.18	[18]

HESS, 04

A&A 425, L13–L17 (2004)
DOI: 10.1051/0004-6361:200400055





Alexey Boyarsky[1,2], Denys Malyshev[3], Oleg Ruchayskiy[4]

Complementarity with Antimatter CRs

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