Origin of Dark Matter

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1 Introduction

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- CMB anisotropies (WMAP 5 yr) imply
  $\Omega_{\mathrm{DM}} h^2 = 0.1099 \pm 0.0062$ **Dunkley et al., arXiv:0803.0586 [astro-ph]**

Was $\Omega_{\mathrm{DM}} h^2 = 0.105^{+0.007}_{-0.013}$ **Spergel et al., astro–ph/0603449**

Network activities: Making DM

Let χ be a generic DM particle, n_χ its number density (unit: GeV^3). Assume $\chi = \bar{\chi}$, i.e. $\chi\chi \leftrightarrow$SM particles is possible, but single production of χ is forbidden by some symmetry.

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Evolution of n_χ determined by Boltzmann equation; in standard cosmology:

$$\frac{dn_\chi}{dt} + 3Hn_\chi = -\langle \sigma_{\rm ann} v \rangle \left(n_\chi^2 - n_{\chi,\,\rm eq}^2 \right)$$

$H = \dot{R}/R$: Hubble parameter
$\langle \dots \rangle$: Thermal averaging
$\sigma_{\rm ann} = \sigma(\chi\chi \rightarrow \text{SM particles})$
v : relative velocity between χ's in their cms
$n_{\chi,\,\rm eq}$: χ density in full equilibrium

Neutralino DM

Two papers investigated neutralino DM in SUGRA scenarios with non–universal boundary conditions:

- Finetuning in NUHM: "Finetuning" decreases if several contributions to σ_{ann} happen to be comparable (which is not generic). Ellis, King, Roberts, arXiv:0711.2741 [hep-ph]

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- Non–universal models with single extra parameter: NU in Higgs *or* gaugino sector opens many new regions of parameter space. Combinations of collider and DM detection data can distinguish those. Baer, Mustafayev, Park, Tata, arXiv:0802.3384 [hep-ph]

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Decreasing $H(T \lesssim T_F)$ in ST gravity: Need several "matter sectors" with different CFs to decrease H; increasing H is easier. Catena, Fornengo, Masiero, Pietroni, Schelke, arXiv:0712.3173 [hep-ph].

DM Candidates

- $\tilde{\nu}_R$ as inflaton *and* DM: Can work, albeit at price of tiny neutrino Yukawa coupling. Allahverdi, Dutta, Mazumdar, arXiv:0708.3983 [hep-ph].

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- 10–point test: $\Omega_\chi h^2$; cold; neutral; BBN; stellar evolution; self–interactions; direct searches; γ rays; other astro-physics; testable. Taoso, Bertone, Masiero, arXiv:0711.4996 [astro-ph].

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- Primordial black holes in slow–roll inflation: Significant PBH formation possible in standard inflation (running mass model): even easier with curvaton. Kohri, Lyth, Melchiorri, arXiv:0711.5006 [hep-ph]. ⋆

DM Candidates (cont.'d)

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- Z_2 singlino: OK if it interacts with Higgses through scalar S with $m_S \lesssim 10$ TeV; applicable to NMSSM; does not need $R-$parity. McDonald, Sahu, arXiv:0802.3847 [hep-ph].

DM detection

- Constraining DM properties with INTEGRAL/SPI: No evidence for strong angular variation of flux in $X-$ray lines between 20 keV and 7 MeV; constrains e.g. “sterile” ν. Boyarsky, Malyshev, Neronov, Ruchayskiy, arXiv:0710.4922 [astro-ph].

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- Multi-wavelength analysis of WIMP annihilation at galactic center: Given known TeV γ sources, $X-$rays and/or radio offer best sensitivity. Regis, Ullio, arXiv:0802.0234 [hep-ph].

DM detection (cont.'d)

- WIMP–mass from direct detection experiments: Can be done model–independently with ≥ 2 positive detections.

  Drees, Shan, arXiv:0803.4477 [hep-ph].

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- Solar ν background to direct WIMP detection: Relevant only for $\sigma_{\chi p} < 10^{-10}$ pb, $Q \lesssim 5$ keV. Vergados, Ejiri, arXiv:0805.2583 [hep-ph].

Outside developments: Experiment

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- PAMELA preliminary data confirm HEAT excess; Phys. Rev. (sensibly) refuses to publish theory papers on this until data are official.

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- Experiment may give clues soon: LHC, GLAST, PAMELA, Xenon–100, . . .