Euclid SWG-TH WP3 Dark matter & particle cosmology

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Sezione di Torino

UNIVERSITY of the WESTERN CAPE

Programma per Giovani Ricercatori "Rita Levi Montalcini"

Physics Torino Department of Excellence

WP3 Members

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1. Achitouv, I.
2. Ajani, V.
3. Archidiacono, M.
4. Avgoustidis, A.
5. Baldi, M.
6. Ballardini, M.
7. Bartolo, N.
8. Bertacca, D.
9. Boehm, C.
10. **Camera, S.**
11. Carbone, C.
12. Casarini, L.
13. Clesse, S.
14. Codis, S.
15. Da Silva, A.
16. Del Popolo, A.
17. Di Valentino, E.
18. Dipak M.
19. Finelli, F.
20. Galli, S.
21. Garcia-Bellido, J.
22. Germani, C.
23. Giannantonio, T.
24. Harvey, D.
25. Hashim, M.
26. Heisenberg, L.
27. Jalivand, M.
28. Kashlinsky, A.
29. Kitching, T.
30. Kunz, M.
31. Lesgourgues, J.
32. Levi, M.
33. Li, B.
34. Liguori, M.
35. Lombriser, L.
36. Markovic, K.
37. Martins, C.
38. Matarrese, S.
39. Mazumdar, A.
40. Melchiorri, A.
41. Mimoso, J.
42. Mina, M.
43. Moliné, A.
44. Moscardini, L.
45. Mota, D.
46. Pace, F.
47. Pandolfi, S.
48. Pettorino, V.
49. Raccanelli, A.
50. Riotto, A.
51. Rozas, A.
52. Sahlen, M.
53. Sakellariadou, M.
54. Sakr, Z.
55. Santos, M.
56. Sefusatti, E.
57. Stein, G.
58. Tanidis, K.
59. Taylor, A.
60. Tilquin, A.
61. Tutusaus, I.
62. Viel, M.
63. Yoo, J.
64. Ziaeepour, H.

WP3 Aims

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WP3 is meant to gather all the efforts and interests that SWG-TH members have on dark matter and, more generically, astroparticle physics.

WP3
A particle physicist's perspective

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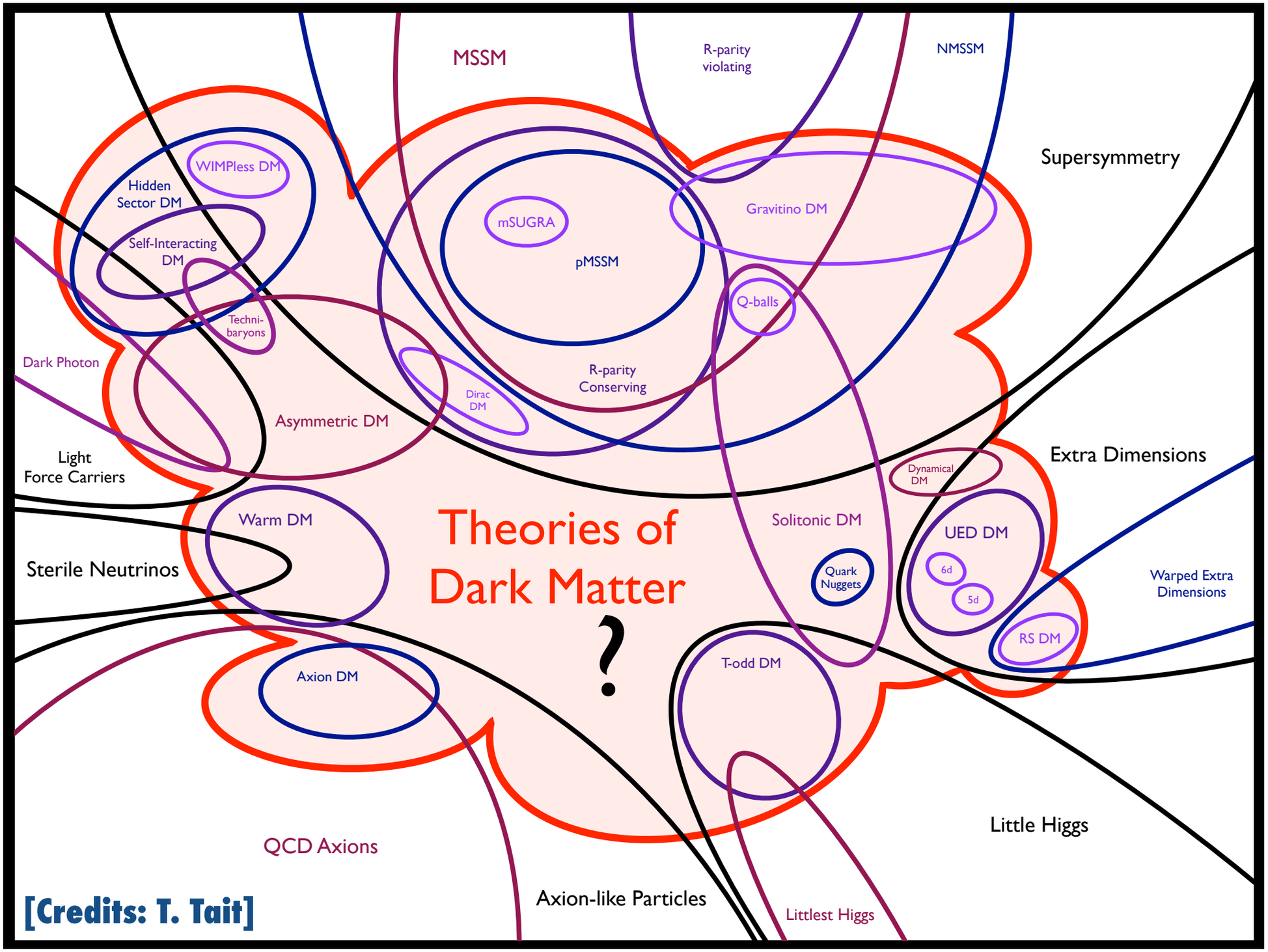

[Credits: T. Tait]

WP3
A cosmologist's perspective

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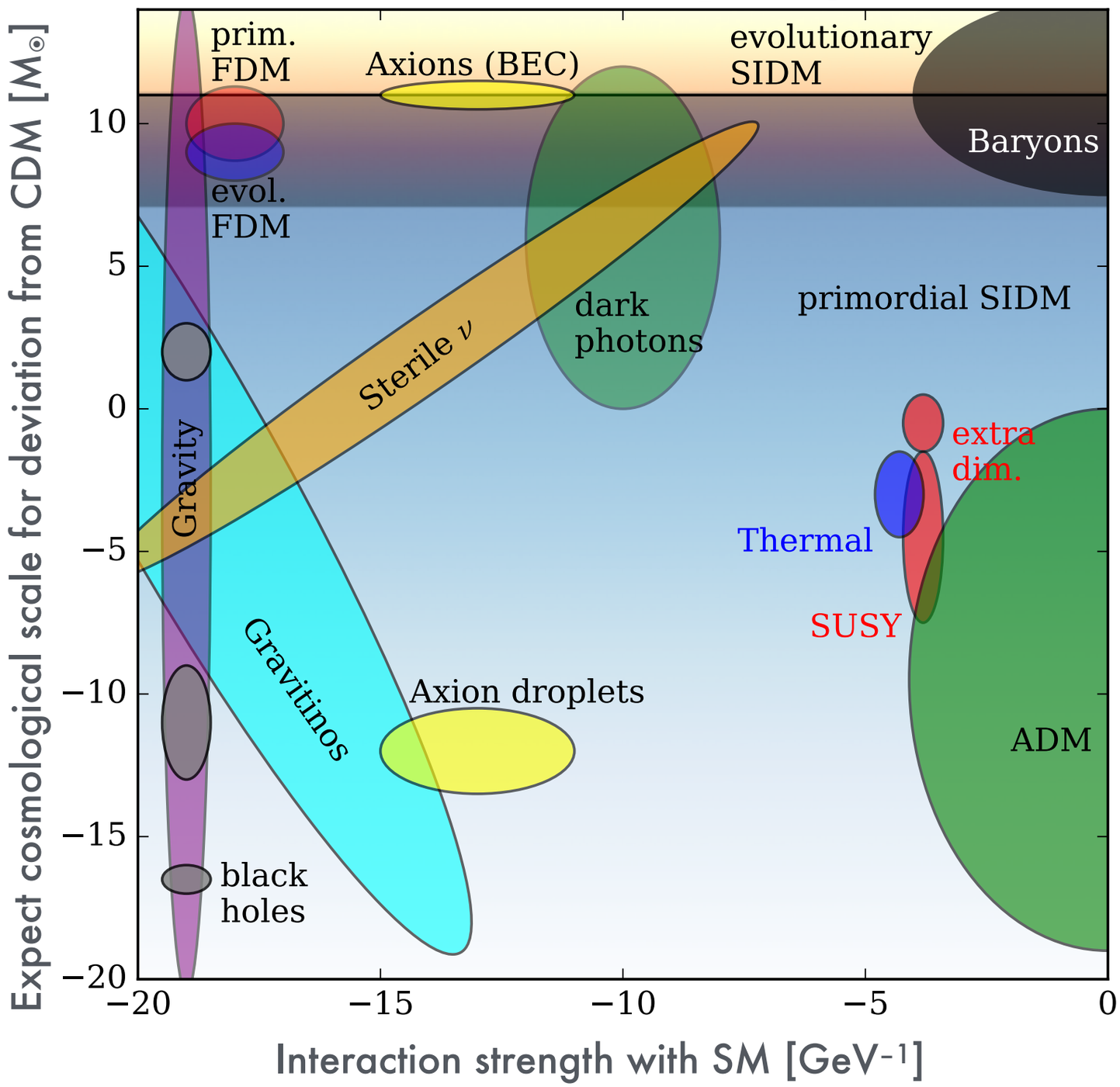
[Buckley & Peter 2017]



WP3 2017-18 activities

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- Telecons (~30 active participants)
- Work on Parameter Definition Document
- Suggestions for SWG-TH paper on extended models
- Focus on key science cases (as requested @ EC Meeting '17)

WP3: PDD

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- Short paragraph(s) describing a specific model
- List of model parameter(s) constrainable by Euclid

5.4 Generalised dark matter

Generalised Dark Matter (GDM) models (e.g. see [62, 63, 64, 65, 66]) design scenarios where dark matter is an imperfect fluid with pressure and shear viscosity.

In general, these models contain one time-dependent free function, the background equation of state parameter $w_{\rm DM}(a)$ as well as two functions $c^2_{s\rm DM}(k,a)$ (the sound speed) and $c^2_{v\rm DM}(k,a)$ (the viscosity).

One can use large-scale cosmological observations to place constraints on the dark-matter pressure, sound speed and viscosity, and infer a limit on the mass of warm-dark-matter particles [64]. This constrains the properties of GDM on linear scales at late times, and lead to the upper bounds $c^2_{s\rm DM} < 10^{-5.9}$ and $c^2_{v\rm DM} < 10^{-5.7}$. Because the effects of the shear viscosity and the pressure term cannot mess up the CMB, the matter power spectrum may be the best observables to distinguish between the GDM sound speed and viscosity parameters [64, 63, 66]).The case $w_{\rm DM}(a) = $ const. and $c^2_{s\rm DM} = c^2_{v\rm DM} = 0$ was considered in [67], who showed that the Euclid survey can break the degeneracy between the dark sectors, although the constraints on dark energy are much weaker than on dark matter.

Parameters

$w_{\rm DM}, c^2_{s\rm DM}, c^2_{v\rm DM}$.

WP3: PDD

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- CMD/WIMPs: mass, cross-section, decay rate
- WDM: mass, free-streaming length/scale
- Interacting DM: mass, total cross-section, elastic cross-section, …
- Generalised DM: EoS, sound speed, viscosity
- Quartessence: sound speed
- Mimetic DM: disformal transformation (free function)
- Decaying DM (dark sector): decay rate, decaying DM fraction
- Fuzzy DM: mass, self-interactoin cross-section?
- PBHs: —

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WP3: extended models

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- 1st brainstorming w/ 'eligibility conditions' for a model:
  - Forecast and Boltzmann codes (at least partly owned by Euclideans)
  - Already in SWG-TH review and/or PDD (preferably)
  - Existence of LCDM limit (preferably)
  - Theoretically viable (e.g. no ghosts)
  - Compatibility w/ current data sets (including Solar System and GWs)

WP3: extended models

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- WP3-related proposed extended models:

  1. Fuzzy DM (D. Marsh)
  2. Quartessence (D. Bertacca, S. Camera)
  3. Generalised DM (I. Tutusaus)
  4. Unified DM w/ fast transition (I. Tereno, in contact with #2)
  5. Mimetic gravity (S. Matarrese) [not sure if for DM]
  6. D-material universe (M. Sakellariadou)

WP3 2017-18 activities

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WP3 sub-WPs

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- Definition of sub-WPs based on specific models:
  - CDM/WIMPs (S. Camera)
  - Neutrinos (M. Archidiacono)
  - WDM/Axions/Fuzzy DM (M. Sahlen, D. Marsh)
  - Interacting/Decaying/Self-interacting DM (M. Baldi, J. Lesgourgues)
  - Generalised DM (D. Bertacca, C. Skordis)
  - PBHs (S. Clesse, J. Garcia-Bellido, A. Raccanelli)
  - Modified gravity DM (D. Mota, C. Skordis)