

WG2 Discussion

1st General Meeting of COST Action COSMIC
WISPers (CA21106),
Bari, Italy
September 8, 2023

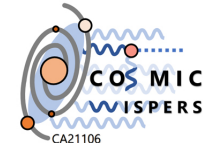
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THE HEBREW UNIVERSITY OF JERUSALEM



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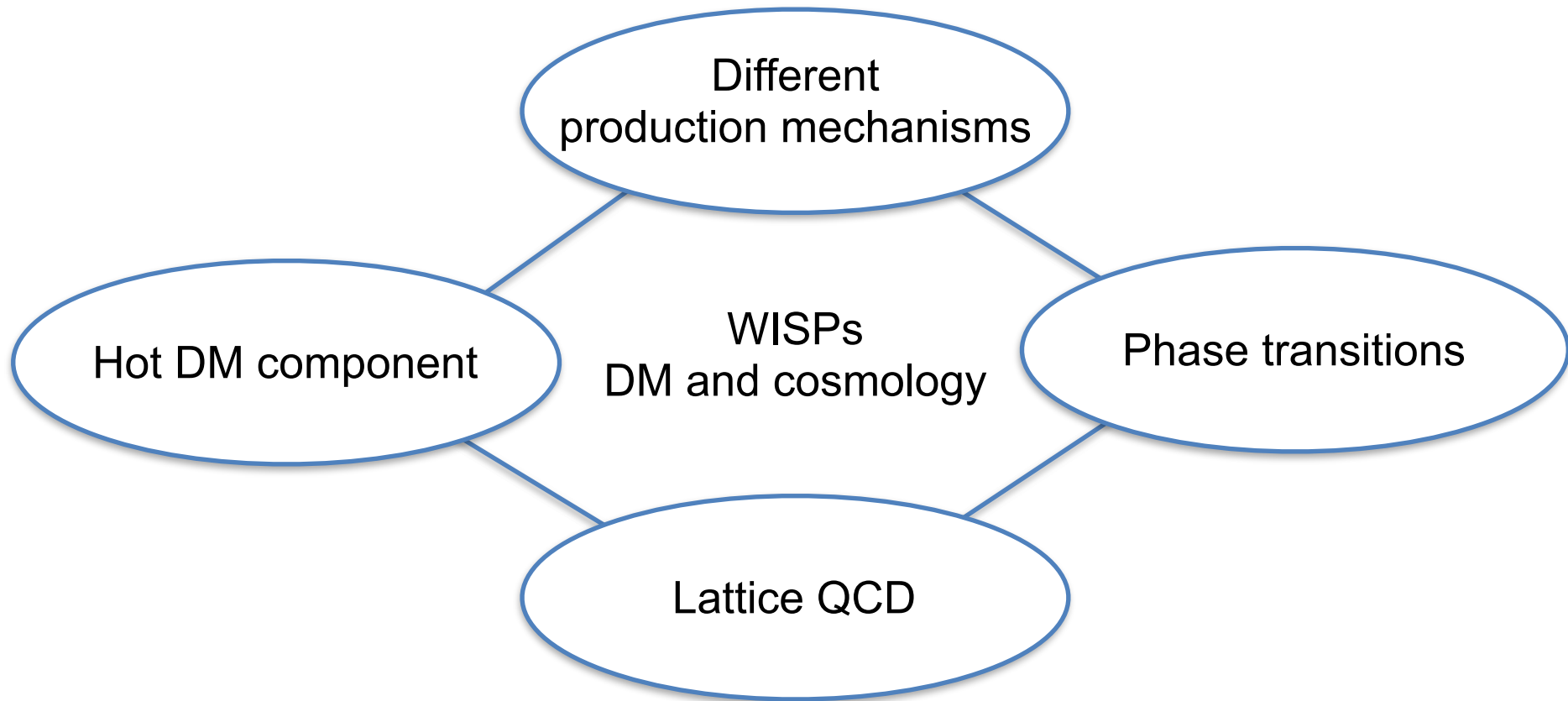
Working group 2 in a glance

Many questions:

- WISPs are a great DM candidate—how many ways to produce them?
- Different non-thermal processes, misalignment mechanism, phase transitions, topological defects networks
- If QCD axion is *the* DM, can we reliably predict its mass and couplings?
- What is the abundance of miniclusters? Huge consequences for WG3 and WG4



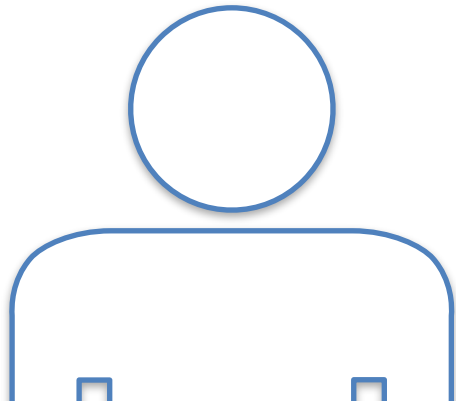
Working group 2 in a glance



A large community with many different expertises

- Around 150 people in the WG
- Great overlap with all the other WGs
- Several activities organized together with WG3

Coordinators



Edoardo Vitagliano



Javier Redondo



Important to get results

- Great experimental efforts to detect the QCD axion—extremely valuable to identify an expected mass range
- Very important consequences for large density variations
- Astrophysical signals might be very important to discover the nature of dark matter



Ongoing activities

Together with WG3, we have organized a timely online mini workshop on NANOGrav results

Wednesday, 5th of July

- 3pm Prof. Alberto Sesana, **Nano-Hz gravitational waves: first evidence and implications**

From 4pm on the same day

- Fabrizio Rompineve (CERN), **Footprints of the QCD Crossover on Cosmological Gravitational Waves at Pulsar Timing Arrays**
- Yann Gouttenoire (Tel Aviv University), **TBC**
- Marek Lewicki (University of Warsaw), **Cosmic Superstrings Revisited in Light of NANOGrav 15-Year Data**
- Antonio Iovino (La Sapienza University of Rome), **The recent gravitational wave observation by pulsar timing arrays and primordial black holes: the importance of non-gaussianities**
- Anish Goshal (University of Warsaw), **Probing the Dark Matter density with gravitational waves from super-massive binary black holes**



Planning ahead

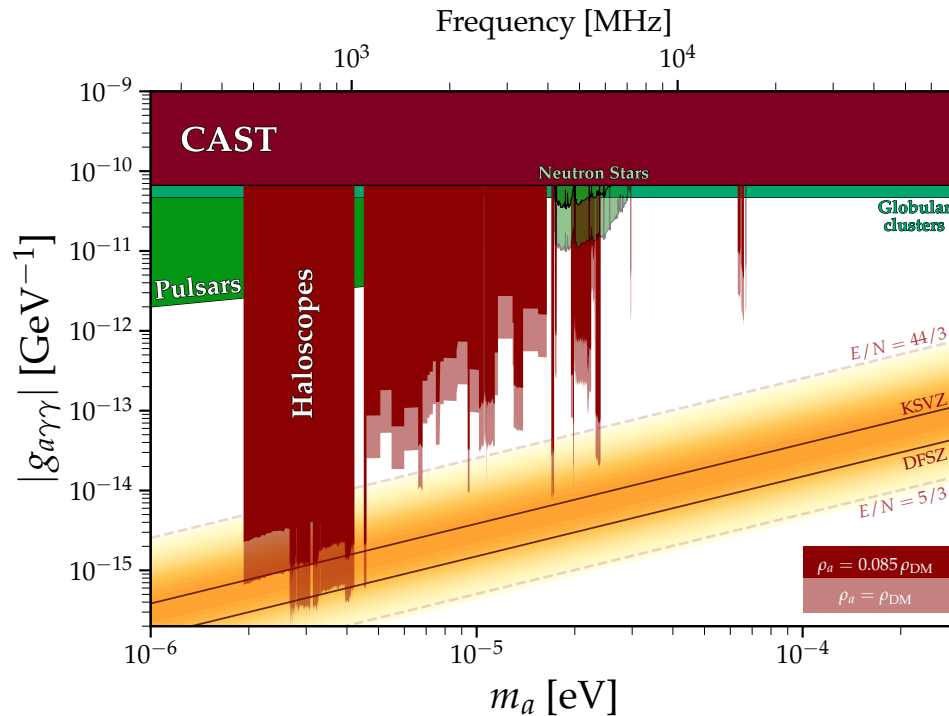
- Possible workshops and schools dedicated to prediction of the DM abundances
- Possibility of funding visiting periods
- We plan to ask all the people in the working group to fill up a form with name, institution, reasons why they join the working group, and how they could contribute to the success in reaching the goals of the WG
- Continued collaboration with WG3 (planning a mini-workshop similar to the one dedicated to NANOGrav)
- Subtask 2.1.4 an important goal to be reached with the collaboration of the members
- Other subtasks could be realized as the result of collaborations inspired by the WG



This workshop

Implications for haloscopes

Ciaran O'Hare talk



Typical density in the minivoids is
~0.085 of the mean density of
dark matter

→ the miniclusters are no longer
growing at the final redshift of the
simulation, therefore this places a
lower bound on the density of
axions

→ Not a nice conclusion, but it
could have been much worse!

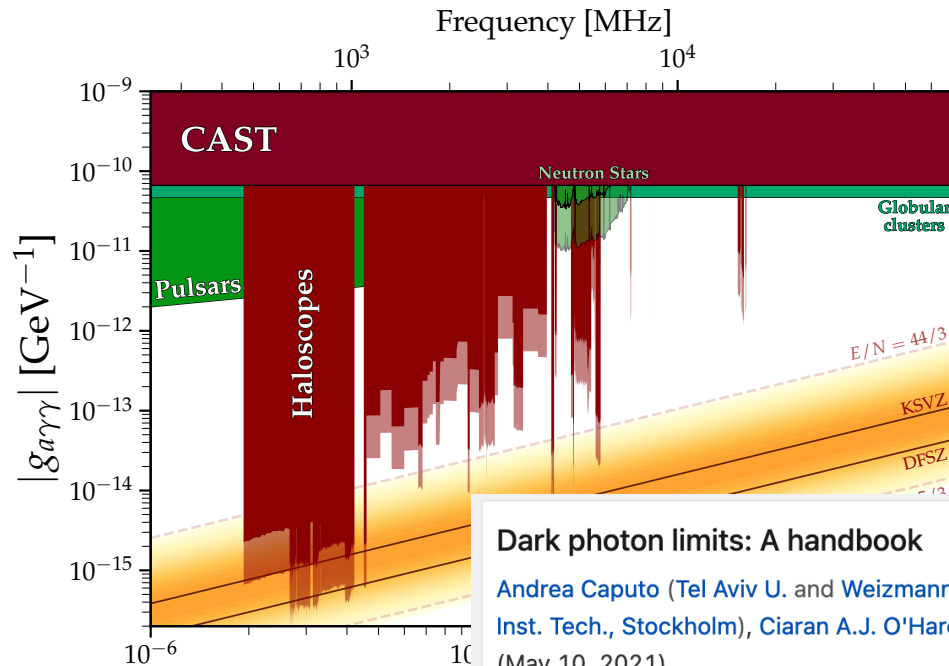
Eggemeier, CAJO+ [2212.00560]



This workshop

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Dark photon limits: A handbook

#4

Andrea Caputo (Tel Aviv U. and Weizmann Inst.), Alexander J. Millar (Stockholm U., OKC and Nordita and Royal Inst. Tech., Stockholm), Ciaran A.J. O'Hare (Australia, CSIRO, Sydney and Sydney U.), Edoardo Vitagliano (UCLA) (May 10, 2021)

Published in: *Phys.Rev.D* 104 (2021) 9, 095029 • e-Print: [2105.04565](https://arxiv.org/abs/2105.04565) [hep-ph]

Eggemeier, CAJO+ [2212.0056]

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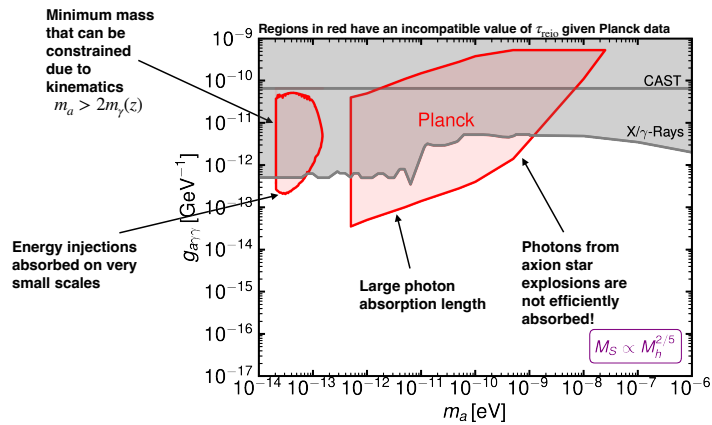
reference search

125 citations

This workshop

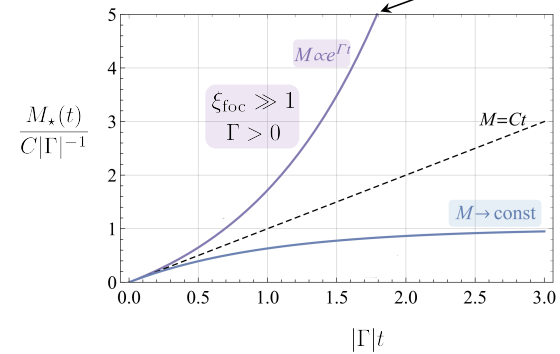
Miguel Escudero talk

Resulting Constraints



Marco Gorghetto talk

Phases of formation



$$\dot{M}_\star = C + \underbrace{(\Gamma_1 - \Gamma_2)}_{\Gamma} M_\star$$

$$\rho_{\text{crit}} \equiv \frac{2\Phi_{\text{ex}} m^2}{|g|} \simeq 2 \frac{\alpha^2 m^2}{|g|} \simeq 6 \cdot 10^4 \rho_{\text{dm}} \left[\frac{f_a}{5 \cdot 10^7 \text{ GeV}} \right]^2 \left[\frac{m}{1.7 \cdot 10^{-14} \text{ eV}} \right]^4 \left[\frac{M}{M_\odot} \right]^2 \left[\frac{0.4 \text{ GeV/cm}^3}{\rho_{\text{dm}}} \right]$$



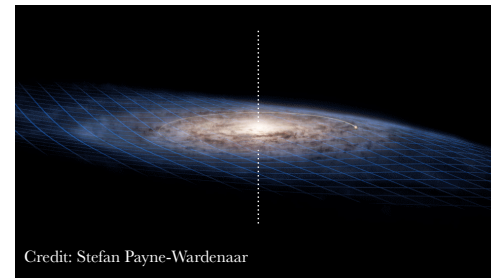
This workshop

Maria Benito talk

Dark Matter distribution (under steady-state and axial symmetry)

accounting for uncertainties on:

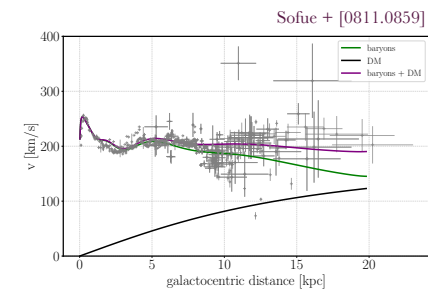
1. Rotation curve measurements
2. Morphology (3D shape) baryons
3. Normalisation (mass) baryons
4. Galactic parameters: Sun's velocity & Galactocentric distance



$$\chi_{\text{RC,prof}}^2(V_0, R_s, \rho_0, \gamma)$$

Likelihood accounts for astro uncertainties & its available @
<https://github.com/mariabenitocst/UncertaintiesDMinTheMW>

MB + [1901.02460] / MB + [2009.13523] / Pöder, MB + '23 (accepted in A&A)

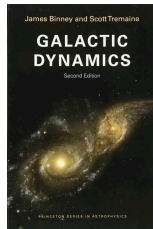
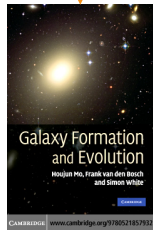
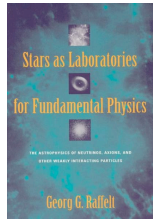


María Benito - COST Action COSMIC WISPerS



This workshop

Diego Blas talk



Conclusions

- Galactic dynamics is modified for “extreme” DM (e.g. ULDM or DDM)
 - many “classical aspects” modified (not fully explored!)
- ULDM: for $m \lesssim \text{eV}$ occupation number of DM states in MW $\mathcal{O}(1)$
 - wavy halo: coherent oscillating patches (modified heating, DF, grav scattering)
 - soliton: extra features at galactic centres. Can be probed with dynamics
- Degenerate DM: for $m \lesssim \text{keV}$ occupation number of DM states in dSph $\mathcal{O}(1)$. Fermionic DM will be close to degeneracy
 - degeneracy pressure: presence of core.
 - filled Fermi surface: gravitational scattering modified (DF, heating...)




This workshop

Many more talks! Mimoza Hafizi, Salvatore Bottaro, Matteo Galaverni, Manuel Masip+large overlaps with talks in other WGs

This afternoon: Simone Blasi, Amelia Drew, Maria Paola Lombardo



This workshop



WG1:
Which
particle
models are
interesting?

WG2:
Computing
the
abundance,
large
overlaps with
numerical
simulation
communities

WG3:
Effects on
astrophysical
bounds!

WG4:
Effects on
laboratory
searches!

WG5:
Nice plots and
visualizations,
good help for
outreach

