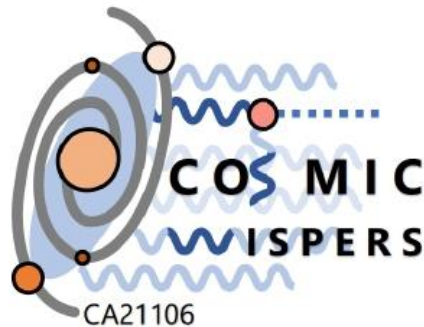


WG1: WISPs Model Building

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Bologna Univ. and INFN

3rd General Meeting COSMIC WISPers, 9 Sept 2025



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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

WG1: Main goal

Tasks:

- Coordinate **theory advances** and promote **knowledge exchange**
- Give **theoretical guidance** to experiments
- Determine nature, number, masses and couplings of **WISPs** with applications to particle physics, cosmology and astrophysics via **2** complementary approaches:

1) **Bottom-up**: indication of **WISP** models promising for pheno

UV scenarios compatible with observations



phenomenology in low-energy effective field theory

2) **Top-down**: restrict **WISP** models from UV consistency (string theory)

UV complete model building



UV constraints on WISP properties

WG1: Organisation

- Leader: Michele Cicoli (Bologna) michele.cicoli@unibo.it
- Co-leaders: Nicole Righi (King's College London) nicole.righi@kcl.ac.uk
Arturo de Giorgi (Durham) arturo.de-giorgi@durham.ac.uk
- Google group “CosmicWISPers WG1”:
<https://groups.google.com/g/cosmicwispers-wg1/>
- About 150 members so far
- Mailing list: cosmicwispers-wg1@googlegroups.com

WG1: Activities during year 3

- Contributions to **organisation**:

- i) Working group Meeting, 13-14 Feb 2025, Heidelberg

- ii) Brainstorming Meeting, 3 Apr 2025

- **new** COST proposal “Dark Waves: exploring the wavy sector of the Dark Universe”
Physics case at the interface between **WISPs** and **high frequency GWs**

- iii) 3rd General Meeting, 9-12 Sep 2025, Sofia

- Plenary: A. Ringwald, G. Villadoro, E. Teixeira, C. Delaunay, F. Mescia

- Parallel: N. Selimovic, G. Villa, L. Brunelli, A. Stuhlfauth

- iv) 3rd Training School, 16-19 Sep 2025, Annecy

- “Non-axionic WISP theory”, Lecturer: M. Goodsell (LPTHE, Paris)

- Trainer: M. Reig Lopez (Oxford)

- **Outreach talk**: “The infinity, the electron and the string”

- Michele Cicoli, Occhialini Foundation, 9 May 2025, Pesaro (Italy)

WG1: Activities during year 3

- **Monthly WG1 meetings:**
 - i) Online via Zoom on Mondays at 3pm CET
 - iii) Duration: 1 hour: 30 minute talk by an invited speaker + 30 minute discussion
- **WISPtionary** – catalogue of WISPs models
 - i) Editors: A. de Giorgi, M. Fuentes Zamoro, X. Ponce Diaz
 - ii) Models classified in terms of spin: 0, 1/2, 1, 3/2, 2
 - iii) Model name, key-features, bounds, references
 - iv) Contribute by adding models to googledoc:

<https://docs.google.com/document/d/127LC8d8EzBKV7NwrJSdRJzCP4jXxb3e4BxDJE5FKeVo/edit?usp=sharing>

- Contribution to writing up of **White Paper**
 - i) WG1 Editors: A. de Giorgi, N. Righi, M. Reig Lopez
 - ii) WG1 chapter:
 - Low-energy WISP models from string theory
 - WISP model building in QFT
 - WISP EFTs
 - iii) Basically finished and ready to be incorporated in version with chapters from other WGs
- A few **STSMs**

WG1: Future activities

- Contributions to **organisation** of meetings and training schools
- **Dissemination** talks at major conferences and **outreach** activities
- Monthly WG1 **meetings**:
Same format for year **4**: topical discussions, invitation of external speakers, recent papers...
- More **STSM**: please apply!
- Toward end of year **3**: organise a **3-day WG1 workshop** in person (in Bologna?)
focused on specific topic of WISPs and GWs from UV physics
- Deliverables:
 - i) **talks** at major conferences and workshops
 - ii) **publications** on top refereed journals
 - iii) contribution to the writing up of **WISPtionary**, **white paper** and **scientific reports**
 - iv) increase **interactions with other WGs**
 - predictions from UV motivated classes of models superimposed on exclusion plots
- Suggestions!

Incitement for discussion

- 1: Does QCD axion exist? Do non-axionic solutions to strong CP probl. work? UV-motivated?
- 2: Is QCD axion a closed or an open string? Shift symmetry from higher dimensional gauge symmetry or U(1)s on branes?
- 3: What breaks $U(1)_{PQ}$ and sets f_a ? Non-linear realisation in EFT or SUSY breaking?
- 4: Is f_a related to some scale? $f_a \approx M_{kk}$ for closed strings on bulk cycles, $f_a \approx M_s$ for closed strings on local cycles or $f_a \ll M_s$ for open strings?
- 5: Pre- (closed strings) or post-inflationary (open strings) scenario?
- 6: What sets initial conditions, i.e. initial misalignment, in the pre-inflationary scenario?
- 7: What is dynamics of topological defects in post-inflationary scenario?
- 8: What breaks $U(1)_{PQ}$ explicitly and sets m_a ? QCD vs stringy instantons/gaugino condensation
- 9: What solves axion quality problem? perturbative shift symm + control over EFT?
- 10: What is statistical distribution of closed vs open string axions in landscape?
- 11: Can QCD axion be dark radiation? Produced from moduli decay or thermally?
- 12: How many ALPs can arise? How many are light? How many couple to SM?
- 13: What is parameter space of f_a and m_a for ALPs? What is their statistics?
- 14: Role of ALPs? Inflation? Fuzzy DM? Dark radiation? Quintessence? Astrophysics? EDE?...
- 15: UV correlations among ALPs and other physics? as SUSY breaking, infl., DM, dark rad. ...
- 16: Non-standard histories with early matter or kinetic domination? dilution of DM, baryogenesis, and GWs, production of dark radiation, formation of cosmic string networks, growth of pert...
- 17: Properties of hidden photons with kinetic mixing with ordinary photons?
- 18: Fully consistent WISP models from string theory? instead of just string-inspired scenarios
- 19: WISPs in non-perturbative limits? Interesting for pheno?
- 20: Generic stringy signatures for WISPs not motivated from QFT viewpoint?