Explore the hidden Universe

Teaming for Excellence

ASTROCENT Plus

Particle Astrophysics Science and Technology Centre

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Funded by the European Union

European Funds Smart Growth

Republic of Poland

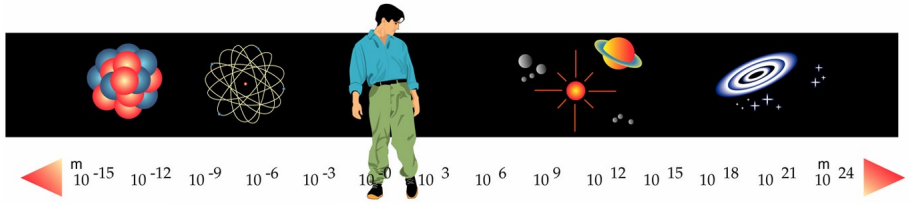
FNP Foundation for Polish Science

European Union European Regional Development Fund

NICOLAUS COPERNICUS ASTRONOMICAL CENTER OF THE POLISH ACADEMY OF SCIENCES

Main themes of my research

- Theoretical studies of:
  - the macrocosm (Universe)
  - the microcosm (quantum world)
  - the Big Bang



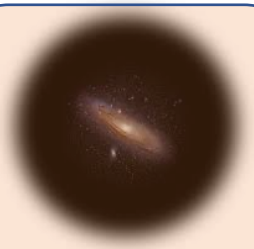
- ``New physics" beyond the well-known Standard Model of particle physics
- DM cannot be one of known particles

- Dark matter:
  - What it is (→ candidates)
  - Where it comes from (→ underlying theory: ``new physics")
  - How to link it to what we know (→ experimental data)
  - How to detect it (→ predictions for experiment)
    - Direct searches (underground detectors)
    - Indirect searches (Fermi LAT, H.E.S.S., CTA, etc)
    - Collider (LHC+), non-collider (e.g., rare decays,…)

Two prime *classes* of candidates:
- WIMP
- axion (+axion-like)

Other possibilities:
- dark photon
- …

- Dark matter and …
  - $(g\text{-}2)_{muon}$
  - Long-lived particles (LLPs) — Faser @ CERN
  - Theories of the Big Bang (standard, non-standard)
  - …



Dark matter:
1/4 of the Universe

Some recent papers on axions as DM…

- **Dark Matter Axions in the Early Universe with a Period of Increasing Temperature,**
  Paola Arias Reyes, Nicolas Bernal, Jacek Osiński, LR, 2207.07677 → JCAP

- ***Dark matter production through a non-thermal flavon portal,***
  ***Andrew Cheek, Jacek Osiński*, LR, Sebastian Trojanowski, 2211.02057 → JCAP**

- **Revisiting signatures of thermal axions in nonstandard cosmologies,**
  Paola Arias, Nicolás Bernal, Jacek K. Osiński, Leszek Roszkowski, Moira Venegas,
  e-Print 2308.01352 → JCAP

- ***Extending preferred axion models via heavy-quark induced early matter domination,***
  Andrew Cheek, Jacek K. Osiński, Leszek Roszkowski,
  e-Print 2310.16087 → Phys. Rev. D, 109, 123529

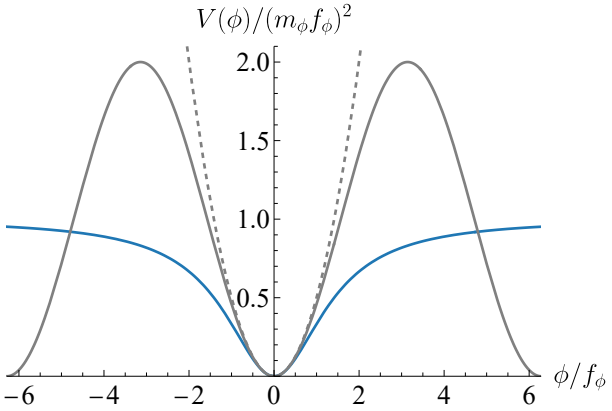
- **Dark photon dark matter from flattened axion potentials,**
  Hong-Yi Zhang, Paola Arias, Andrew Cheek, Enrico D. Schiappacasse, Luca Visinelli,
  Leszek Roszkowski, JHEP 10 (2025) 142, 10.1007/JHEP10(2025)142

Dark photon dark matter from flattened axion potentials,

al. et Leszek Roszkowski,

JHEP 10 (2025) 142, 10.1007/JHEP10(2025)142

❖ **a technically-involved study**



a new scenario with a key outcome:

➢ **dark photons can be efficiently produced from axion potentials that are shallower than quadratic at large field values**

➢ **for dark photon mass up to three orders of magnitude below the axion mass, the produced dark photons can account for a significant fraction of the present-day dark matter**