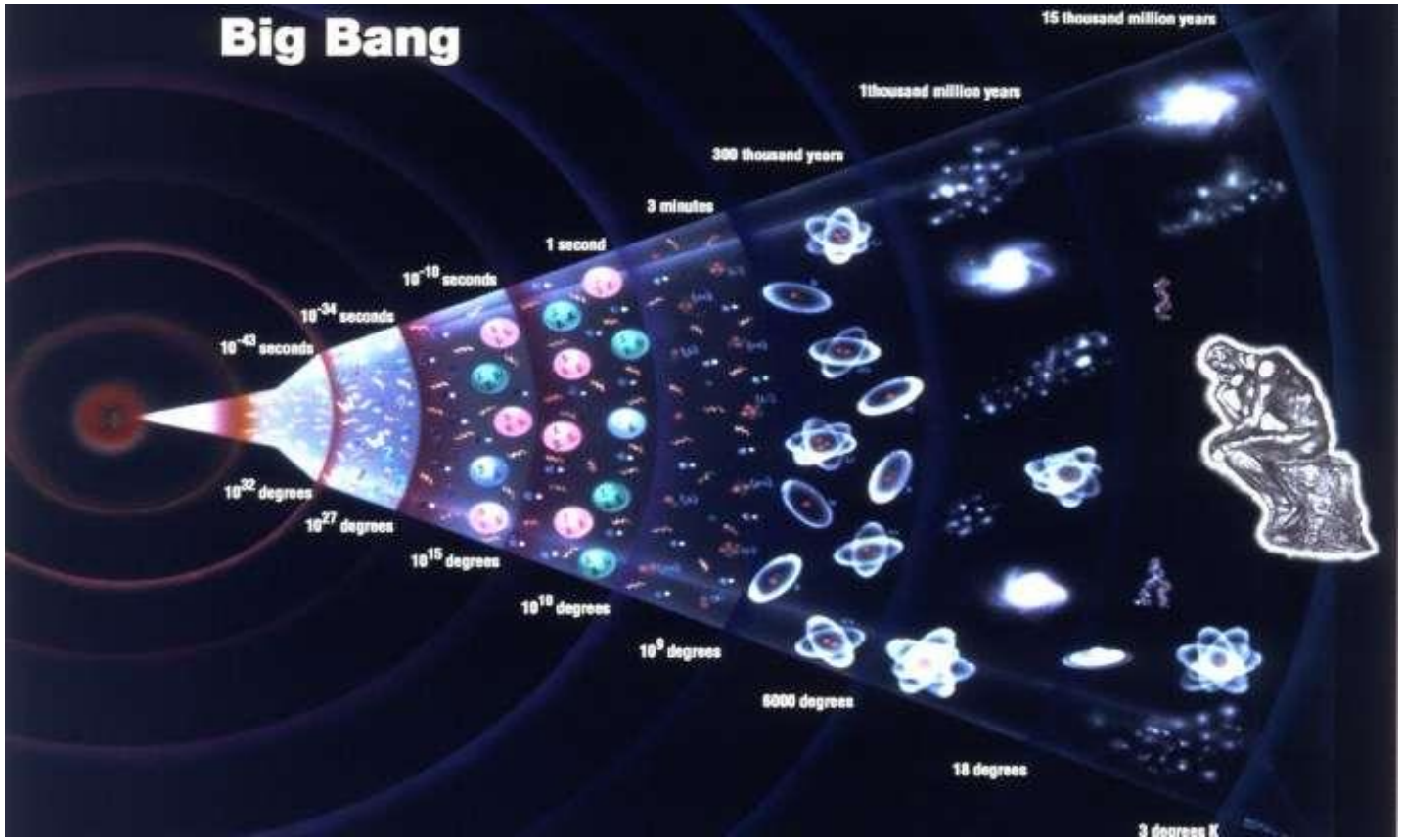
Report for 2024

AstroCeNT

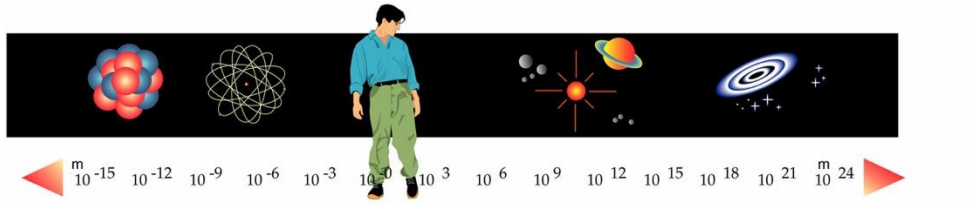
Leszek Roszkowski



European Funds Smart Growth
Republic of Poland
FNP Foundation for Polish Science
European Union European Regional Development Fund

Main themes of 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)

- Dark matter and …
  - $(g-2)_{muon}$
  - 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

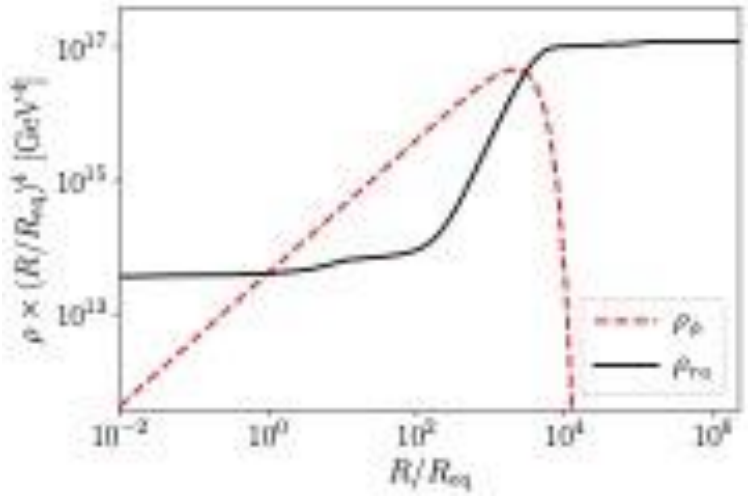
- ***Extending preferred axion models via heavy-quark induced early matter domination,***
  Andrew Cheek, Jacek K. Osiński, Leszek Roszkowski,
  e-Print 2310.16087 → Phys. Rev. D, 109, 123529

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

Consider:

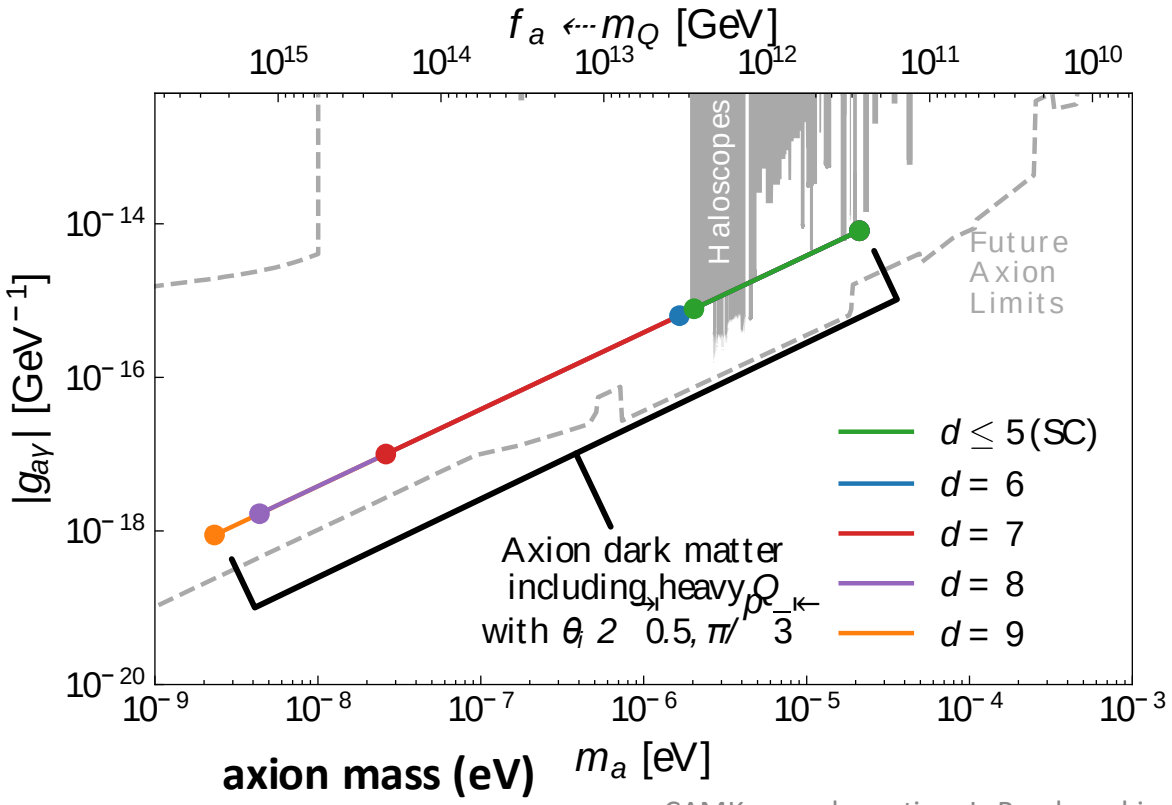
- **Axion DM**
- **Non-standard models of very early Universe**



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

- **Early matter domination ``built into" the QCD axion model**
  - **KSVZ axion model contains very heavy (~f_a~10^{12}GeV) singlet quarks**
  - **They decay in the early Universe, causing short period of EMD**



Quark decay proceeds via interactions:

- **Ren (d=4)**
- **Non-ren (d>4)**

Depending on d, allowed range of axion mass gets strongly extended towards lower mass values

A follow-up project with Cheek, Arias, Visinelli in progress