Light dark matter at high energies

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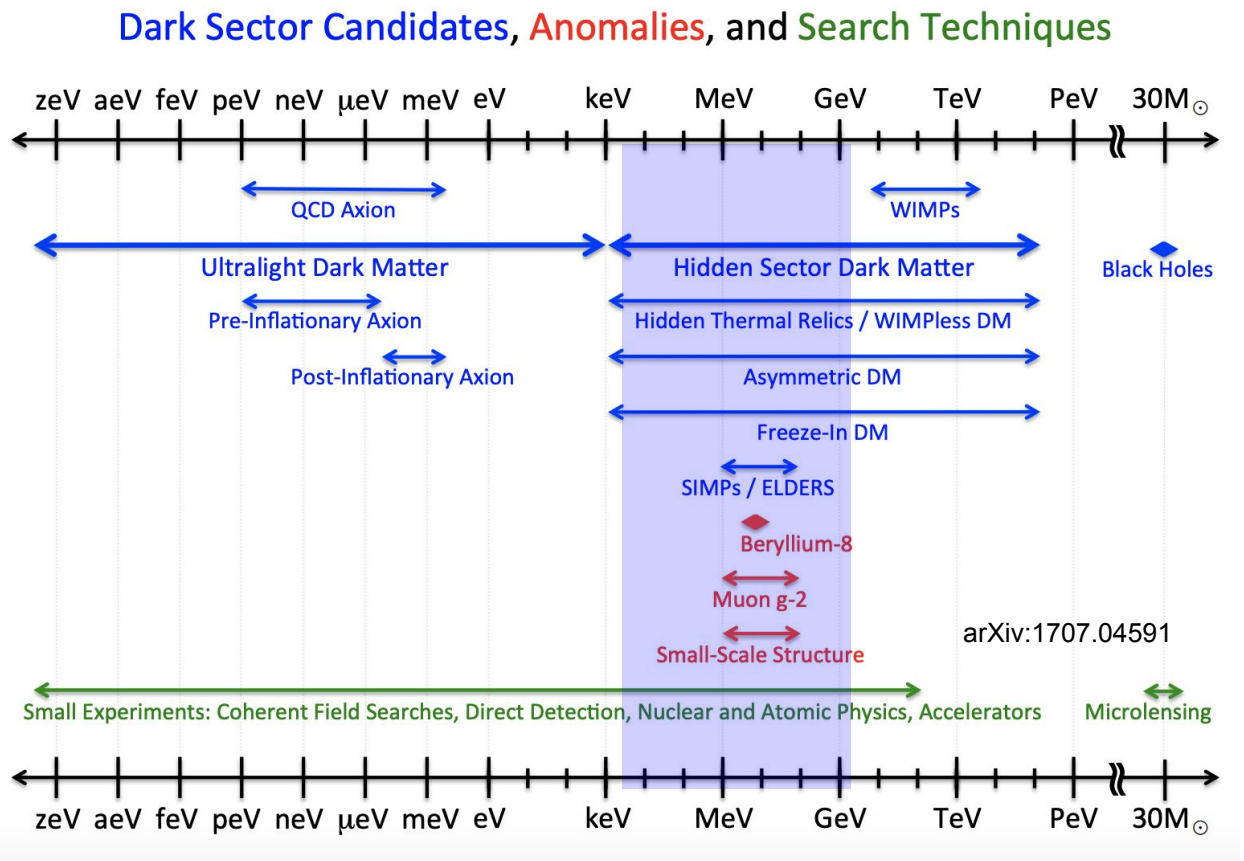
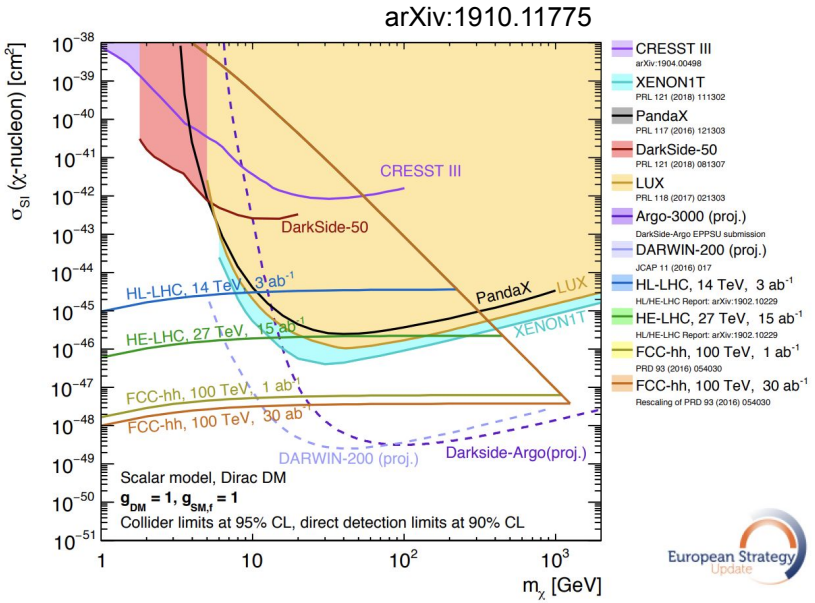
Light dark matter - motivation



- Potential solution to multiple anomalies
- Offers multiple ways to generate relic density and hence accelerator signatures
- This talk: only on accelerator searches

See also N. Blinov's talk

Light dark matter at high energies

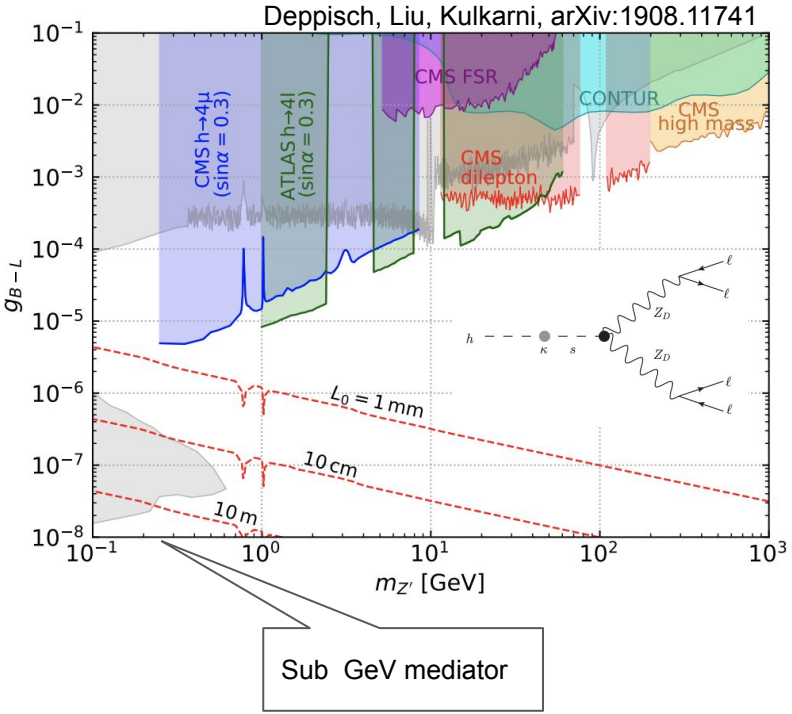


- Producing light dark matter itself is not necessarily an issue at colliders (missing energy is not a proxy for DM mass)
- Things get tricky when alternate relic density mechanisms are considered → lead to light mediators (trigger limited), small couplings (cross section limited), long lifetime (lumi/detector size limited)

- Need to identify models which can be probed or devise new ways to probe light dark matter at accelerators
- What happens below 1 GeV?

Mediator phenomenology

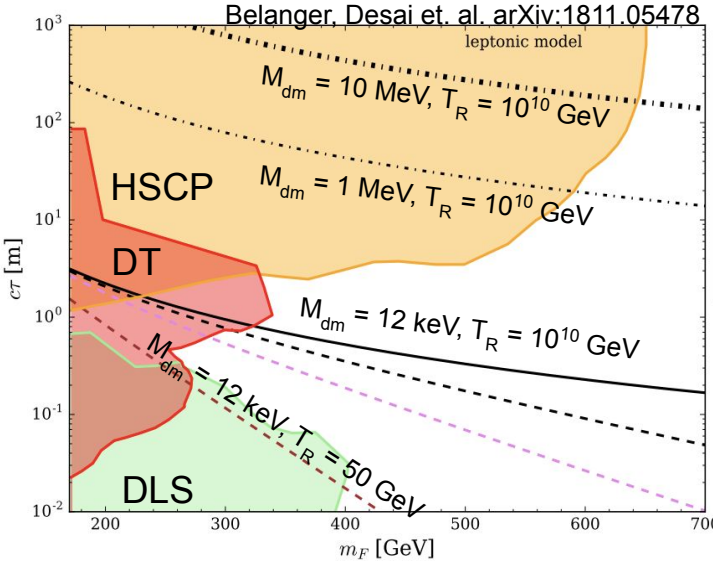
- Light dark matter can be produced in cascade decays of heavier particles in complete models
- Model dependent limits but worth exploring
- Future colliders and HL-LHC reach
  - Vector-Portal Search for Dark Matter Particles LOI
  - Feasibility study on probing the Seesaw Mechanism with full detector simulation for 250 GeV ILC LOI
- Mapping between neutrino portal models and DM phenomenology?



LHC searches already cover low couplings via h → XX searches

Connections to early Universe

- What kind of production mechanisms can be targeted at accelerators?
  - Collider Signals of FIMP Dark Matter with Heavy Mediators LOI
- What kind of early history can be probed by colliders?
  - Feebly interacting Dark Matter at colliders and Early Universe Cosmology LOI
- Potential connection between matter - antimatter asymmetry and DM relic mechanisms
  - Sharing but not Caring at colliders LOI
  - Search for Asymmetric Dark Matter model at CEPC by displaced lepton jets LOI



FIMP DM: LHC can have great coverage for very light DM and heavy mediator

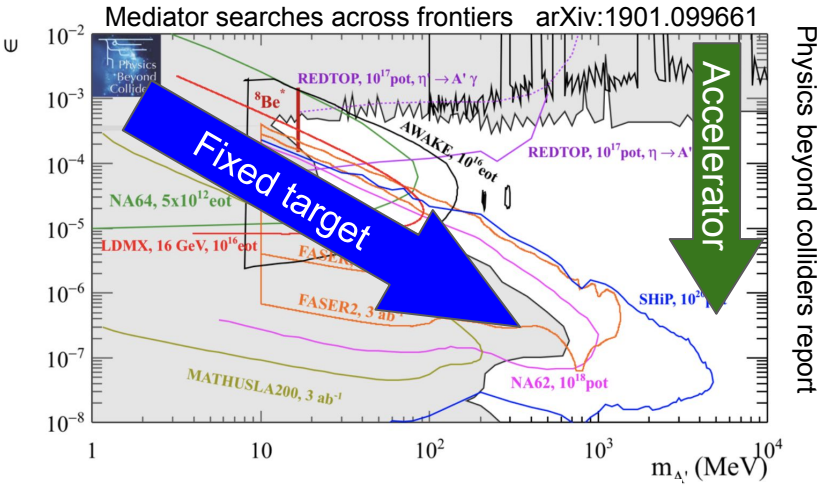
Signatures of interest include displaced leptons, displaced lepton jets, disappearing track depending on model

See also N. Blinov's talk

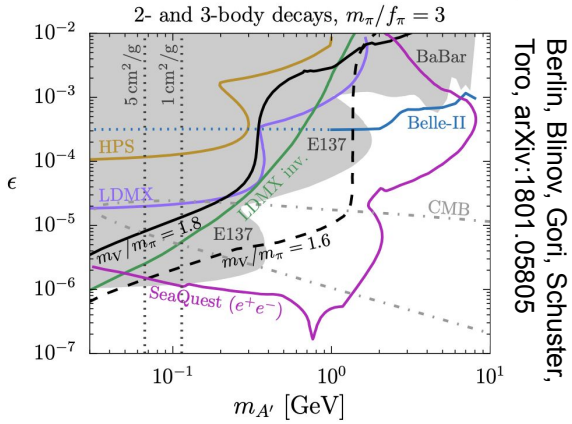
Complementarity across frontiers

- Light dark matter is accessible across frontiers
- Can also manifest in the form of bound states, important to understand reach of different experiments
  - Accelerator Search for a Stable, Neutral Long-Interaction-length Dark Matter Particle (feat. heavy ion collisions) LOI
- What is the complementarity with $h \to XX$ searches in extended models?

See also G. Krnjaic's, W. Jang's talk



Effect of including sub-GeV DM



Conclusions

- Light dark matter could be a potential solution of many observed anomalies including the core-cusp problem
- Searching for light dark matter at accelerators demands new ideas in model building and new avenues in search developments
- Can be realised via multiple production mechanisms, each can lead to spectacular signatures at the colliders
- Essential to evaluate the reach of future accelerators in order to optimise detector designs and demonstrate physics scenarios
- Essential to understand complementarity across frontiers
- Let’s search for light (dark matter) with high (energies)

Join us, give input

- Webpage of EF 10: https://snowmass21.org/energy/dark_matter
- Slack channel: #ef10-dark_matter under https://snowmass2021.slack.com
- Email list: SNOWMASS-EF-10-DARK_MATTER@FNAL.GOV
- Instructions on how to join: https://snowmass21.org/energy/start#communications
- List of all EF10 LOIs (title / authors): Spreadsheet with presentation recordings (more will be added)

LOIs submitted

1. Accelerator Search for a Stable, Neutral Long-Interaction-length Dark Matter Particle
2. Feebly interacting Dark Matter at colliders and Early Universe Cosmology
3. Search for Asymmetric Dark Matter model at CEPC by displaced lepton jets
4. Vector-Portal Search for Dark Matter Particles
5. Collider Signals of FIMP Dark Matter with Heavy Mediators
6. Sharing but not Caring at colliders
7. Feasibility study on probing the Seesaw Mechanism with full detector simulation for 250 GeV ILC