CF1. Dark Matter: Particle-Like

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Goal of this topical group “CF1: Dark Matter: Particle-Like”

This group covers dark matter in the regime where it appears in experiments as individual quanta, rather than coherently via wave phenomena. Techniques to search for such particles include directly through its interaction with detector materials, indirectly from products of its annihilation, and via production at accelerators (primarily covered in other frontiers).

- ➢ Distinguished from CF2 (Dark Matter: Wave-like) by focus on higher mass range (roughly ~1 eV and above)
- ➢ Distinguished from CF3 (Dark Matter: Cosmic Probes) by focus on particle signals of DM: CF1 covers (among other topics) classic indirect-detection searches for the particle products of DM annihilation/decay, but CF3 contains a broader range of astrophysical/cosmological probes

CF1 Activities to date

- Informational survey in June - 65 responses
- Series of nine CF1 meetings through August and September - mostly stepping down in mass range starting at GeV-TeV scales
  - Topics listed at https://snowmass21.org/cosmic/dm_particle#summerfall_2020_meetings
  - Indico with links to full recordings and minutes: https://indico.fnal.gov/category/1193/
  - Included theory and direct and indirect detection
  - >50 participants per meeting on average, with a high of 75.
- 147 LOIs cross listed with CF1 - *the most of any topical group*

CF1 @ CPM

- CF1 conveners engaged in planning 8 sessions at CPM (#136, #77, #127, #51, #97, #150, #75, #115)

CF1 going forward

- Dark matter is top priority of field. We want to make sure that comes out clearly from process
- Dark matter is in all frontiers. We want to update our understanding of complementarity between different searches and techniques, including developments since last Snowmass
  - Session #150 tomorrow is a start
  - Dedicated complementarity workshop early in 2021
- At CPM, start converging on number and format of summary white papers to convey the physics of particle like dark matter
  - 147 LOIs -> <10 summary white papers

CF1 at #136

- CF1 dedicated meetings focused on the high-mass range in August:
  - https://indico.fnal.gov/event/44765/ - direct detection - liquid argon, liquid xenon, bubble chambers
  - https://indico.fnal.gov/event/44939/ - indirect detection - cosmic rays, gamma rays, neutrinos
  - https://indico.fnal.gov/event/45030/ - theory - WIMPs, hidden sectors, TF/CF coordination
- About 54 LOIs with direct relevance for this session
  - See here for some categorization of #136-relevant LOIs with links
  - More detail on next slide

Attempted summary of LOIs

- Direct detection: liquid argon, xenon (liquid, including hydrogen doping, and dual-phase), bubble chambers, snowball chambers, sodium iodide modulation searches, directional detection, calibration and background reduction, paleodetectors, neutrinos from the Sun, neutrino backgrounds, new analysis tools
- Indirect detection: future large ground-based gamma-ray telescopes (CTA, SWGO), new analysis techniques for Galactic Center and dwarf galaxies in gammas; new probes with charged cosmic rays (GAPS antideuteron search, cosmic-ray ensembles); neutrino observatories (IceCube, HyperKamiokande, Pacific Ocean Neutrino Experiment) and searches
- Ultra-heavy DM: searches with ultra-high-energy cosmic rays/photons/neutrinos, multi-scattering in neutrino experiments.
- Theory/analysis/computing: many techniques for direct detection - simulations, machine learning, quantum information, effective field theory. Models: heavy neutral leptons, composite dark matter, feebly interacting dark matter, signatures of very-high-scale physics.

CF1 at #136

- Direct detection in this mass range in transitional moment
  - G2 - LZ and SuperCDMS projects ended or ending - new data coming!
  - G3 Dark Matter is a 2013/2014 P5 priority that has not yet started in US
  - Explosion of interest in lower mass direct detection since 2014
  - Community is still committed to high mass direct detection searches, but needs reinforcement? What is the right scale?
  - How does complementarity affect arguments for these experiments?
- Indirect detection - where next in this mass range?
  - Where do we anticipate potentially large increases in sensitivity for indirect-detection searches over the next ~decade? Are there gaps (e.g. “Fermi successor”)?
  - Are there cases where better modeling/measurement of backgrounds would greatly improve sensitivity? Same question for theoretical modeling of signals.
  - Are their targets we should be aiming for? (e.g. what would it take to probe the thermal relic cross-section up to the unitarity bound on the DM mass? This may be impossible...)
  - How does complementarity affect arguments for these searches/missions?

Date/Time	CF1 Sponsored Sessions	
Tuesday 10/6 @11:30 AM CDT	#136: “Heavier particle dark matter >~ 10 GeV”	#77: “Quantum Sensors for Wave and Particle Detection”
Tuesday 10/6 @ 2-4 PM CDT	#127: “Searches for dark sectors”	
Tuesday, 10/6 @3PM CDT	#51: “Requirements for low background and underground detectors”	#97: “Neutrinos as Probes of Standard and BSM Particle Physics”
Wed 10/7 @12.15PM CDT	#150: multi-frontier summary session on complementarity of dark matter searches across frontiers.	
Wed 10/7 @ 1PM CDT	#75: “Cosmic Probes of Dark Matter Physics”	#115: “Neutrinos, dark matter, and underground facilities”