

# CF03: Cosmic Probes of Dark Matter Physics

*SnowMass2021*

Alex Drlica-Wagner (Fermilab/UChicago)

on behalf of CF3 Conveners:

Chanda Prescod-Weinstein & Hai-Bo Yu

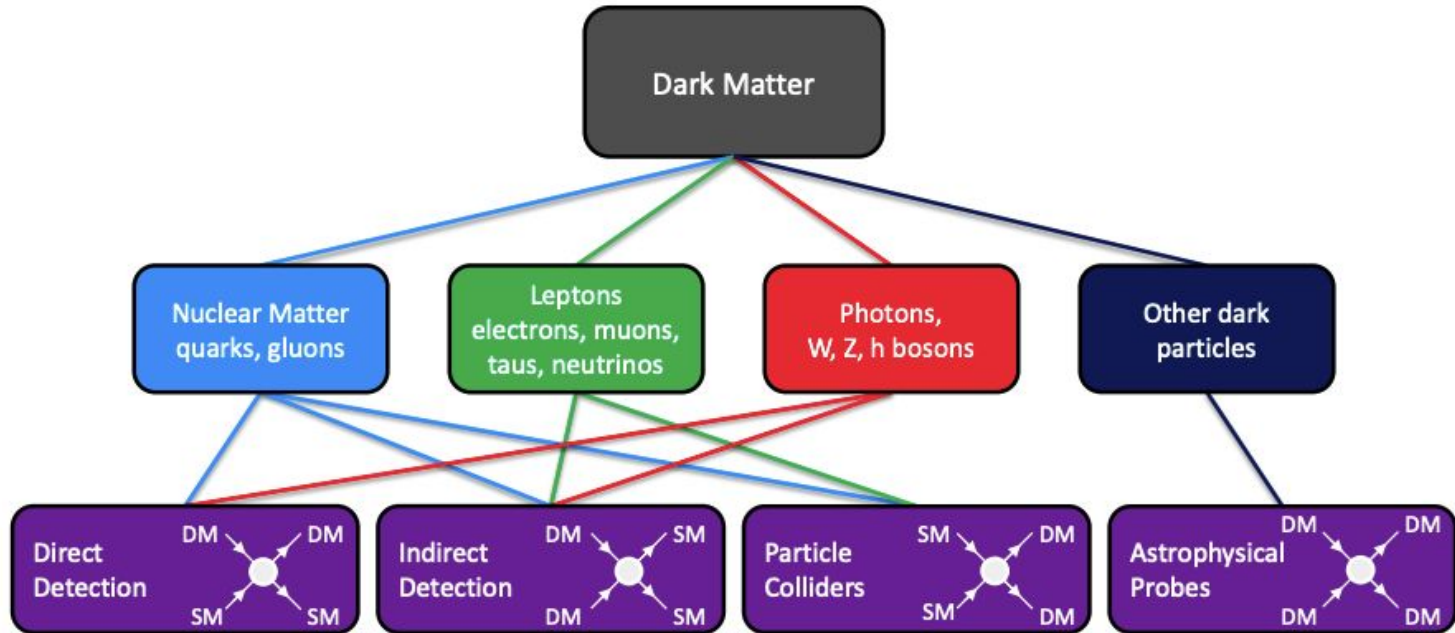
Snowmass Day

September 24, 2021

# Outline

- Dark Matter: Cosmic Probes
- Solicited white papers
- Timelines
- How to get involved

# Dark Matter in Snowmass 2013



# 2014 P5 without CF03...

The 2014 P5 report did not identify dark matter as a science driver for the large cosmic survey efforts (LSST, DESI, CMB-S4).

DOE resists expanding the scientific scope of these experiments to support dark matter research \*even though\* dark matter is a DOE mission priority.

We would like to avoid having this happen again...

## Table 1 Summary of Scenarios

Project/Activity	Scenarios			Science Drivers				Technique (Frontier)
	Scenario A	Scenario B	Scenario C	Higgs	Neutrinos	Dark Matter	Cosm. Accel.	
<b>Large Projects</b>								
Muon program: Mu2e, Muon g-2	Y <small>Mu2e small reprofile needed</small>	Y	Y					✓ I
HL-LHC	Y	Y	Y	✓		✓		✓ E
LBNF + PIP-II	Y <small>LBNF components delayed relative to Scenario B.</small>	Y	Y, enhanced		✓			✓ I, C
ILC	R&D only	R&D, <small>possibly small hardware contributions. See text.</small>	Y	✓		✓		✓ E
NuSTORM	N	N	N		✓			I
RADAR	N	N	N		✓			I
<b>Medium Projects</b>								
LSST	Y	Y	Y			X	✓	C
DM G2	Y	Y	Y			✓	✓	C
Small Projects Portfolio	Y	Y	Y		✓	✓	✓	All
Accelerator R&D and Test Facilities	Y, reduced	Y <small>some reductions with redirection to PIP-II development</small>	Y, enhanced	✓	✓	✓		✓ E, I
CMB-S4	Y	Y	Y			X	✓	C
DM G3	Y, reduced	Y	Y			✓		C
PINGU	Further development of concept encouraged				✓	✓		C
ORKA	N	N	N					✓ I
MAP	N	N	N	✓	✓	✓		✓ E, I
CHIPS	N	N	N		✓			I
LArl	N	N	N		✓			I
<b>Additional Small Projects (beyond the Small Projects Portfolio above)</b>								
DESI	N	Y	Y			X	✓	C
Short Baseline Neutrino Portfolio	Y	Y	Y		✓			I

Astrophysical  
Probes



**Astrophysics** provides  
the **only robust, positive**  
**empirical measurement**  
of **dark matter**

### CF Dark Matter Topical Groups

**CF01: Dark Matter: Particle-like**  
**CF02: Dark Matter: Wave-like**  
**CF03: Dark Matter: Cosmic Probes**

### Topical Groups in other Frontiers

CF07: Cosmic Probes of Fundamental Physics  
EF10: BSM: Dark Matter at colliders  
TF09: Astro-particle physics & cosmology

**Dark  
Matter**

Direct  
Detection



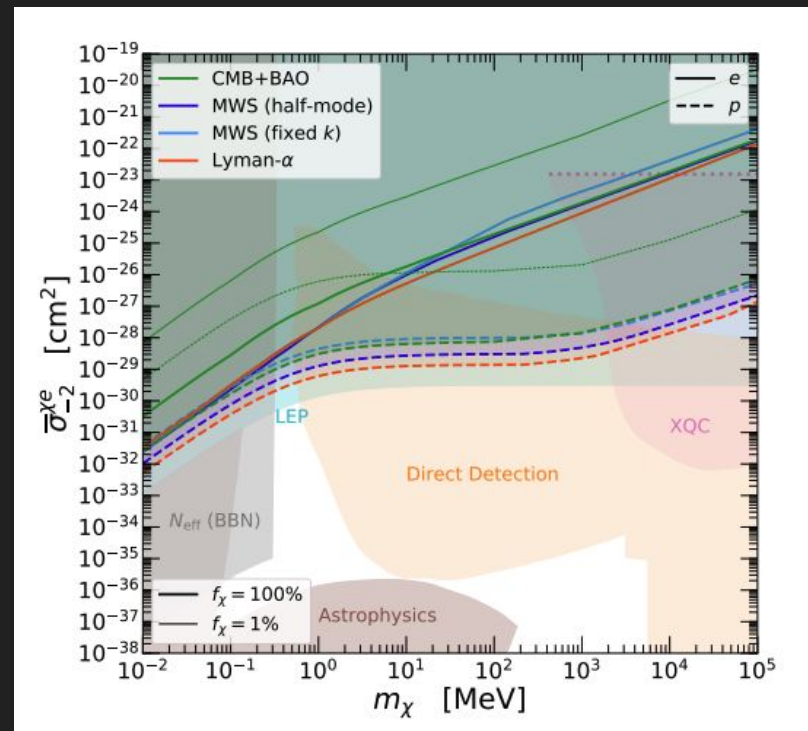
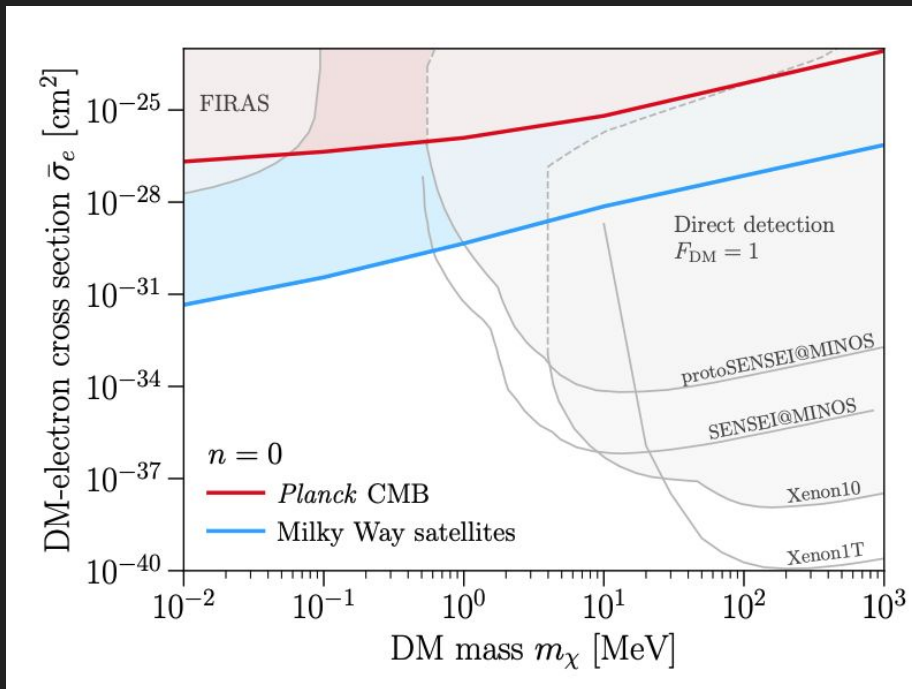
Particle  
Colliders



Indirect  
Detection



# Some recent examples...



# Letters of Interest and Solicited White Papers

- CF03 received **~75 Letters of Interest** from the community.
- Through a series of discussions (including the Community Planning Meeting), we arrived at a list of **6 solicited white papers** with designated facilitators.
- CF03 is **happy to accept** additional contributed white papers, **but we encourage people to join these efforts when possible.**

## CF03 “Solicited” White Paper Topics

- **Dark matter physics from halo measurements** [[#wp-cf03-dark\\_matter\\_halos](#)]  
Dark matter physics from dark matter halos ranging from large-scale structure to sub-galactic scales.  
Facilitators: **Keith Bechtol, Simon Birrer, Francis-Yan Cyr-Racine, Katelin Schutz**
- **Primordial Black Holes & Gravitational Waves** [[#wp-cf03-dark\\_matter\\_pbh\\_gw](#)]  
Primordial black holes as dark matter and probes of inflation (joint with CF7?)  
Facilitators: **Andrea Albert, Simeon Bird, Will Dawson**
- **Numerical simulations and systematics** [[#wp-cf03-dark\\_matter\\_sims](#)]  
Importance of numerical simulations for extracting dark matter physics (joint with CompF2?)  
Facilitators: **Arka Banerjee, Ferah Munshi, Annika Peter**
- **Connecting dark matter to early universe physics** [[#wp-cf03-dark\\_matter\\_early\\_universe](#)]  
Light relics, 21cm (EDGES), etc. **Likely to be merged into WPs from CF5 & TF9**  
Facilitators: **Kim Boddy, Cora Dvorkin, Vera Gluscevic, Julian Muñoz**
- **Dark matter physics in extreme astrophysical environments** [[#wp-cf03-dark\\_matter\\_xtreme](#)]  
Includes stellar interiors, neutron stars, non-primordial black holes (joint with TF9?)  
Facilitators: **Masha Baryakhtar, Regina Caputo, Djuna Croon, Kerstin Perez**
- **Facilities for cosmic probes of dark matter physics** [[#wp-cf03-dark\\_matter\\_facilities](#)]  
Proposed facilities for cosmic probes of dark matter including MSE, MegaMapper, CMB-HD, etc.  
Facilitators: **Sukanya Chakrabarti, Ting Li, Neelima Sehgal, Josh Simon**





Snowmass 2021

DPF Community Planning Exercise



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## Solicited White Paper Topics

Through a series of discussions, CF03 has arrived at a list of 6 solicited white papers. CF03 is happy to accept additional contributed white papers, but we encourage people to join these efforts when possible.

1. Dark matter physics from halo measurements
2. Primordial Black Holes & Gravitational Waves
3. Numerical simulations and systematics
4. Connecting dark matter to early universe physics
5. Dark matter physics in extreme astrophysical environments
6. Facilities for cosmic probes of dark matter physics

More information on the CF3 white papers can be found [here](#) and an FAQ can be found [here](#).

# CF03 Internal White Paper Timeline (updated)

## Proposed timeline for CF03 paper writing:



- **Nov 2020:** identify “solicited” white papers and “facilitators”
- **Aug 30, 2021:** facilitators start identifying writers for each white paper
- **Oct 18, 2021:** White paper outlines/skeletons -- what will the paper cover, begin to articulate key questions and opportunities; identify key questions and opportunities for each white paper
- **Jan 17, 2022:** first draft of white paper to CF03 conveners, for feedback and discussion; share among sub working groups; reminder, topical group report is written in parallel to white papers (so need to know early)
- **Feb-Mar, 2022:** further polish the white papers and submit them

# How to Get Involved

Join our meetings and engage on the Snowmass Slack!

Meetings: October 18th @ 12PM EDT/9AM PDT

Slides/Recordings: <https://indico.fnal.gov/category/1195/>

Slack: [#cf03-dark\\_matter\\_cosmic](#)

Email: [snowmass-cf-03-dm-cosmic@listserv.fnal.gov](mailto:snowmass-cf-03-dm-cosmic@listserv.fnal.gov)

Snowmass Wiki: [https://snowmass21.org/cosmic/dm\\_probes](https://snowmass21.org/cosmic/dm_probes)

Questions for the CF03 Conveners?

Alex Drlica-Wagner [kadrlica@fnal.gov](mailto:kadrlica@fnal.gov)

Chanda Prescod-Weinstein [Chanda.Prescod-Weinstein@unh.edu](mailto:Chanda.Prescod-Weinstein@unh.edu)

Hai-Bo Yu [haiboyu@ucr.edu](mailto:haiboyu@ucr.edu)