



Dark Matter - Baryon Scattering with CMB

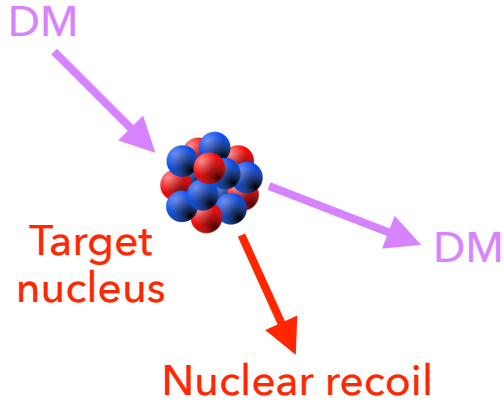
Kimberly Boddy

CMB-S4 Collaboration Meeting
May 9-13, 2022

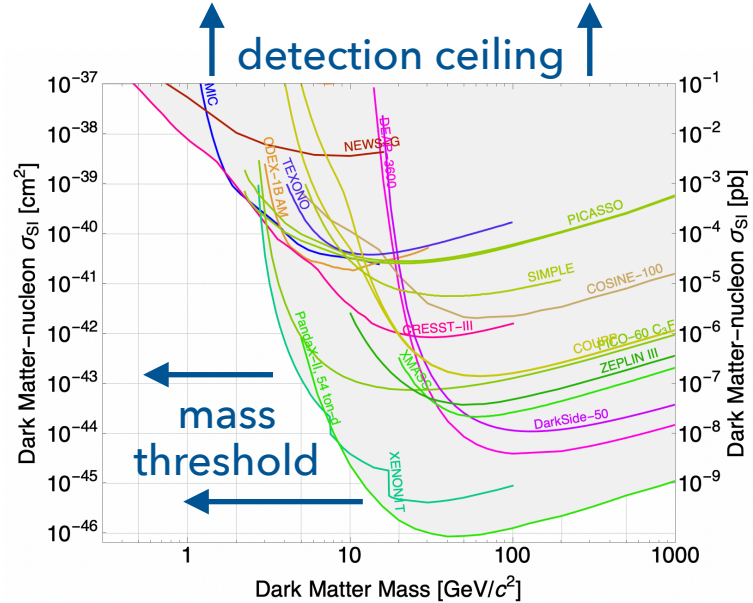


WIMP Searches

- Dedicated laboratory experiments search for dark matter interactions with Standard Model particles
- Notably, direct detection places stringent limits on interaction cross section

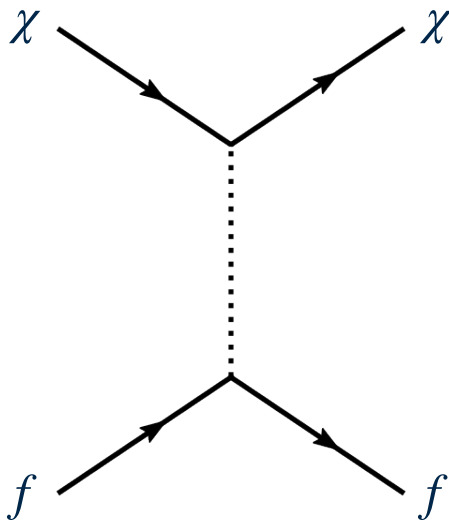


search for same physics with cosmological observables



from Dark Matter Limit Plotter by Saab & Figueroa

Dark Matter Scattering

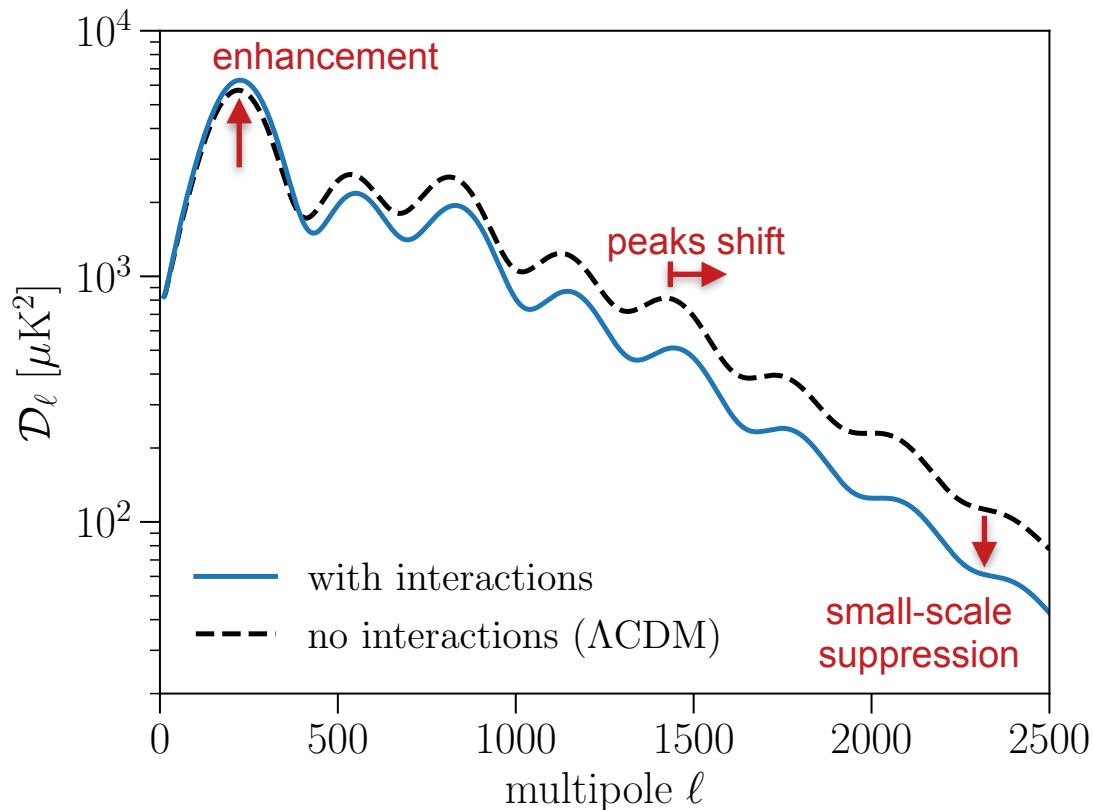


$$\sigma_{MT}(v) = \int (1 - \cos \theta) \frac{d\sigma}{d\Omega} d\Omega = \sigma_0 v^n$$

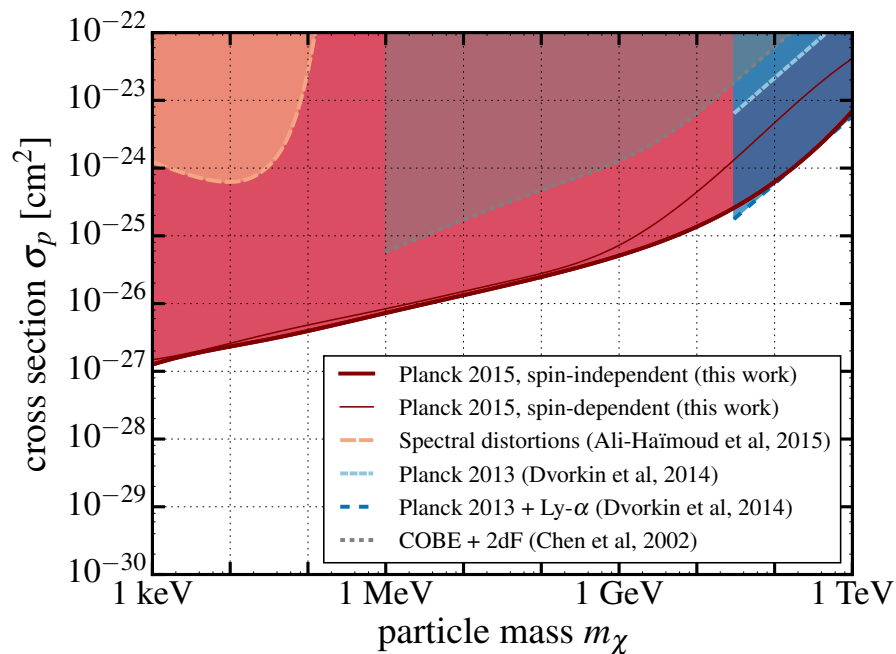
f in early Universe: e^- , p , He

Chen+ (PRD 2002); Sigurdson+ (PRD 2004); Dvorkin+ (PRD 2014);
Gluscevic and KB (PRL 2018); KB and Gluscevic (PRD 2018);
Xu+ (PRD 2018); Slatyer+ (PRD 2018); KB+ (PRD 2018); KB+ (2204.04225)

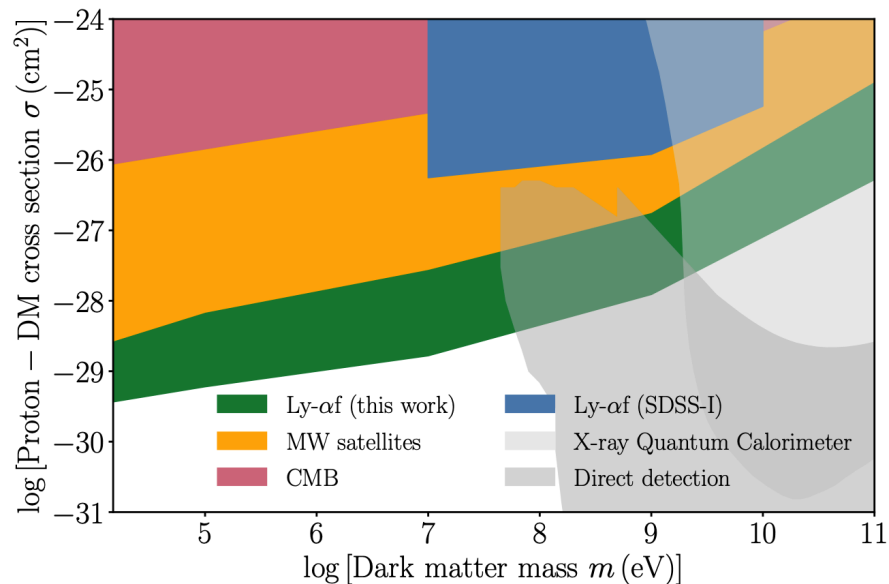
Effects of Dark Matter Scattering



Scattering with protons ($n = 0$)

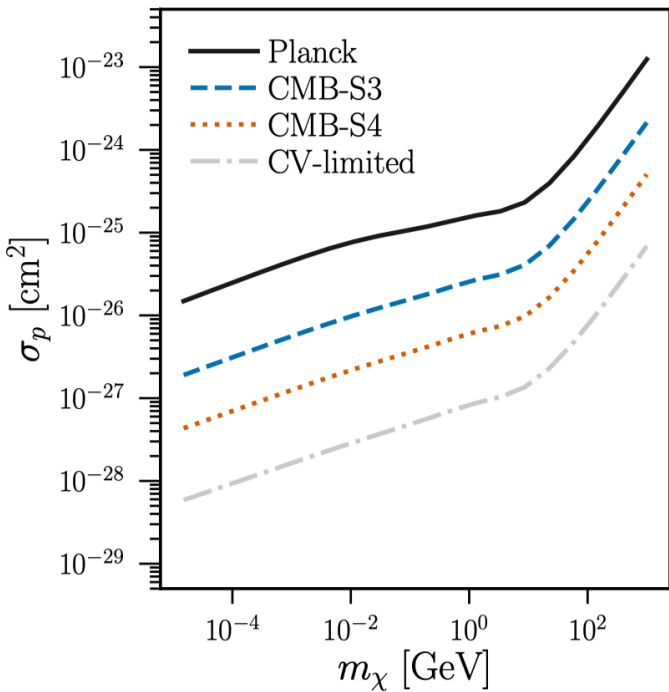


Gluscevic, KB (PRL 2018)
see also: KB, Gluscevic (PRD 2018)



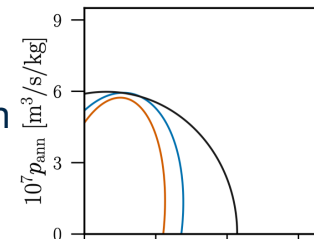
Rogers, Dvorkin, Peiris (PRL 2022)

CMB Projections: Scattering with protons ($n = 0$)

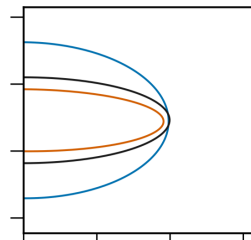
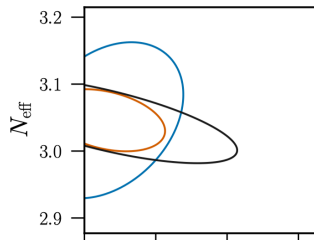


Li, Gluscevic, KB, Madhavacheril (PRD 2018)

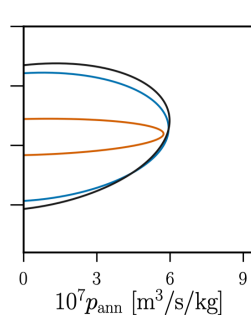
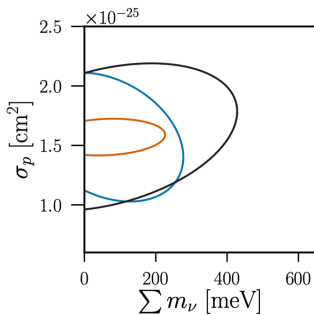
annihilation



N_{eff}

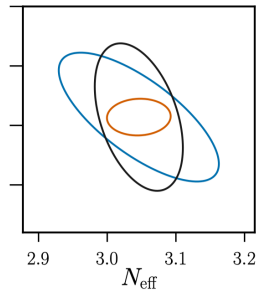


scattering

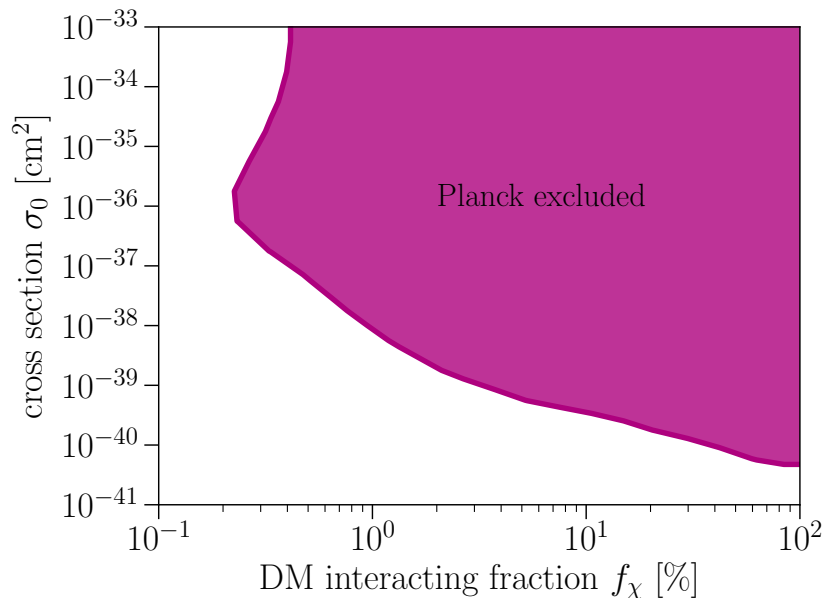
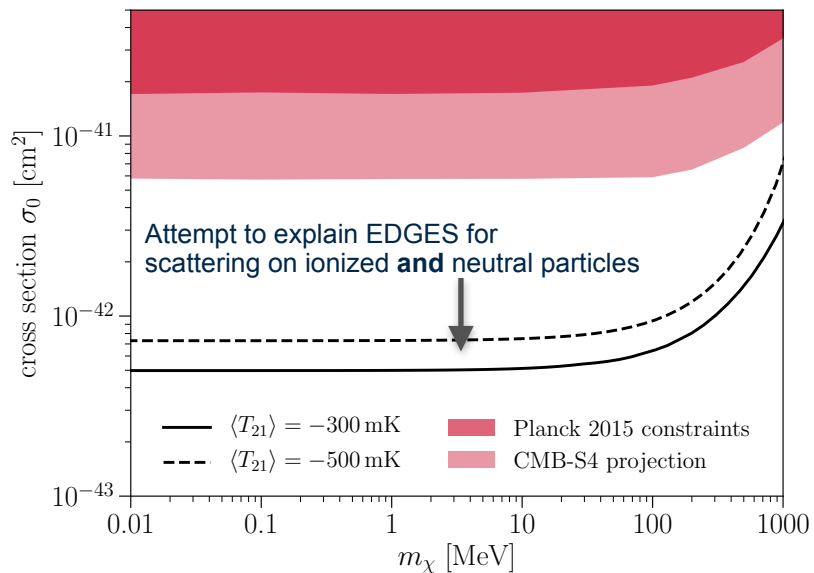


- Unlensed TT/TE/EE
- Lensed TT/TE/EE
- TT/TE/EE/ $\kappa\kappa$

neutrino mass



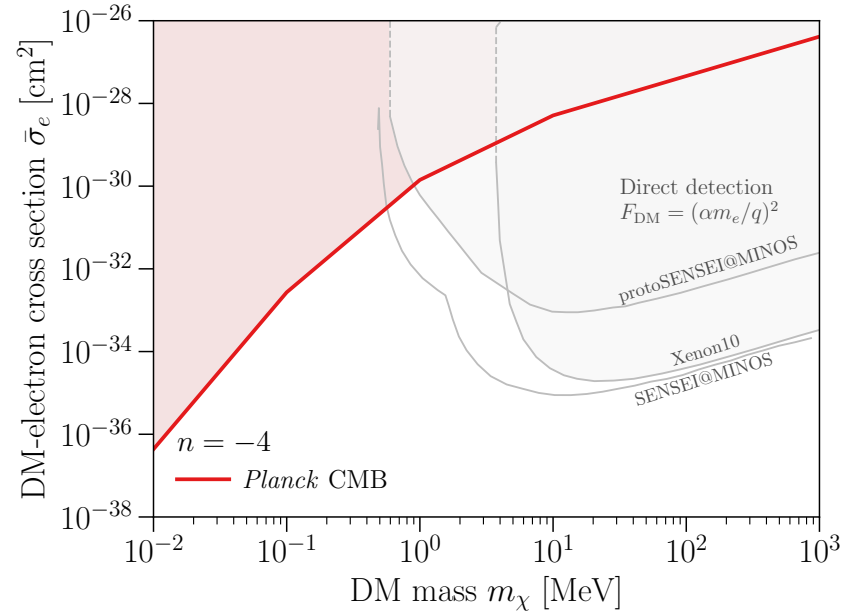
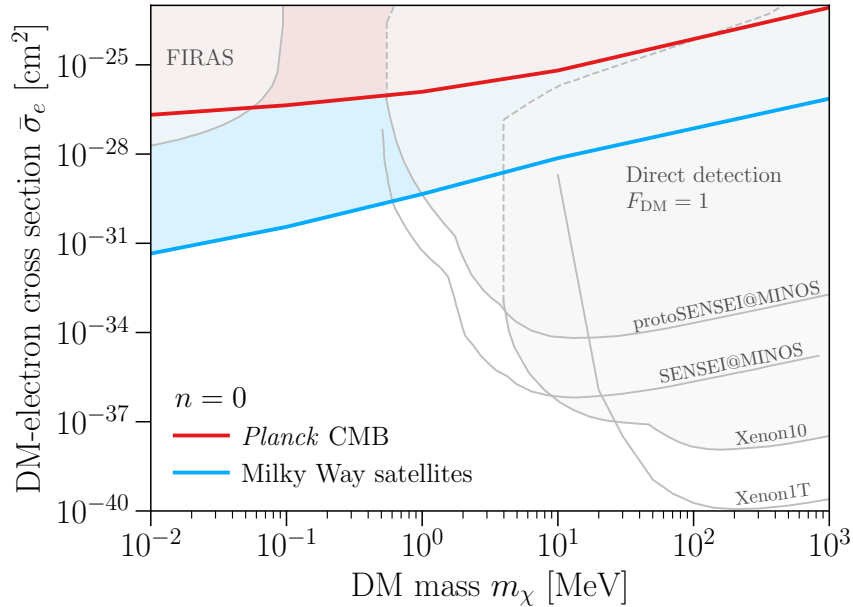
Scattering with protons ($n = -4$)



see also de Putter+ (PRL 2018)

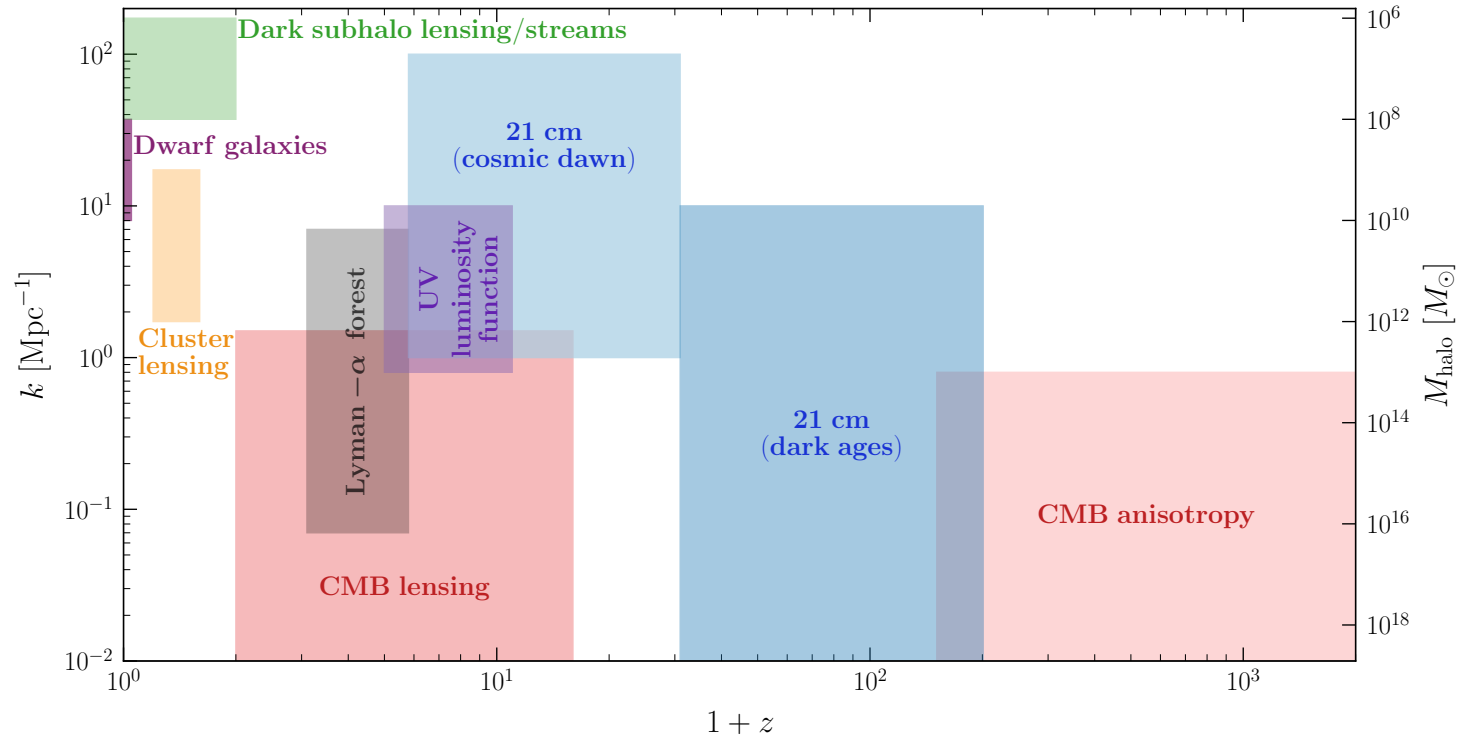
KB, Gluscevic, Poulin, Kovetz, Kamionkowski, Barkana (PRD 2018)
Kovetz, Poulin, Gluscevic, KB, Barkana, Kamionkowski (PRD 2018)

Scattering with electrons



Nguyen, Sarnaik, KB, Nadler, Gluscevic (PRD 2021)
see also Buen-Abad+ (2021)

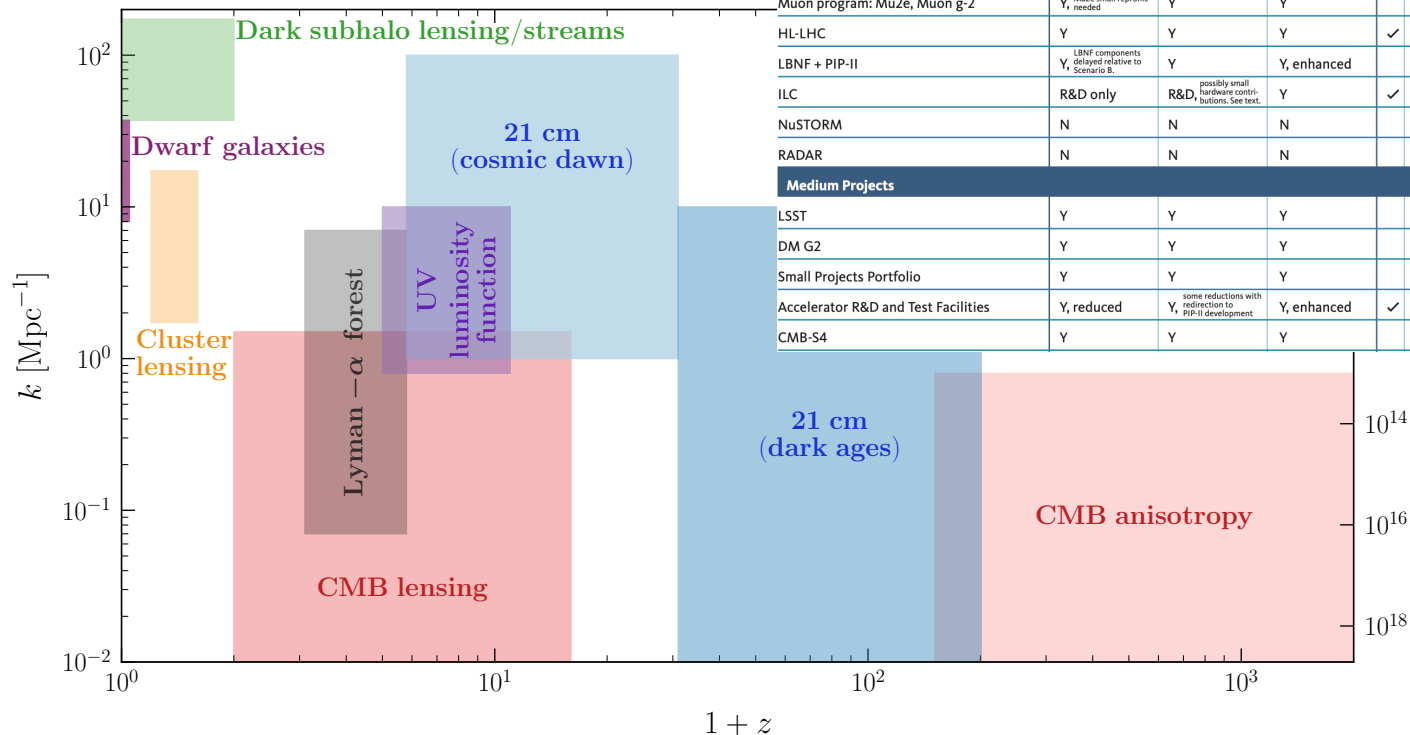
Complementarity



Snowmass 2021 Theory Frontier: Astrophysical and Cosmological Probes of Dark Matter (2203.06380)

Complementarity

P5 Report
May 2014



Project/Activity	Scenarios			Science Drivers					
	Scenario A	Scenario B	Scenario C	Higgs	Neutrinos	Dark Matter	Cosm. Accel.	The Unknown	Technique (Frontier)
Large Projects									
Muon program: Mu2e, Muon g-2	Y, Mu2e small reprofile needed	Y	Y						✓ I
HL-LHC	Y	Y	Y	✓	✓				✓ E
LBNF + PIP-II	Y, LBNF components delayed relative to Scenario B.	Y	Y, enhanced		✓				✓ I,C
ILC	R&D only	R&D, possibly small hardware contributions. See text.	Y	✓	✓				✓ E
NuSTORM	N	N	N		✓				I
RADAR	N	N	N		✓				I
Medium Projects									
LSST	Y	Y	Y		✓	○	✓		C
DM G2	Y	Y	Y			✓			C
Small Projects Portfolio	Y	Y	Y		✓	✓	✓		All
Accelerator R&D and Test Facilities	Y, reduced	Y, some reductions with redirection to PIP-II development	Y, enhanced	✓	✓	○	✓		E,I
CMB-S4	Y	Y	Y		✓	○	✓		C

Snowmass 2021 Theory Frontier: Astrophysical and Cosmological Probes of Dark Matter (2203.06380)

