

DM SNSPD Status

12/22/2020
DM-SNSPD Working Meeting

Cristián Peña, Si Xie (Caltech/Fermilab)



Dark Matter with SNSPD

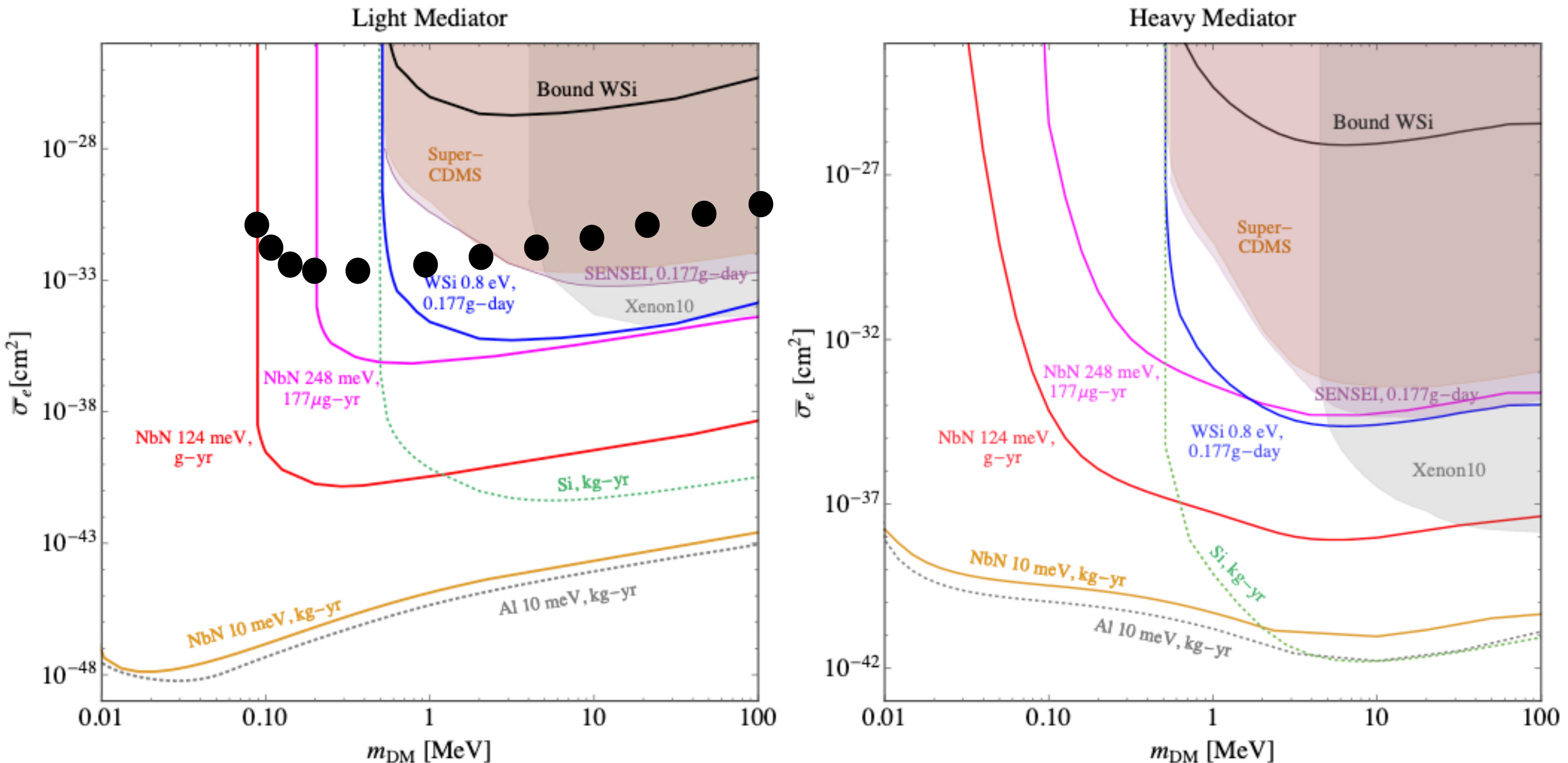
- Large parameter space (DM mass and coupling) to be explored
- From US Cosmics vision: many opportunities for small scale experiments
- Hidden Sector DM focus is in the keV - GeV range (6 orders of magnitude)
- Ultralight DM (e.g axion) mass in 10^{-22} - 10^3 eV range (25 orders of magnitude)
- **A multi-experiment programs is encouraged by US cosmic vision as just a few experiments are not enough to cover all the ground**

SNSPD Specs/Advantages

- Intrinsic low-energy threshold: $\sim [0.01] 0.1 - 1 \text{ eV}$ ($[100] 10 - 1 \mu\text{m}$)
- Low dark counts ($< 1 \text{e-4 Hz}$)
- Runs at cryogenic temperatures which is required by most DM experiments (reduce bkg)
- High photon detection efficiency — other radiation to be studied
- Con: generally small area per sensor $500 \mu\text{m} \times 500 \mu\text{m}$
- Con: low target mass per sensor : $\sim 1 \text{ ng}$
- Even with small target mass new DM parameter-space are accessible
- Can couple to targets: dielectric stack, scintillators, polar crystals

DM SNSPD Sensitivity Out of the Box

10.1103/PhysRevLett.123.151802



Take NbN 124 meV (10 μm), 1mm $\times$ 1mm $\times$ 10nm (1e-7 g) per 1/10 year (36 days)

Cover new parameter space $\rightarrow$ black dots in left plot

DM SNSPD Target Options

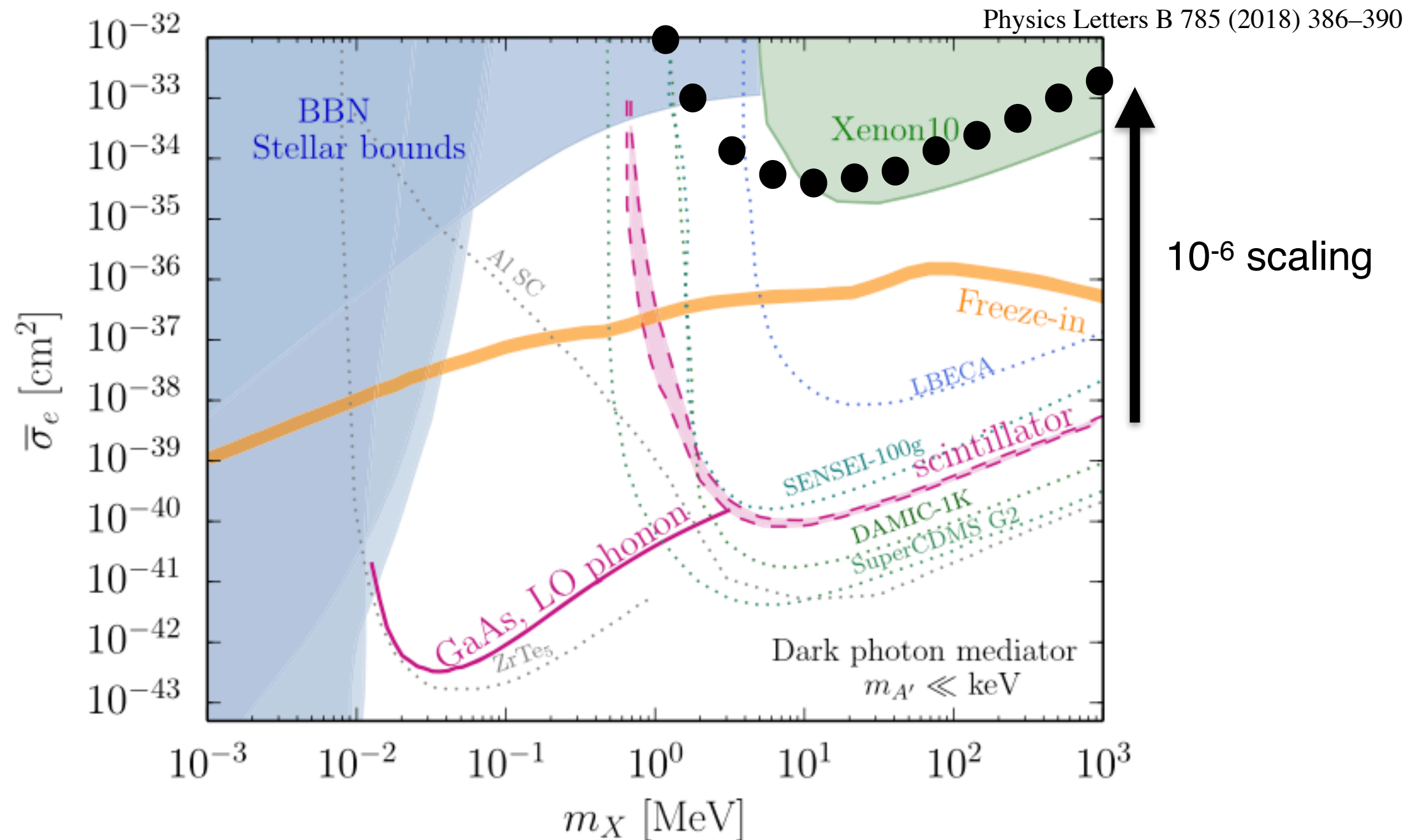
- Bare SNSPD
 - Hidden Sector (DM) → DM-electron recoil
- Dielectric stack
 - dark photons and axions → photon detection through mixing
- Scintillators (e.g GaAs)
 - Hidden Sector (DM) → DM-electron recoil
 - dark photons → absorption
- Polar Crystals (GaAs, Al₂O₃, SiO₂)

Lower energy threshold will expand reach for ALL target options

DM SNSPD Target Options

- Focus of this meeting is to explore further all these options
- Today we will have GaAS from Jamie
 - GaAs looks promising as it probes many DM models
 - Sensitive to different detection mechanisms

DM SNSP, GaAs as a Scintillating Target

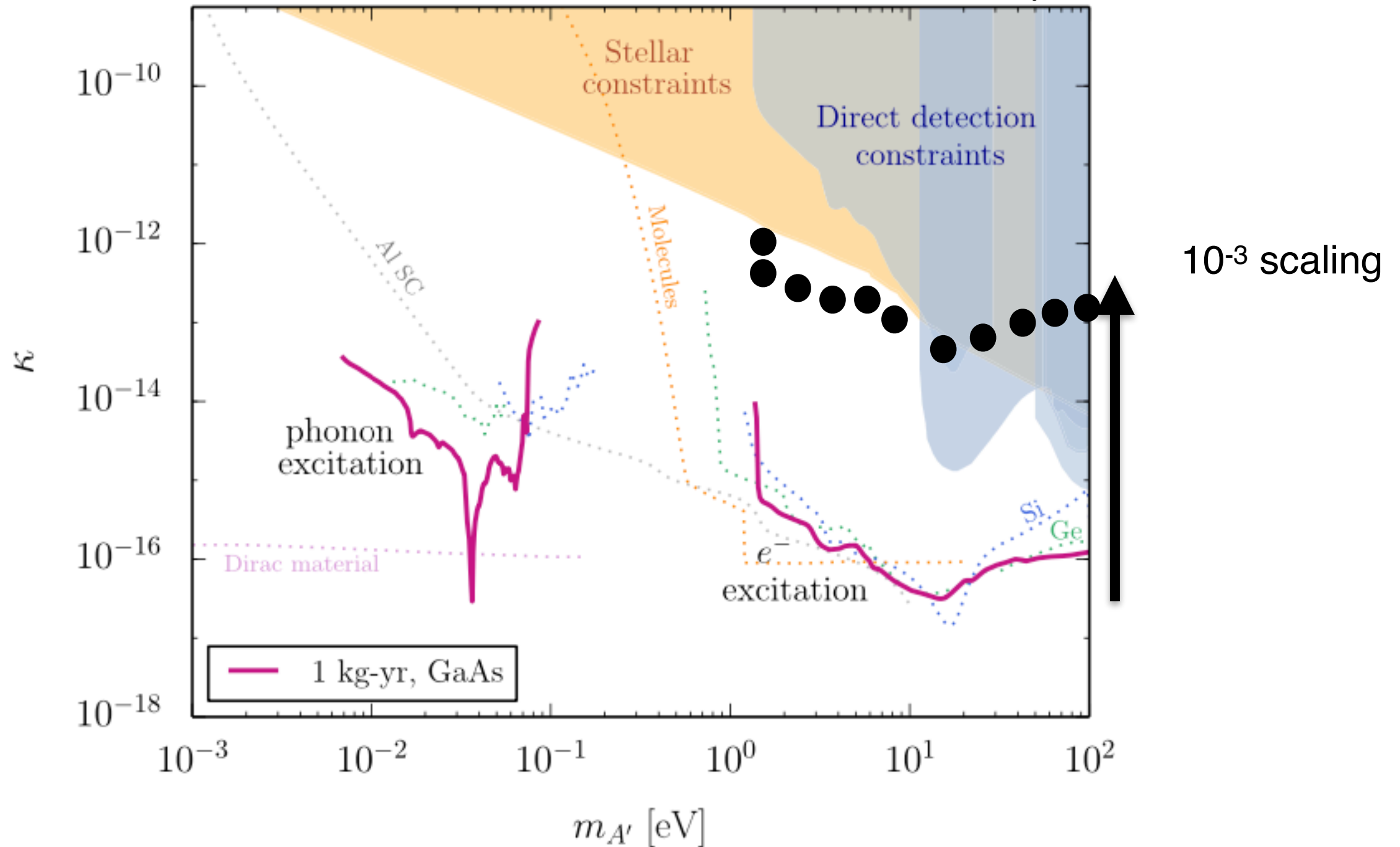


Take 1mm × 1mm × 1mm GaAs crystal (5e-3 g) per 1/5 year (70 days)

Cover new parameter space → 1-10 MeV

DM SNSP, GaAs as a Scintillating Target

Physics Letters B 785 (2018) 386–390



Take 1mm × 1mm × 1mm GaAs crystal (5e-3 g) per 1/5 year (70 days)

Cover new parameter space → 1-10 eV