

Cosmology of Axino.

Th

SM \supset Electroweak + QCD

Finetuning \downarrow $m_h \ll M_{pl}$ (or $m_{w,z}$) \downarrow $\bar{\theta} \ll 1$.

remedy

SUSY

Peccei-Quinn

+
Signal

~~SUSY~~

~~PQ~~

\downarrow
sparticles
at LHC? ...

\downarrow
axion. \Rightarrow CAPP

Pheno.

SUSY + PQ \Rightarrow $a \longrightarrow \hat{A}$: axion SUPERfield.

$$\hat{A} = \frac{1}{\sqrt{2}} (S + ia) + \sqrt{2} \hat{\theta} \hat{a} + \hat{\theta}^2 F_A$$

\uparrow
superspace
coordinate.

1) inherited interaction

$$\sim \frac{1}{f_a} \Rightarrow \text{Feebly interacting particle}$$

$> 10^9 \text{ GeV}$ from axion searches

\Rightarrow either Long-Lived or FIMP DM.

2) Wide Mass range.

~~SUSY~~ generates but highly depends on UV model.

keV — TeV — PeV (?)
 \uparrow freeze-in DM. \uparrow LHC/DM. \uparrow Decaying DM.

Cosmology

1). TeV (maybe 10 TeV?).

TeV scale SUSY: $M_{\text{soft}} \sim M_{\tilde{a}}$

Thermal production \Rightarrow late-decay. $\tau_{\tilde{a}} \sim 10^{-8} \sim 10^{-5}$ or longer
alters neutralino abundance

\Rightarrow mismatch with direct/indirect detection?

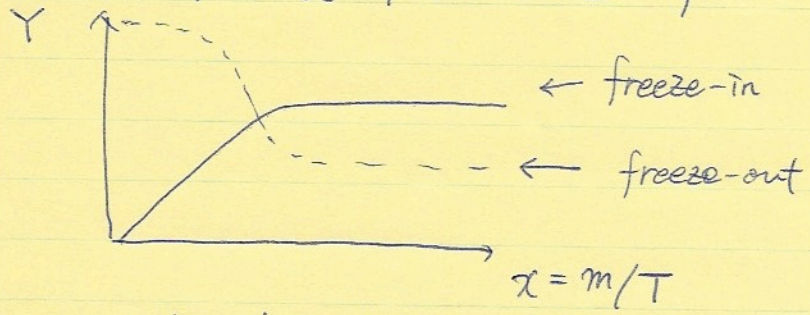
+ long-lived particle searches at LHC.

e.g., MATHUSLA

2) keV

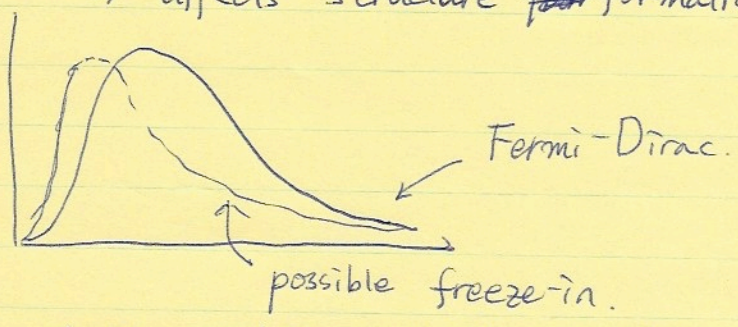
~~UV~~ UV model for $m_{\tilde{a}} \ll M_{\tilde{g}}$

Thermal FREEZE-IN production



non-trivial phase-space distribution

\Rightarrow affects structure ~~for~~ formation w/ Ayuki



+ sterile neutrino = keV axino?

3) PeV & nearly degenerate with Gravitino.
 (UV model for degeneracy.)

long-lived $\tau_{\tilde{a}} \sim 10^{17} \text{ s}$ (age of the Universe)

$\tilde{a} \rightarrow \tilde{G} + a$ $v_k \sim 20-40 \text{ km/s} > v_{\text{max}}$ of dwarf galaxy

$< v_{\text{max}}$ of galaxy
 \Downarrow

destroy small scales
 \Downarrow

solution to small-scale problems

$E_a \sim 50 \text{ GeV}$
 \Downarrow

$a \rightarrow \gamma \Rightarrow$ Fermi-LAT
 CTA

$|\vec{B}| \sim \mu\text{G}$ (Galactic)

w/ Ayuki

+ other signals?
 or different model?