

Mo' \rightarrow Asymmetric DM

13 NOV 2013

Motivation: $\rho_{DM} \sim 5 \rho_{baryon}$

1308.0338

same Ω magnitude ... same mechanisms?

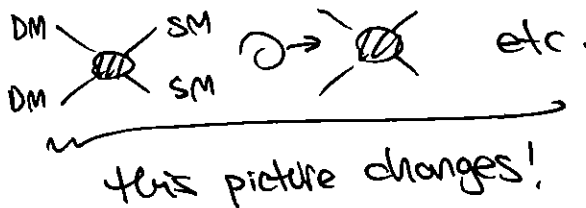
Why do we have baryons?

Asymmetry in early universe

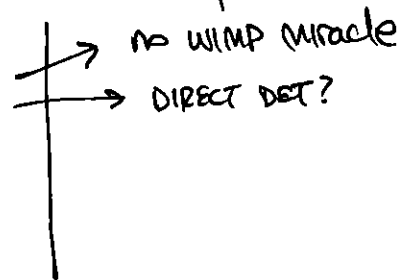
SO WANT: $n_x - n_{\bar{x}} \sim n_B - n_{\bar{B}}$
 $\Rightarrow m_x \sim 1-15 \text{ GeV}$

What this buys us

• DIFFERENT PHENO VS. WIMP



\rightarrow not thermal ρ



• Motivates HIDDEN SECTORS

eg. Mirror DM
SUSY HIDDEN SECTORS

• Inherently self-interacting

$$\sigma \approx 5 \times 10^{-23} \text{ cm}^2$$

$$\frac{\sigma}{m_x} \sim 10^{-24} \text{ cm}^2/\text{GeV}$$

\uparrow close to astro targets for small scale struc.

- Plan
1. GENERATE ASYM IN BOTH SECTORS \leftarrow CP ASYM.
 2. DECOUPLE SECTORS
 3. ANNIHILATE \bar{X} EXCESS

I. Generate ASYM.

A. transfer B asym into DARK ASYM

- electroweak sphalerons

\hookrightarrow break $B+L$

CAN CONSTRUCT S.T. DM AS WELL. \nearrow cons. $B - \frac{N_B}{N_X} D$

\hookrightarrow but requires DM is EW charged

if $2M_X < M_Z \rightarrow$ ~~R_{AB}~~ ruled out! eg LEP.

Ways out: make X HEAVY. (what about $M_X \sim 1-15$ GeV)

- $\frac{R_X}{R_B} = \frac{N_X M_X}{N_B M_B} = 5$ maybe some NR game?

- TUNING: Baryon + DM #s

- USE NEW GAUGE GROUP

\checkmark $W = \Theta_{B-L} \Theta_D$

- Non Ren Op: shares (transfers) asym.

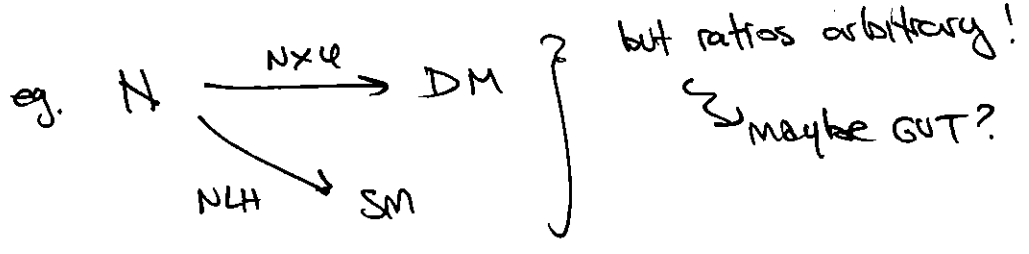
- MORE FIELDS: $H X X_2$

Q. How does SU(2)_L GEN B ASYMMETRY DOING VIOLATE CP?

B. Direct Generation of Asym (in either ^{BOTH SEE} ONLY DM)

1. Cogenesis : B & D asym gen. simultaneously

Parent particle: LONG LIVED → OUT OF EQUILIB
BOTH χ 's ~~OP~~ DECAYS
VIBRATES B, K, ϕ



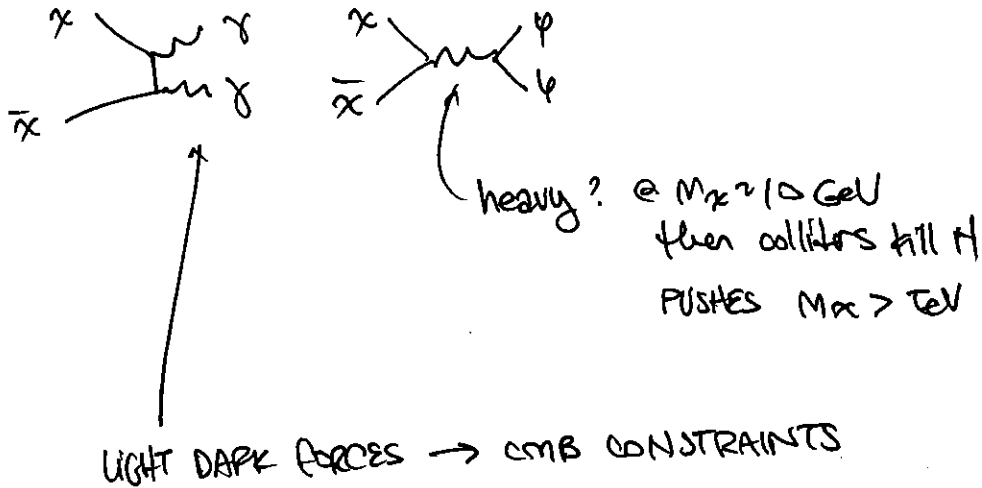
2. ~~the~~ Aligned DM
 ↳ flat directions
 HAVE $(B-K)$ CONFIG.

3. Darkogenesis
 ↳ GEN ASYM IN DARK SECTOR (eg DARK SPHALERON)
 + TRANSFER TO SM

- Dark endo baryo
- Spont. Darkogen.

2. just do.

3. Annihilate $\bar{\chi}$



How to exclude

- neutron stars : $\chi n \rightarrow \chi n \Rightarrow$ THERMALIZE
 SELF GRAVITATE \rightarrow BEC IF FERMIONS
 \Downarrow BLACK HOLE
 \downarrow
 fermions \rightarrow FERMI PRESSURE
 no meaningful limit

- energy transfer near stars
 eg. the SUN? DM DENSITY TOO LOW.
 causes stars of $0.1 M_\odot \rightarrow$ brown dwarfs
 contraction of white dwarf stars

Indirect Det

WIMP: upper bound on $\langle\sigma v\rangle$

ADM: LOWER BOUND from req. of annihilation.

Milky Way: γ from decays
 γ from scattering cosmic rays (HARD)
 cosmic rays

Direct Det

$\sigma \sim \chi\chi$ not a DD sig... but maybe from UV completion

more useful: if DARK FORCE mixes w/ hypercharge

\hookrightarrow COSENT, COMS, DAMA

DM ann. to light mediators?

$$\sigma \sim \alpha \times g_n^2 \quad \leftarrow \begin{array}{l} \text{EARLY UNIV. ER.} \\ \text{LOWER BOUND} \end{array} \Rightarrow \sigma > 10^{-48} \text{ cm}^2$$

↑
ANN. BOUNDED FROM BELOW

Collider: Mono-j + MET

ADM hard to produce: $\left\{ \begin{array}{l} \text{HEAVY MED} \\ \text{LIGHT MED, BUT WEAKLY COUPLED} \end{array} \right.$