

: Breve presentación en Sociedad"

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HAVANE → MADRID → BRUXELLES → ANNÉCY
UG Phd PD PD

I

- WHAT DO I DO ??

SHORT ANSWER: DARK MATTER

PHENO

Complementarity of
constraints from diff.
experimental strategies

LHC $\Leftrightarrow$ DIRECT DETECTION $\nwarrow$
 $\nearrow$ EARLY $\Leftrightarrow$ INDIRECT DET. $\searrow$
UNIVERSE

MODEL

BUILDING

ALL POSSIBLE

THERMAL HISTORIES
OF DARK MATTER

- WIMP-like

- SIMP-like

- FIMP-like

- GRAVITINO-LIKE

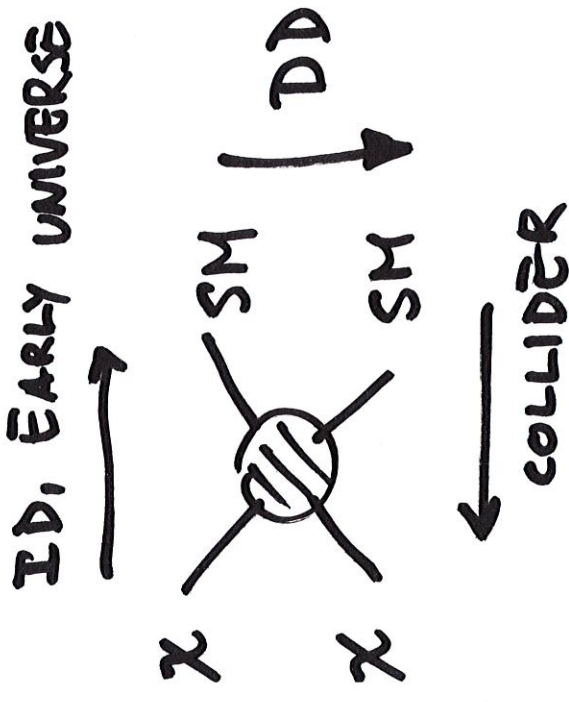
- ASYMMETRIC

...

II

STANDARD PICTURE

- LEAD BY WIMP SEARCHES
- NO SIGNALS SO FAR
- IT MAY NOT BE CONSISTENT WITH ALL ASTRO DATA



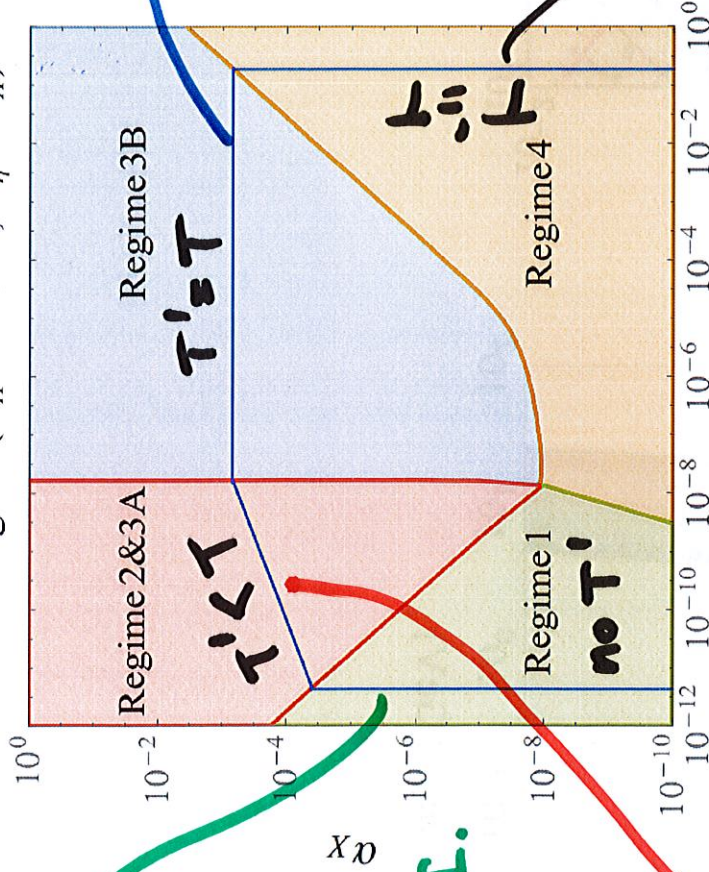
STRATEGIES:

- KEEP SEARCHING (GOOD LUCK TO US)
- EXPAND TO OTHER PARAMETER REGIONS
(like going to TeV dark matter)
- STUDY OTHER CANDIDATES WITH DIFFERENT PHENO
(LIKE 'SIMP', LIKE SELF-INTERACTIONS)

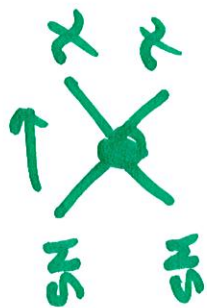
III A WORD ABOUT THERMAL HISTORIES

e.g. $\alpha = \alpha_{SM} + \alpha_{HS} \left(\chi \chi \begin{matrix} \text{SM} \\ \text{SM} \end{matrix} \right) + \begin{matrix} \text{SM} \\ \text{SM} \end{matrix} \chi \chi \begin{matrix} \text{SM} \\ \text{SM} \end{matrix} \right)$

Phase diagram ($m_A = 10 \text{ GeV}$, $m_\eta \ll m_A$)



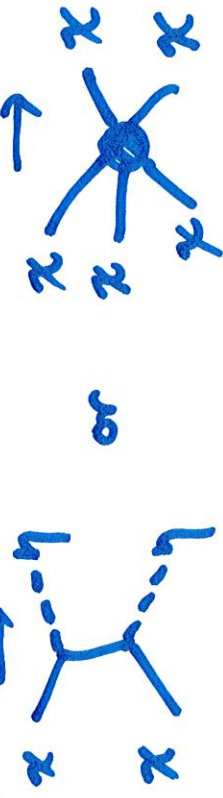
• FIMP-like



+ Good Self-I.

+ OK with everything

• SIMP-like (dark F.O.)



+ Good Self-Interactions

- Problematic Early Universe

• WIMP-like (Standard F.O.)



• Dark F.O. with T' < T

FIMP-production $\oplus$ SIMP-annihilation

+ Good Self-Interact.

+ Can be OK with Early Universe

+ Rich Pheno (LHC, DD, 2D)

- Not good Self-Interact.

IV DARK MATTER AND SELF INTERACTIONS

- ASTRO OBSERVATIONS ARE ABLE TO PREDICT AND CONSTRAIN SELF-INTERACTING CROSS SECTIONS

- COLLISION OF CLUSTERS

$$\sigma_m \lesssim O(1) \text{ cm}^2/\text{g}$$

(CLUSTER SCALE)

- DM HALOS MAY

HAVE SOME FRICTION

CONSISTENT WITH NON-GRAVITATIONAL INTERACTIONS

- SIMULATIONS IN TENSION WITH COLD DARK MATTER PARADIGM

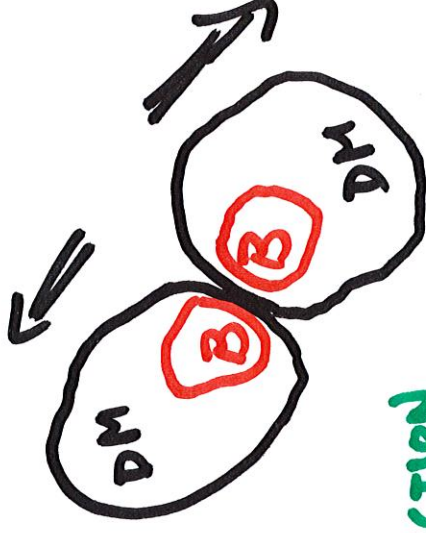
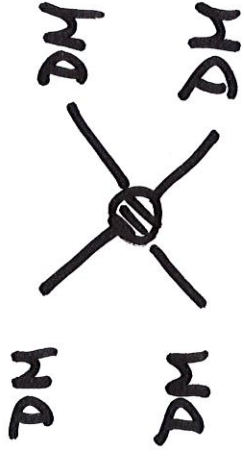
- CORE-VS-CUSP PROBLEM
- TOO-BIG-TO-FAIL "

(*) TYPICAL WIMP CROSS SECTIONS

10¹² times SMALLER !!

$$0.1 \lesssim \sigma/m \lesssim 10 \text{ cm}^2/\text{g}$$

(GALAXIES SCALE)



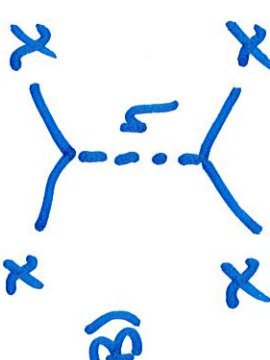
V

• ALTERNATIVES SO FAR:

A)  $\sigma \sim \alpha_X^2$ } ^{maximum possible} $\frac{\alpha_X^2}{m_X^2} \sim 100 \text{ MeV}$ (Volansky et al 2014)

- IMPLIES

DOMINANT F.O. CHANNEL 

B)  e.g. EW

$\sigma \sim \alpha_X^2 \frac{f(m_X, m_h, \alpha_X, v)}{m_X^2}$

wide range $f \gg 1$ for LONG-RANGE INTERACTIONS

- Non-perturbative enhancements
- SCHRÖDINGER EQUATION

$$m_h \ll \alpha_X \cdot m_X$$

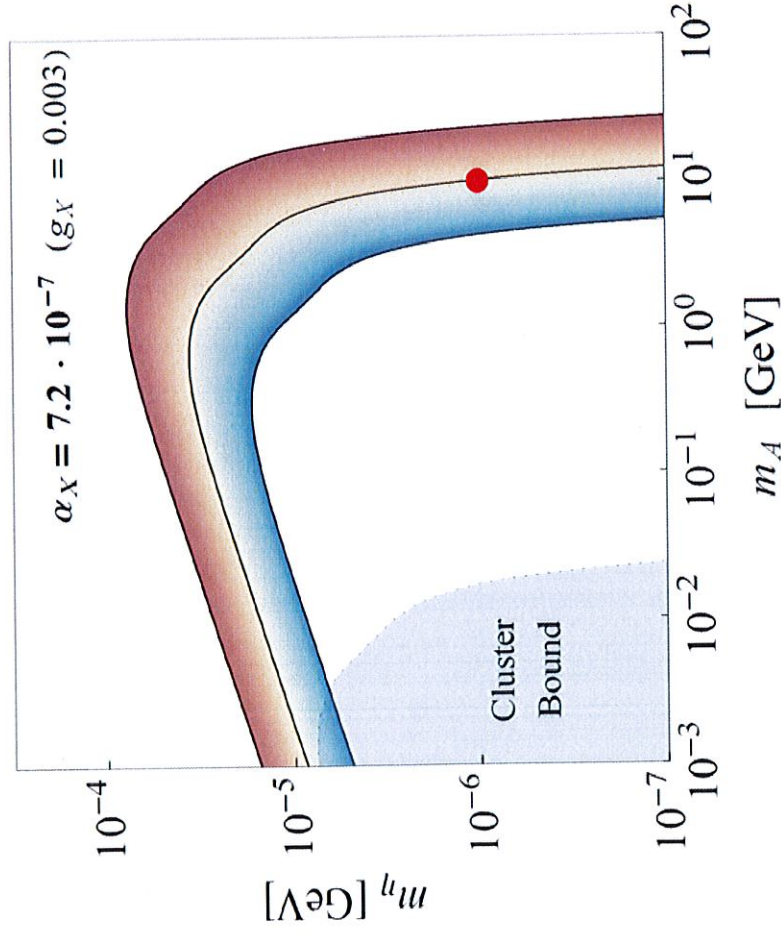
• PROBLEMS

A) DM SECTOR REHEATS ITSELF (STRUCTURE FORMATION),
COUPLING SOMETIMES TOO LARGE

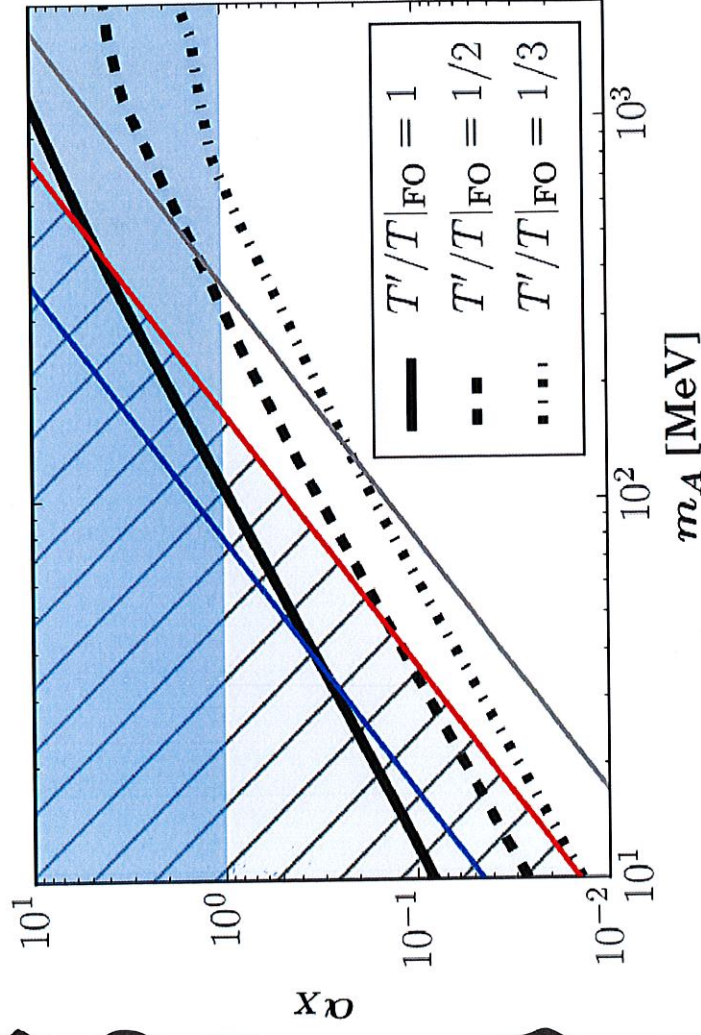
B) DIRECT DETECTION AND OTHER EARLY UNIVERSE CONST. (LIGHT MEDIATOR)

VI

RESULTS (arXiv: 1510.08063)



- Light Mediator
- Freeze-In Regime
- Compatible with
 - Self-Int.
 - Direct Detection
 - Early Univ.



- No light Mediator
- $T' < T$ compatible with
 - Self Interact.
 - Perturbativity
 - Structure formation
- No probs with Early Univ. nor with Direct Detection

CONCLUSIONS

- THERE ARE MANY OTHER THINGS THAT INTEREST ME!!
(LHC KINEMATICAL VARIABLES,
WARM DARK MATTER, NEUTRINOS, REHEATING EPOCH
SUPERSYMMETRY, COSMIC RAYS AND DM)
- I LIKE TO DISCUSS WITH EVERYONE
IF I CAN BE USEFUL, EVEN BETTER
- I'M QUITE HAPPY TO BE @ LAPTh !!

Thanks