# How Asymmetric Dark Matter May Alter the Conditions for Stardom

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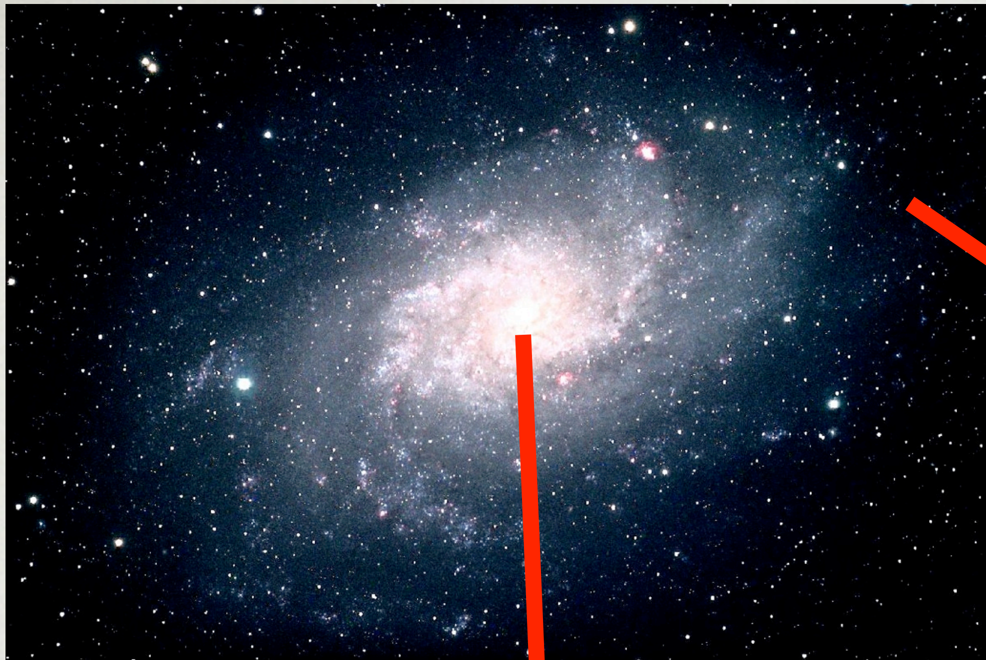
PRD 80, 063501 [arXiv:0907.3448]
PRD 84, 101302 [arXiv:1110.5919]

# Outline

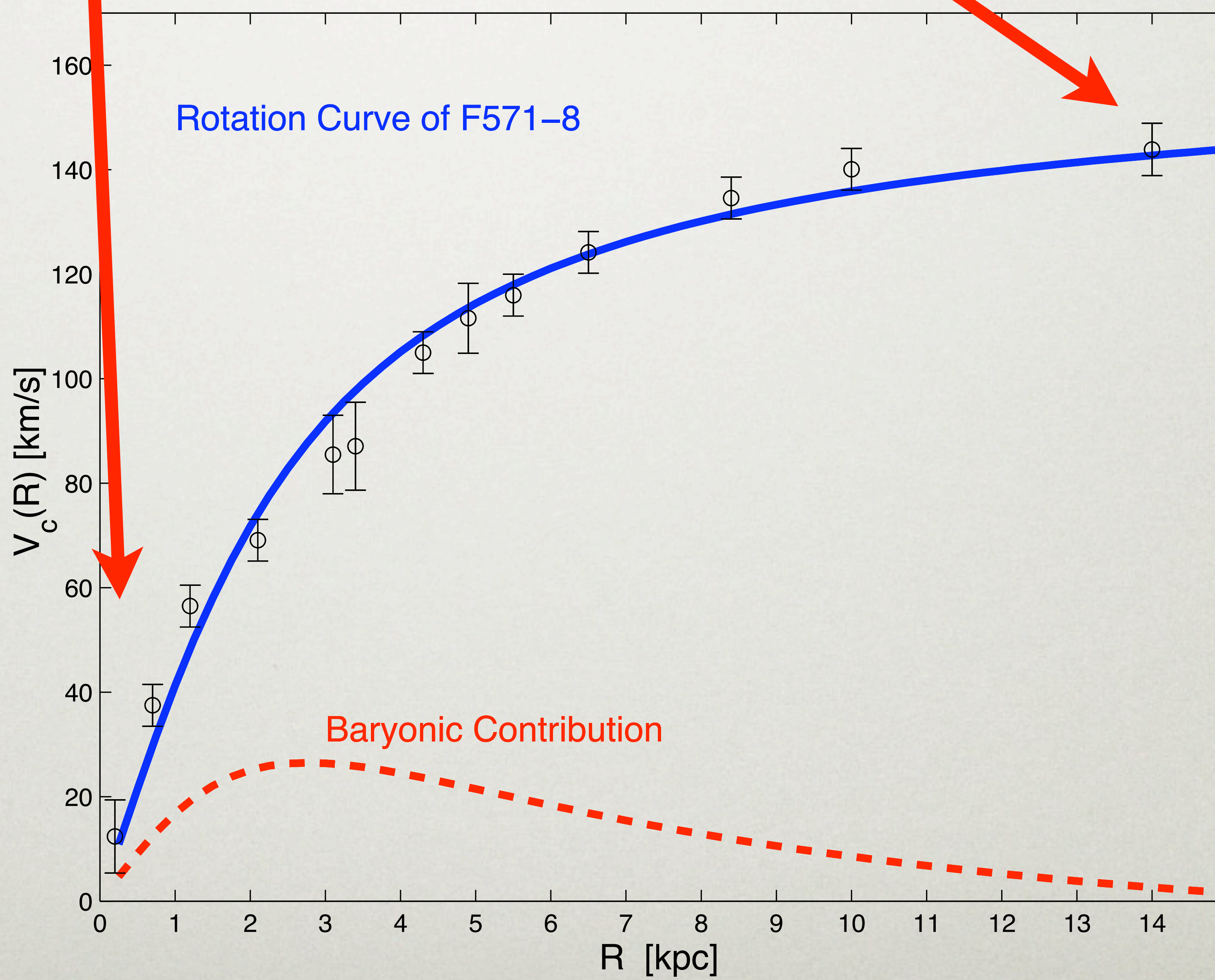
1. Dark Matter Status Report
2. Dark Matter in Stars
3. Low-Mass Stars as Possibly Interesting Dark Matter Laboratories
4. Example results for the influence of "Asymmetric" Dark Matter on Very Low-Mass stars and Brown Dwarfs

# DARK MATTER



**Velocities: Observed vs. Expected from Light**

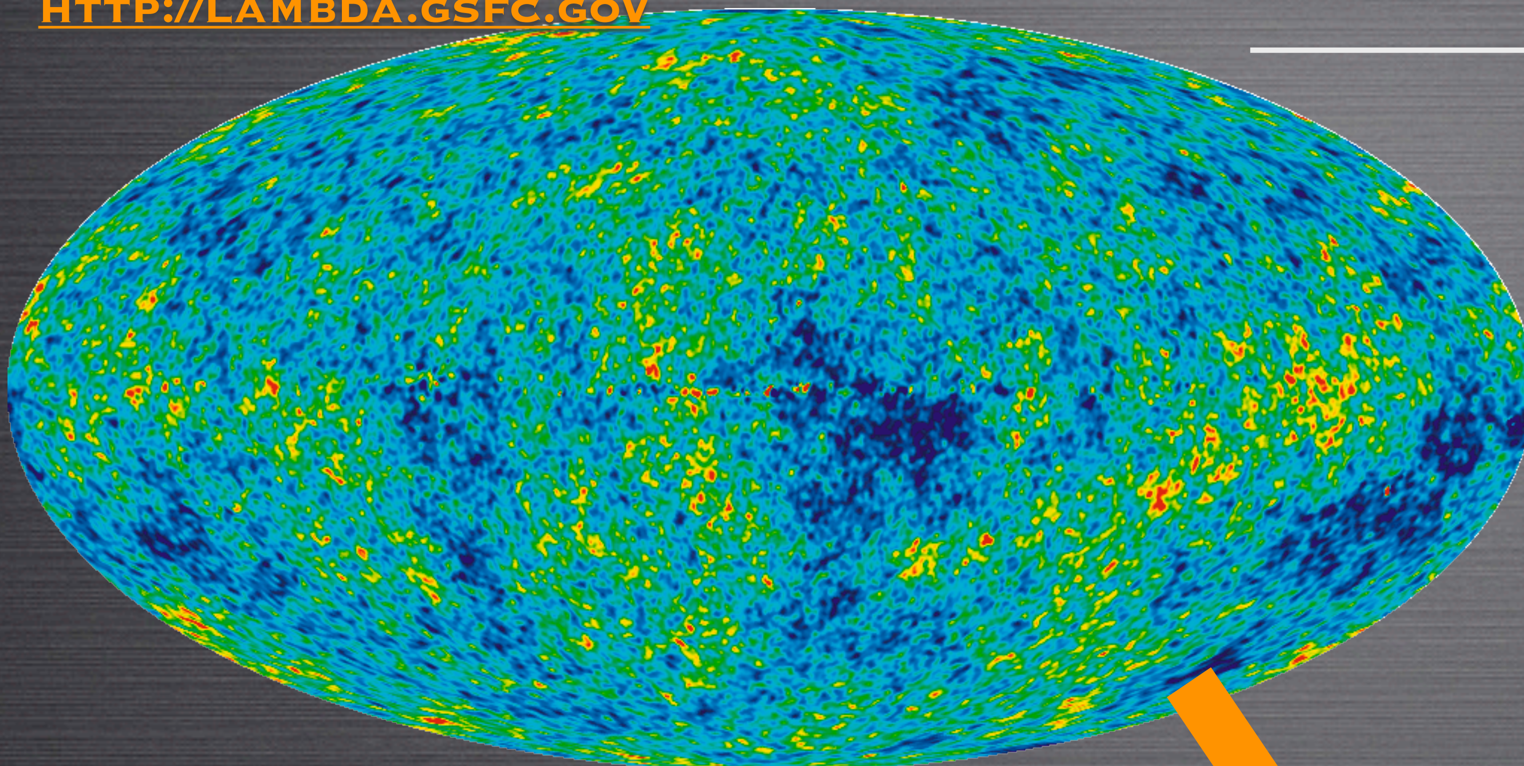
**Rotational Velocity**




**Distance from Galactic Center**

# Dark Matter

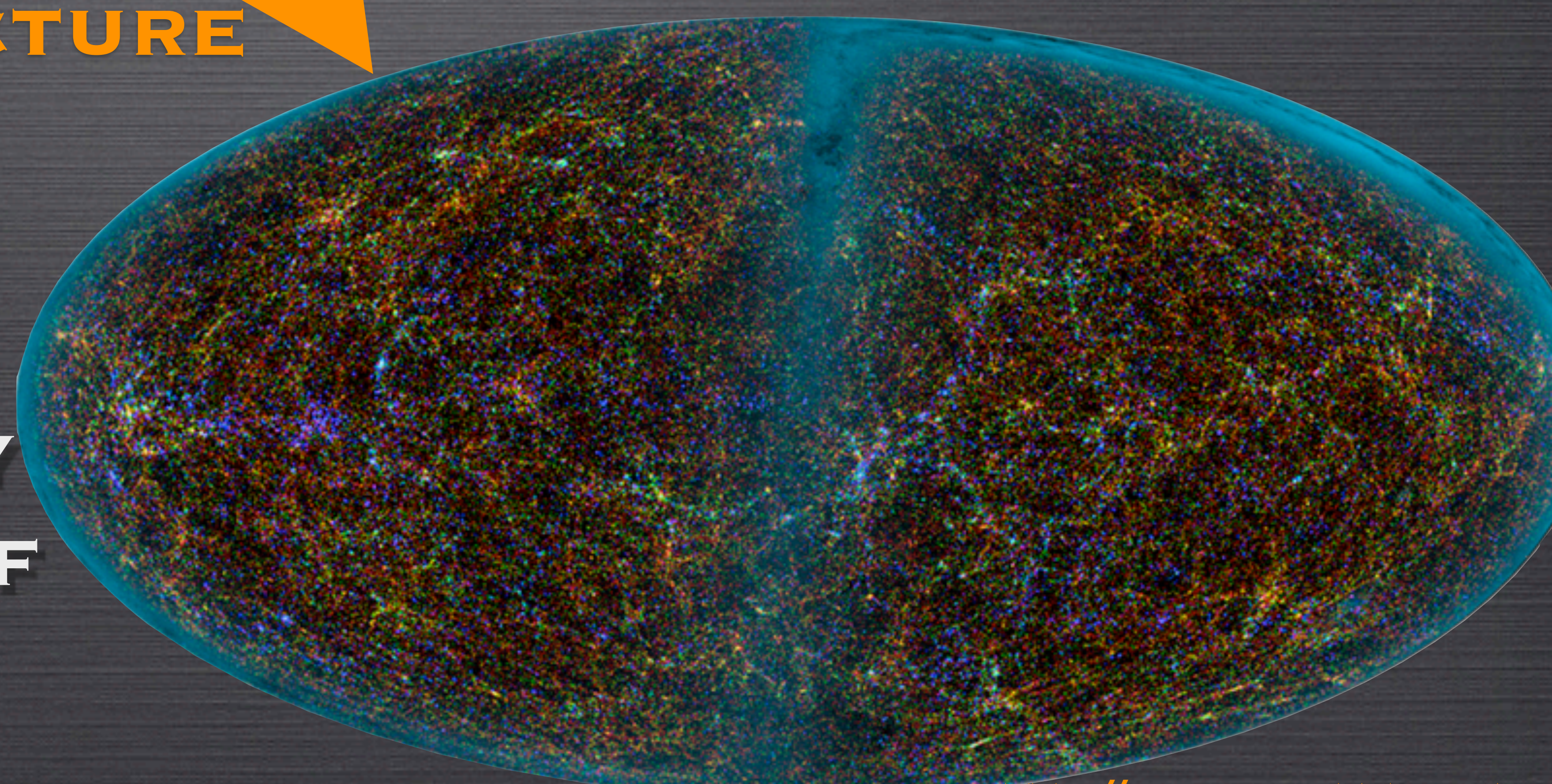
http://lambda.gsfc.gov



Microwave Background Image of the Universe 13 Billion Years Ago

Necessary to Grow Structure

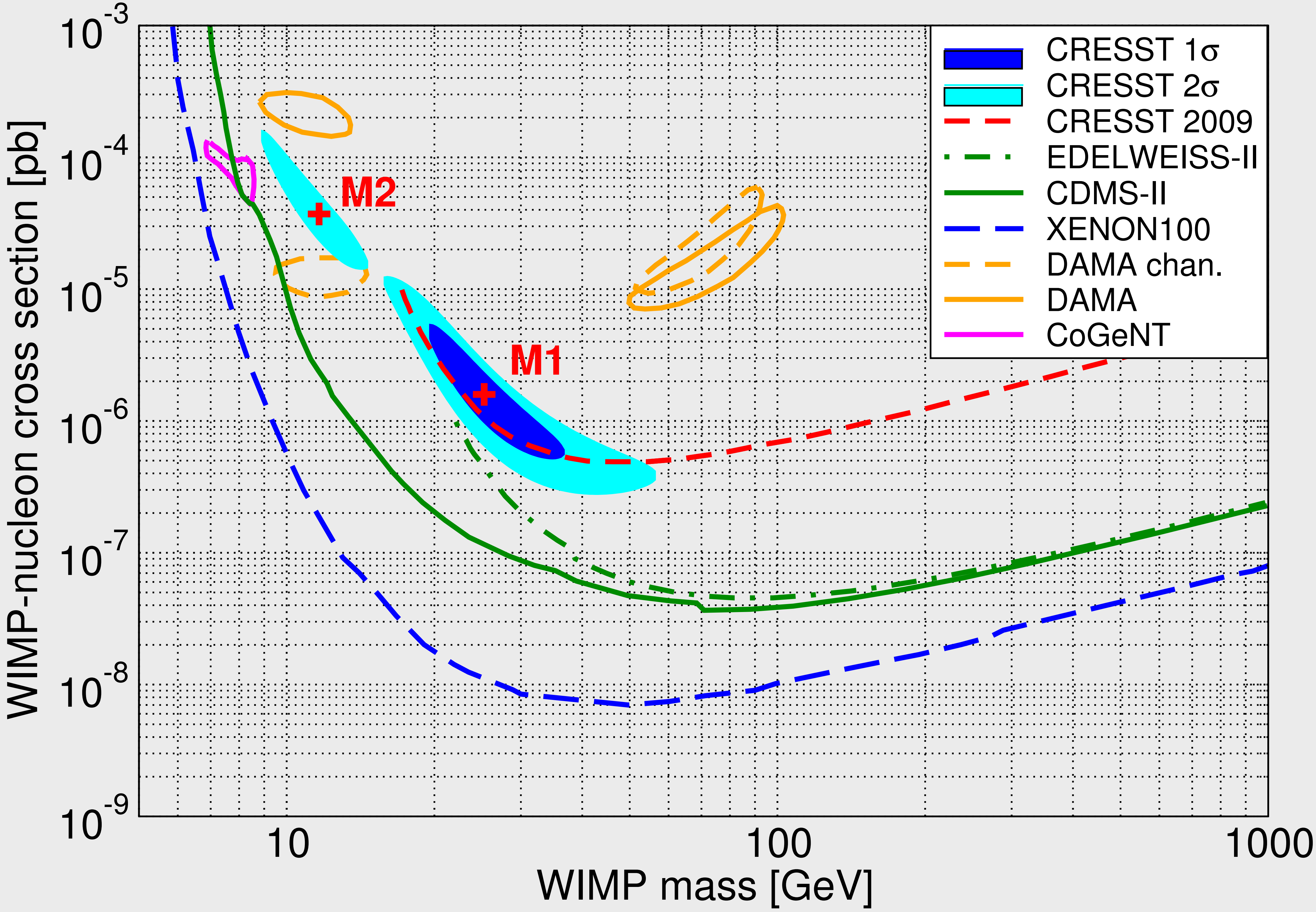
Contemporary Distribution of Galaxies



http://ipac.caltech.edu

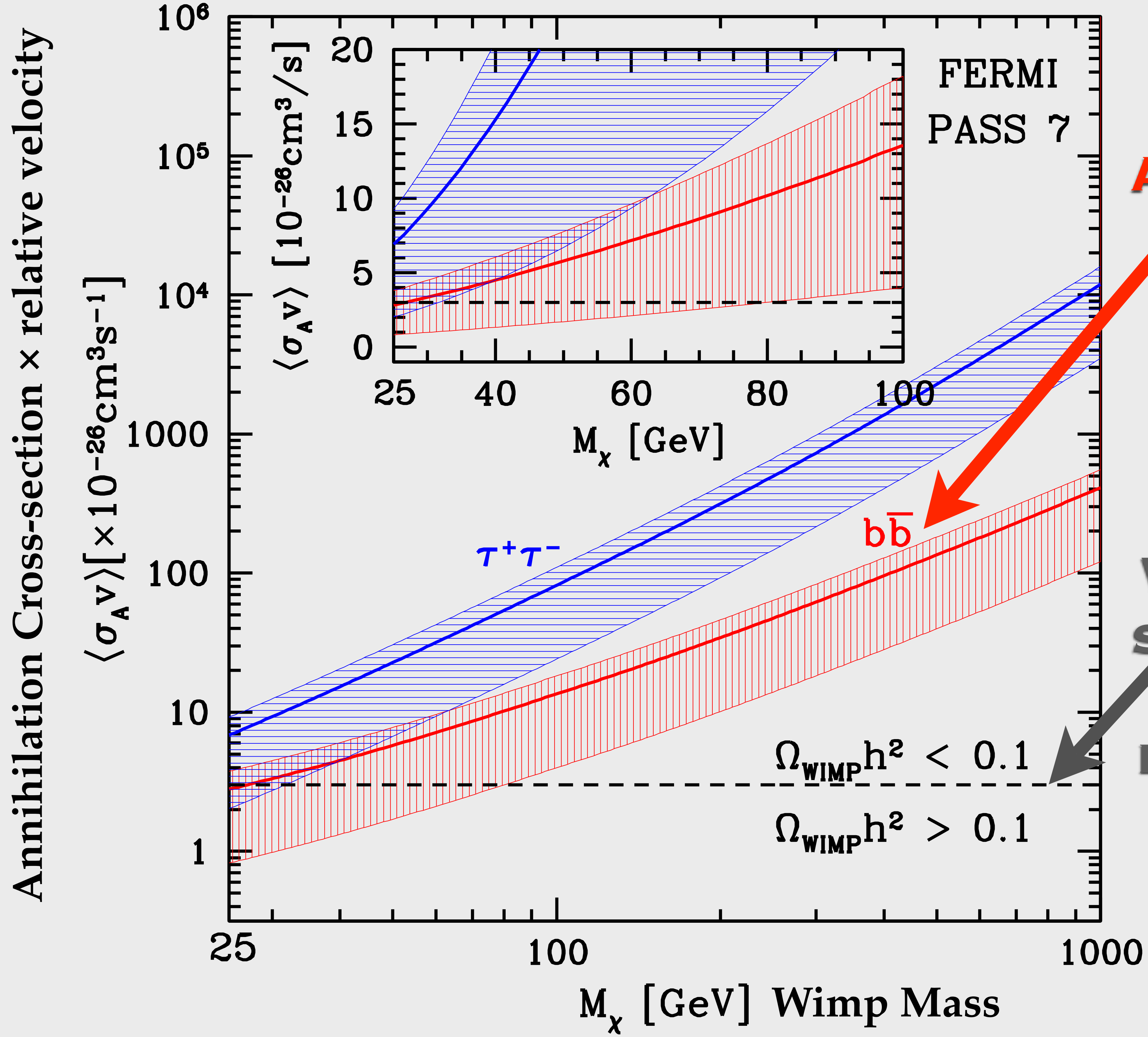
# Dark Matter: Status Report

# Direct Detection




CRESST Collaboration arXiv:1109.0702

# Indirect Detection



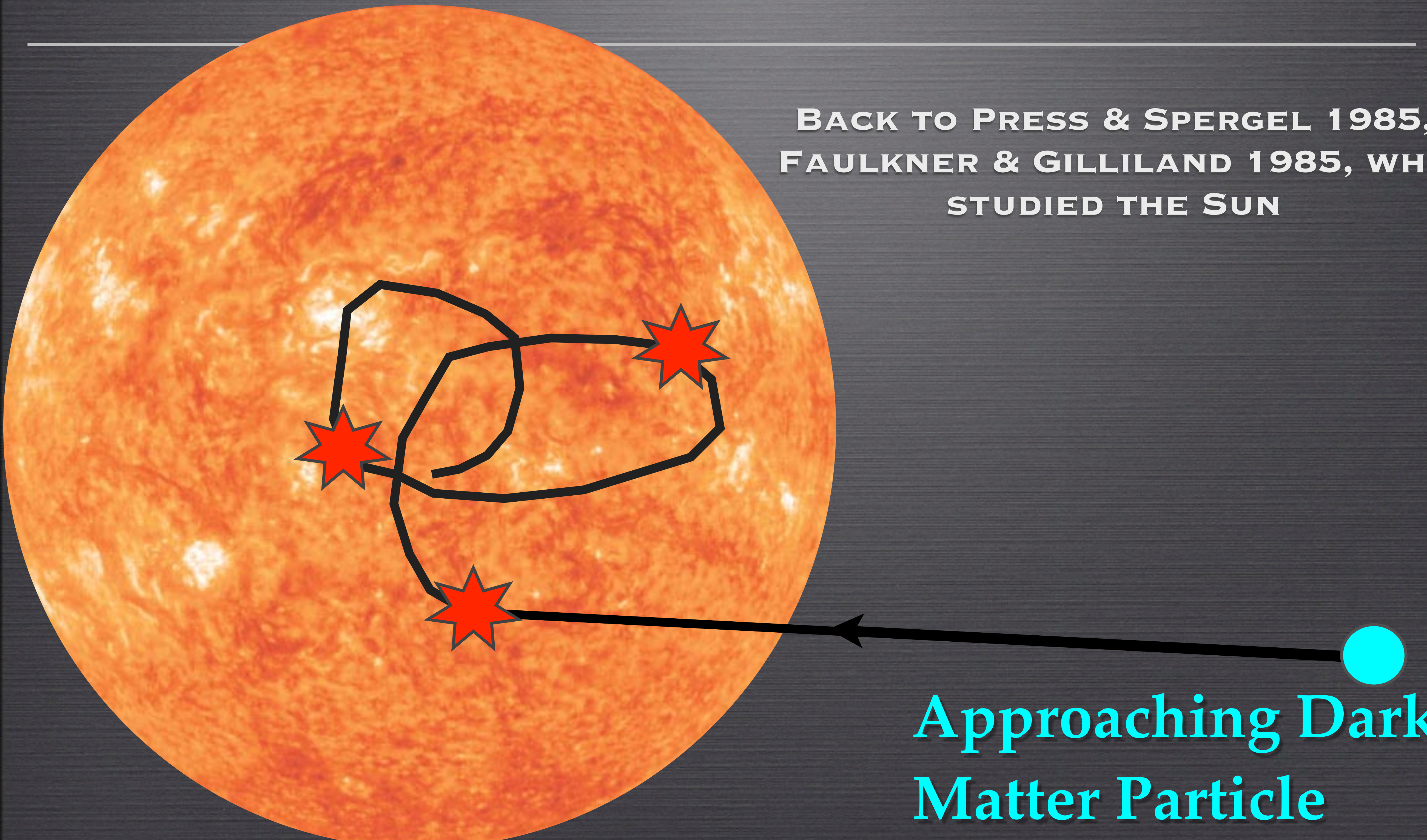

Annihilation Product

Canonical WIMP cross-section that gets relic dark matter abundance correct

Geringer-Sameth & Koushiappas [arXiv:1108.2914] and Fermi collab. [arXiv:1108.3546]

# Signatures of Light Dark Matter in Stars

Back to Press & Spergel 1985, Faulkner & Gilliland 1985, who studied the Sun



# Two Equations

- **Standard wimp capture rates of dark matter in stars:**

$$C_{\rm DM} \propto \rho_{\rm DM}\, \sigma_{\rm DM-N}\, \frac{v_{\rm esc}^2}{v_\infty}\, M_\star \sim \; 10^{22}\,{\rm s}^{-1}$$

- **Stellar Luminosity Scaling with Mass:**

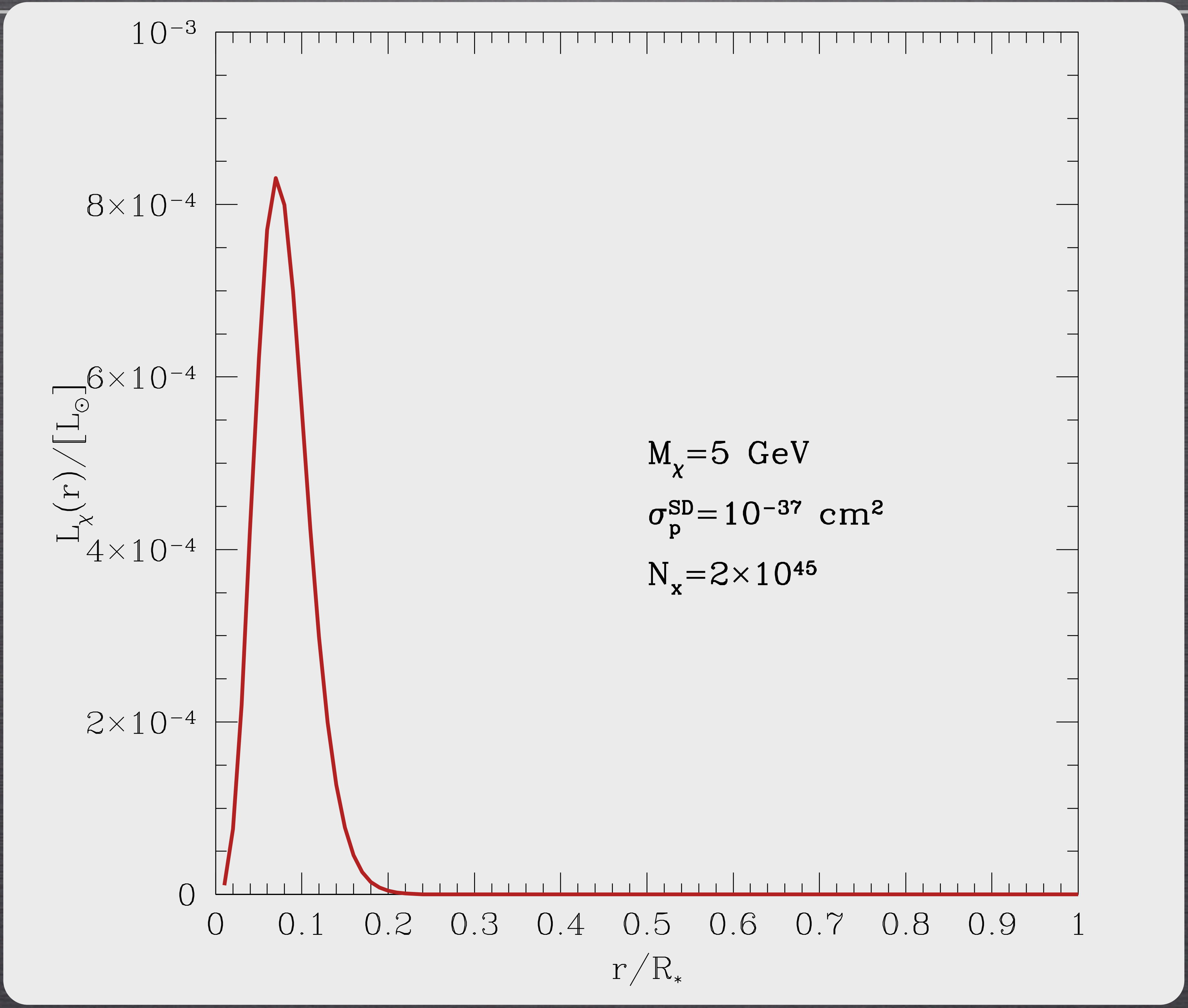
$$L \propto M^{3.5}$$

# Low-Mass Stars as DM Labs

1. For stars, $M \propto R$: low-mass stars capture as much DM per unit mass as the Sun!
2. $L \propto M^{3.5}$ : Less energy needs to be moved around to dramatically alter the stellar structure
3. Low-mass ($\lesssim 0.1\ M_{\odot}$) are just hot enough to fuse hydrogen and fusion rates are VERY sensitive to core temperature.
4. Astronomical observatories are just becoming capable of taking a census of low-mass stars!

# In the Sun

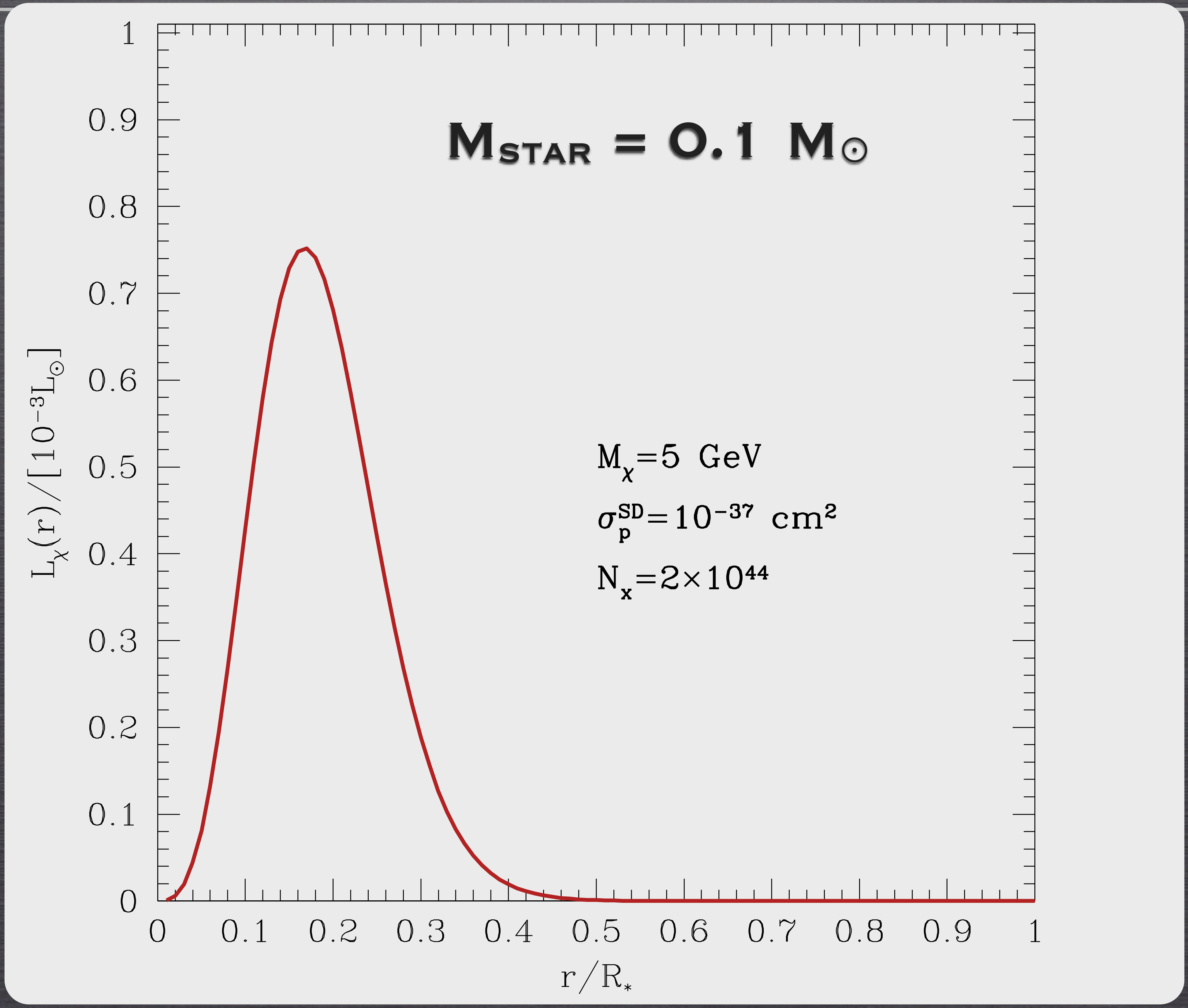
Luminosity Transported by Dark Matter through surface at R




Radial Position, in units of stellar radius

# In Low-Mass Star

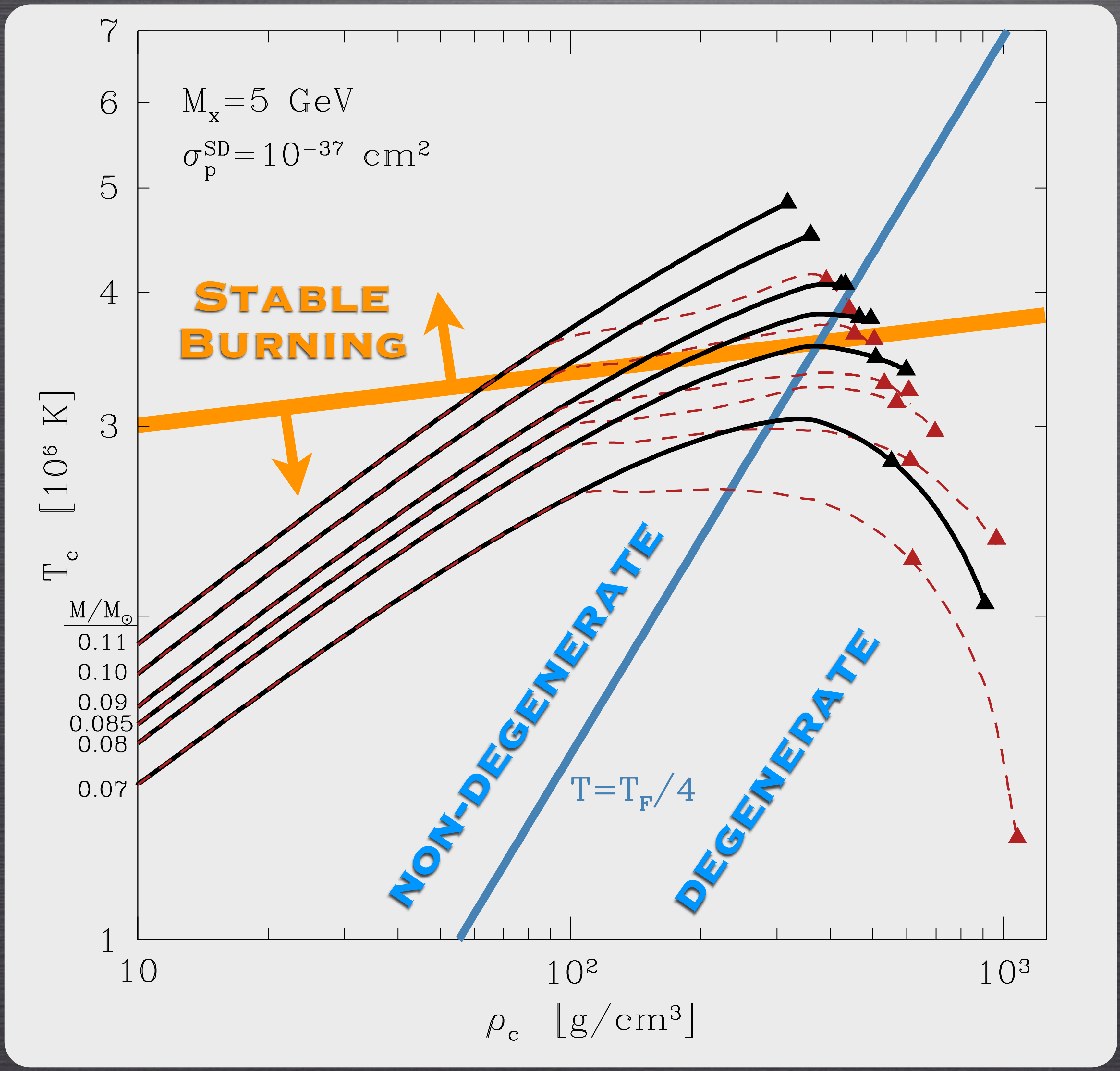
Luminosity Transported by Dark Matter through surface at R




Radial Position, in units of stellar radius

# Core Temperature

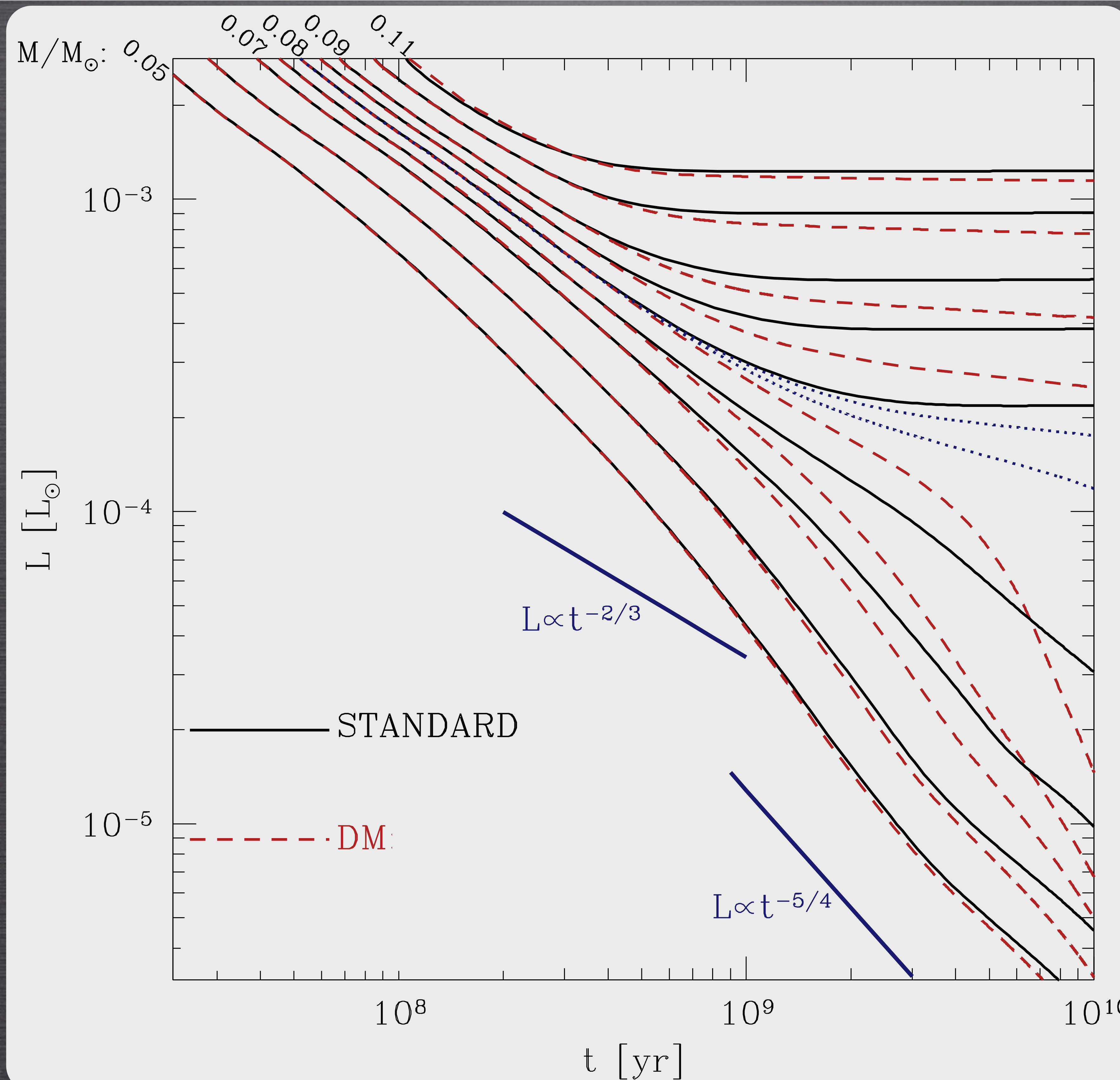
Core Temperature [10⁶K]




Core Density [cgs]

Similar Results for $M_X \sim 7$ GeV, $\sigma^{SI} \sim 10^{-40}$ cm²

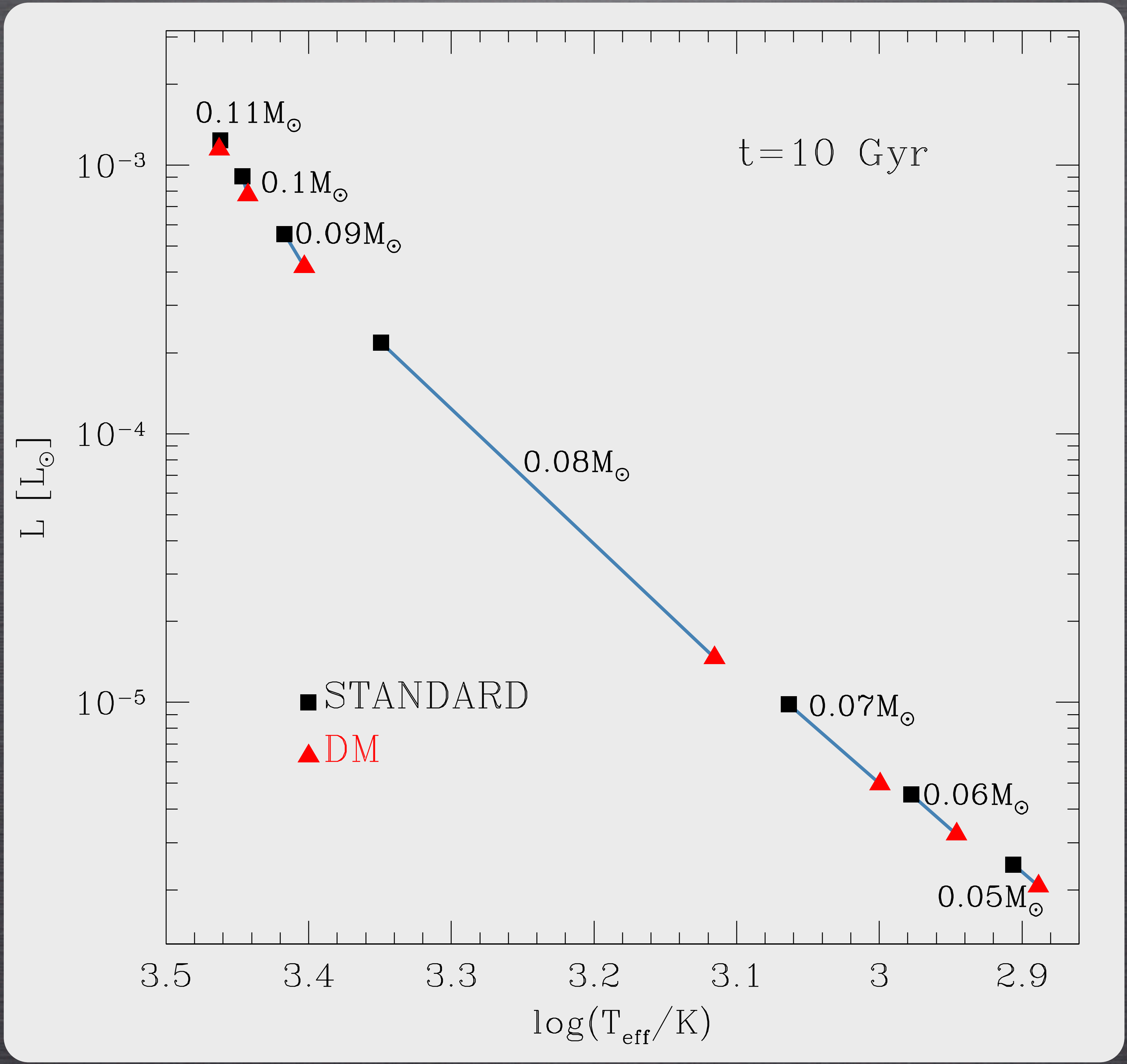
# Evolution




Luminosity [Solar Luminosities]

Time [Years]

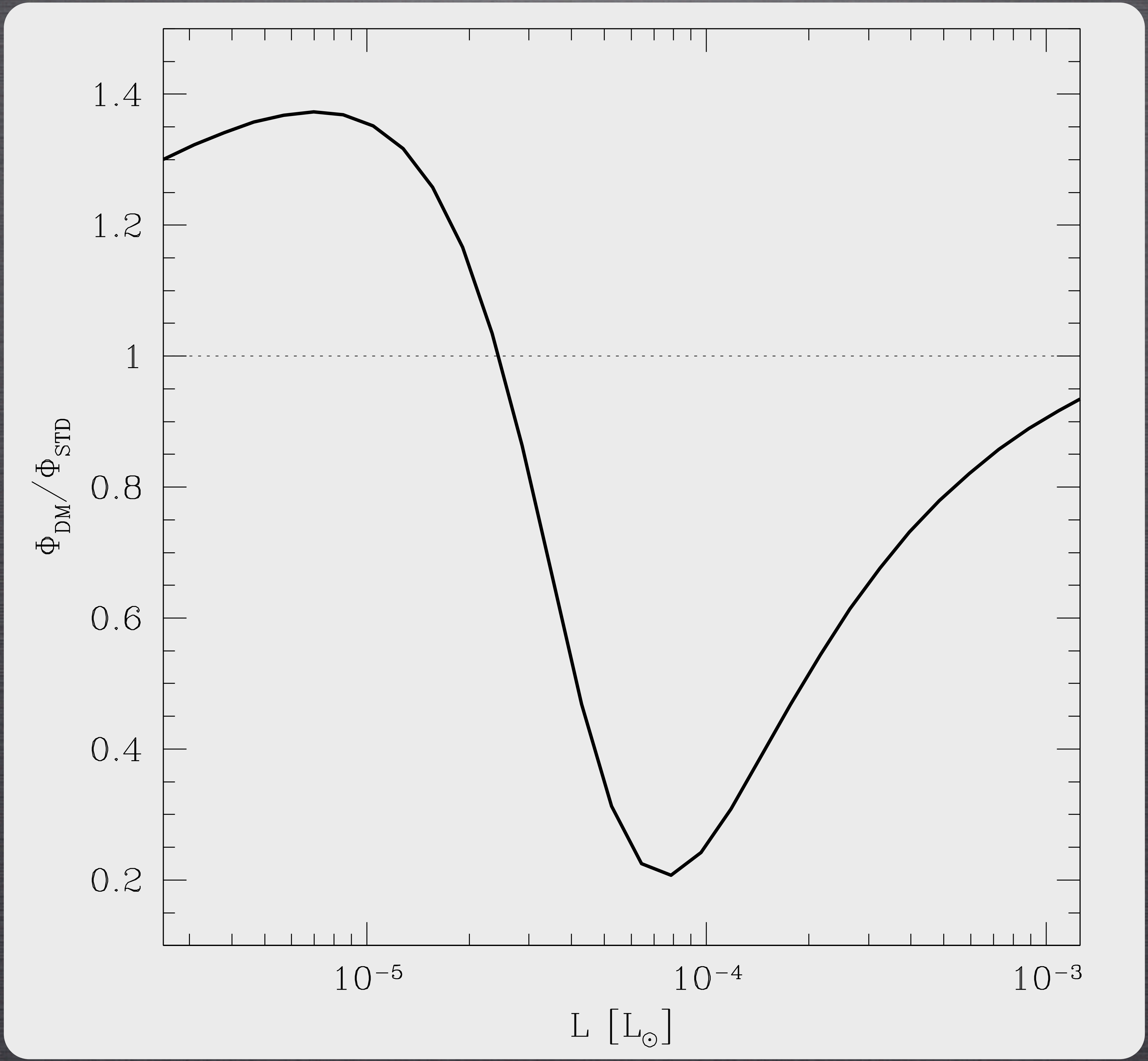
# Evolution




Luminosity [Solar Luminosities]

Surface Temperature [K]

# Abundances




Number of stars relative to standard model

Luminosity [Solar Luminosities]

# Summary

- Viable models of Asymmetric Dark Matter may cool the cores of low-mass stars such that they **do not become stars at all**

- Brown dwarfs will cool significantly **more quickly** in such models

- Forthcoming astronomical censuses of very low-mass stars (LSST, PannSTARRS, TMT, GMT, JWST, ...) may aid **indirect DM identification** efforts, **stellar evolution may be altered by DM** (and perhaps other applications...)