LSA LEINWEBER CENTER FOR THEORETICAL PHYSICS UNIVERSITY OF MICHIGAN

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1811.XXXXX

Boosting the Annihilation Rate with Ultracompact Minihalos

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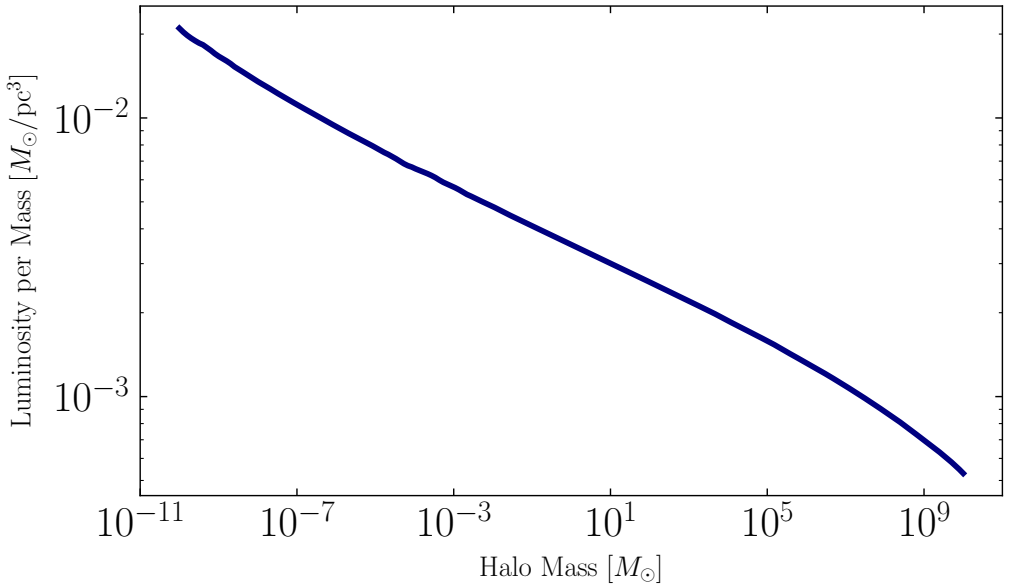
WIMPs and Indirect Detection

$$\frac{d\Phi}{dE_\gamma} = J \times \frac{\langle \sigma v \rangle}{m_\chi^2} \sum_i \frac{1}{8\pi} \mathrm{Br}_i \frac{dN_i}{dE'_\gamma}\bigg|_{E'_\gamma = (1+z)E_\gamma}$$

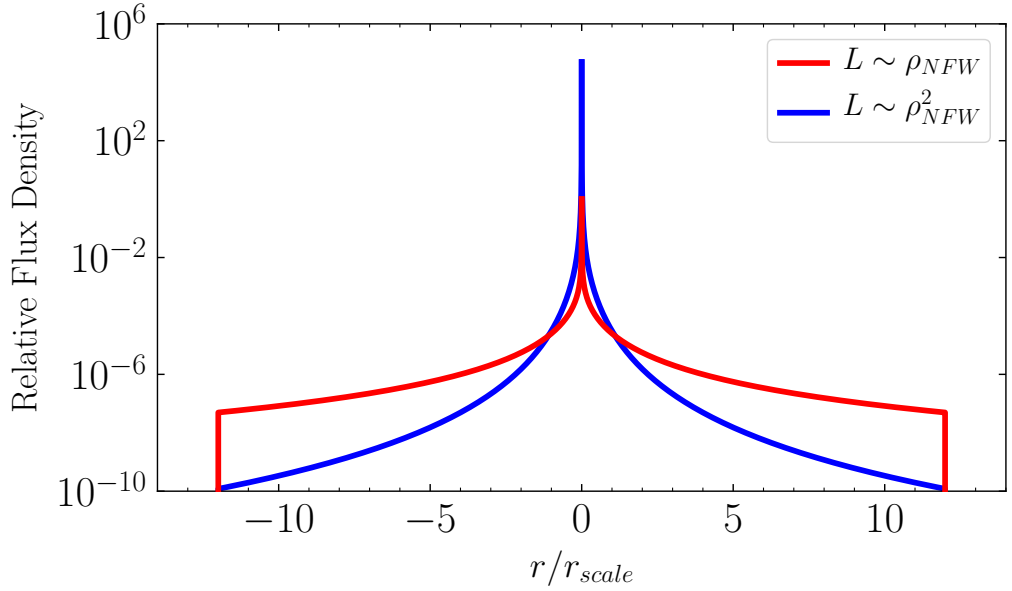
- Gamma flux from annihilation depends on:
  - Astrophysical DM distribution
  - Dark Matter parameters
  - Annihilation products

The Impact of Substructure

$$J = \int ds d\Omega \left[\rho^2_{\rm host}(s,\Omega) + \sum_i \rho^2_{\rm sub,i}(s,\Omega) \right]$$



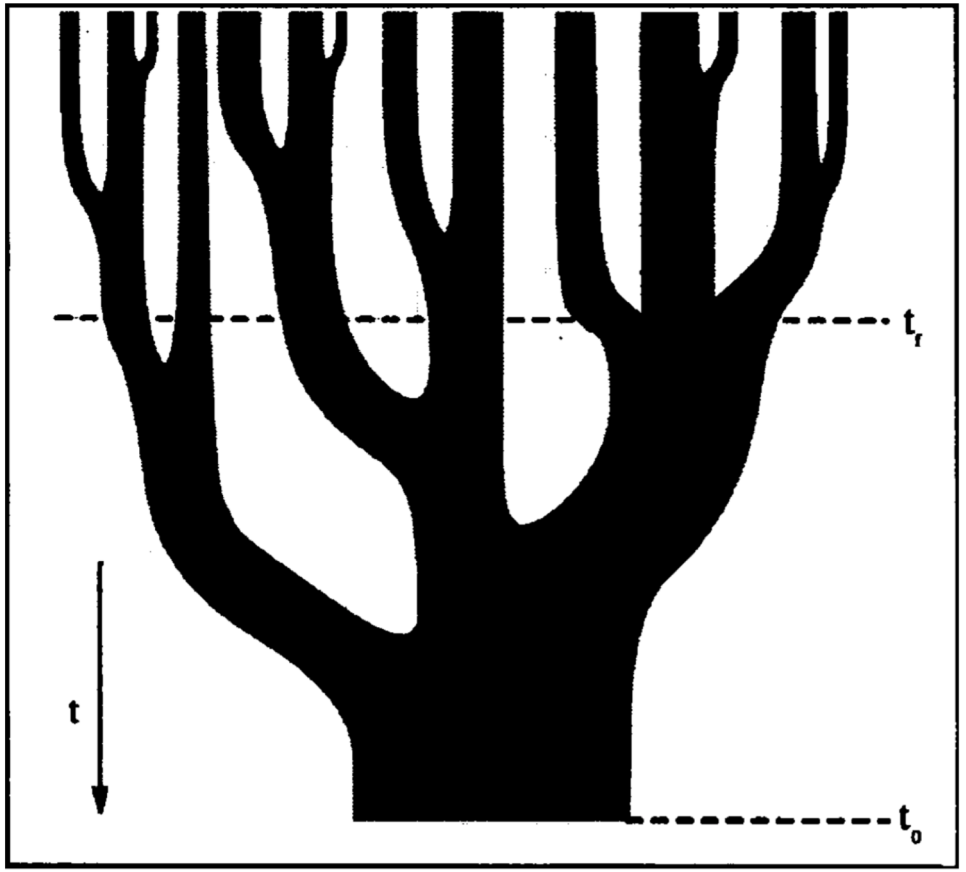
Changes in absolute magnitude of flux



Changes in spatial morphology of flux

The Origin of (Sub)Structure

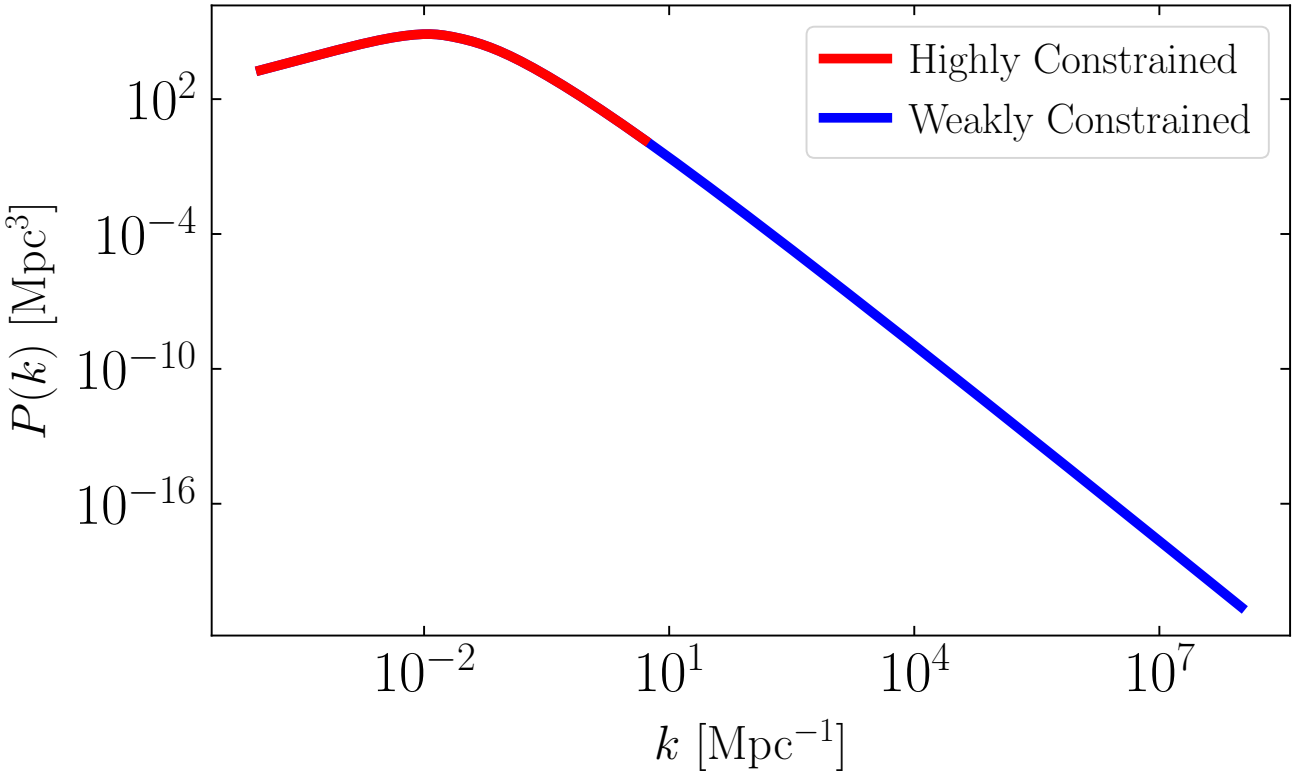
1. Primordial scalar perturbation spectrum
2. Linear growth of initial perturbations
3. Nonlinearity, gravitational collapse
4. Hierarchical formation



Lacey and Cole (1993)

Substructure: Halo Mass Function

- Press-Schechter Ansatz
  - Relates distribution of density perturbations on a scale to fraction of matter collapsed on at least that scale
- Strength of scalar power spectrum constraints are scale dependent
- Translation between power spectrum and perturbation distribution only straightforward for gaussian fields



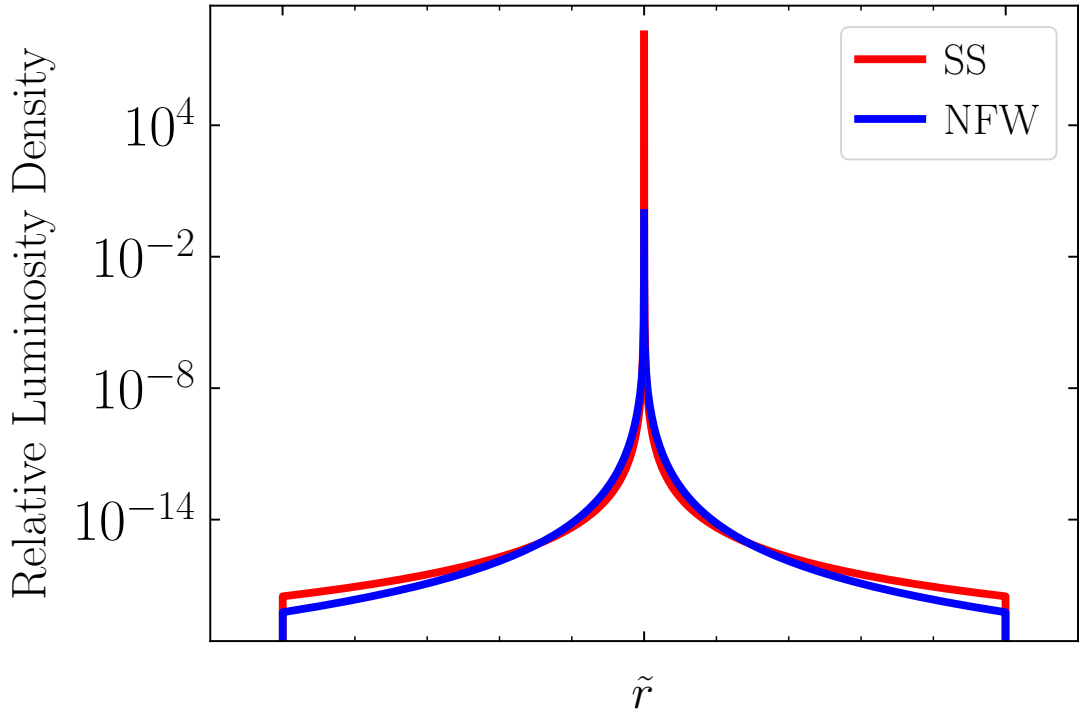
Substructure: Halo Profile

- Self-Similar Profile:

$$\rho(r) \sim r^{-9/4}$$

- NFW Profile:

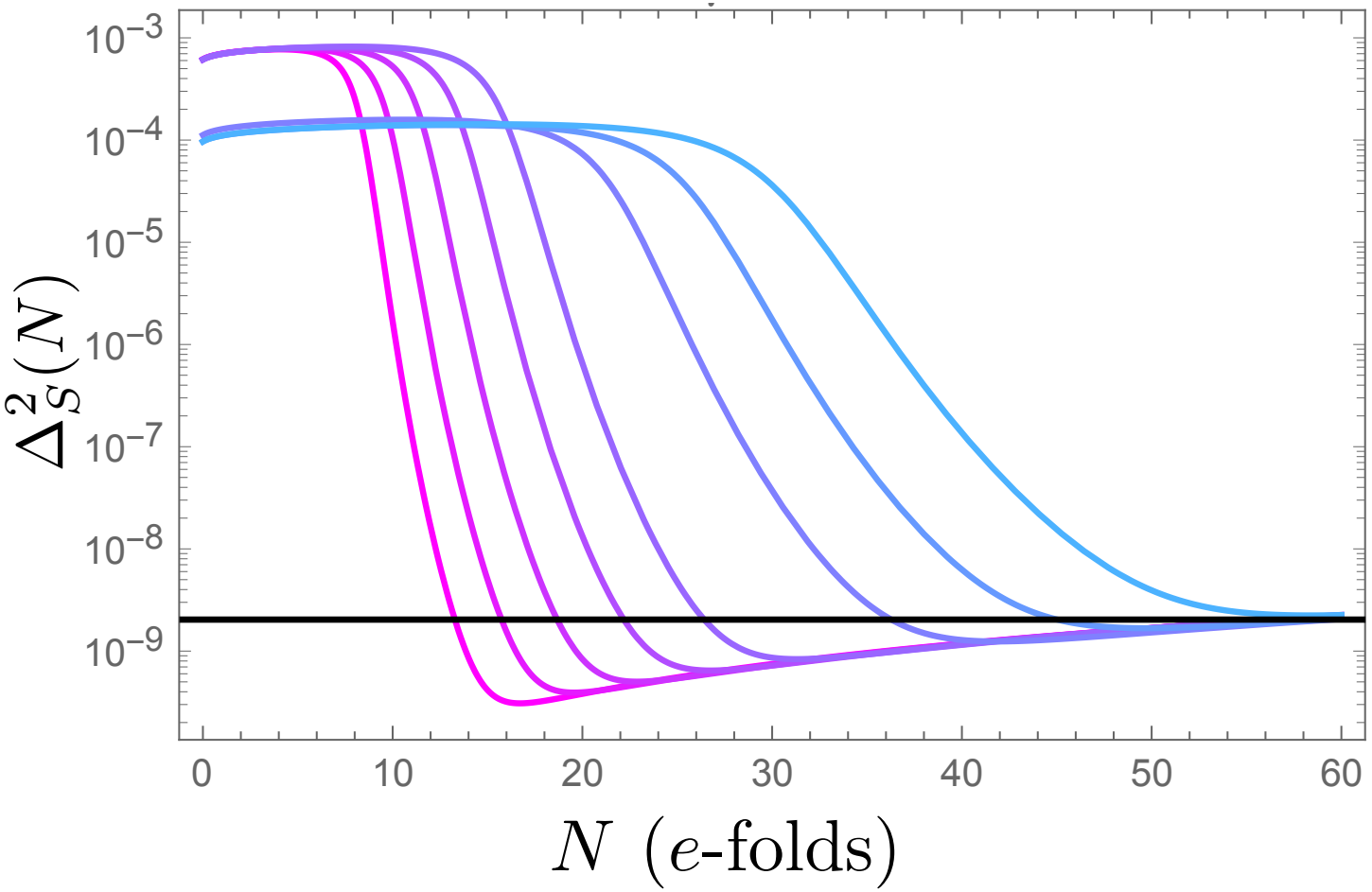
$$\rho(r) \sim \frac{1}{\left(\frac{r}{r_s}\right)\left(1+\frac{r}{rs}\right)^2}$$



An Example: Axion Inflation

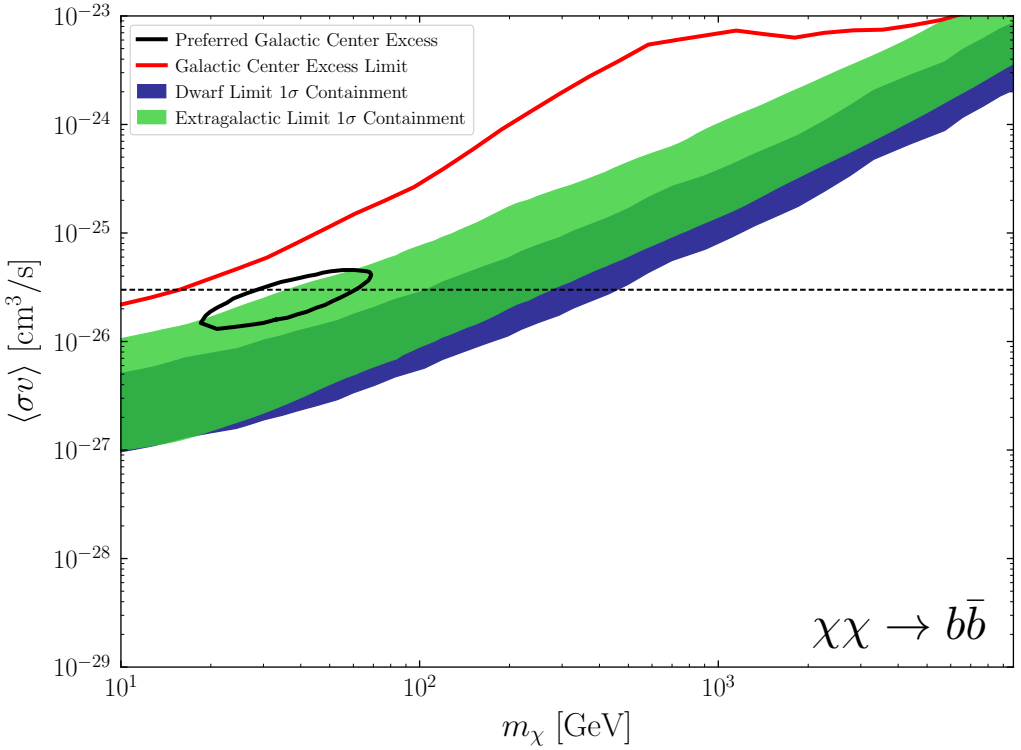
- Inflaton is an axion
  - gauge fields backreact
  - enhanced scalar power spectrum
  - nongaussianities
- Perturbation distribution:

$$P(\delta_R) = \frac{\exp\left(-\frac{\delta_R+\sigma_R^2}{2\sigma_R^2}\right)}{\sqrt{(2\pi\sigma_R^2(\delta_R+\sigma_R^2)}}$$

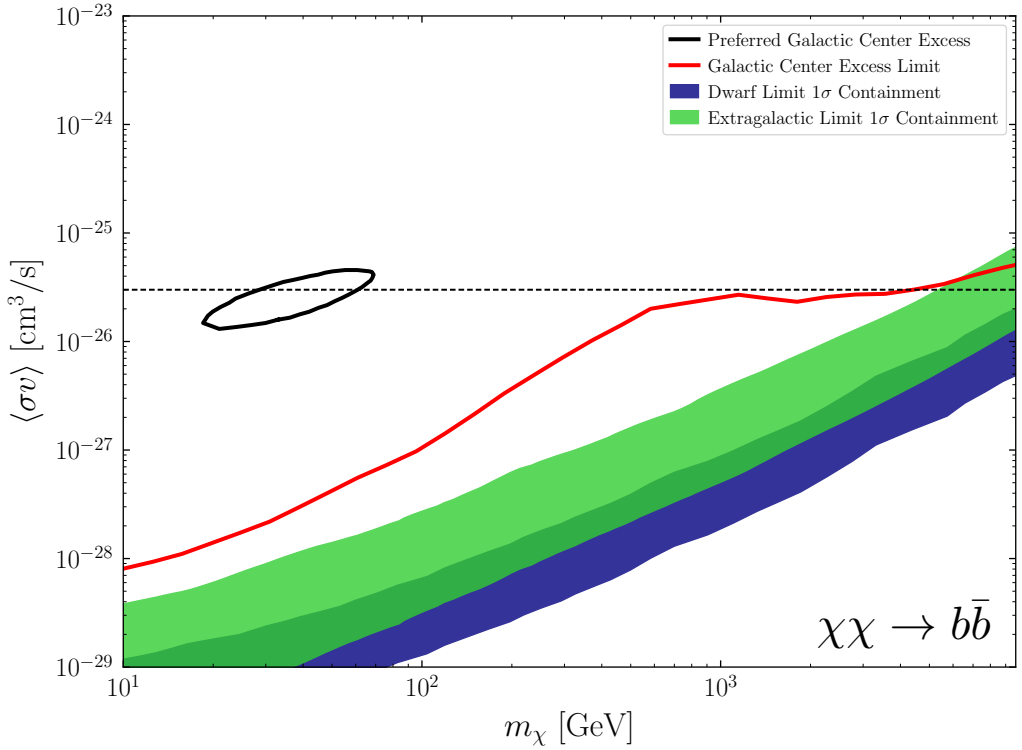


Joint Inflation-WIMP Constraints

Minimum Sensitivity



Maximum Sensitivity



Concluding Remarks

- Emphasis on methodology
- New scenarios + strategies for DM indirect detection
- (Semi-)Analytic techniques need N-body verification