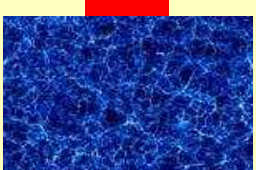


# Light dark matter and galaxy formation



**LDM**

**Predictions**

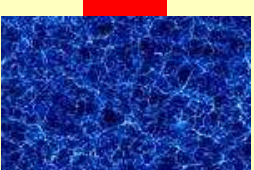
**The 511 keV line**

**Gamma rays**

**A cosmic heater?**

**Conclusions**

# Light dark matter and galaxy formation



## LDM

## Predictions

## The 511 keV line

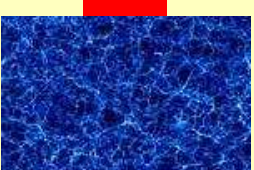
## Gamma rays

## A cosmic heater?

## Conclusions

- What is Light Dark Matter?
  - Tiny spheres of mass  $m_{dm} \sim \text{MeV}$
  - Who's afraid of particle physics?
    - Decay:  $\epsilon \propto n_{dm} \Gamma_{decay} \propto \rho_{dm}$
    - Annihilation:  $\epsilon \propto n_{dm}^2 \sigma_{ann} \propto \rho_{dm}^2$
  - 4 parameters + density profile
- Our goal
  - Look at the bright side of dark matter ...
  - ... and try to falsify the LDM scenario!

# Light dark matter and galaxy formation



## LDM

### Predictions

### The 511 keV line

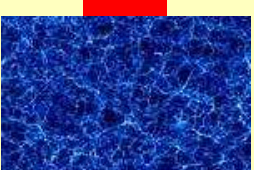
### Gamma rays

### A cosmic heater?

### Conclusions

- **Particle scales**
  - *NuTeV anomaly*
  - *Fine structure constant*
- **Cosmic scales**
  - *CMB anisotropies*
  - *Thermal history of the Universe*
  - *Gamma-ray background*
- **Galactic scales**
  - *511 keV line*
  - *Gamma rays*
  - *A cosmic heater?*

# Light dark matter and galaxy formation



## LDM

## Predictions

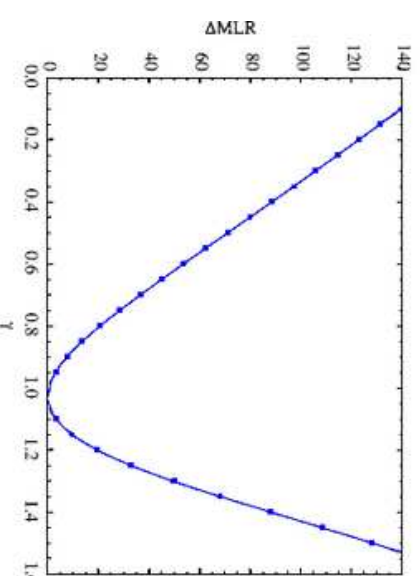
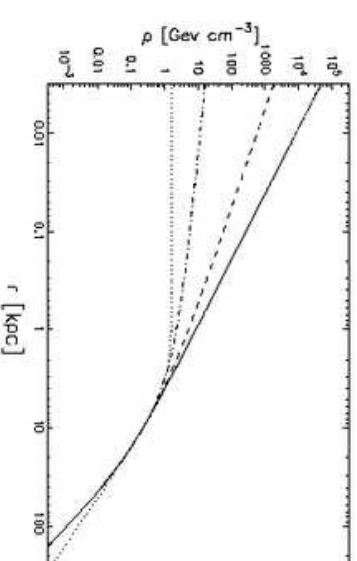
## The 511 keV line

## Gamma rays

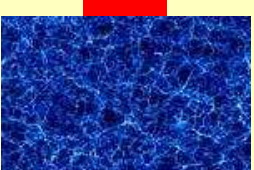
## A cosmic heater?

## Conclusions

- Why dark matter?
  - Intensity *and* morphology
- Free parameters
  - Dark matter mass
  - Decay or annihilation rate
  - Milky Way density profile
- A picture of the dark matter halo
  - Inner slope  $1.03 \pm 0.04$
- Constraints on the dark matter zoo
  - Annihilating, not decaying
  - $a = 10^{-30} m_{\text{MeV}}^2 \text{ cm}^3 \text{ s}^{-1} \Rightarrow F$
  - $m_{\text{dm}} < 100 \text{ MeV} \Rightarrow Z'$
  - $m_{\text{dm}} > 100 \text{ MeV} \Rightarrow \text{secondary } e^+$



# Light dark matter and galaxy formation



## LDM

### Predictions

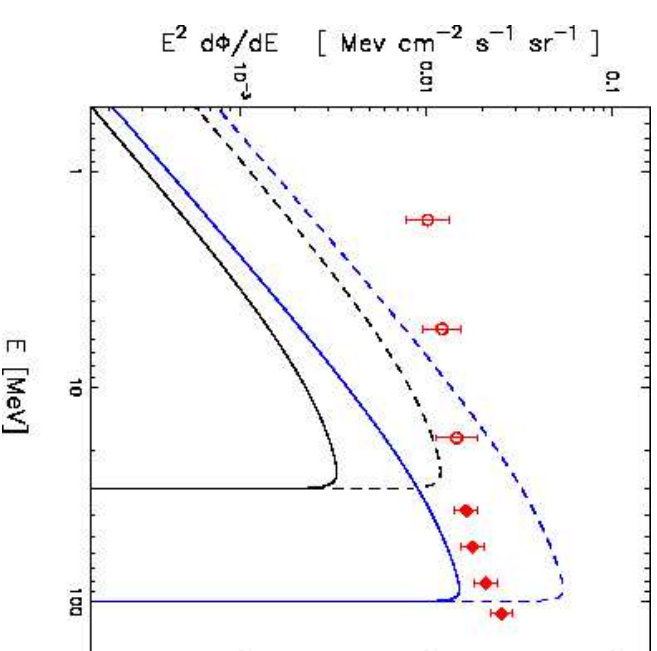
### The 511 keV line

### Gamma rays

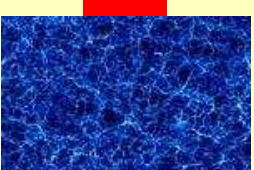
### A cosmic heater?

### Conclusions

- **Emission mechanisms**
  - *Direct annihilation*
  - *Final state radiation*
  - *In-flight annihilation*
  - *Any suggestion?*
- **Uncertainties**
  - *Theory*
  - *Observations*
- **Result**
  - $m_{\text{dm}} < 20 - 50 \text{ MeV}$



# Light dark matter and galaxy formation



## LDM

## Predictions

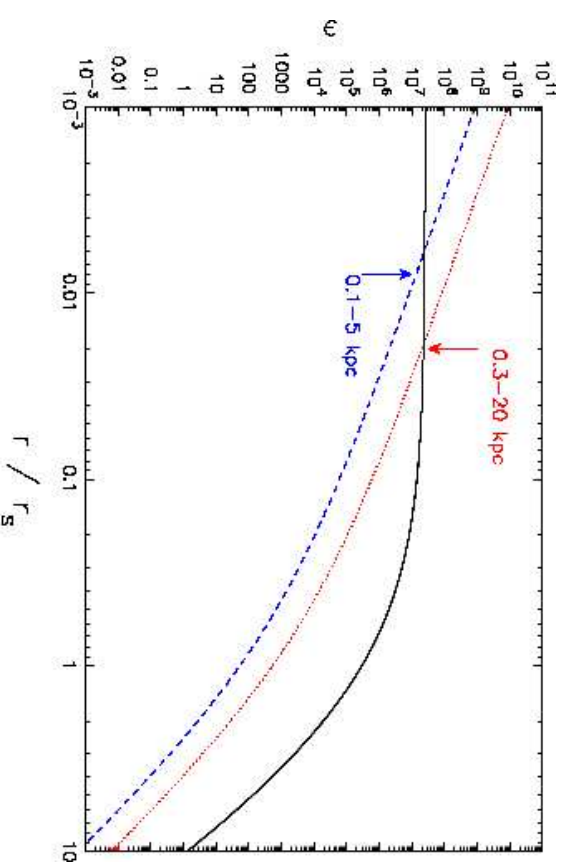
## The 511 keV line

## Gamma rays

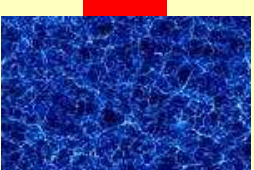
## A cosmic heater?

## Conclusions

- $E = m_{\text{dm}} c^2$ 
  - *Heating vs cooling*
- **Consequences**
  - *Reionization*
  - *Star formation*
    - Missing satellites
    - Red-blue sequence
    - Downsizing
  - *Galaxy clusters*



# Light dark matter and galaxy formation



## LDM

### Predictions

### The 511 keV line

### Gamma rays

### A cosmic heater?

### Conclusions

- **Summary**
  - *LDM predictions*
    - NuTeV anomaly
    - Fine structure constant
    - 511 keV line
    - Gamma rays
    - Cosmic heater
  - *Consistent with  $m_{\text{dm}} \sim 1 - 30 \text{ MeV}$*
- **What to take home**
  - *Dark matter may do more than just weigh*
  - *Light dark matter?*