Searching for Particle Dark Matter with the GLAST-LAT

Conrad, 2007

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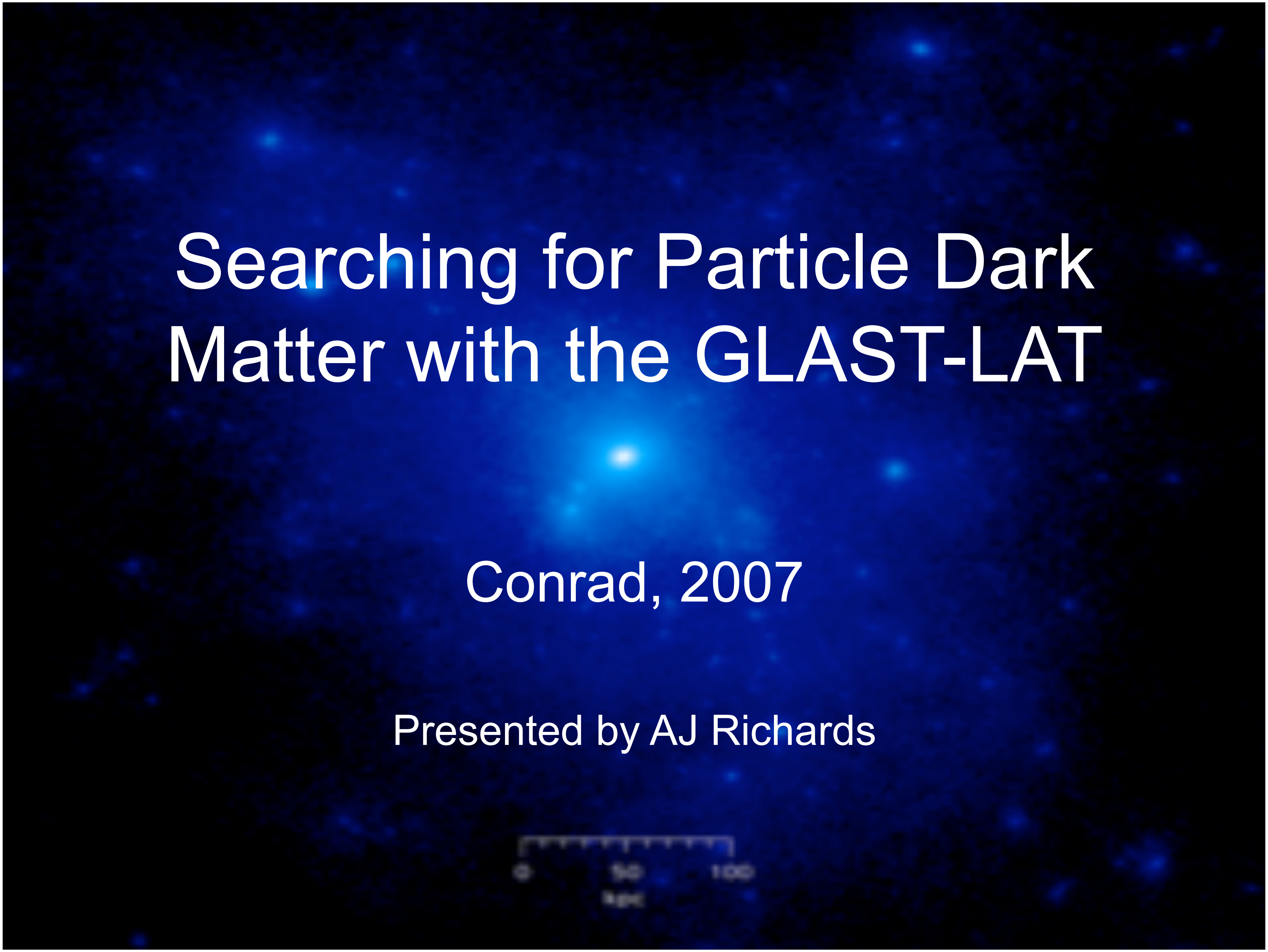


WIMPs

- WIMPs are the most promising candidate for a dark-matter particle
- Eluded direct discovery or identification
- Perhaps we can detect them indirectly?
  - Look at the products of WIMP self-annihilation

WIMP-annihilation Products

$$\frac{dN_\gamma}{dE} = \frac{dN_{\rm cont}}{dE}(E) + \sum_X b_{\gamma X} n_\gamma \delta\left(E - m_\chi(1 - m_\chi^2/4m_\chi^2)\right)$$

- First term from tree-level final states
  - "Cascades" and many-body final states
  - For Majorana WIMPs, light fermion production suppressed
    - Primary fermionic products are $b\bar{b}$, $t\bar{t}$, and $\tau\bar{\tau}$

WIMP-annihilation Products

$$\frac{dN_\gamma}{dE} = \frac{dN_{\rm cont}}{dE}(E) + \sum_X b_{\gamma X} n_\gamma \delta\left(E - m_\chi(1 - m_\chi^2/4m_\chi^2)\right)$$

- Second term from 2-body final states

$\gamma + X$ or 2γ

- In this paper, assume $b\bar{b}$ and 2γ dominate

GLAST

- Detect γ-rays in 20 MeV to 300 GeV range
- 50 times more sensitive; 10 times greater energy range; and 2 times better energy and angular resolution than EGRET
- Silicon detectors rather than spark chambers (EGRET)

Detection

- “Golden” signal
  - Spectral line at WIMP mass
    - Difficult to explain through other causes
  - Very small astrophysical uncertainties
  - Loop-suppressed
    - Low photon count expected

Detection

$$\frac{d\phi_\gamma}{dE_0} = \frac{\sigma v}{8\pi}\frac{c}{H_0}\frac{\bar{\rho}_0^2}{M_\chi^2}\int dz(1+z)^3\frac{\Delta^2(z)}{h(z)}\frac{dN_\gamma(E_0(1+z))}{dE}e^{-\tau(z,E_0)}$$

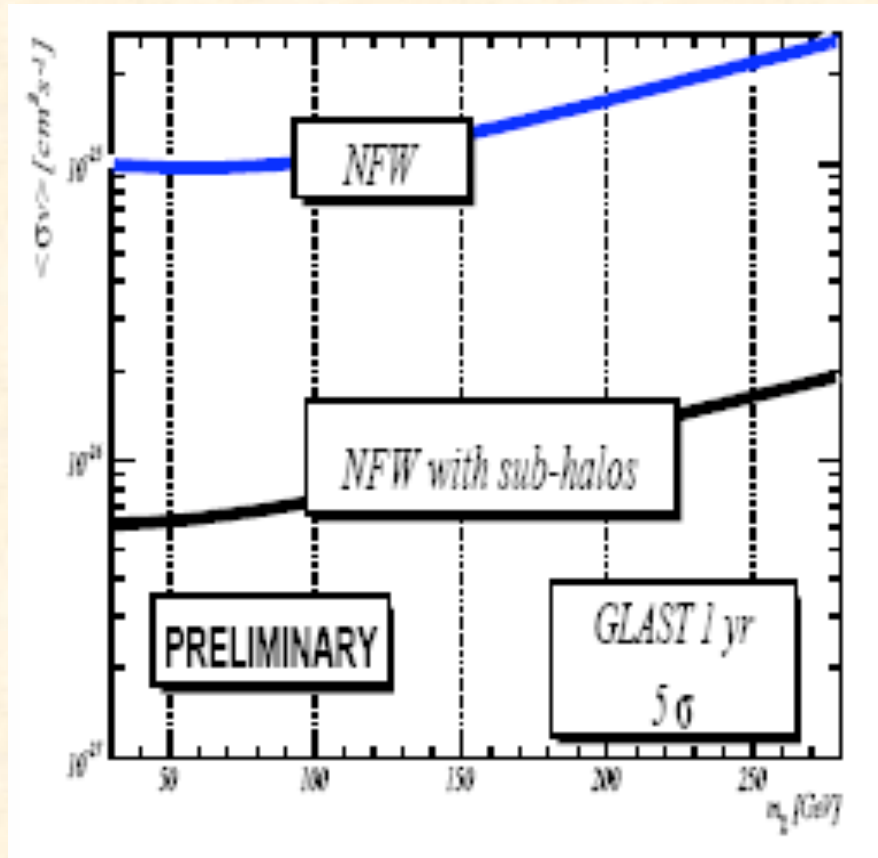
- Particle physicists must find σ and M_χ
- $\dfrac{dN_\gamma}{dE}$ from before
- This goes as DM density *squared*
  - "Clumpiness" strongly affects signal strength

Halo Substructure

- N-body simulations show small subhalos
- Greater density means more WIMP annihilation products
  - Greater flux of gamma rays
- This can be used to detect satellites within the Milky Way halo

Conclusions

- GLAST can help constrain the cross-section for the WIMP self-annihilation



Conclusions

- GLAST can also give us insight into the existence or absence of subhalos