

Title: Theories of Dark Matter- Lecture 3

Date: Jun 26, 2009 09:00 AM

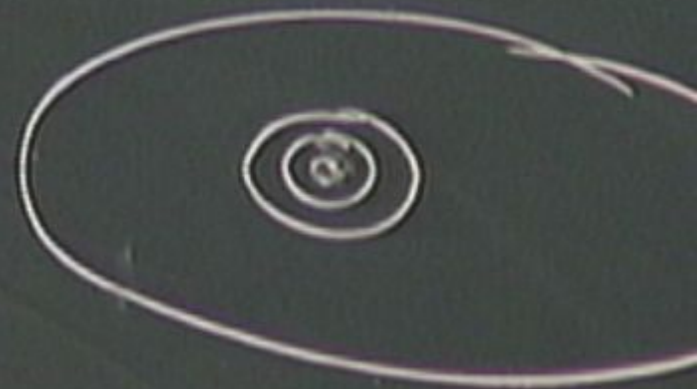
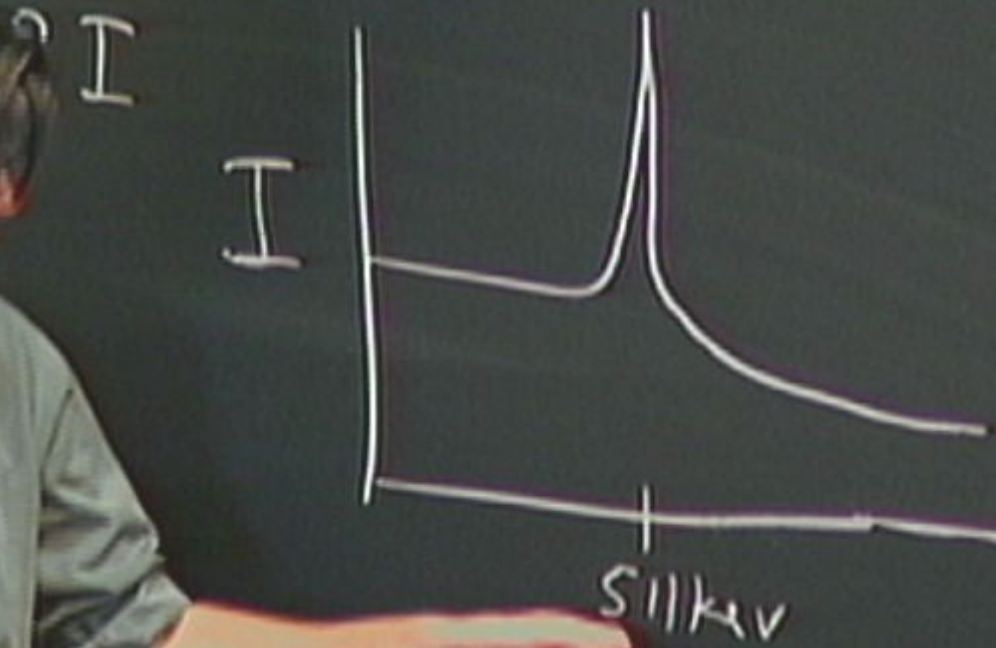
URL: <http://pirsa.org/09060071>

Abstract:

"DM anomalies"

"DM anomalies"

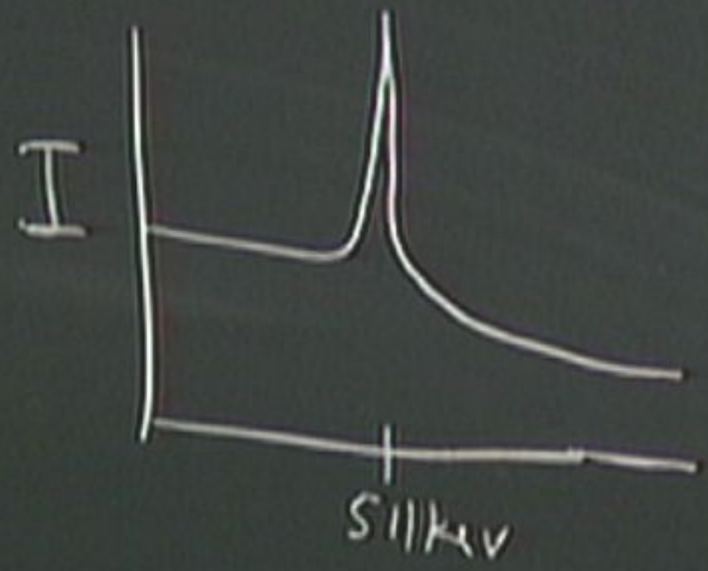
INTEGRAL S11 KeV



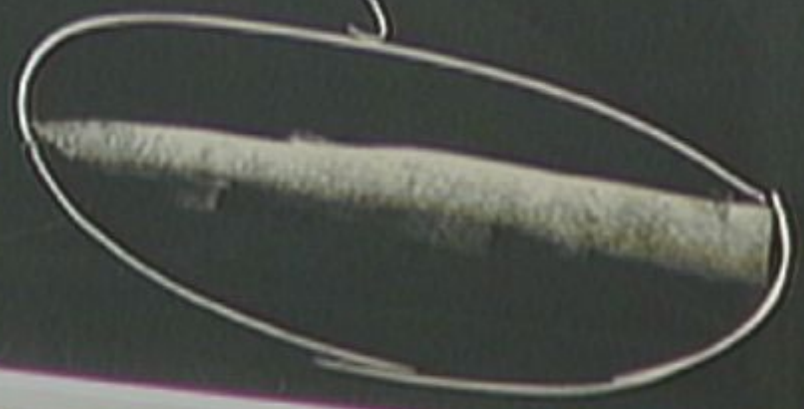
'DM anomalies''

INTEGRAL 511 keV

SPI



$$\frac{3 \times 10^{42} e^+}{s}$$



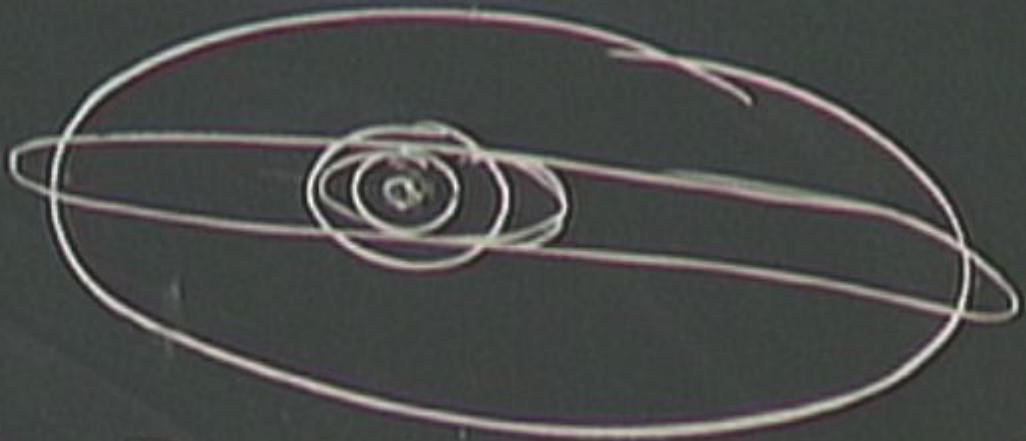
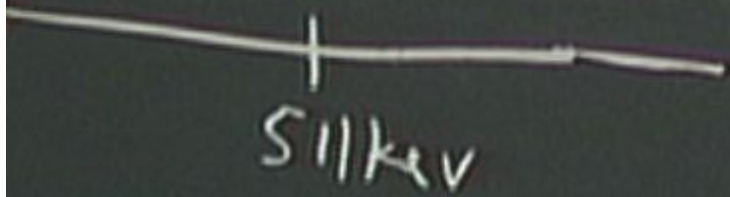
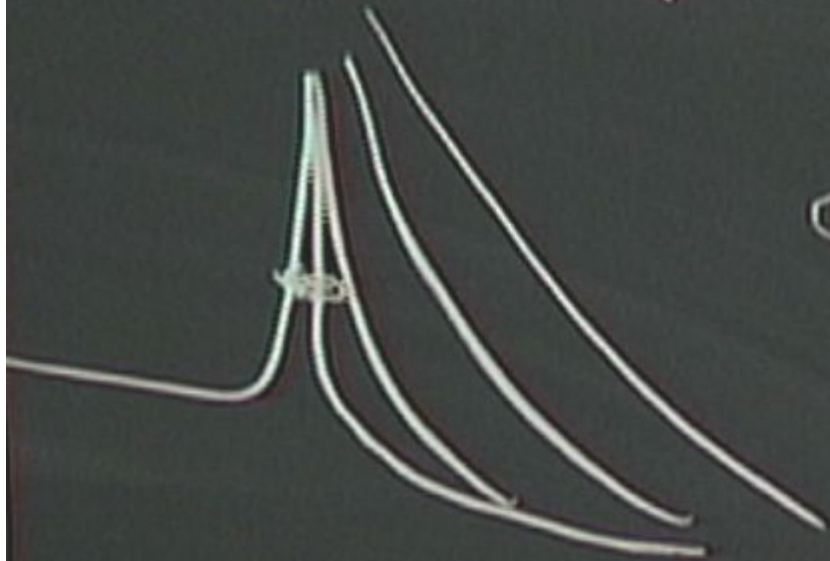
$$\tau^{-1} = 3 \times 10^{12} \frac{e^+}{s} \left( \frac{\sigma V}{2 \times 10^{20} \text{ cm}^{-3} \text{ s}^{-1}} \right) \left( \frac{500 \text{ GeV}}{M_X} \right)$$

$$\tau^{-1} = 3 \times 10^{12} \frac{e^+}{s} \left( \frac{0.1 \text{ V}}{2 \times 10^{20} \text{ cm}^{-3} \text{ s}^{-1}} \right) \left( \frac{500 \text{ GeV}}{M_X} \right)$$

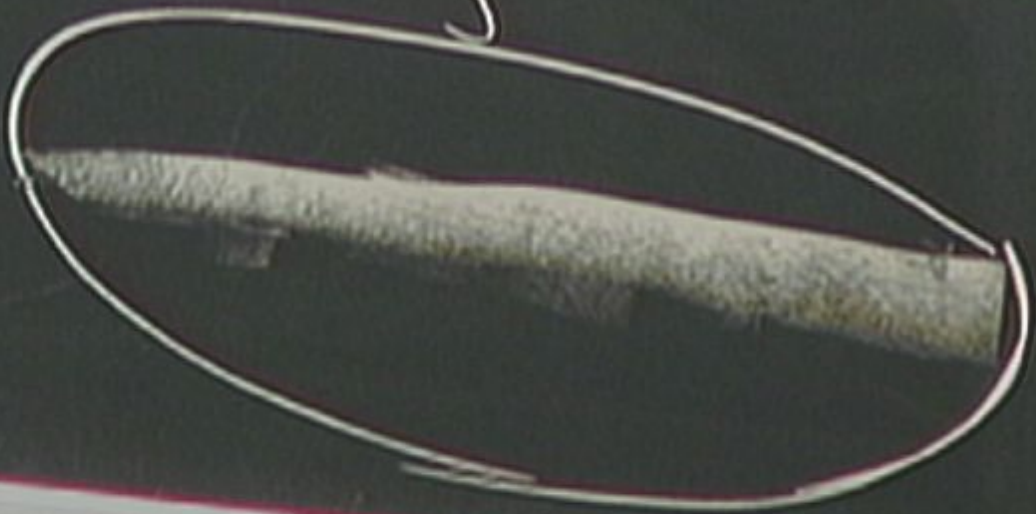
$$\tau^{-1} = 3 \times 10^{12} \frac{e^+}{s} \left( \frac{\sigma v}{2 \times 10^{20} \text{ cm}^3 \text{ s}^{-1}} \right) \left( \frac{500 \text{ GeV}}{M_\chi} \right)$$

line shape  $\Rightarrow$  few MeV  $>$   $E_{\text{injection}}$

BRAL 511 KeV



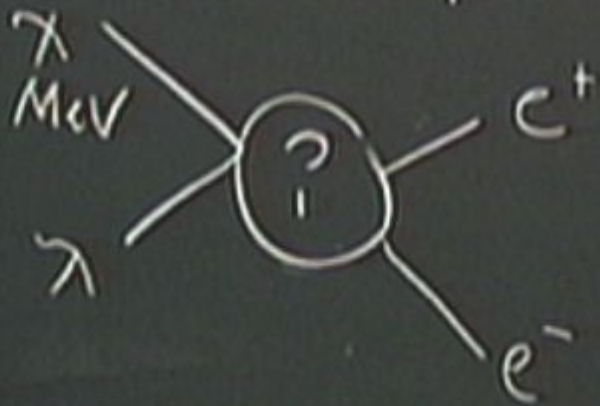
$$3 \times 10^{42} \frac{e^+}{s}$$





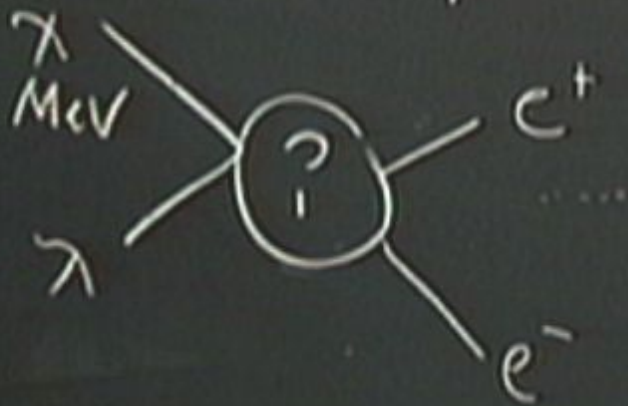
$$\tau^{-1} = 3 \times 10^{12} \frac{e^+}{s} \left( \frac{\sigma v}{2 \times 10^{20} \text{ cm}^3 \text{ s}^{-1}} \right) \left( \frac{500 \text{ GeV}}{M_\chi} \right)$$

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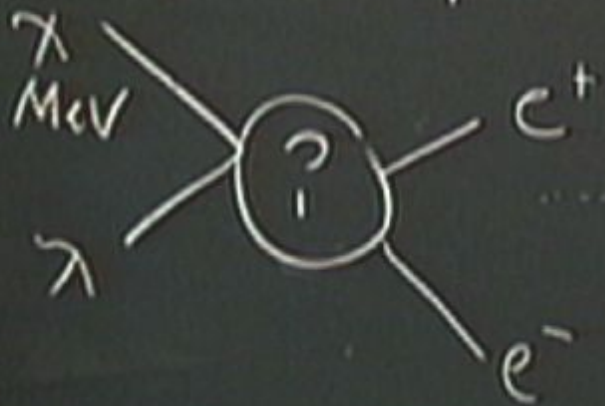
line shape  $\Rightarrow$  few MeV  $>$   $E_{\text{injection}}$



exciting DM (XDM)

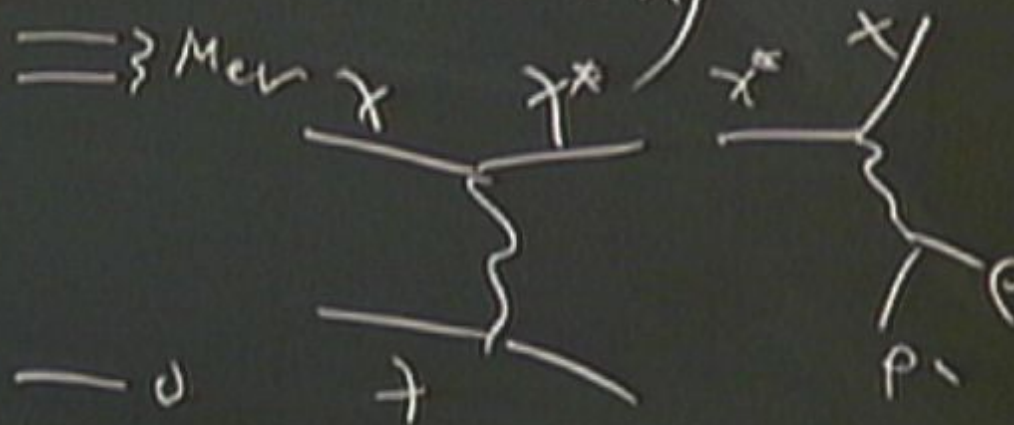
$$\Upsilon^{-1} = 3 \times 10^{12} \frac{e^+}{s} \left( \frac{\sigma v}{2 \times 10^{-20} \text{ cm}^3 \text{ s}^{-1}} \right) \left( \frac{500 \text{ GeV}}{M_\chi} \right)$$

line shape  $\Rightarrow$  few MeV  $>$   $E_{\text{injection}}$



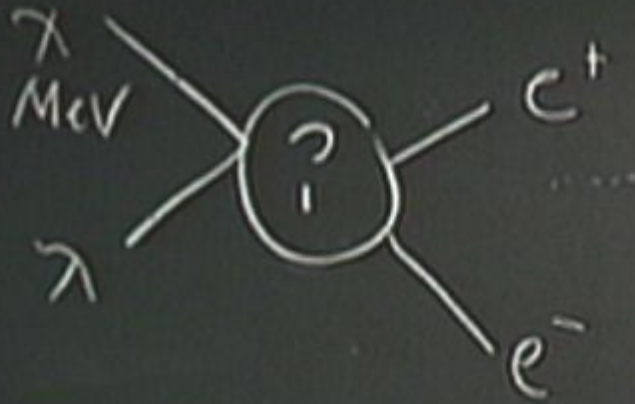
exciting DM (XDM)

$\chi^* \Rightarrow$  MeV  $\chi$



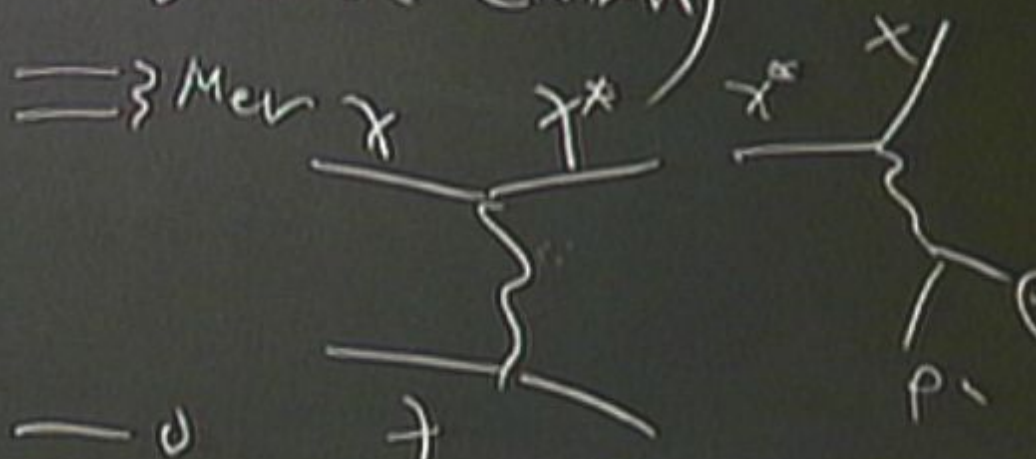
$$\frac{1}{5} (2 \times 10^{10} \text{ cm}^3 \text{ s}^{-1}) (M_\chi)$$

line shape  $\Rightarrow$  few MeV  $>$   $E_{\text{injection}}$



exciting DM (XDM)

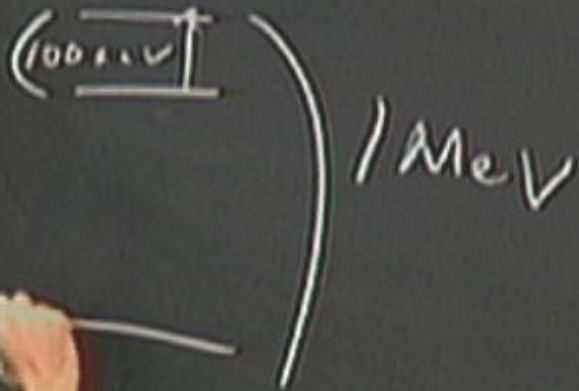
$$\begin{matrix} \chi^* \\ \chi \end{matrix} = \begin{matrix} \chi \\ \chi \end{matrix} \approx \text{MeV}$$



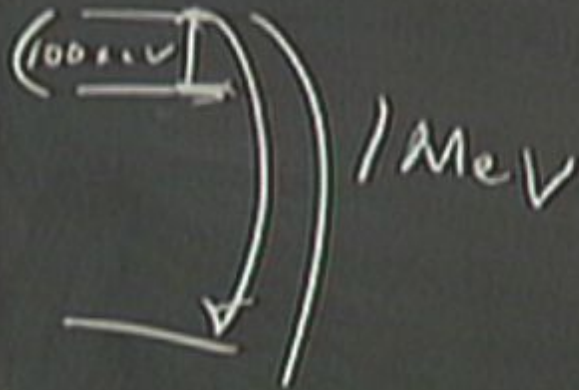
$$DM + \lesssim \text{GeV } \phi$$

$$M_{\text{pl}} \lesssim \text{GeV} \quad \psi$$

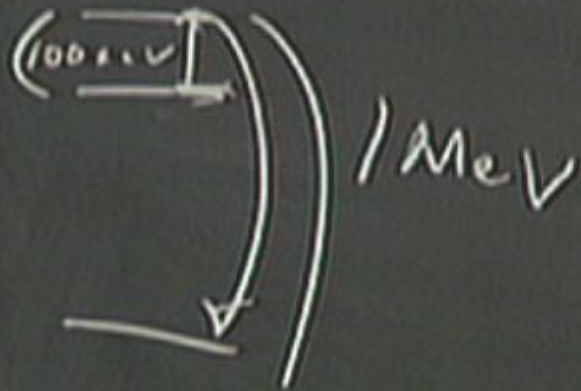
$$DM + \lesssim GeV \quad \psi$$



$$DM + \lesssim GeV \quad \psi$$



$$DM + \lesssim GeV \quad \psi$$





EGRET

③ "anomalies"

SAFETY  
EXIT  
EXIT  
EXIT

# EGRET

③ "anomalies"

① Diffuse XG signal

# EGRET

③ "anomalies"

① Diffuse XG signal

② Diffuse galactic

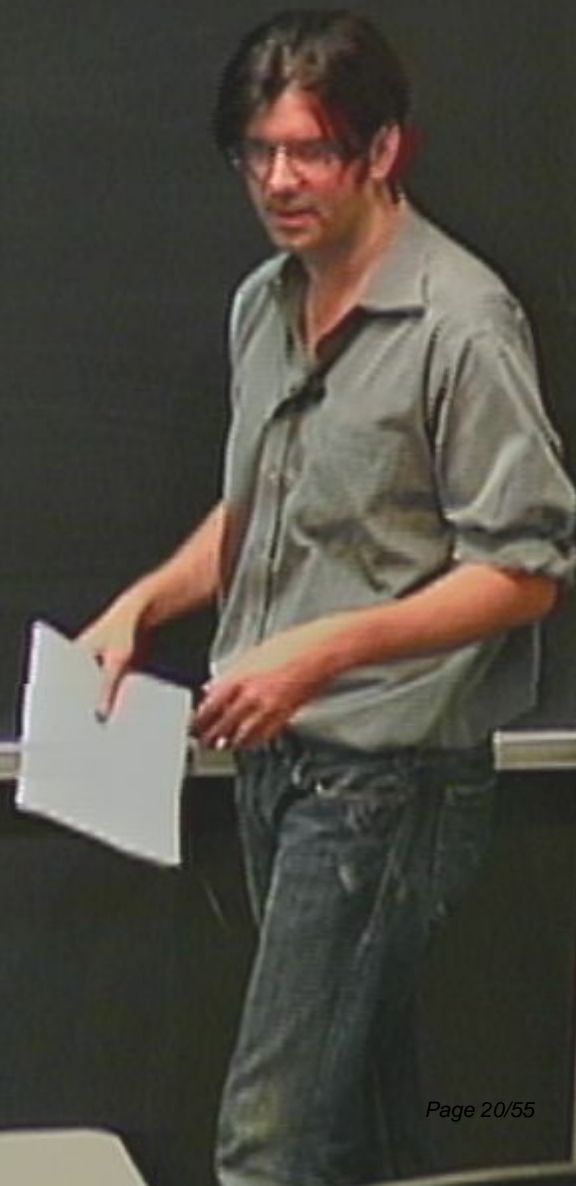
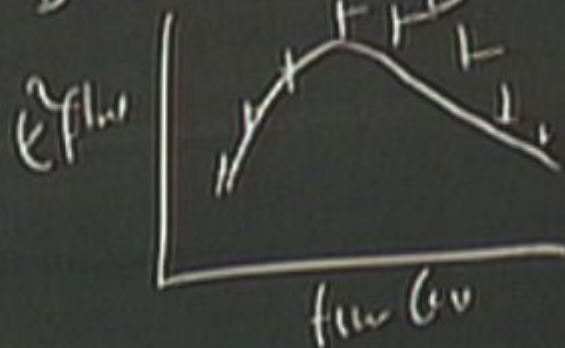


# EGRET

③ "anomalies"

① Diffuse XG signal

② Diffuse galactic

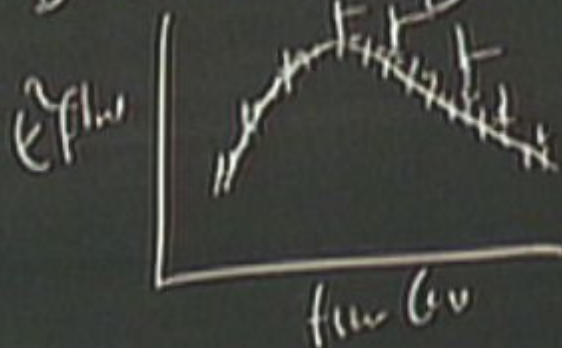


# EGRET

③ "anomalies"

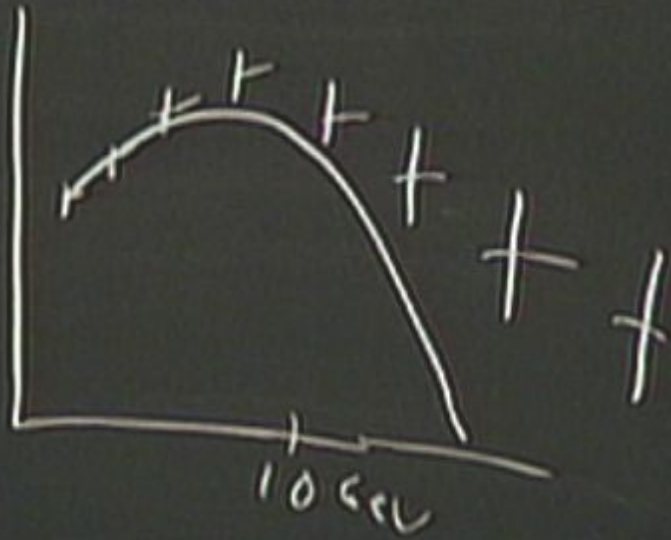
① Diffuse XG signal

② Diffuse galactic

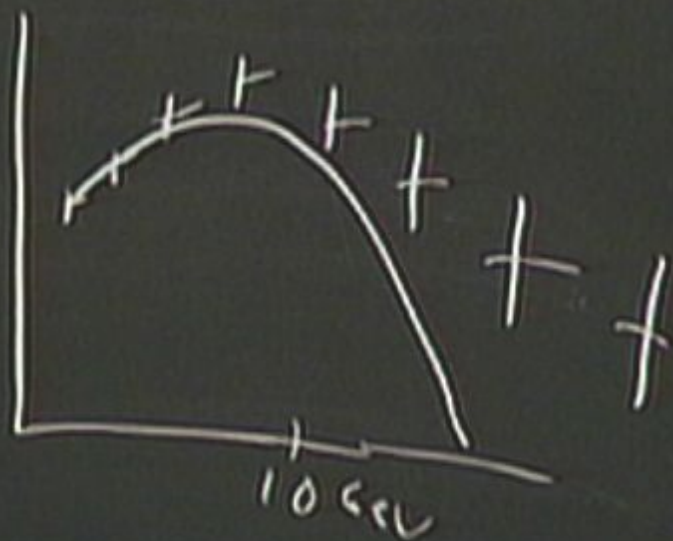


③ GC inside 5'

③ GC inside 5"

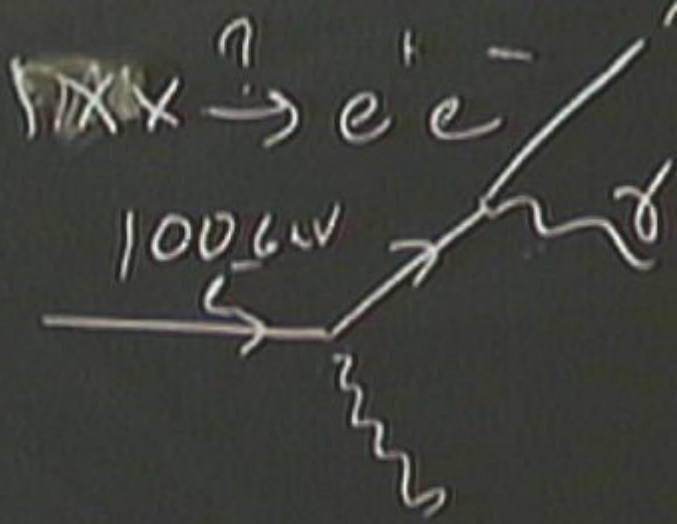
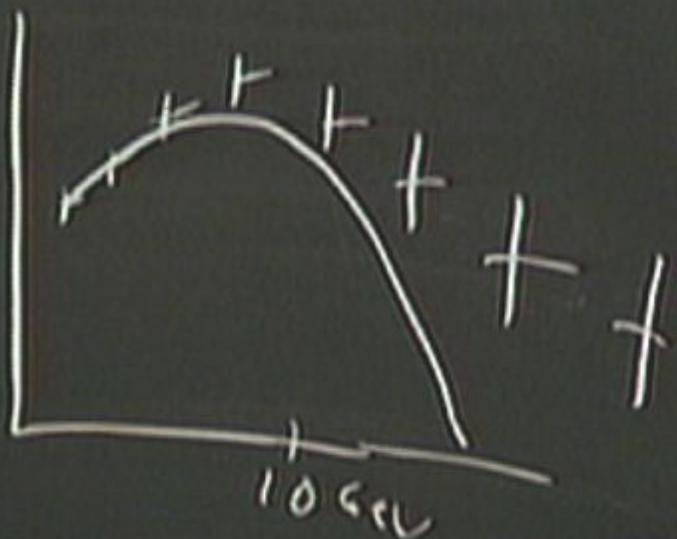


③ GC inside 5"

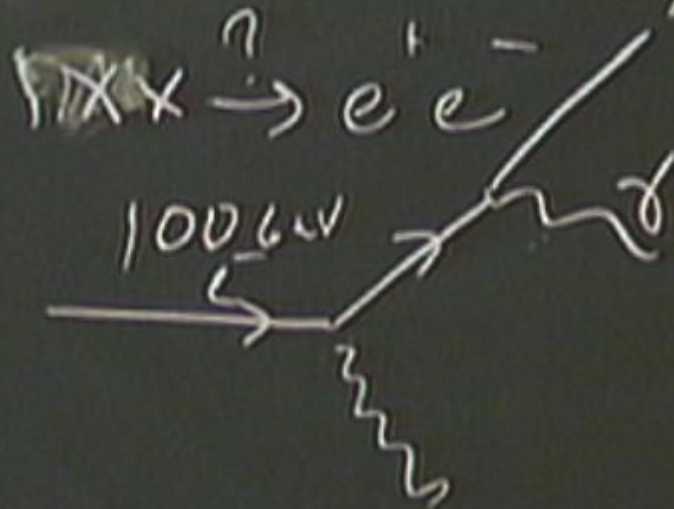
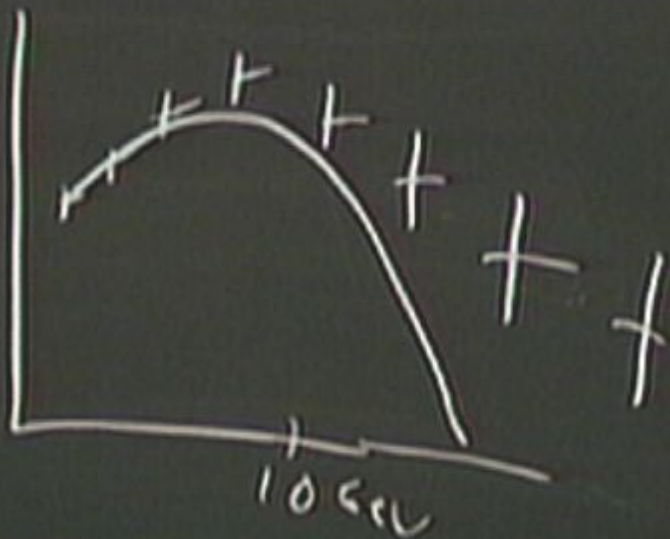




③ GC inside  $5''$



(3) GC inside  $S'$

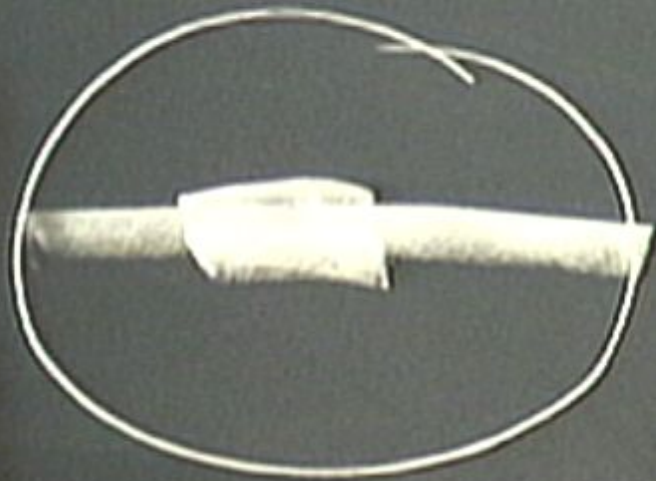


WMA P Haze  
Finkbeine, '04, Dobler + Fink '08



WANDA P Haze

Finkbeine, '04, Dobler + Fine '08



WMAP Haze

Finkbeiner, '04, Dobler + Fine '08



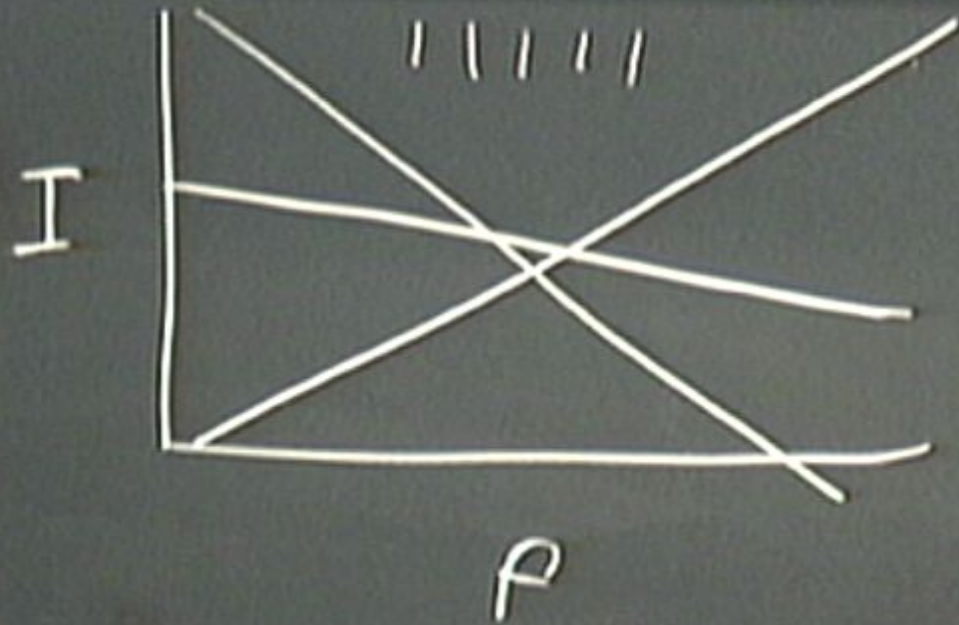
Soft-synchrotron

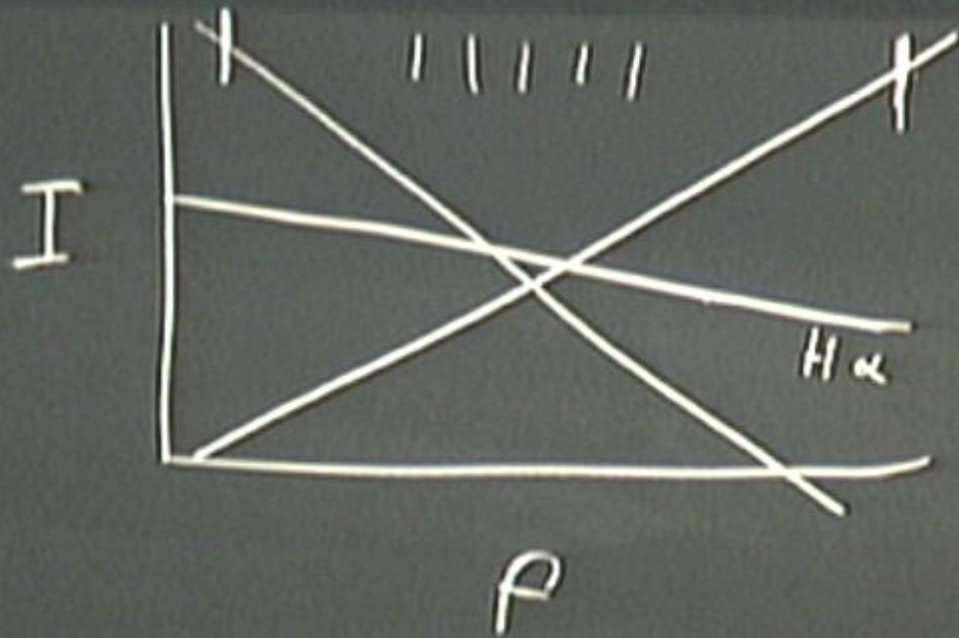
CMB

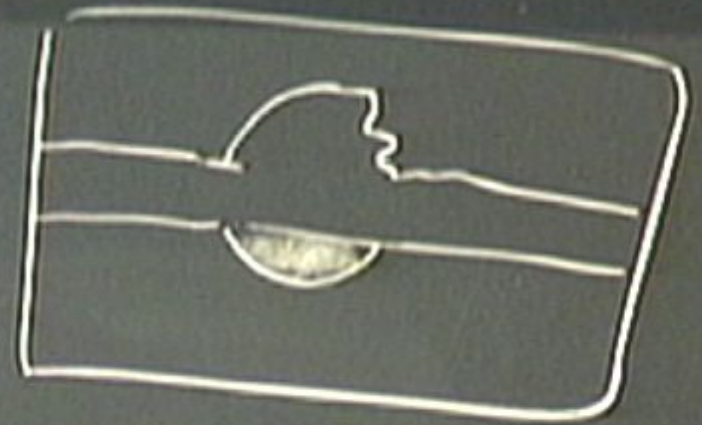
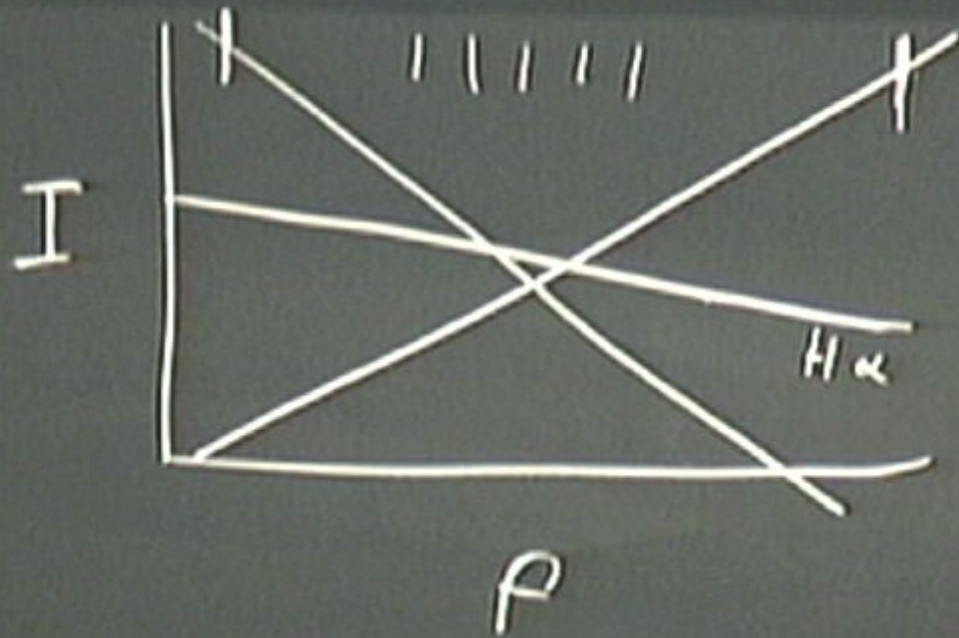
Free-free Bremsstrahlung

Dust

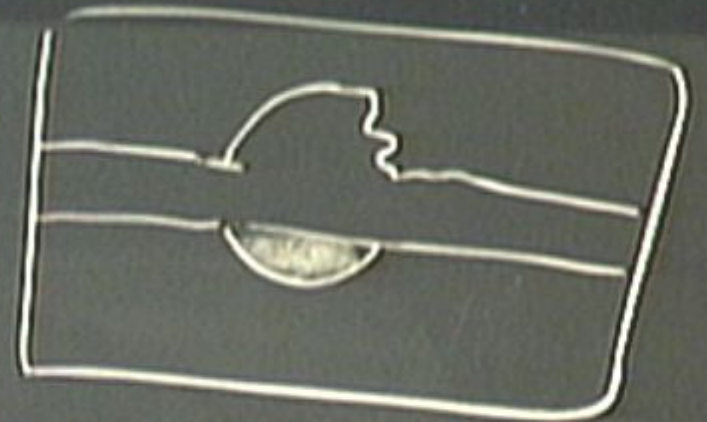
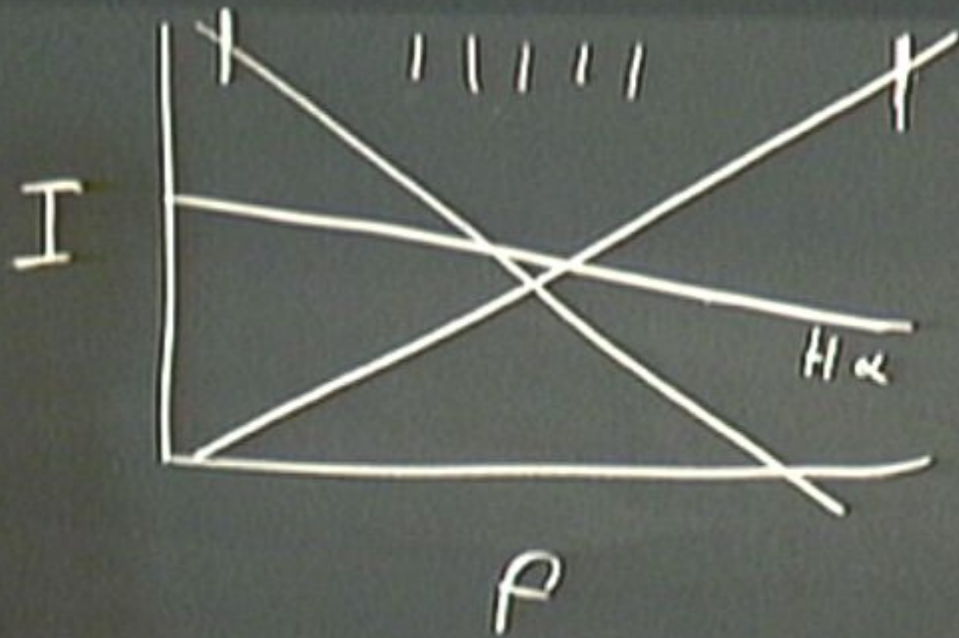
Spinning dust?



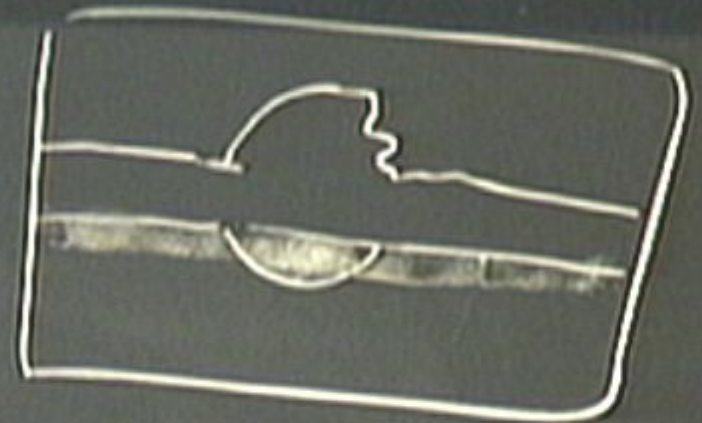
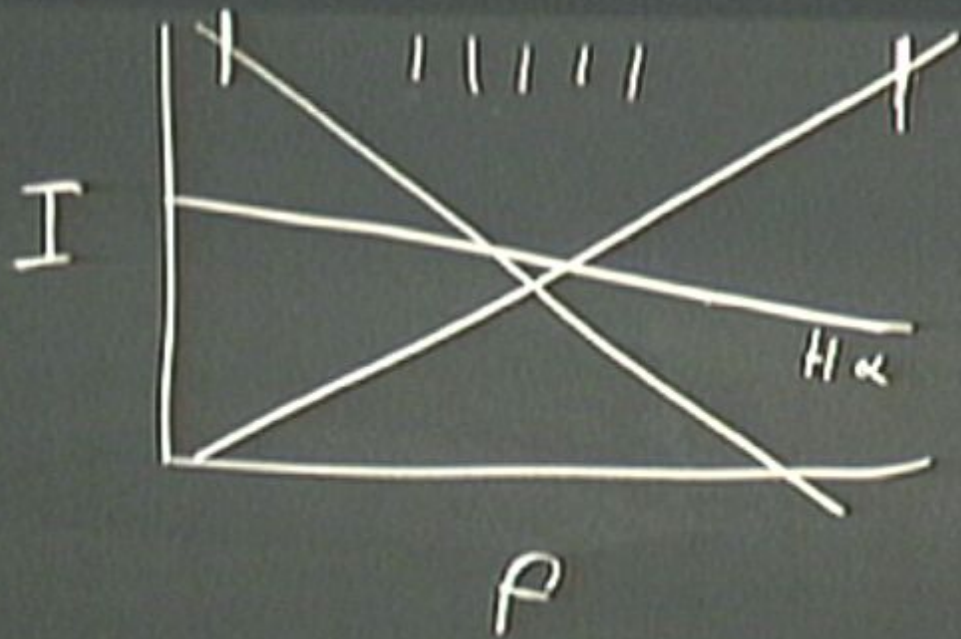






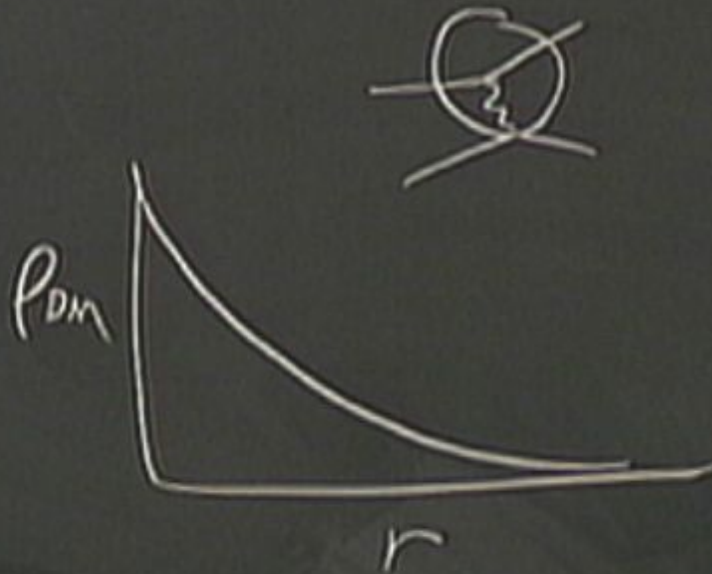
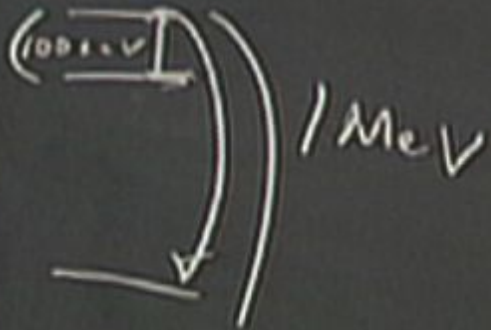


new source of  
 $e^+ e^-$  synch rad



new source of  
 $e^+ e^-$  synch rad

$$DM + \lesssim GeV \quad \psi$$



PAMCLA

$e^+e^-$   
 $e^+e^-$



PAMELA

$e^+$   
|  
 $e^-$

+ + + + +

100 cur

PAMELA

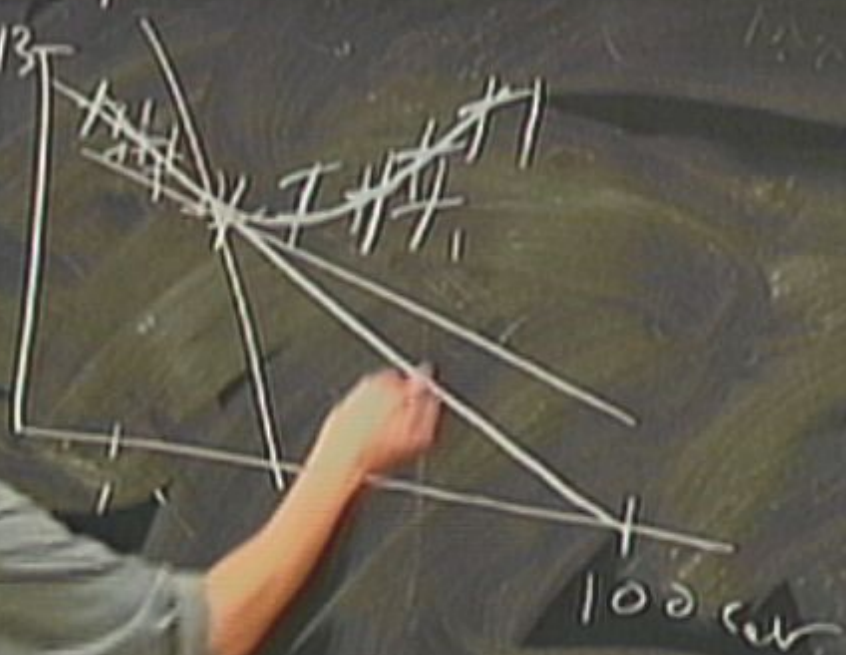
$\frac{e^+}{e^+e^-}$

		T		

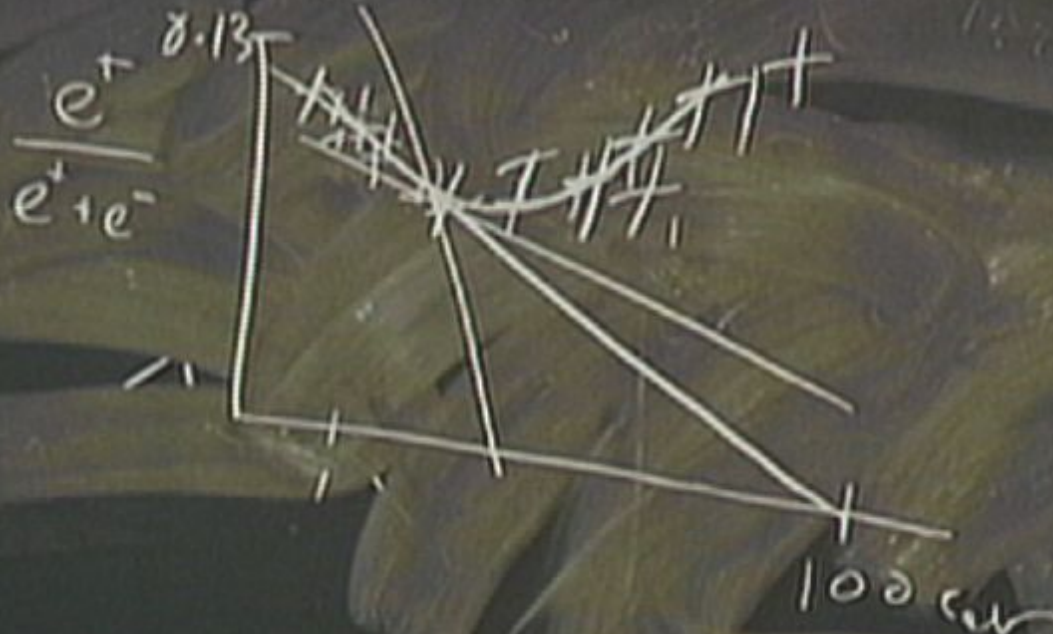
100 cur

PAMELA

$e^+ 0.13$



PAMELA

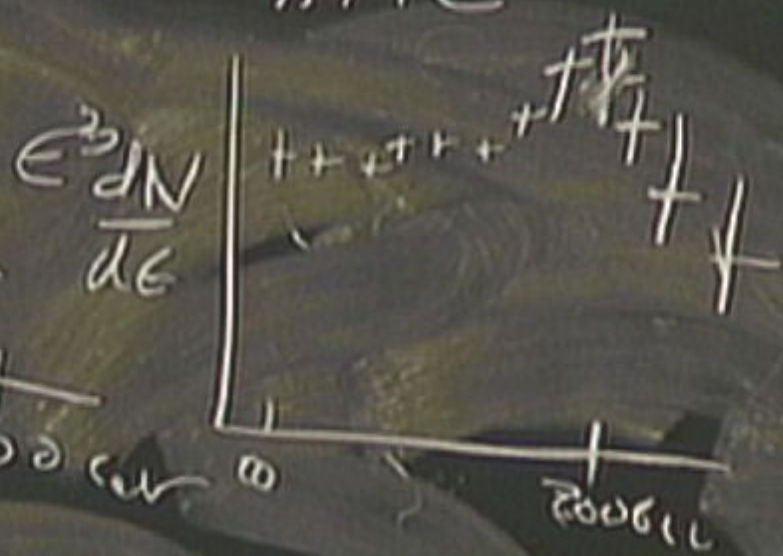




PAMELA



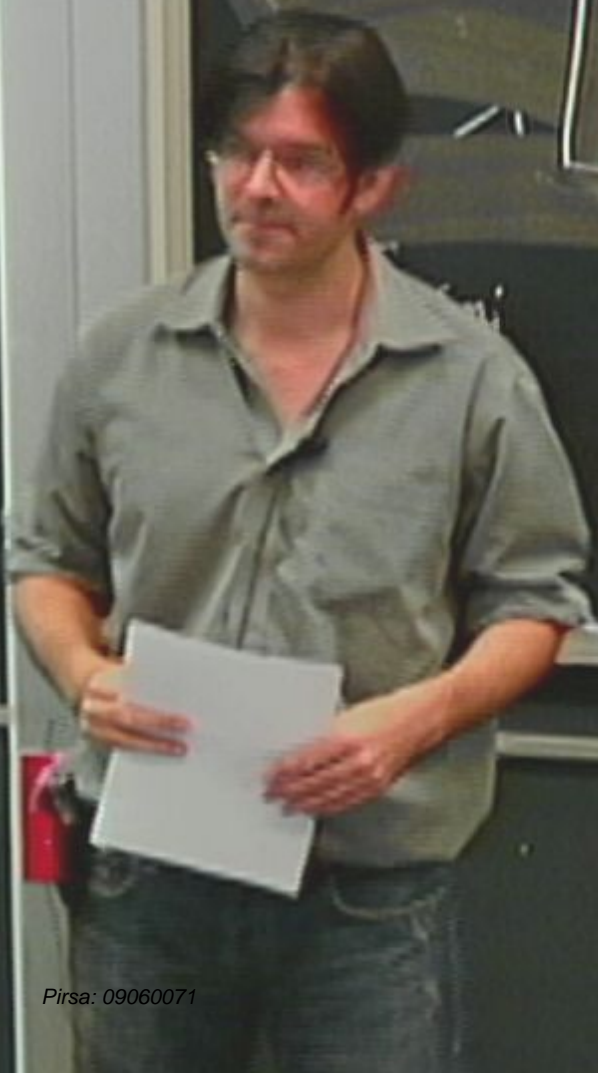
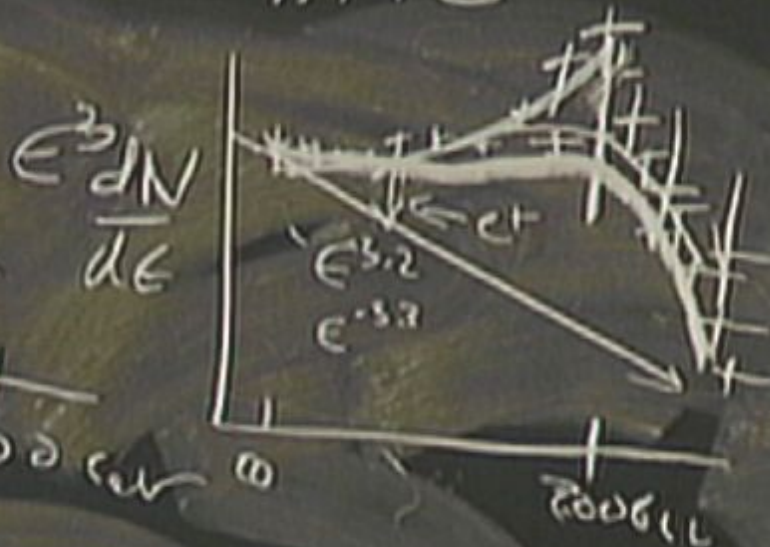
ATIC



PAMELA



ATIC



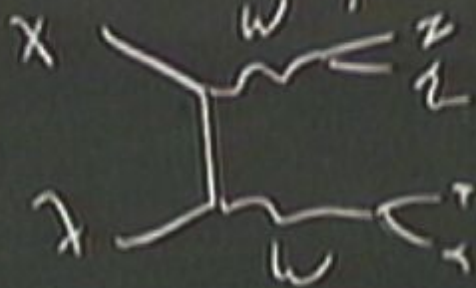
① Size of signal

$$\sigma_v \sim 3 \times 10^{-24} \frac{\text{cm}^2}{\text{s}}$$

① Size of signal

$$\sigma \sim 3 \times 10^{-24} \frac{\text{cm}^2}{\text{s}}$$

② Hard leptons



LA 104  
UNIVERSITY OF CALIFORNIA  
BERKELEY

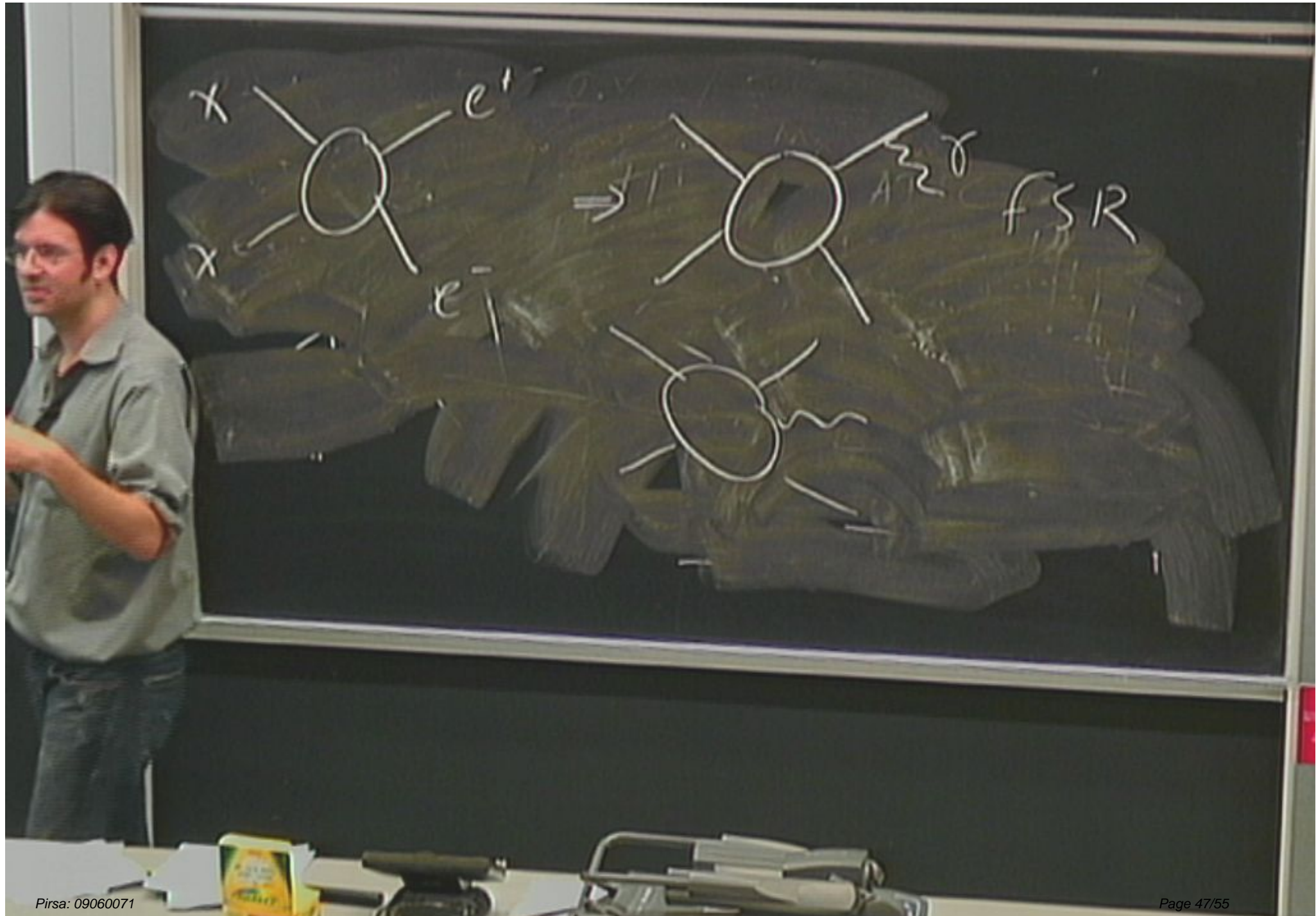
DM decays

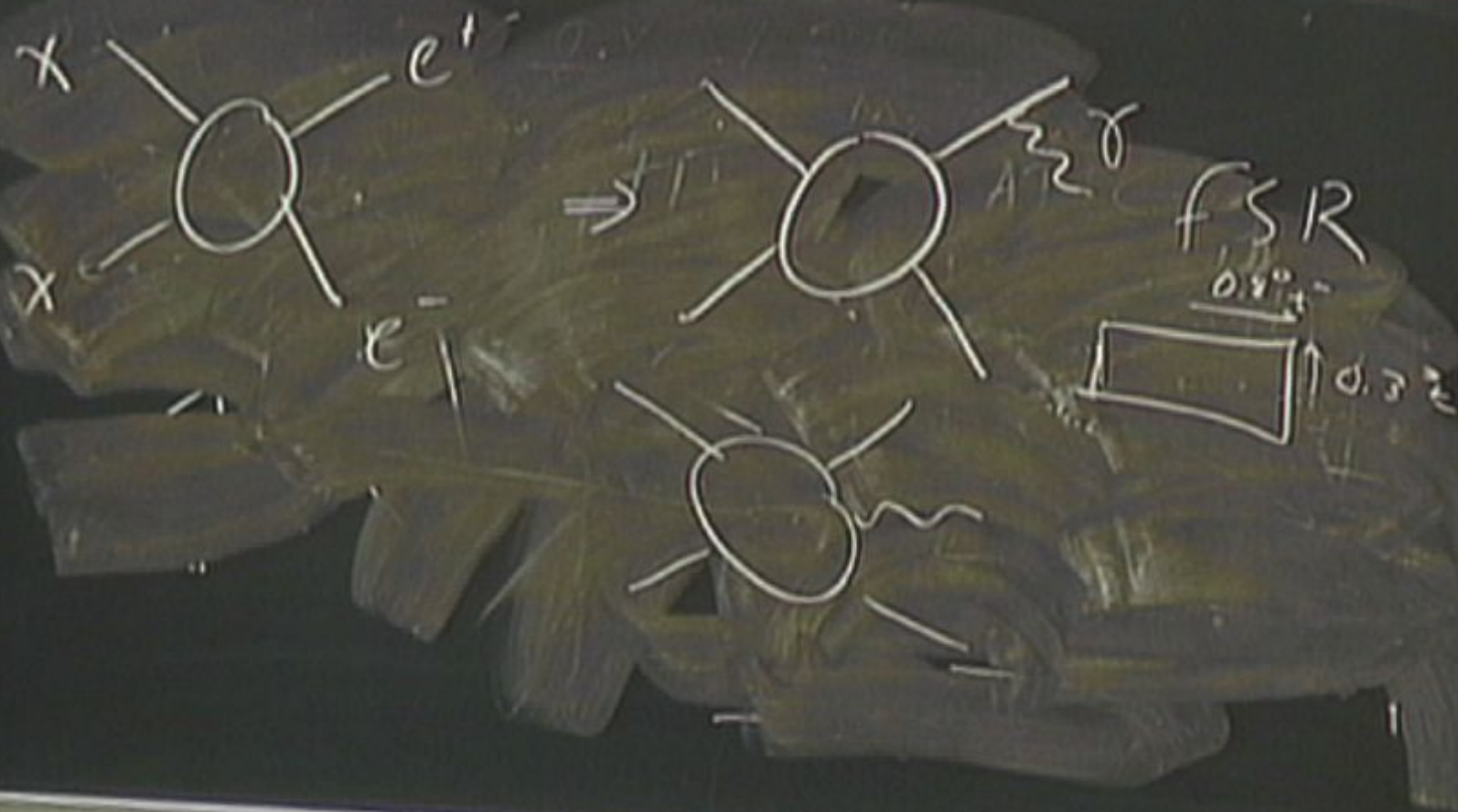
$$T \sim 10^{27} \text{ s}$$

DM decays

$$\tau \sim 10^{22} \text{ s}$$

$$\Gamma \sim \frac{\text{TeV}^5}{M_{\text{GUT}}^4} \sim 10^{26} \text{ s}^{-1}$$



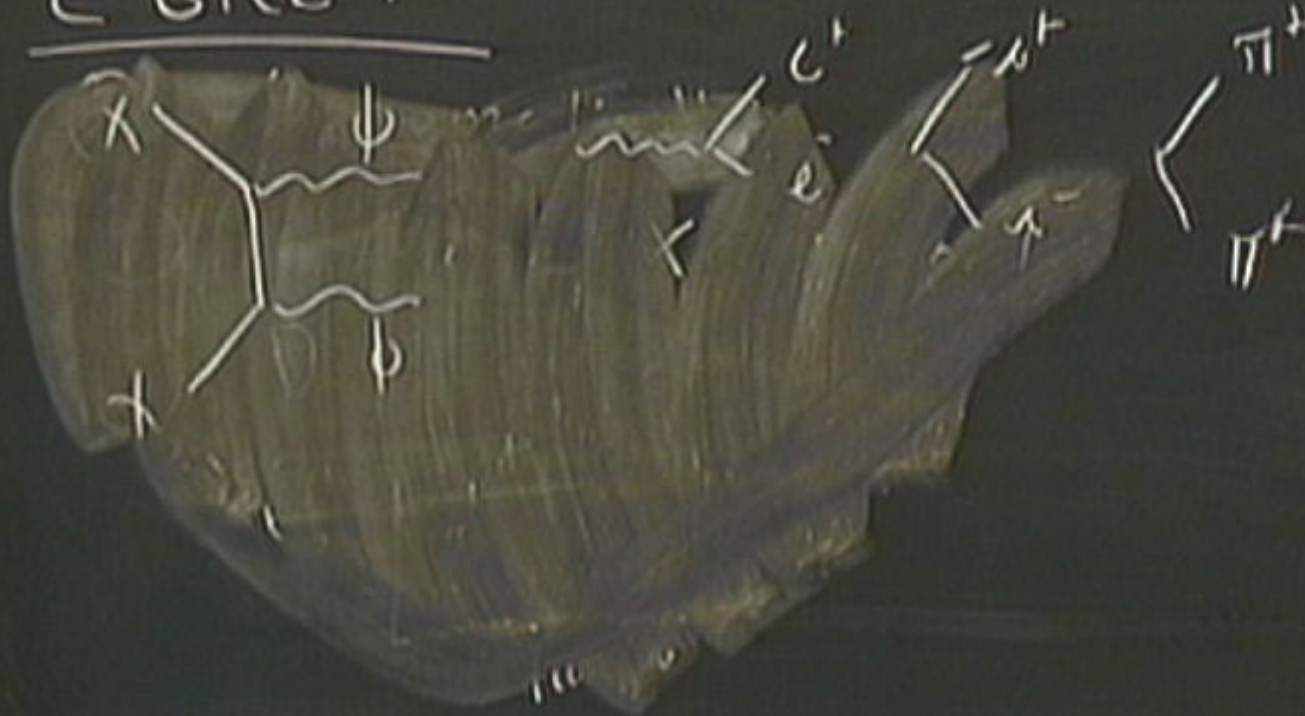




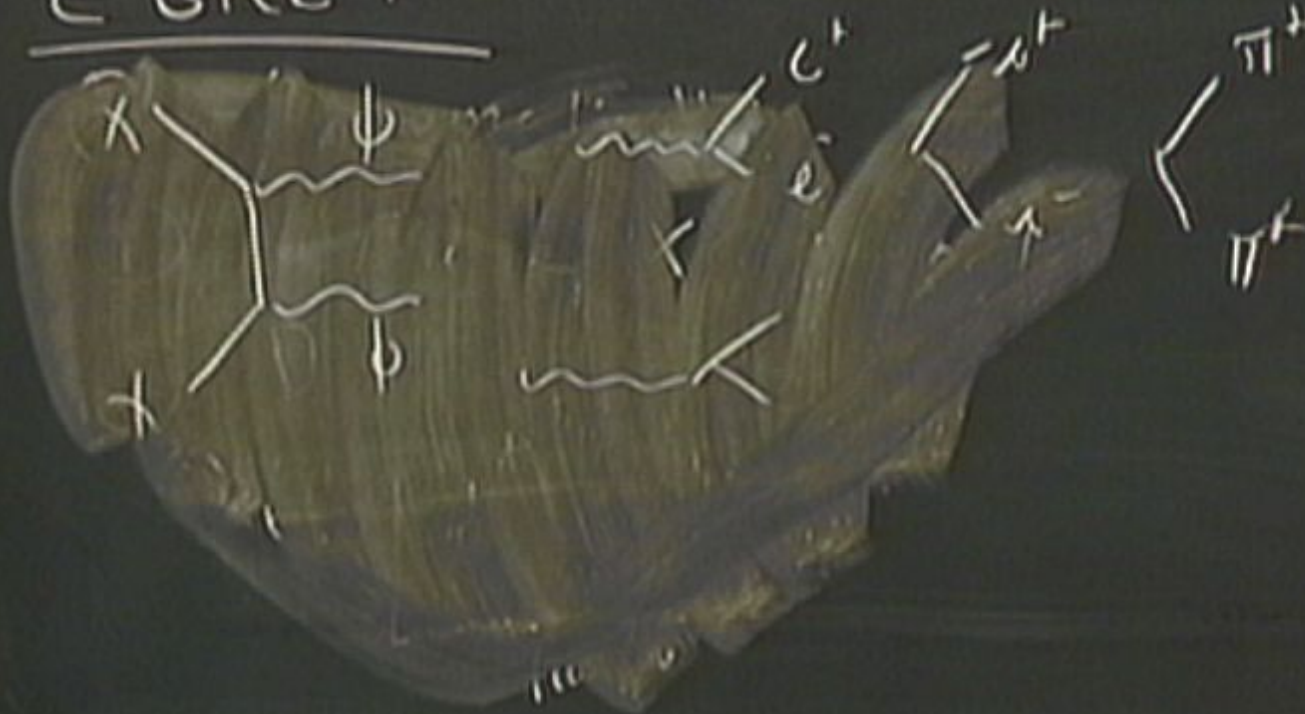
EGRET



# EGRET



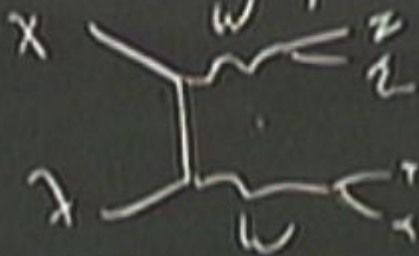
# EGRET



① Size of signal

$$\sigma \sim 3 \times 10^{-24} \frac{\text{cm}^2}{\text{s}}$$

② Hard leptons



③  $\bar{p}$

# Sommerfeld enhancement



$$\sigma = \pi R_0^2$$

5247

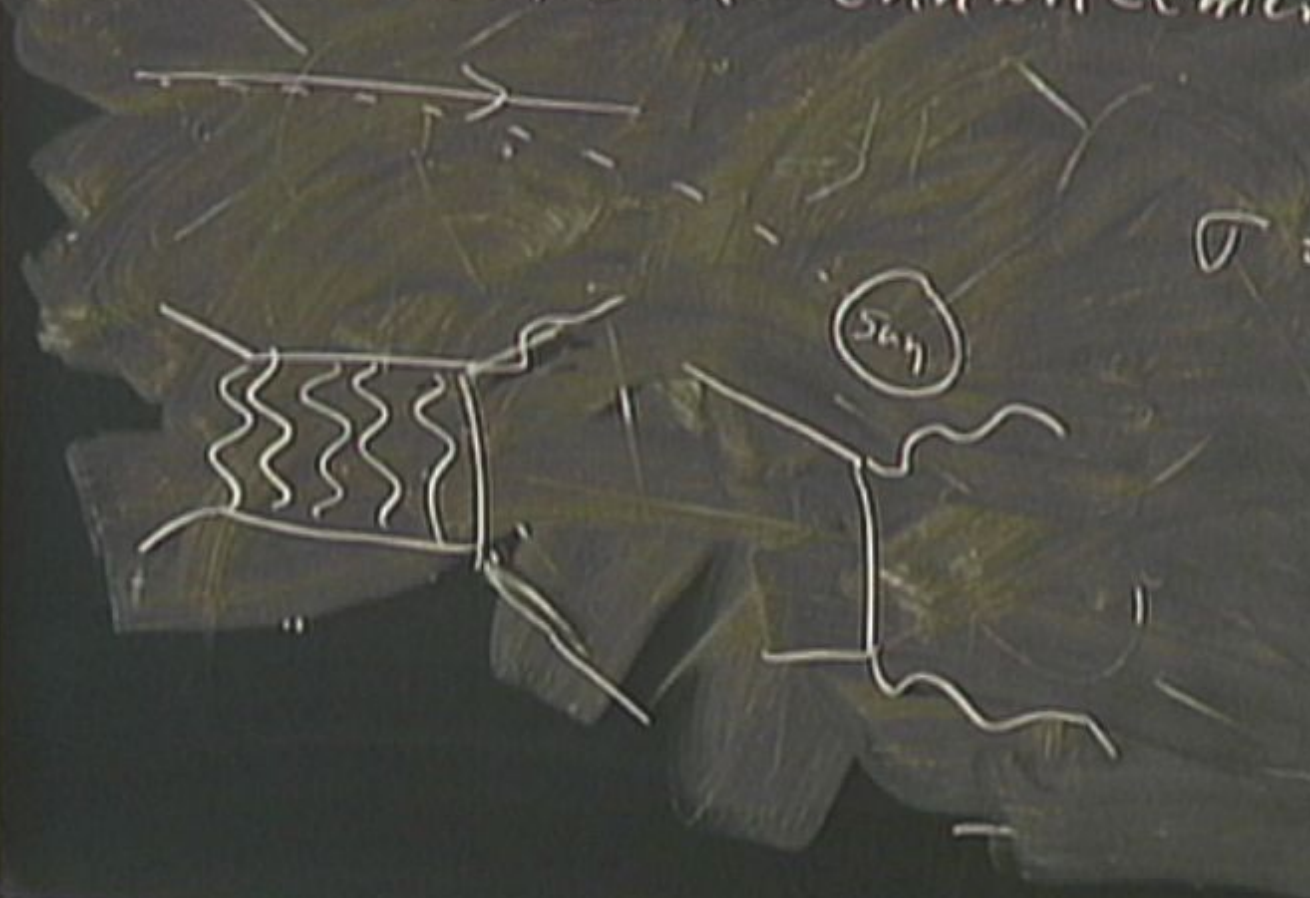
# Sommerfeld enhancement



$\sigma_{\text{tot}}$

$$\sigma = \pi R_0^2 \left( 1 + \frac{v_{\text{esc}}^2}{v^2} \right)$$

# Sommerfeld enhancement



CAUTION  
LASER  
DO NOT STARE INTO THE BEAM  
DO NOT POINT THE BEAM AT OTHERS  
DO NOT TOUCH THE MIRROR  
DO NOT TOUCH THE LENS