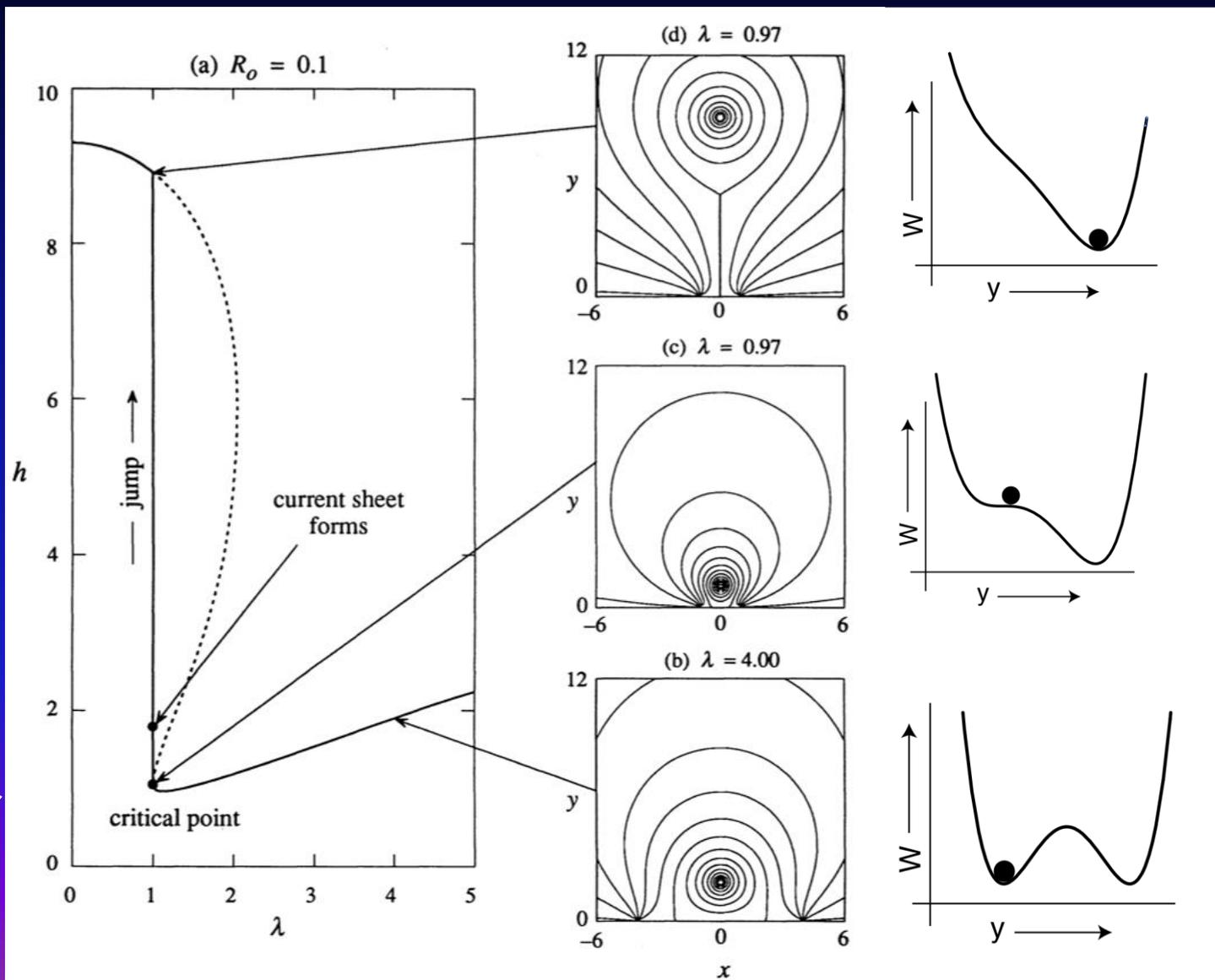


# **Light Curves for a Model of Solar Eruptions**

**Kathy Reeves & Terry Forbes  
University of New Hampshire**

# Loss of Equilibrium Model

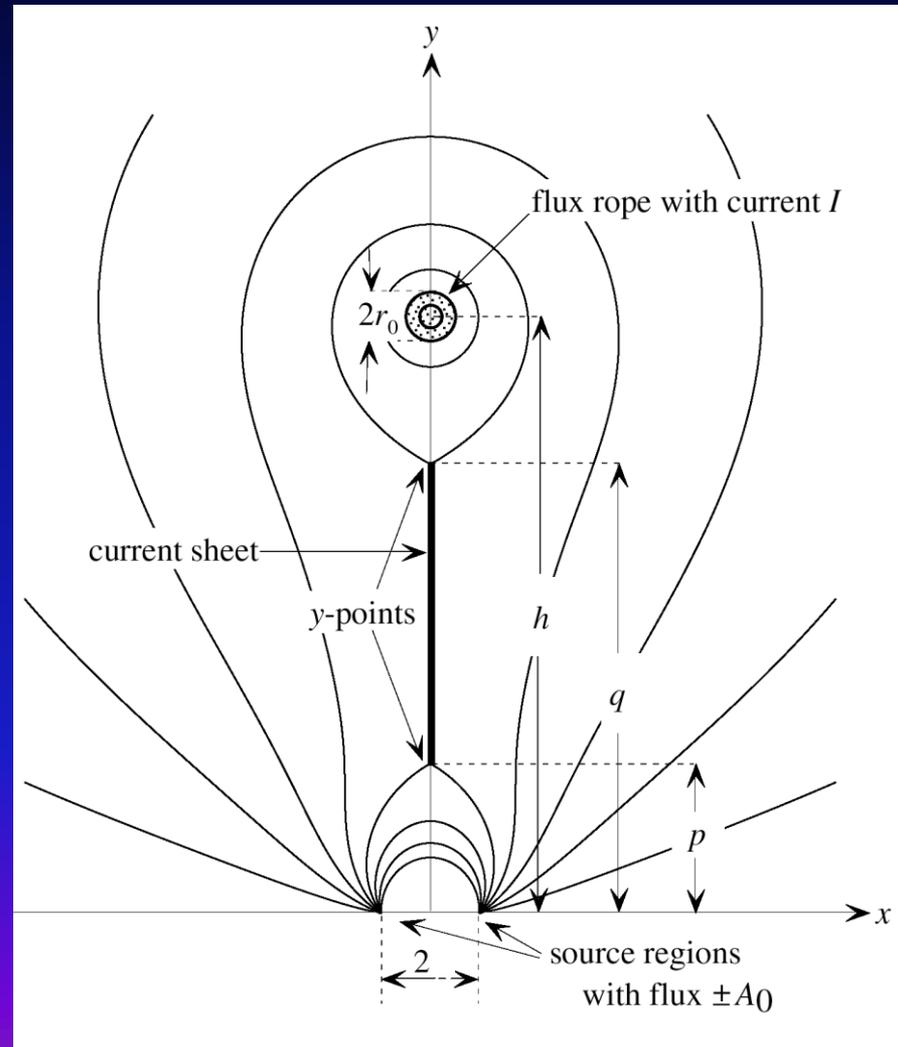


Priest &  
Forbes,  
1995

# Model Assumptions

- **2D, infinite planar geometry**
- **No MHD waves or gravity**
- **Reconnection rate ( $M_A$ ) given at center of current sheet**
- **Gas pressure is small compared to magnetic pressure**
- **Boundary Condition:**

$$A(x,0) = A_0 H(\lambda - |x|)$$

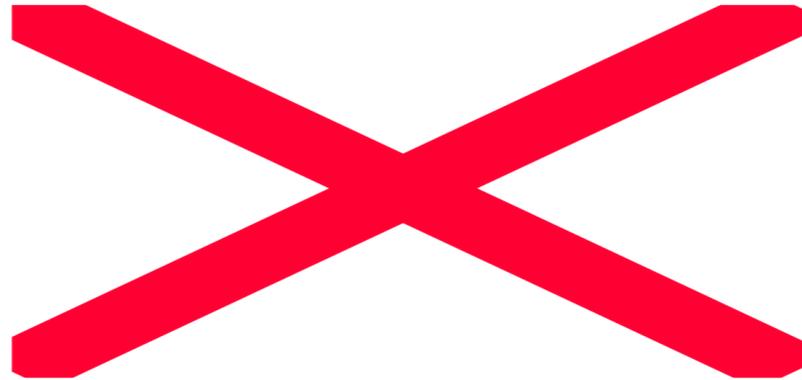


**Lin & Forbes 2000**

# Model Equations

- **Force on flux rope:**  $J \times B_{\text{ext}}$
- **Conservation of Flux:**  $A(0, h-r_0) = \text{constant}$
- **Faraday's Law:**  $E_z = - \frac{1}{c} \frac{\partial A_{\text{cs}}}{\partial t}$
- **Energy conservation:**  $\frac{1}{2} m v^2 + W_{\text{Th}} + W_{\text{B}} = \text{constant}$
- **Thermal Energy:**  $\frac{dW_{\text{Th}}}{dt} = S(t) = \frac{c}{2\pi} E_0(t) \int B_y(0, y, t) dy$

# Thermal Energy Release Rate



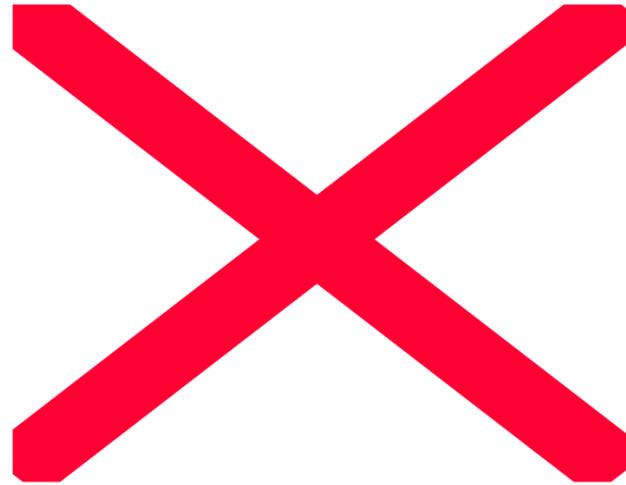
**Poynting flux into the current sheet  
is assumed to be completely thermalized**

# **Cargill Cooling Model**

- **Assumes separation of conductive and radiative cooling phases**
- **Empirical scaling law used to relate temperature and density in the radiative cooling**
- **Easy to use, doesn't take much computing power**
- **See Cargill, Mariska & Antiochos 1995, Reeves & Warren, 2002**

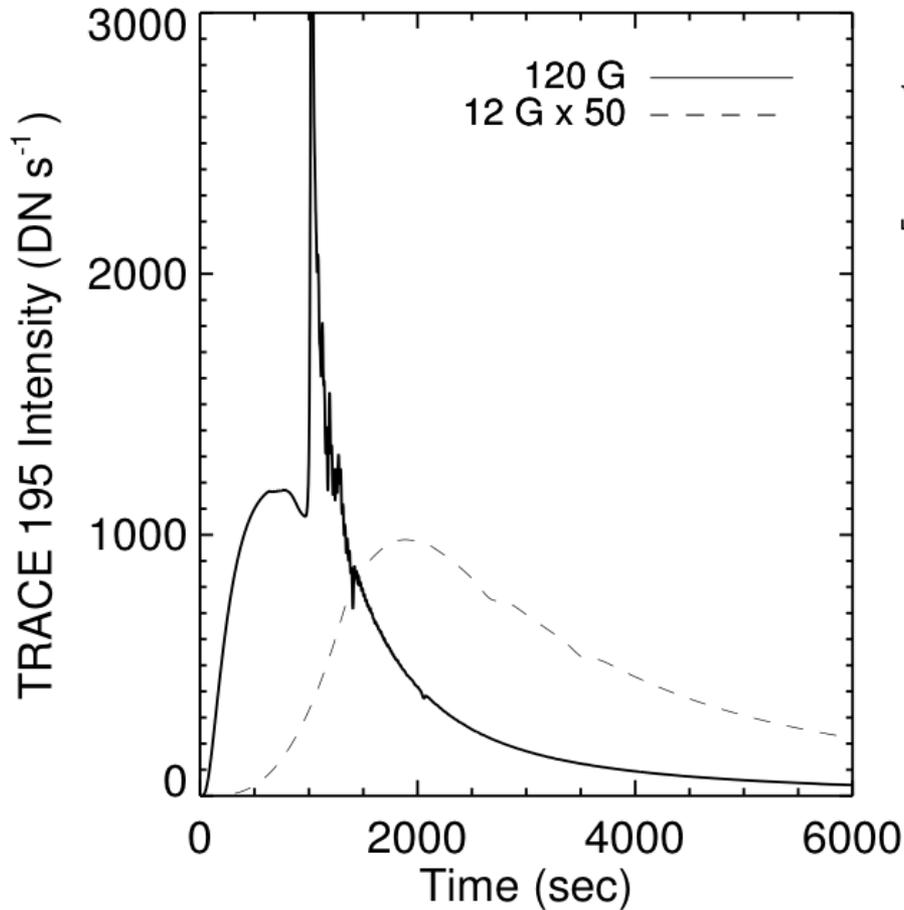
# Temperatures and Densities

$m_0 = 2.1e16 \text{ g}$   
 $\lambda_0 = 2e9 \text{ cm}$   
 $L = 1e10 \text{ cm}$   
 $M_A = 0.025$   
 $B = 120 \text{ G}$

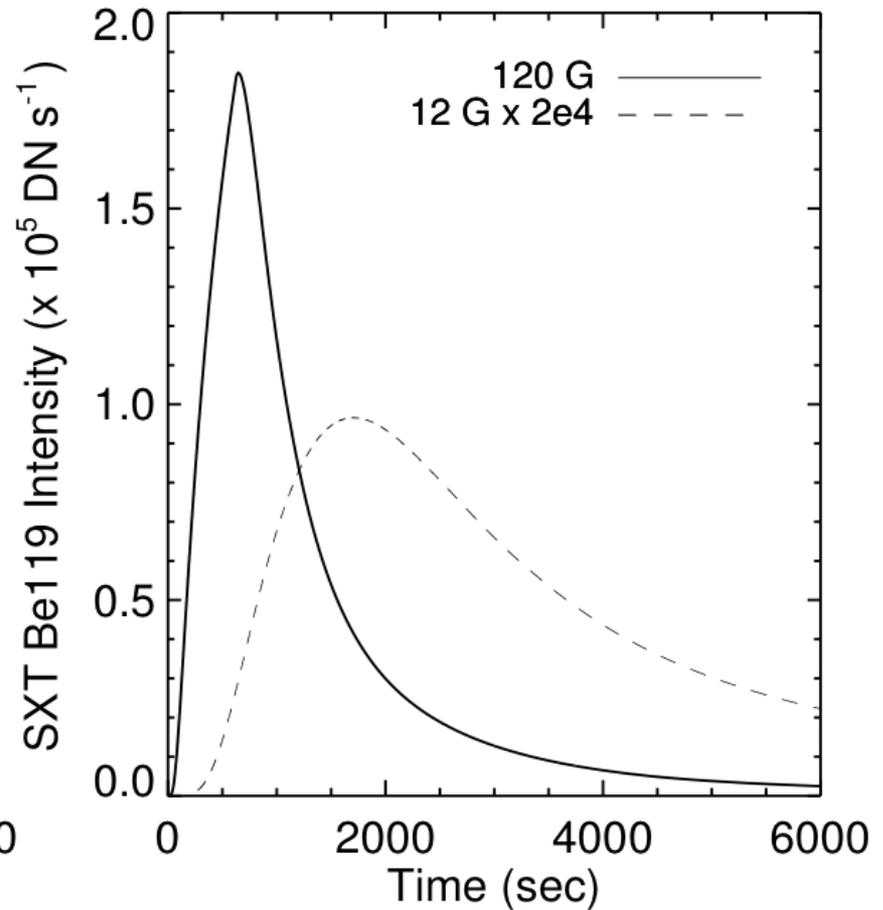


Temperature

# Predicted Lightcurves

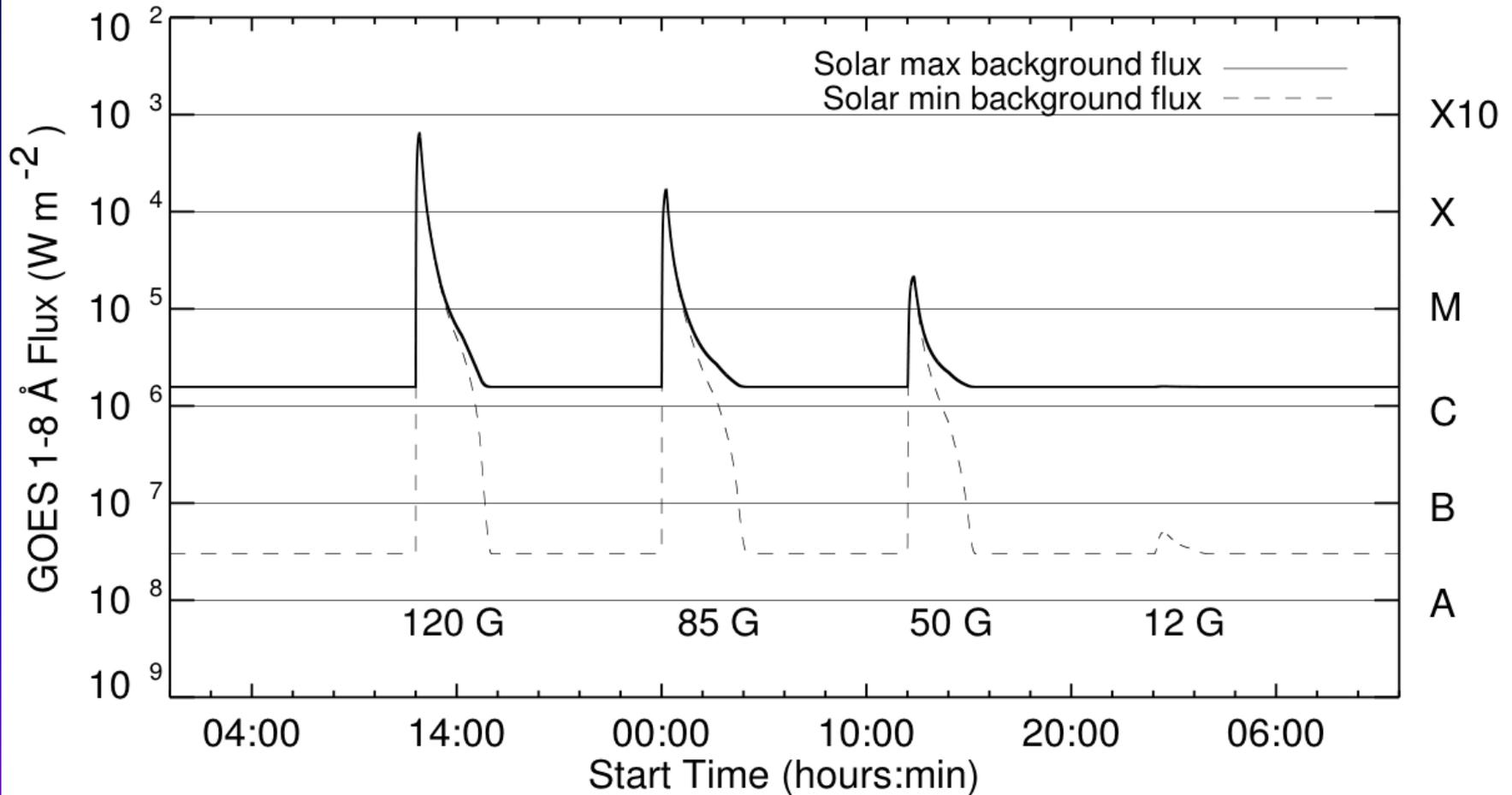


**TRACE 195 Å**



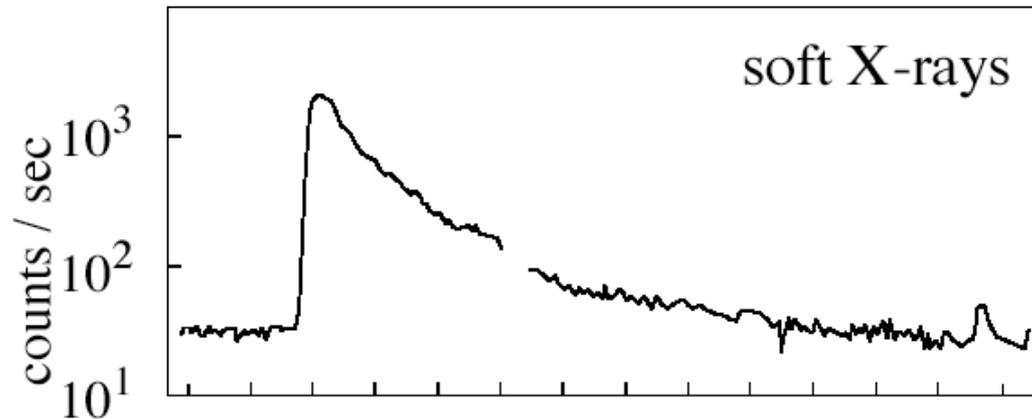
**SXT Be119**

# Predicted Lightcurves for GOES 1-8 Å

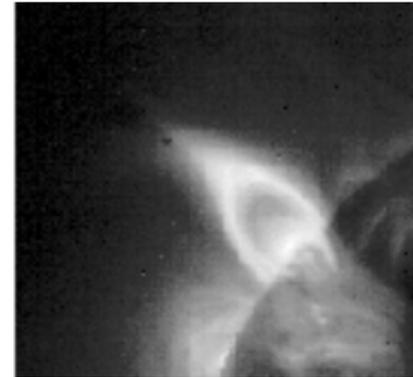


# The Neupert Effect

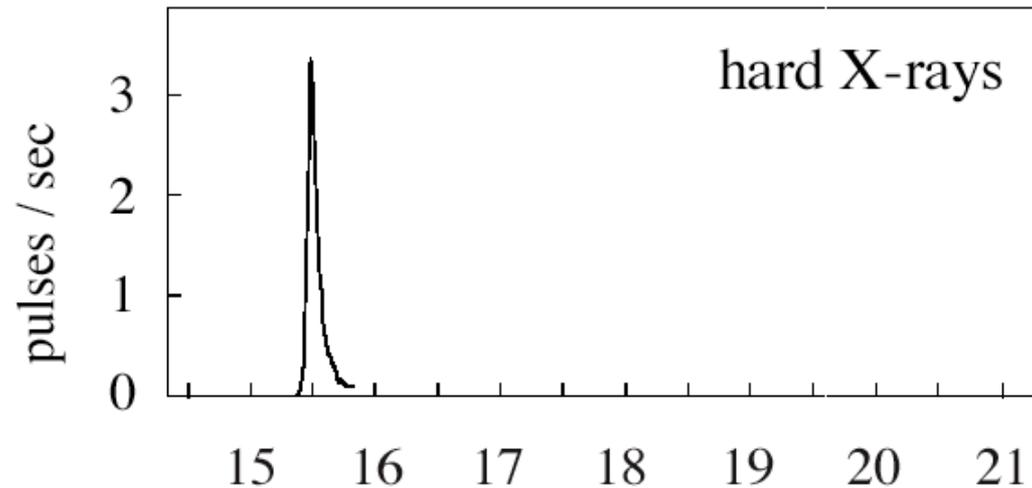
corona



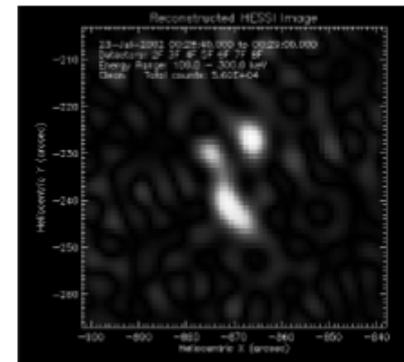
Yohkoh



nonthermal



RHESSI



# The Neupert Effect

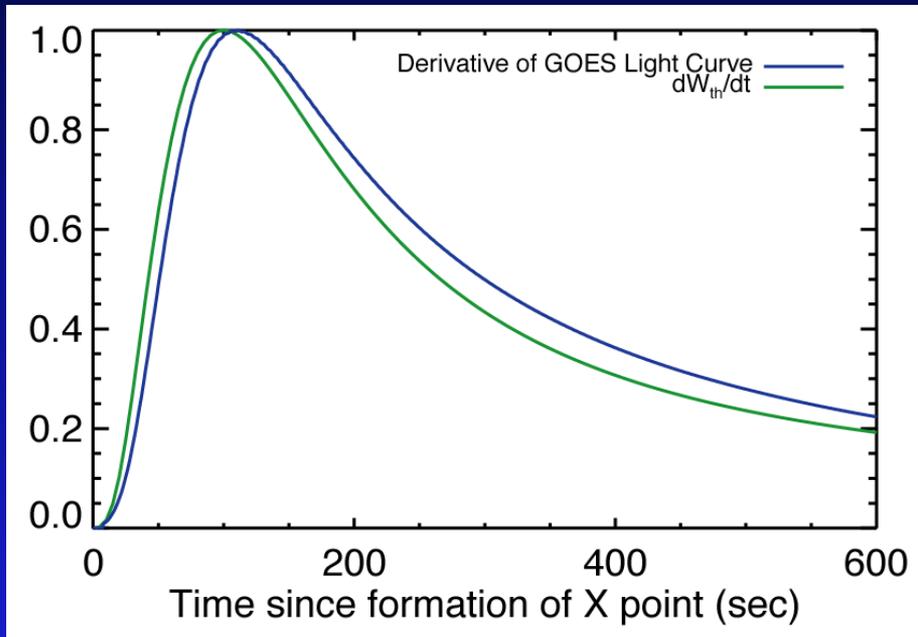
- **An Implication (see, e.g. Takasaki et al., 2004):**

$$\frac{dI_{\text{SXR}}}{dt} \propto \frac{dW_{\text{th}}}{dt}$$

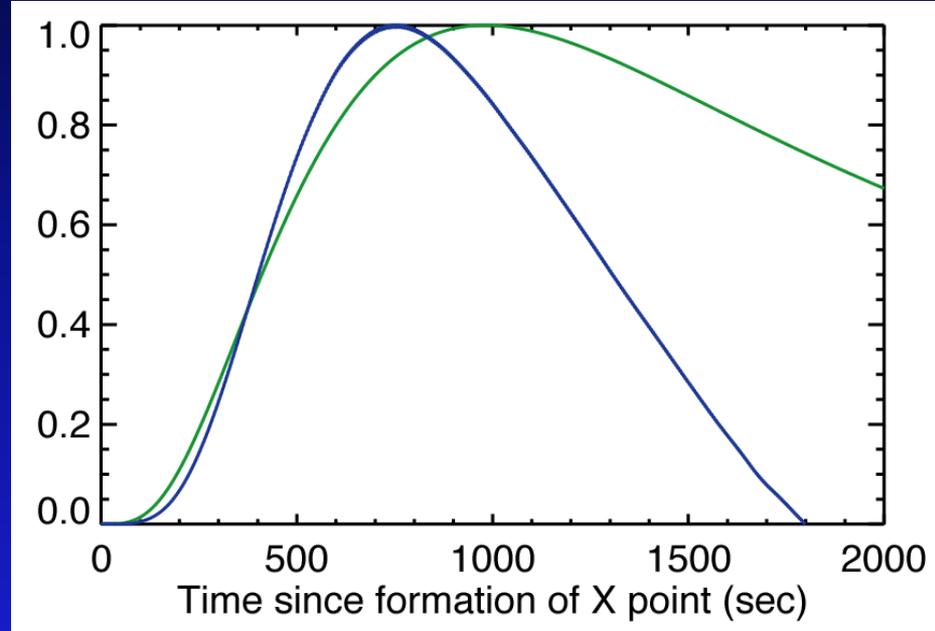
- **Warren & Antiochos (for Cargill cooling loops) :**

$$I_{\text{SXR}} \propto (W_{\text{th}})^{7/4}$$

# Results from Simulation



**120 G Field  
(X flare)**



**12 G Field  
(A flare)**

# Conclusions

- **Using Cargill cooling method, characteristic flare light curves are reproduced**
- **Weak background B field → Weak flare emission**
- **$dI_{\text{SXR}}/dt \propto dW_{\text{th}}/dt$  for large flares with many loops**