

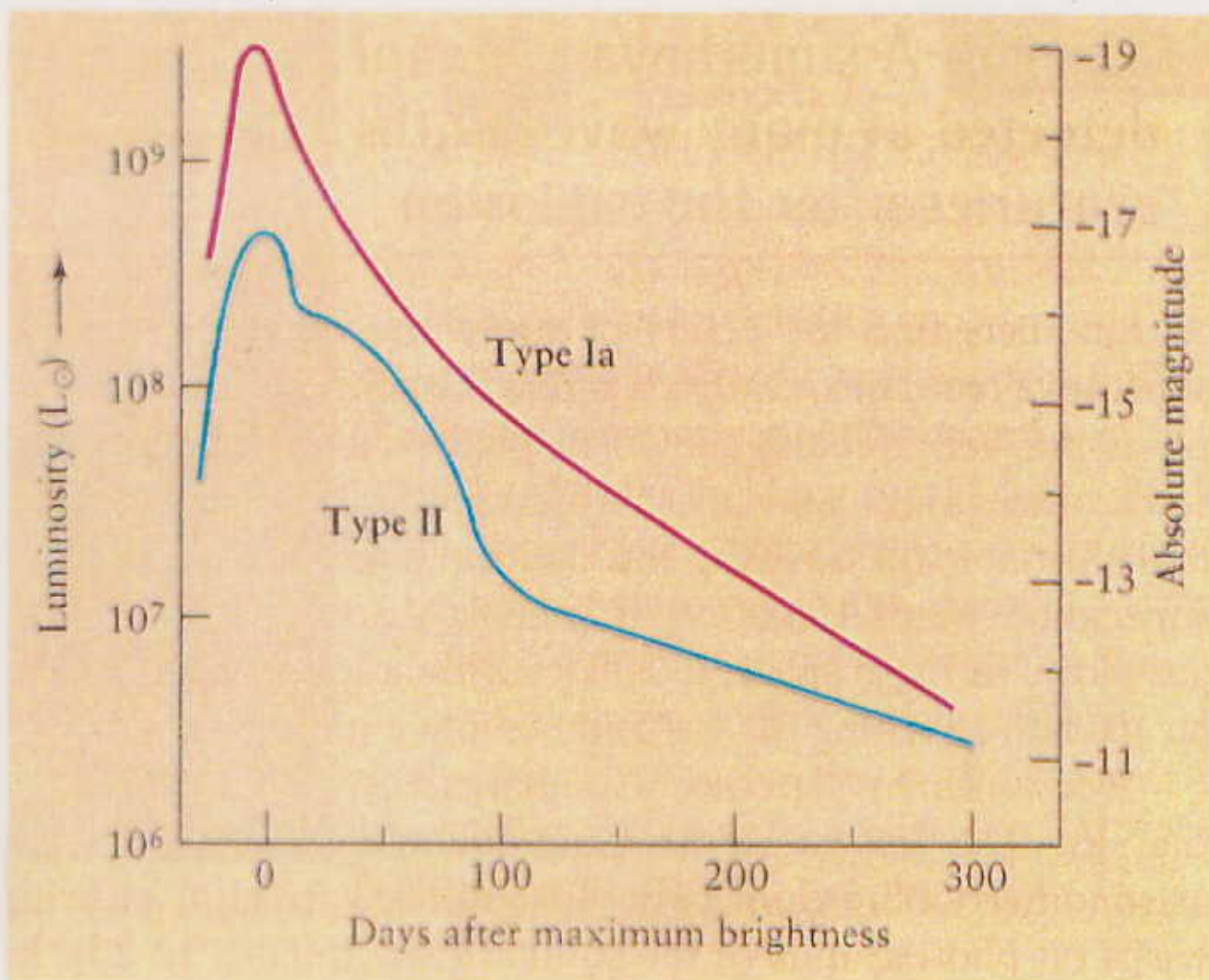
Physical Sciences 120  
Winter 2005

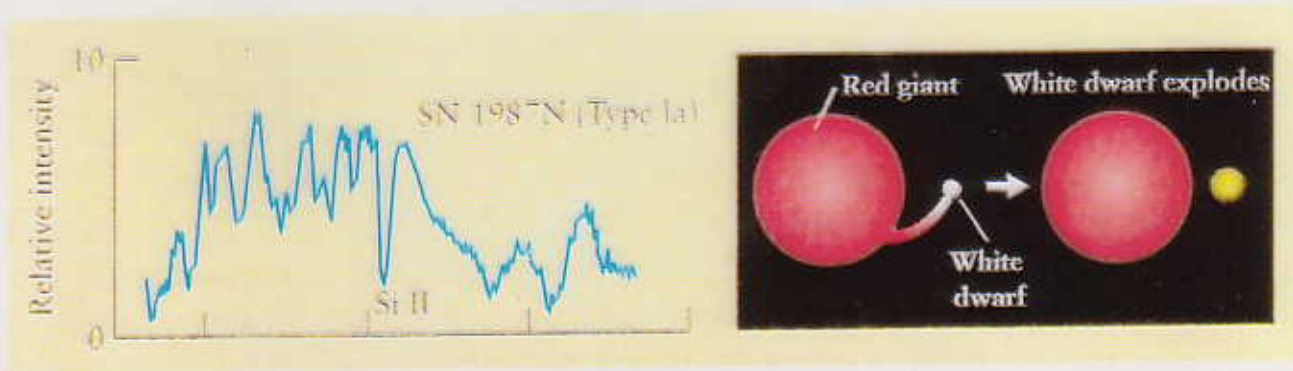
*Origin of the Universe,  
and How We Know*

Don Q. Lamb

Lecture 19

**TYPE II  
SUPERNOVAE**

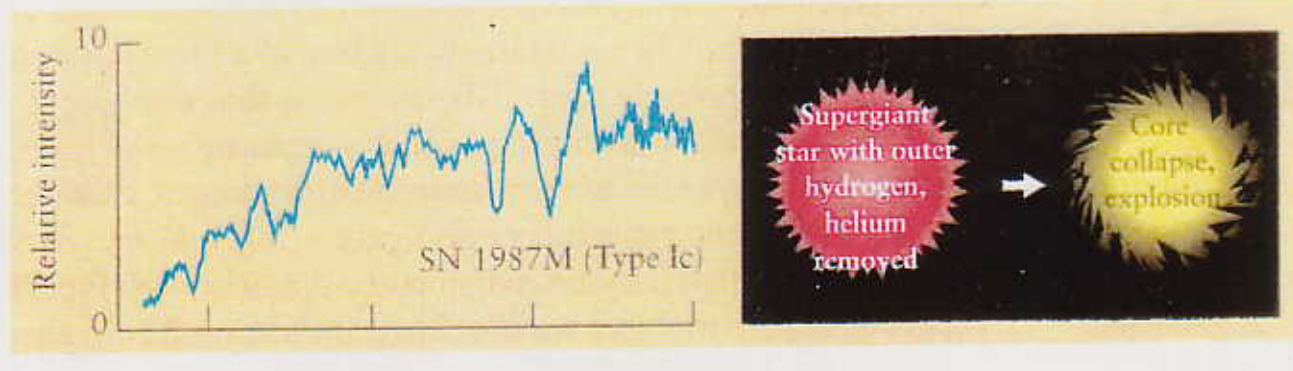




a



b



c



d

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TABLE  
Properties of Supernovae

Property	Type Ia	Type Ib	Type Ic	Type II
Energy Source	Nuclear	Gravity	Gravity	Gravity
Total Energy (ergs)	$3 \times 10^{51}$	$3 \times 10^{53}$	$3 \times 10^{53}$	$3 \times 10^{53}$
Fraction of Energy in $\nu$ 's	$\approx 0$	$\approx 0.1$	$\approx 0.1$	0.99
Fraction of Energy in KE	$\approx 1$	$\approx 1$	$\approx 1$	$10^{-2}$
Fraction of Energy in Light	$3 \times 10^{-3}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$	$3 \times 10^{-3}$
H in Spectrum (Yes/No)	No	No	No	Yes
He in Spectrum (Yes/No)	No	Yes	No	Yes
Si in Spectrum (Yes/No)	Yes	No	No	No
Progenitor Star	White Dwarf	$20 - 60 M_{\odot}$ Star	$20 - 60 M_{\odot}$ Star	$10 - 60 M_{\odot}$ Star
Remnant	None	Black Hole	Black Hole	Neutron Star or Black Hole

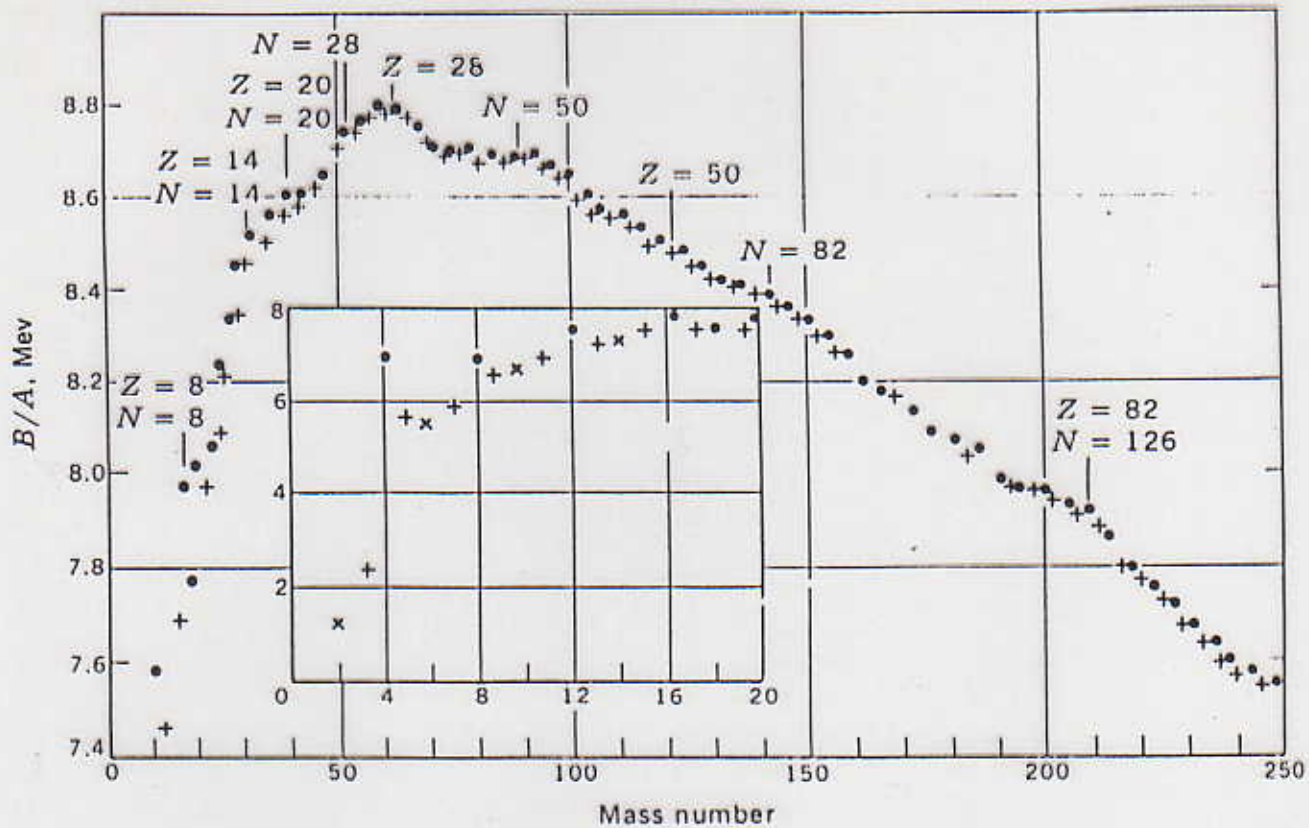


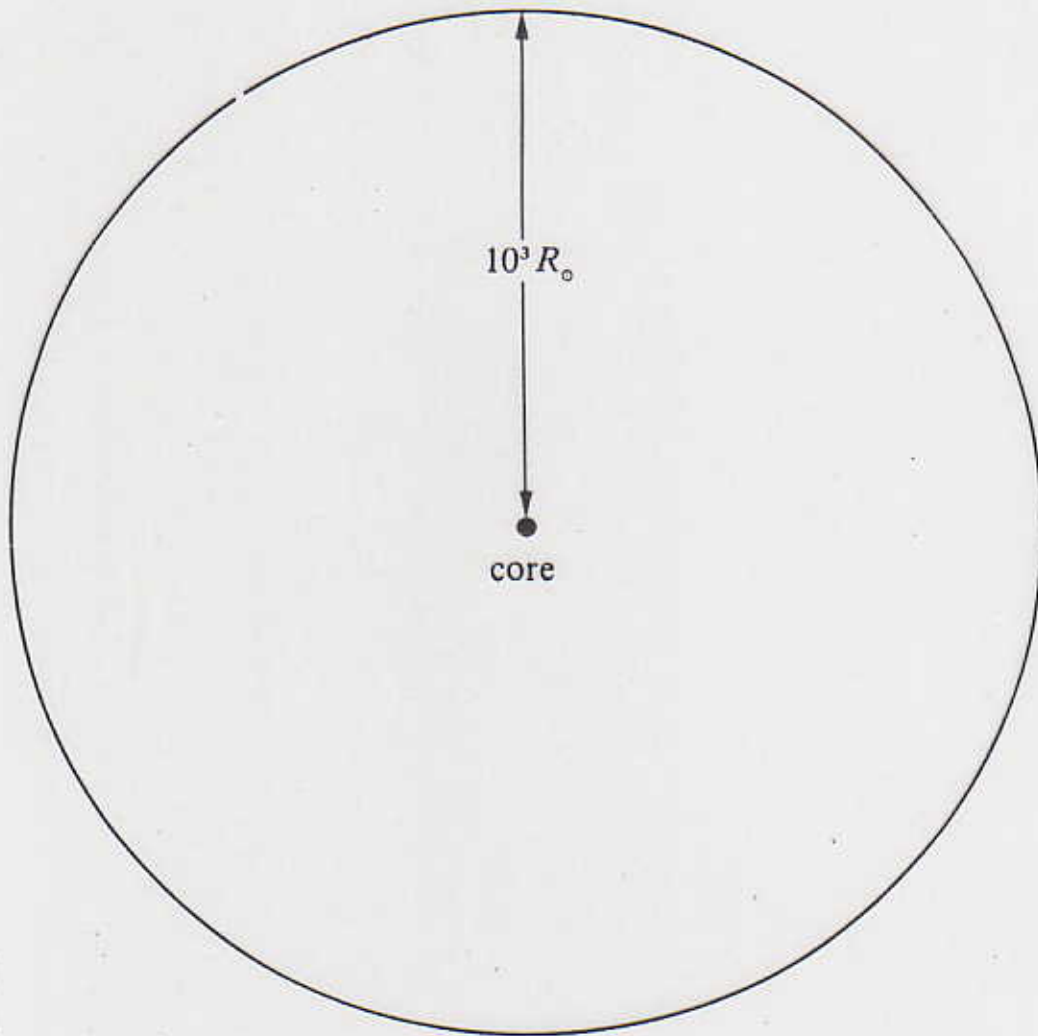
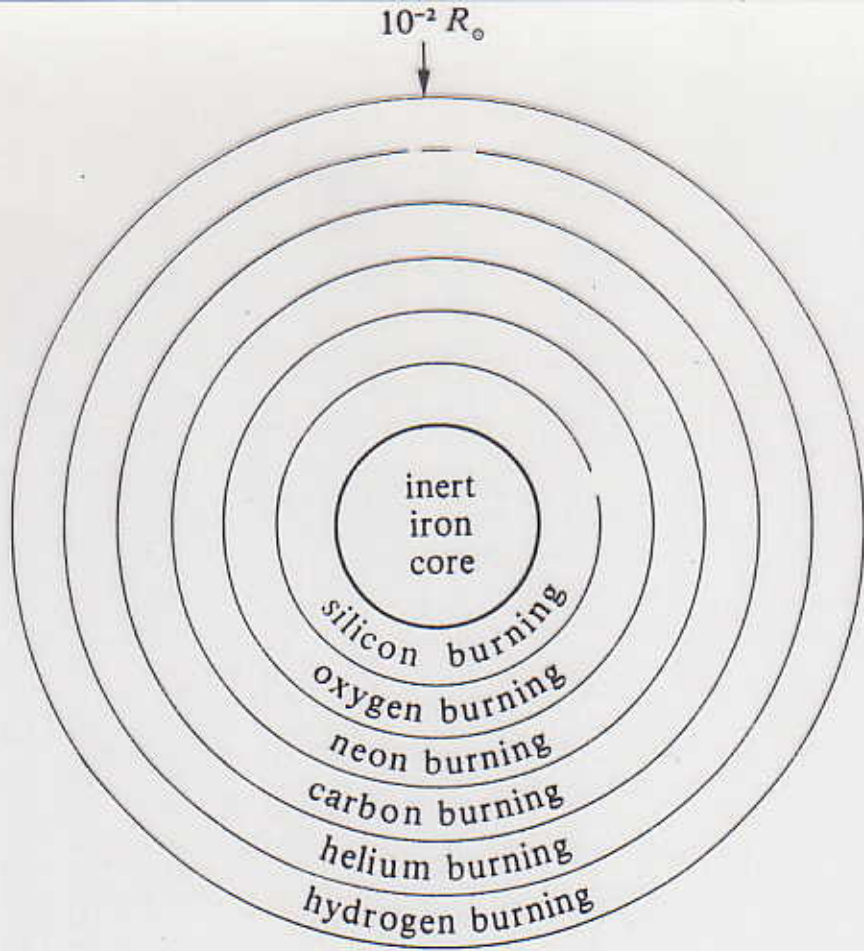
**M74 - Digital Sky Survey  
1990**

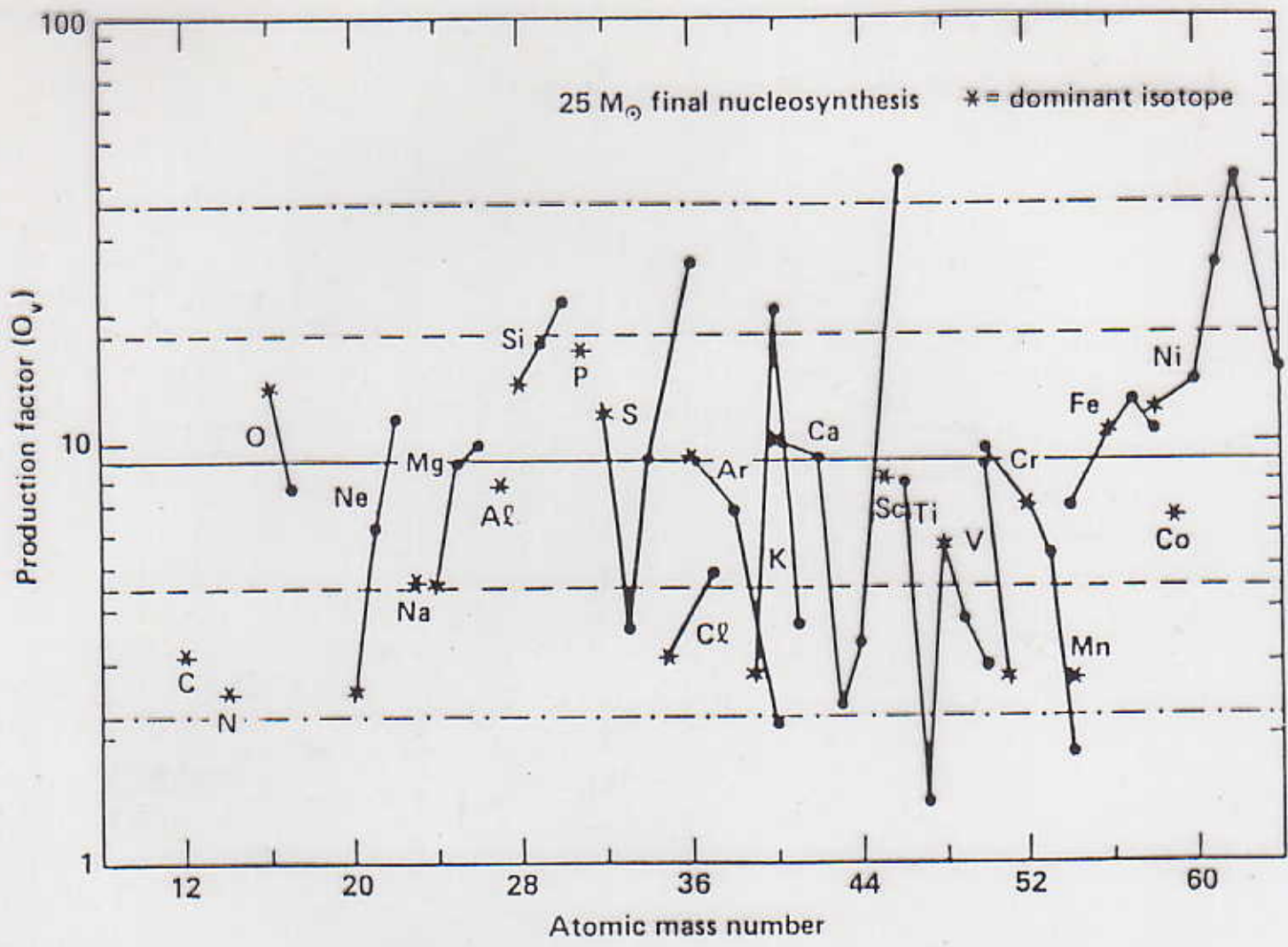


**Mt. Hopkins 1.2m - SN 2002ap  
Jan 31, 2002**

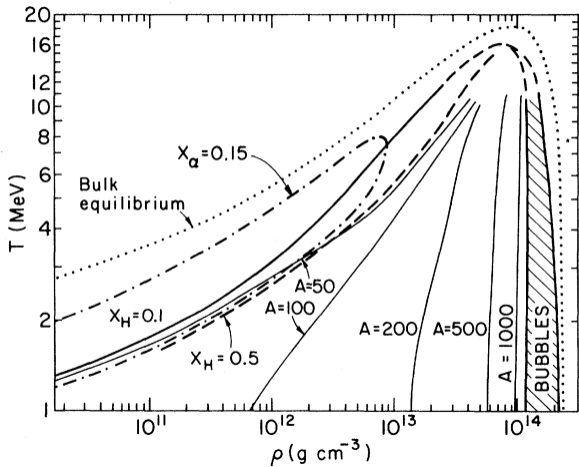












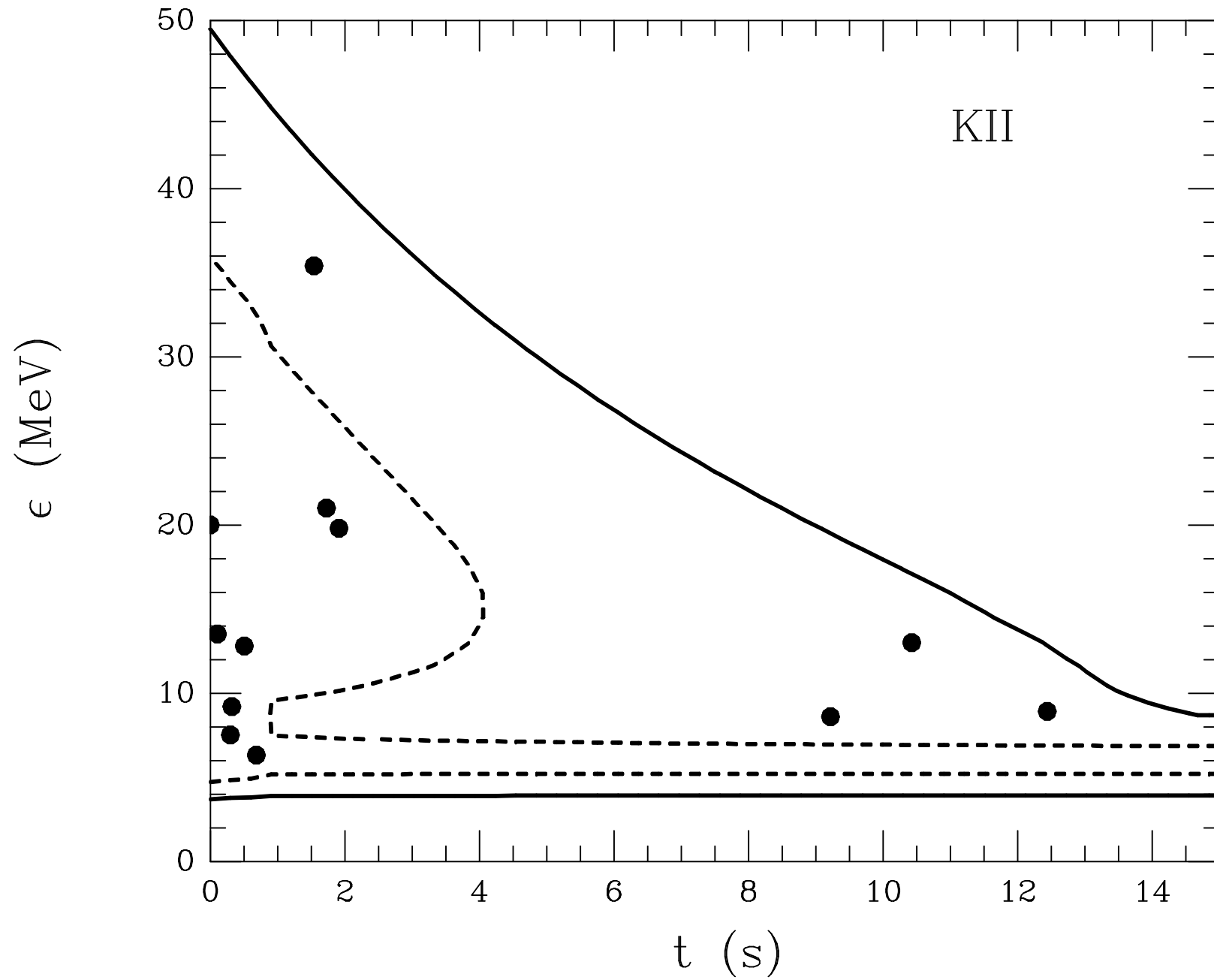


Figure 11a

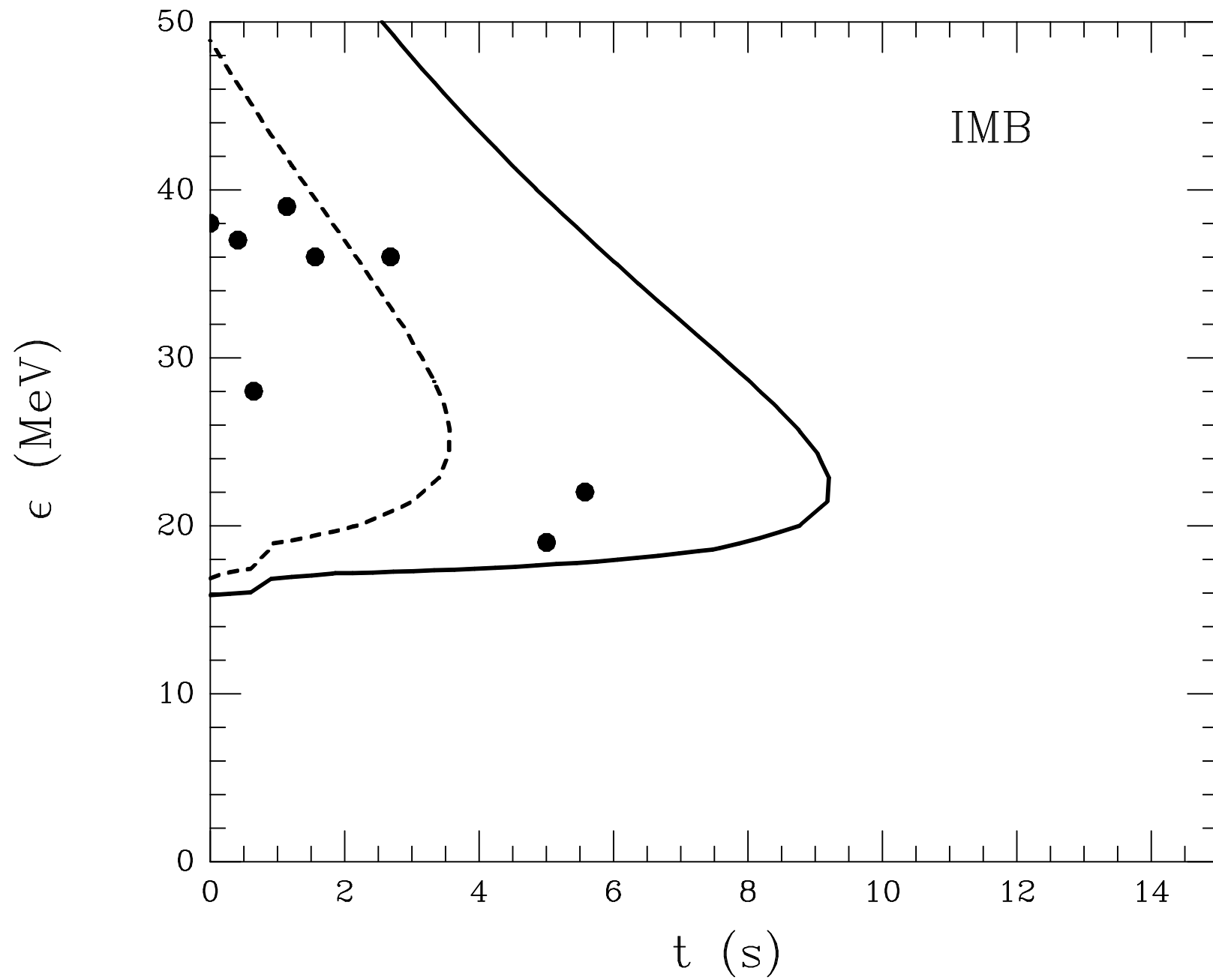


Figure 11b

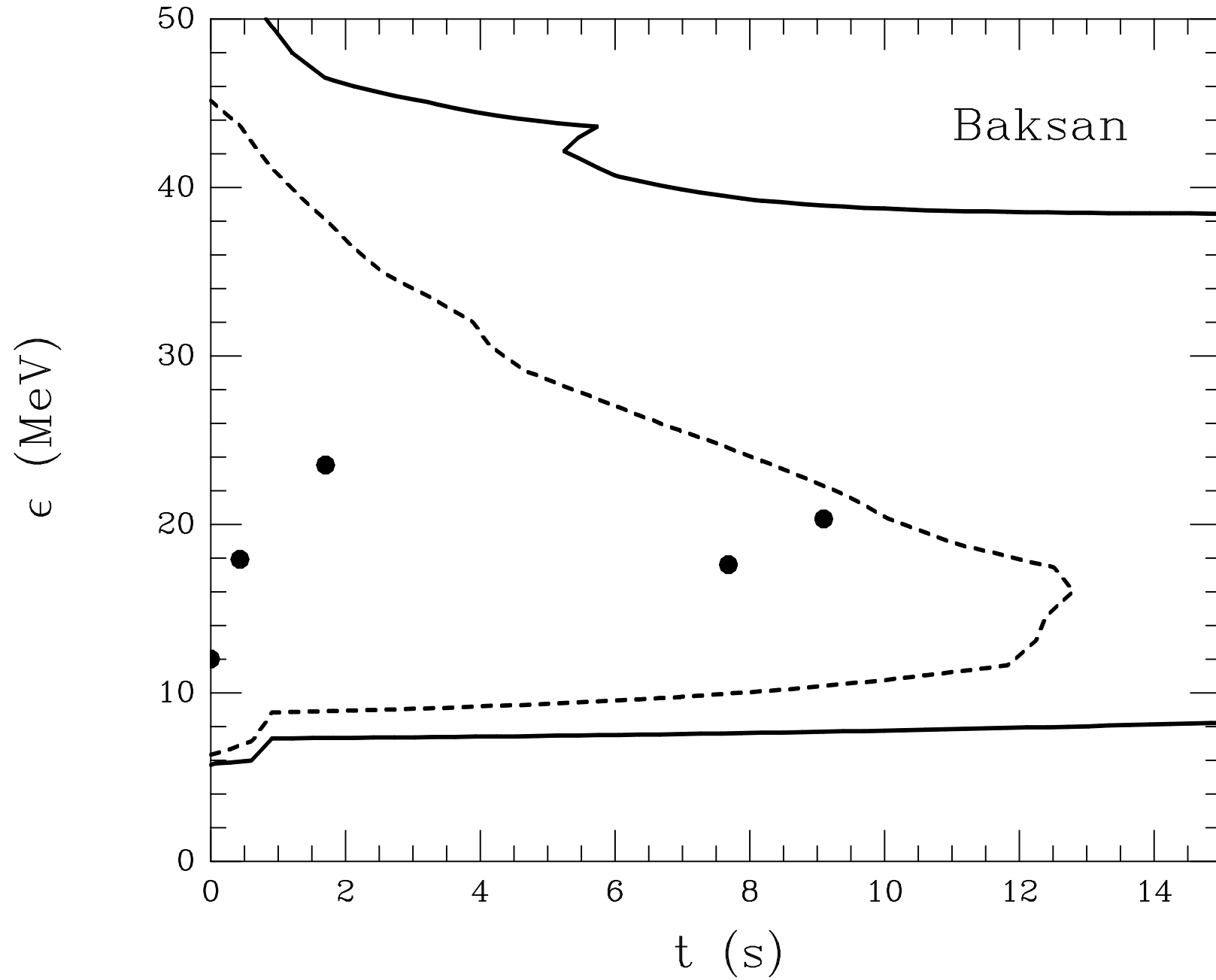


Figure 11c



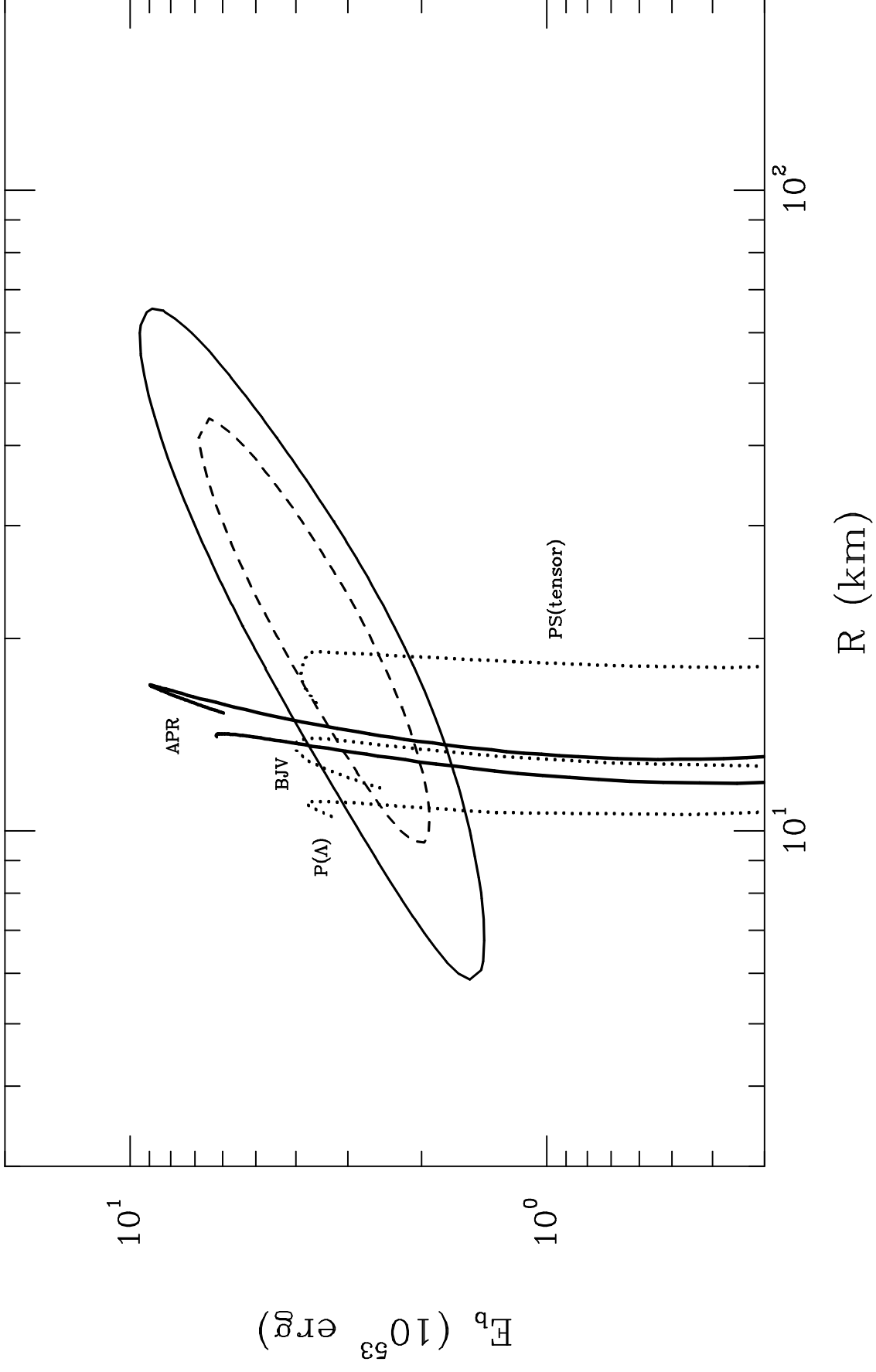


Figure 10

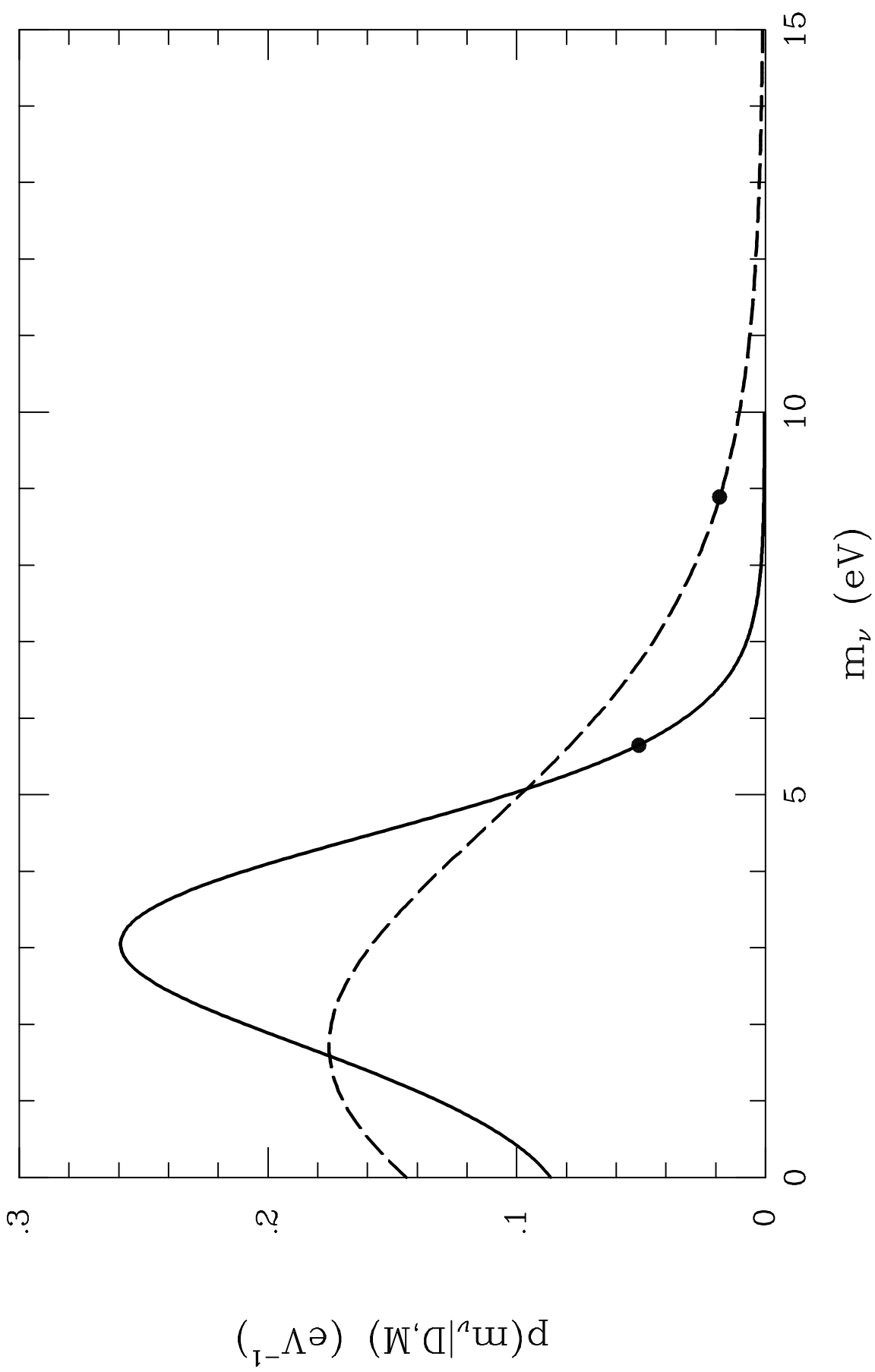


Figure 12

# 56Co

Gamma rays are converted to optical, IR  
 $L(O+IR) \sim \exp(-t/111.3d)$

Observed bolometric luminosity  $\Rightarrow M(^{56}\text{Co}) = 0.069 \pm 0.003 M_{\odot}$

