

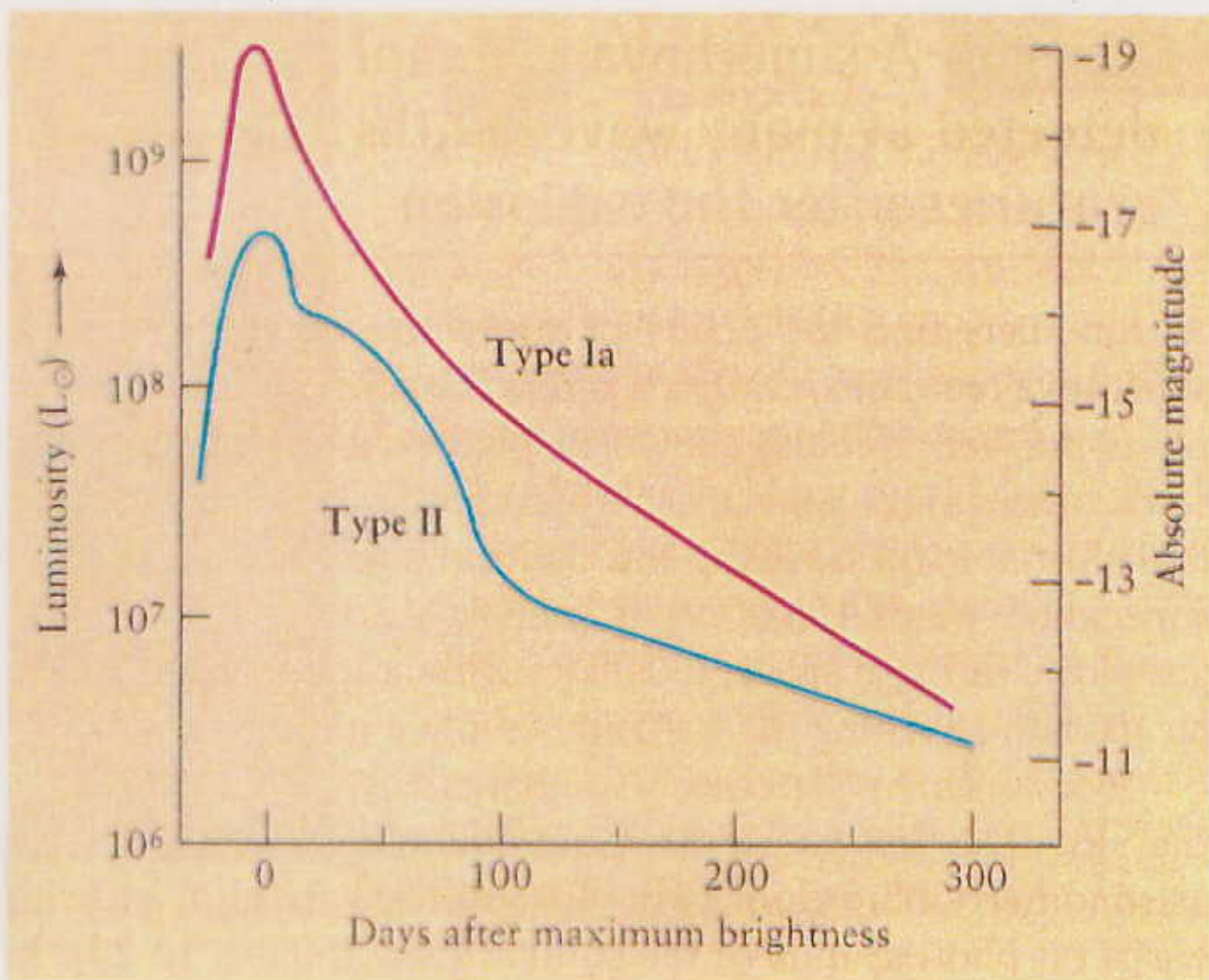
Physical Sciences 120
Winter 2005

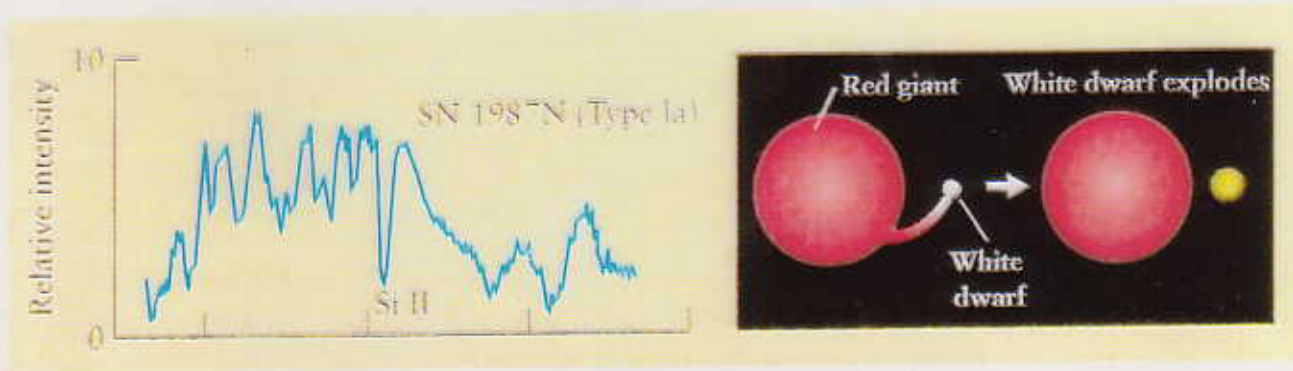
*Origin of the Universe,
and How We Know*

Don Q. Lamb

Lecture 19

**TYPE II
SUPERNOVAE**

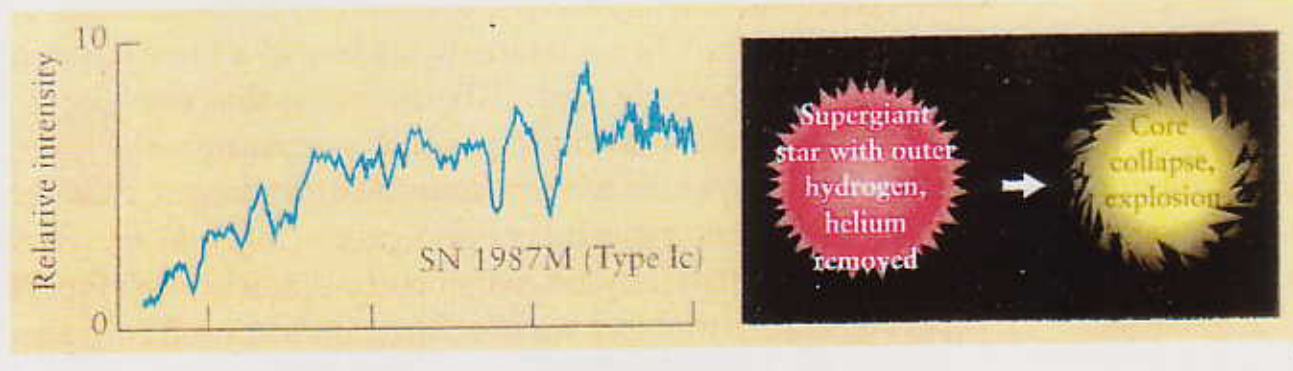




a



b



c



d

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Spring Quarter 2004

TABLE
Properties of Supernovae

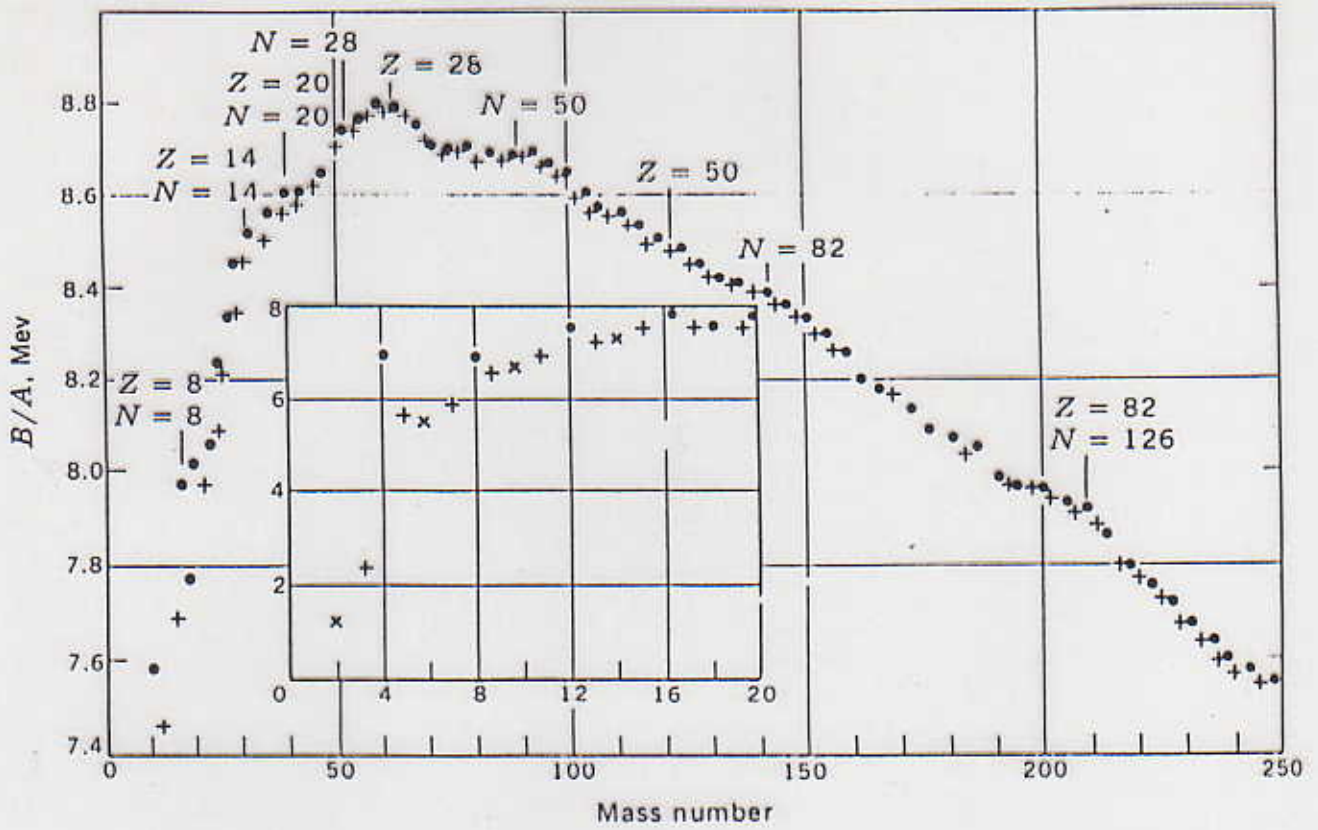
Property	Type Ia	Type Ib	Type Ic	Type II
Energy Source	Nuclear	Gravity	Gravity	Gravity
Total Energy (ergs)	3×10^{51}	3×10^{53}	3×10^{53}	3×10^{53}
Fraction of Energy in ν 's	≈ 0	≈ 0.1	≈ 0.1	0.99
Fraction of Energy in KE	≈ 1	≈ 1	≈ 1	10^{-2}
Fraction of Energy in Light	3×10^{-3}	3×10^{-3}	3×10^{-3}	3×10^{-3}
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

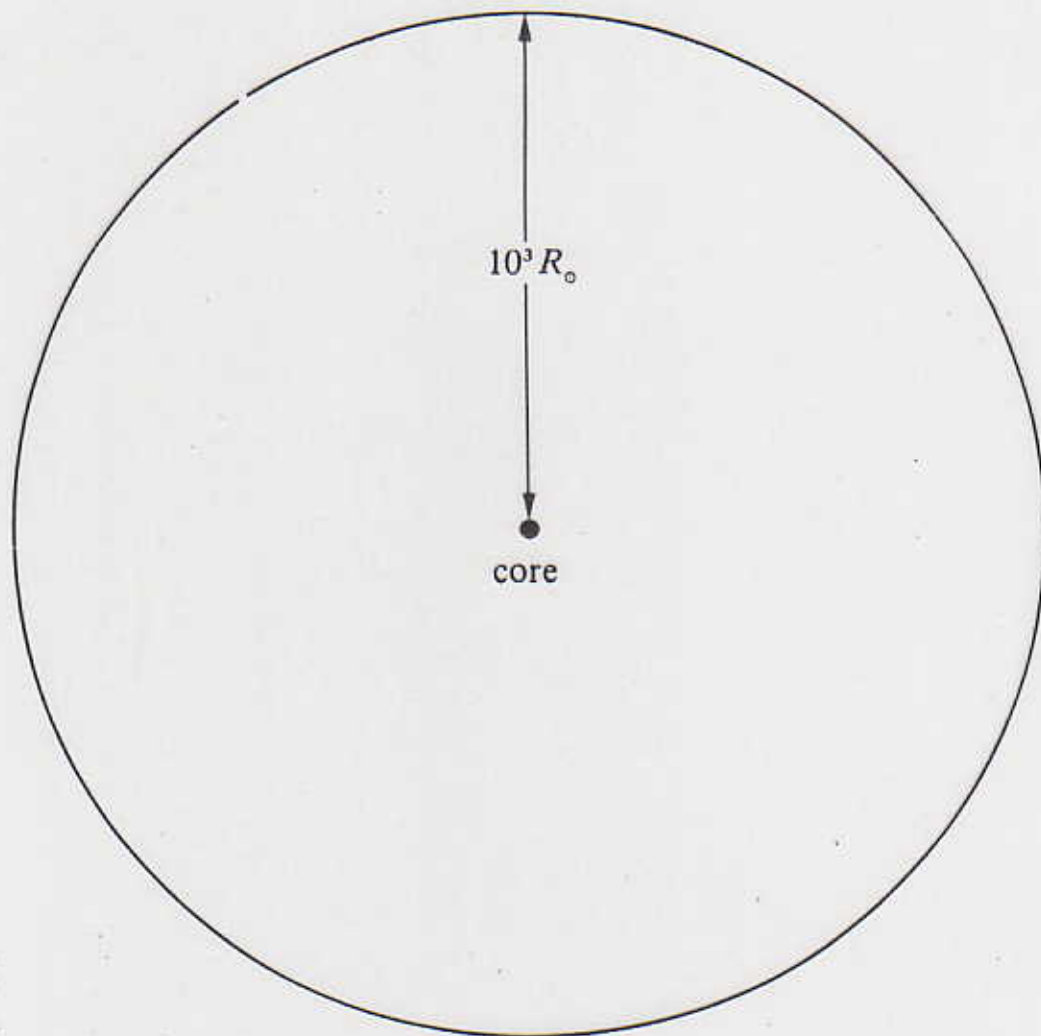
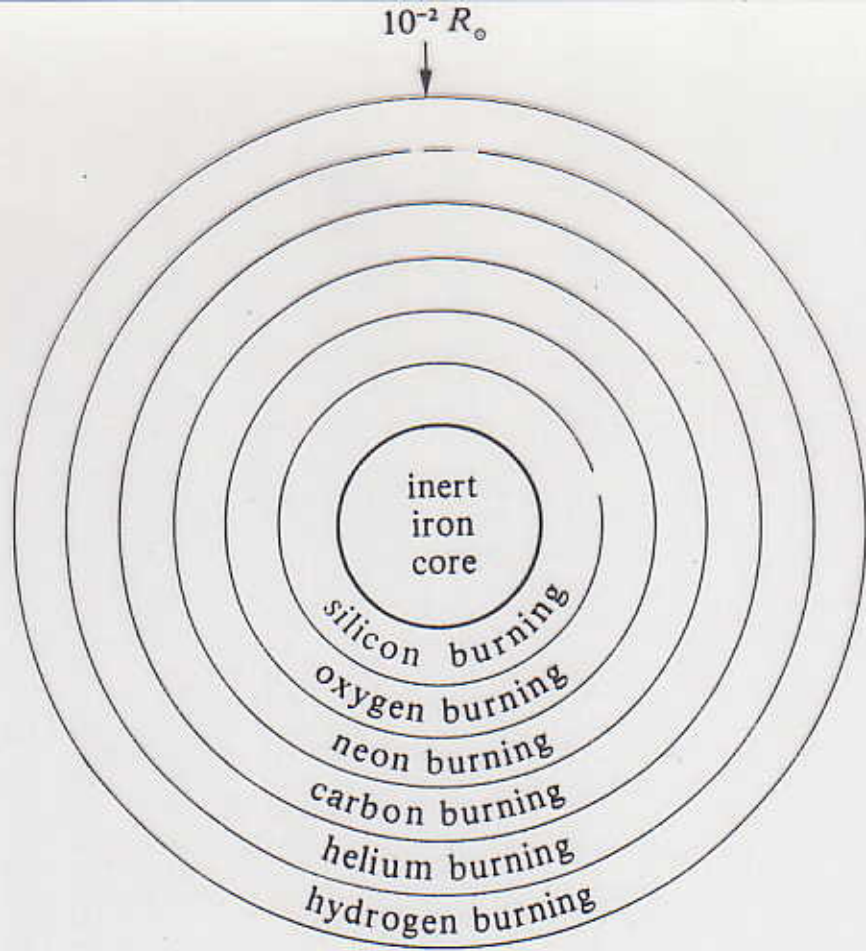
**M74 - Digital Sky Survey
1990**

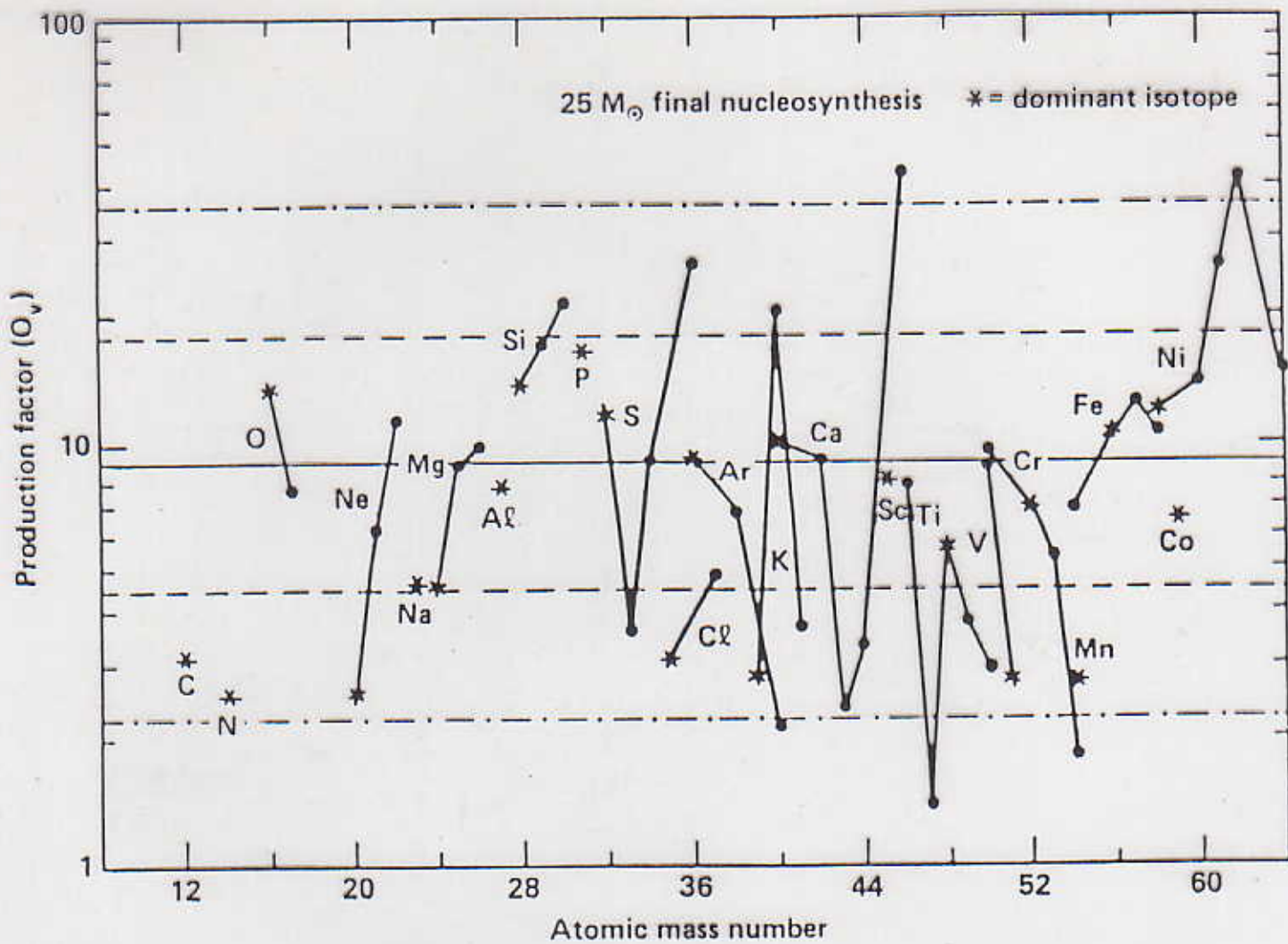


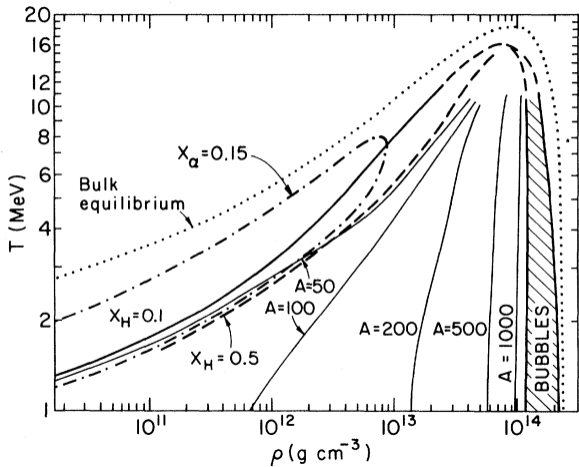
**Mt. Hopkins 1.2m - SN 2002ap
Jan 31, 2002**











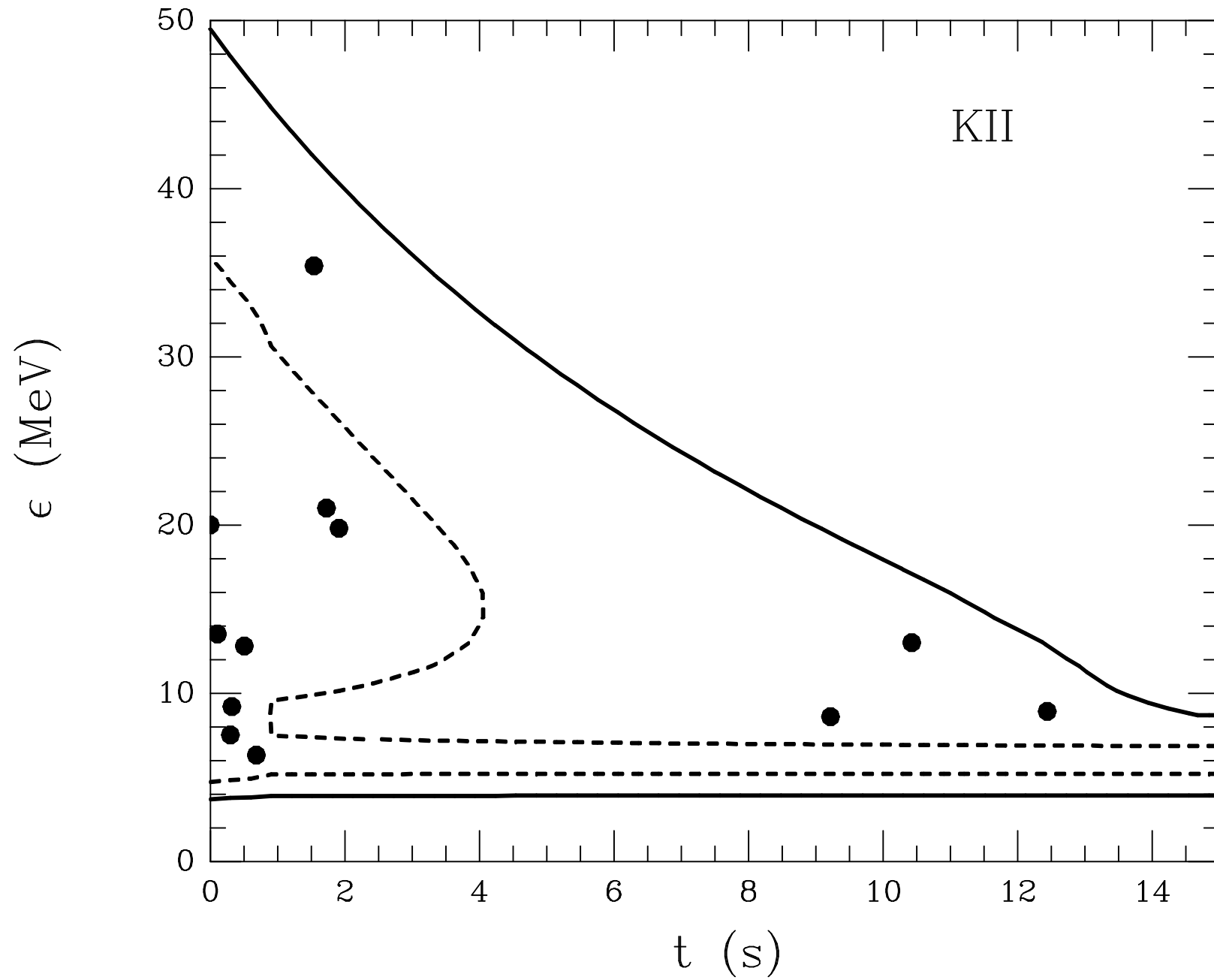


Figure 11a

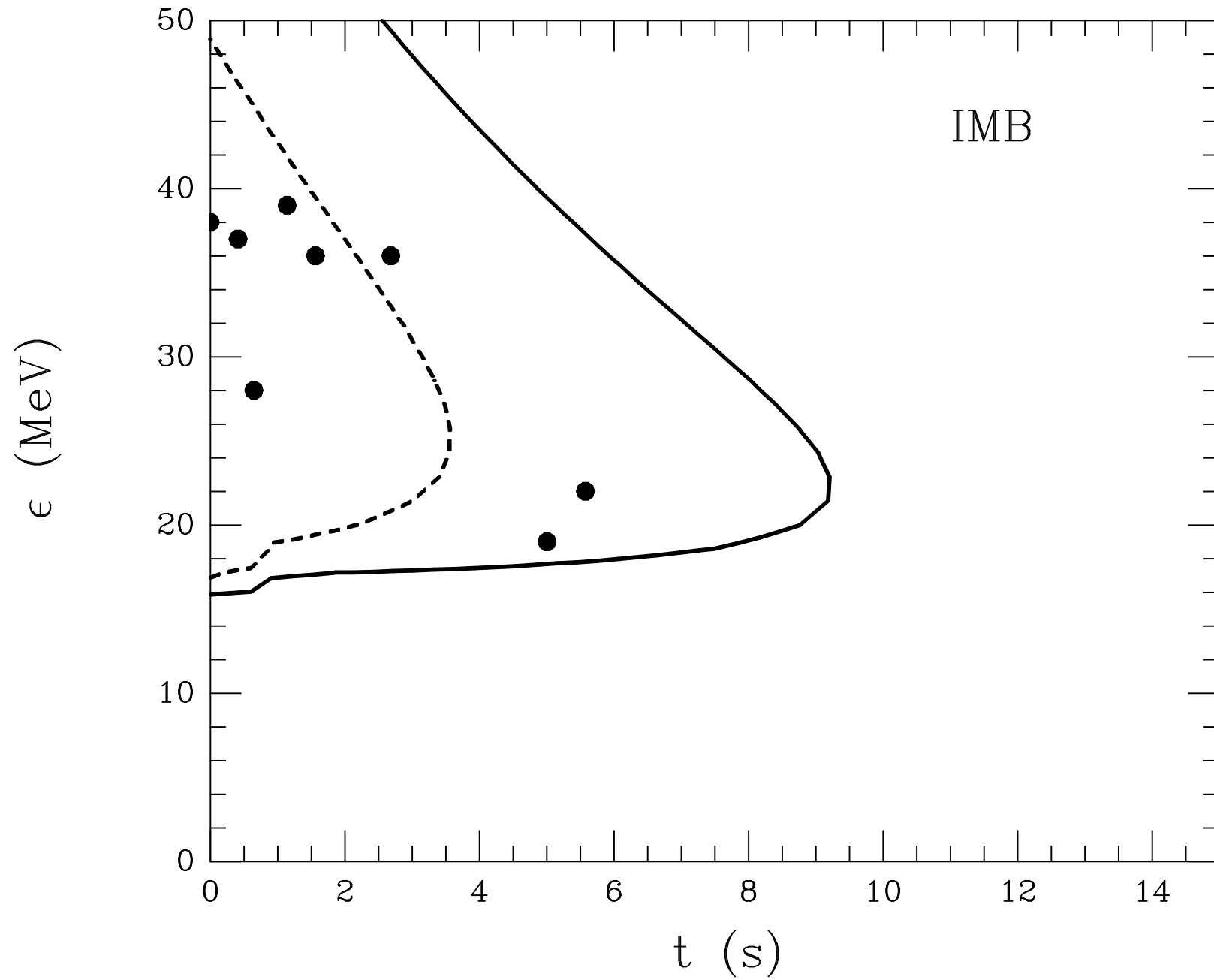


Figure 11b

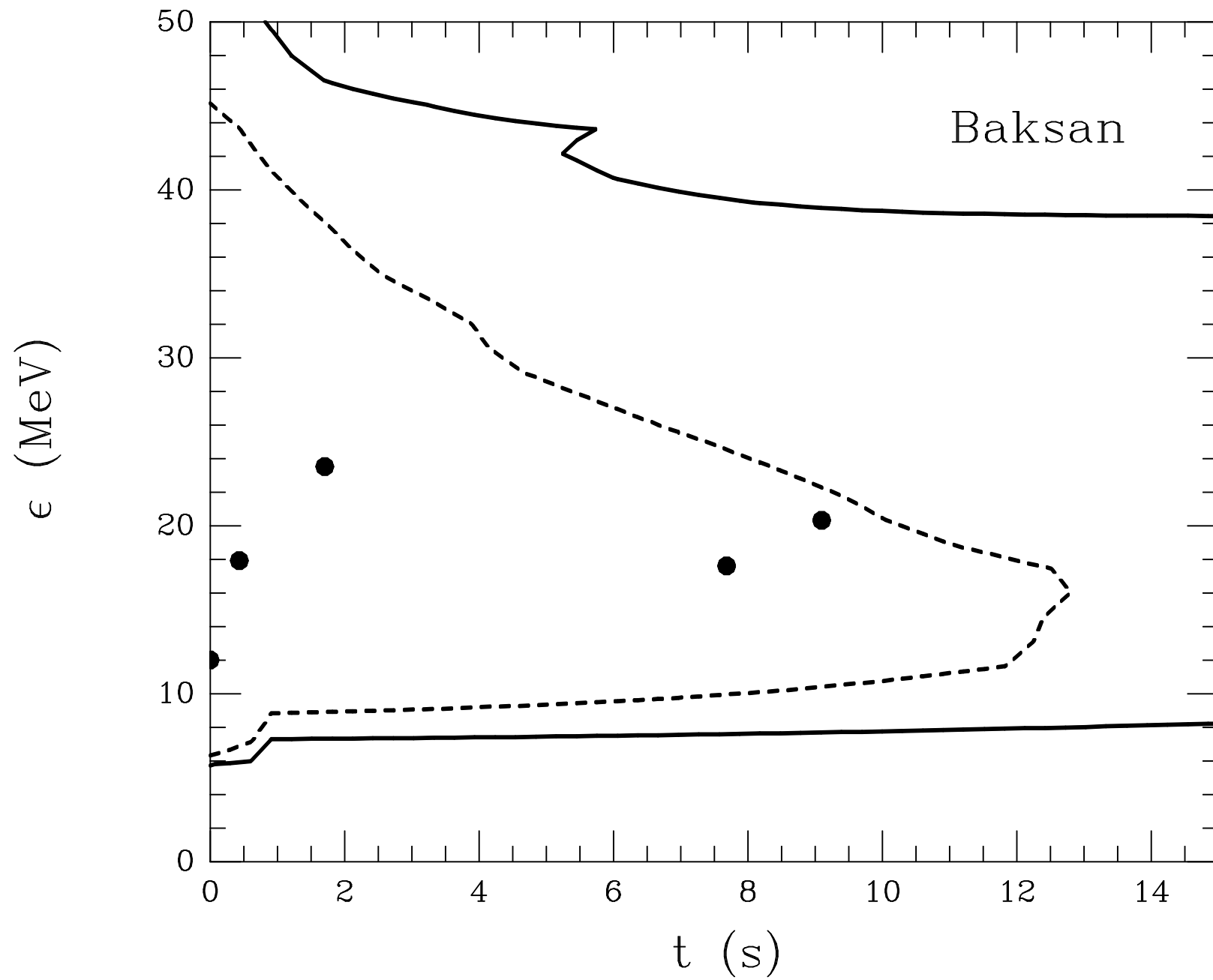


Figure 11c

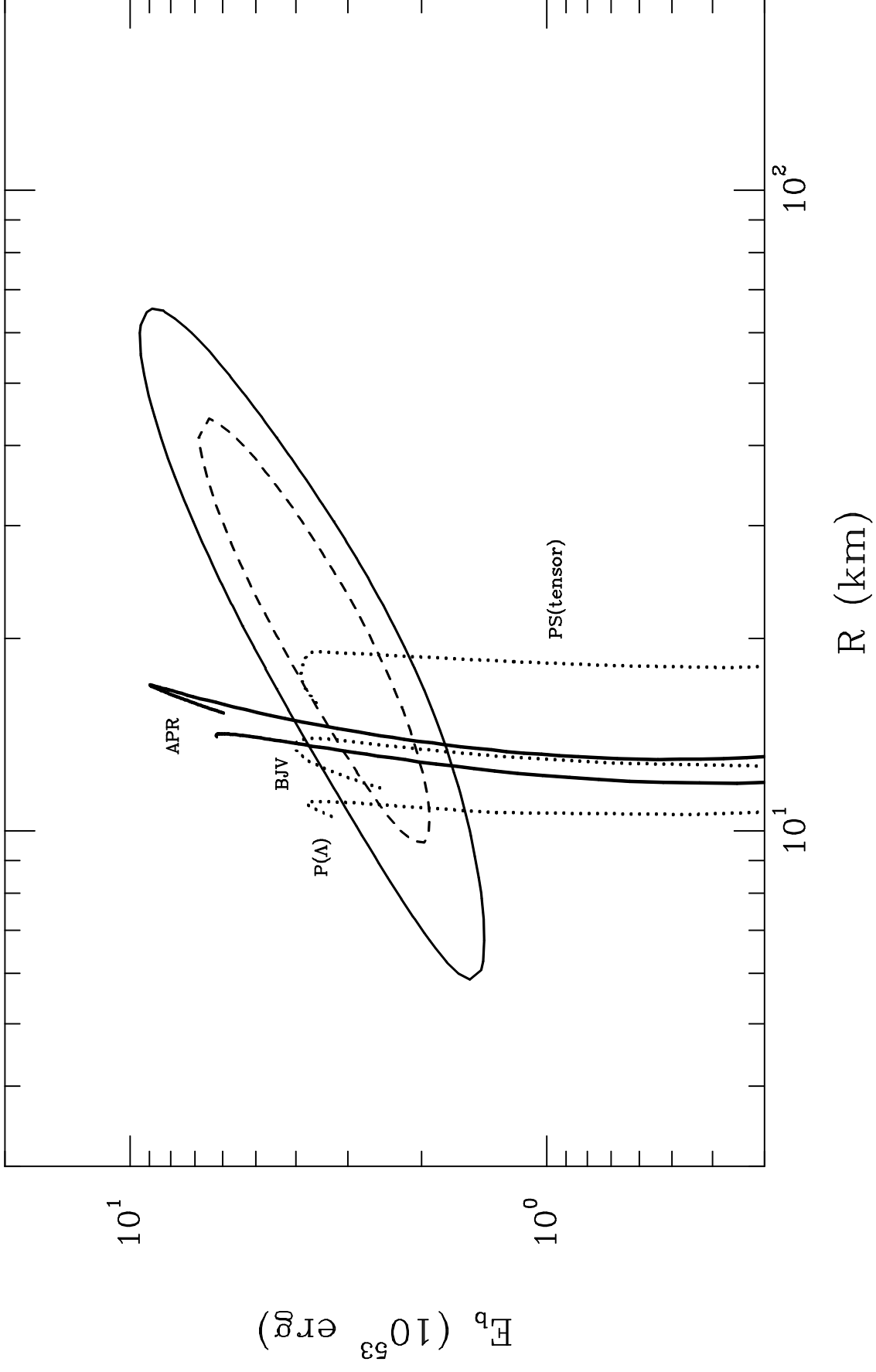


Figure 10

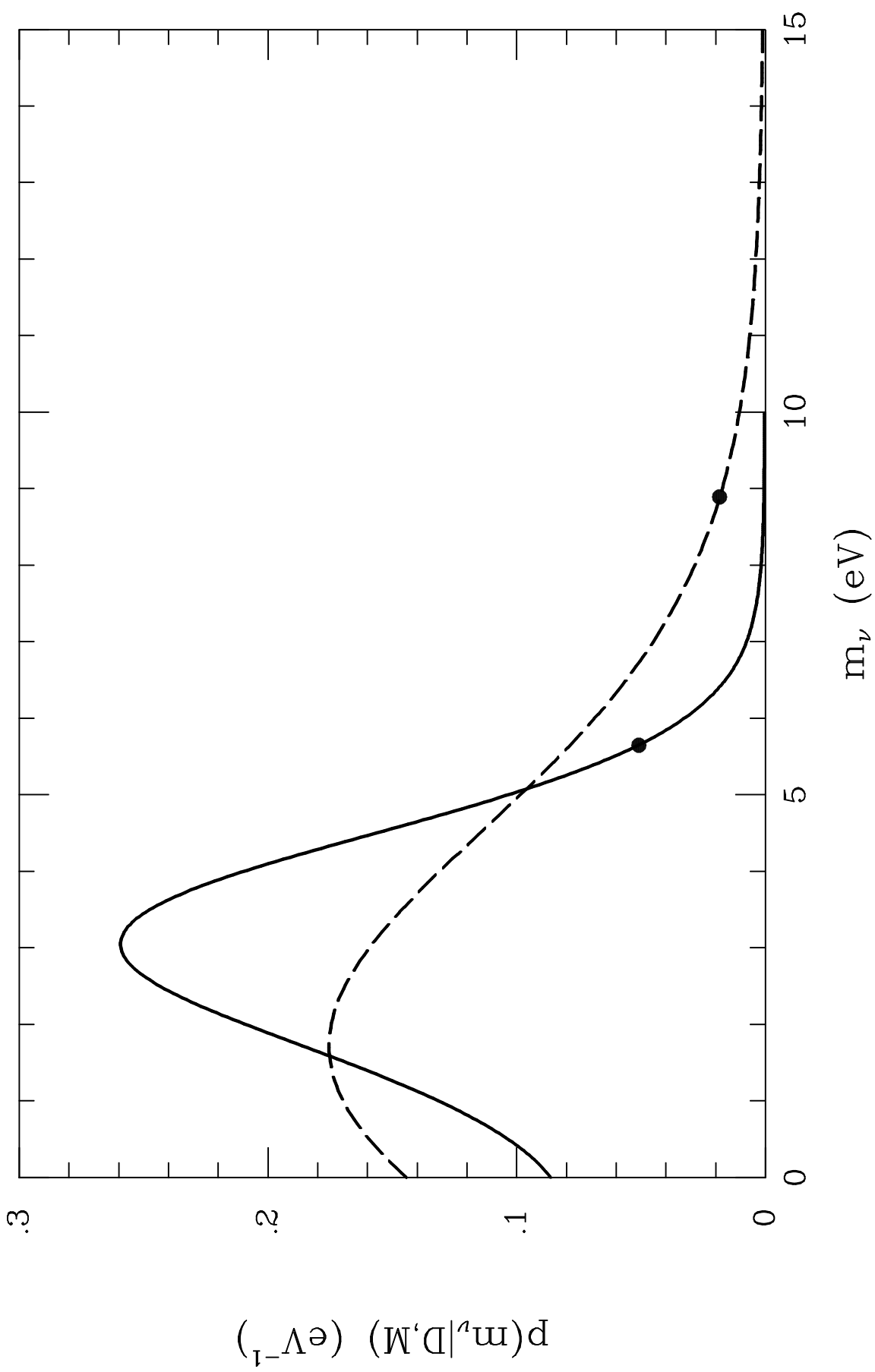


Figure 12

56Co

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

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

