

1. Physics and the Bomb

Physics and the Bomb

- Chronology - 1898 - 1945
 - to fission bomb or A-bomb
- Nuclear Energy
- Discovery of Fission
- Chain Reaction
- Manhattan Project
- Little Boy and Fat Man
- Effects of Nuclear Bombs
- Bigger bombs - 1945 to present
 - to fusion bomb or H-bomb

5/10/2006

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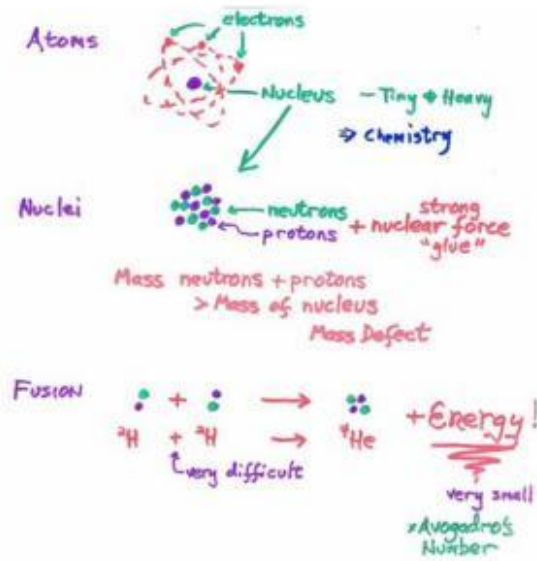
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2. Timeline

Timeline

~100 years ago	X-Rays Radioactivity →	Invisible, Energetic → α, β, γ
1905 ... Einstein	Relativity $E=mc^2$	Mass – Energy 1kg → ~ 1 year of Electrical Energy for Boston
1911 ... Rutherford Bohr	Nuclei/Atoms	Conversion?
1919 ... Aston	Nuclear Masses & Isotopes Mass Defect	
1920's	Nuclear Research & Quantum Mechanics	
1934 ... Szilard	Chain Reaction	
1938 ... Bethe	Fusion → Sun's Energy	
1939 ... Meitner, Hahn, Strassmann, Frisch	Fission Einstein's Letter	
1940 ... Frisch & Peierls (memo)	^{235}U	
1941	Manhattan Project	Fermi's File ^{235}U and/or ^{239}Pu Triggering
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3. Lecture 19: A-bombs and Frisch-Peierls: Slide 3



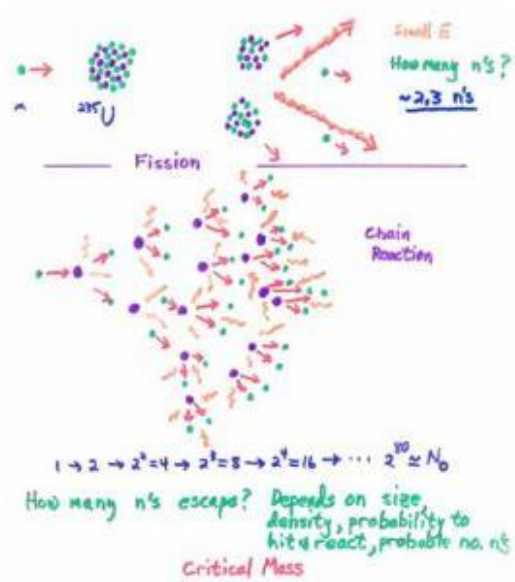
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4. Lecture 19: A-bombs and Frisch-Peierls: Slide 4



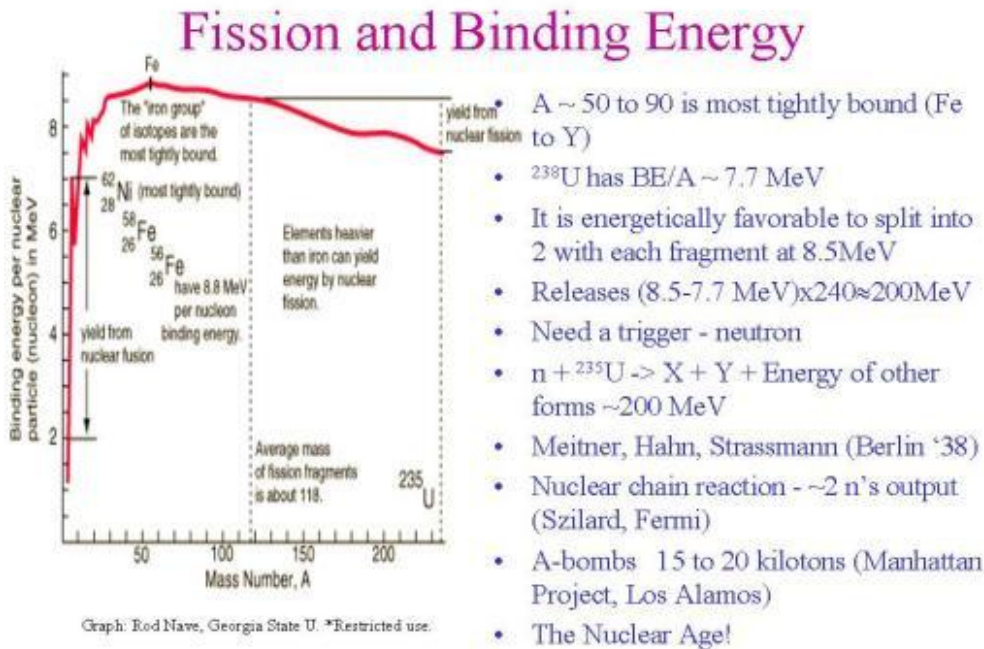
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5. Lecture 19: A-bombs and Frisch-Peierls: Slide 5



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6. Possible energy release in fission

Possible energy release in fission

- 200 MeV is *only* $200 \times 10^6 \text{ eV} = 2.0 \times 10^8 \text{ eV}$
 $= 2.0 \times 10^8 \text{ eV} \times 1.6 \times 10^{-19} \text{ J/eV} = 3.2 \times 10^{-11} \text{ J}$
 ($1 \mu\text{g}$ of dust gets raised $\sim 3 \times 10^{-11} \div (10^{-9} \times 10) = 3 \times 10^{-3} \text{ m} = 3 \text{ mm}$)
- But for 6.0×10^{23} nuclei in 1 mole (235 gram) get
 $6.0 \times 10^{23} \times 3.2 \times 10^{-11} \text{ J} = 1.9 \times 10^{13} \text{ J}$
- Equivalent **explosive** energy
 $1.9 \times 10^{13} \text{ J} \div 4.2 \times 10^{12} \text{ kT/J (kT=kiloton of TNT)}$
 $= 4.5 \text{ kT}$

Gruesome reality ~ 15 kT → ~100,000 people killed instantly

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7. Fission bomb

Fission bomb

- Need a trigger (fission not spontaneous) - neutron
- $n + {}^{235}\text{U} \rightarrow X + Y + \text{Energy of other forms}$
- Nuclear **chain reaction** if ~ 2 n's output
- Sum up to $2^{79} \rightarrow N_{\text{avogadro}} = 6 \times 10^{23}$
- A-bombs **15 to 20 kilotons**
- Size required & limited by critical mass
- ${}_{94}^{239}\text{Pu}$ also works, more delicate

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8. Important concepts

Important concepts

WORDS and PHRASES in Frisch & Peierls:

- fission
- neutrons
- isotopes - 235 and 238 Uranium - separation - thermal separation
- chain reaction - neutrons per fission ~ 2.3
- scattering - elastic, inelastic
- capture
- cross section
- energy - 200 MeV per breakup of U
- critical radius (or mass) and mean free path

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