$$K = \frac{m_0 v^2}{\sqrt{1-(\frac{v}{c})^2}} + m_0c^2\sqrt{1-(\frac{v}{c})^2} - m_0c^2$$

$$= \frac{m_0v^2 + m_0c^2 - m_0v^2}{\sqrt{1-(\frac{v}{c})^2}} - m_0c^2$$

$$K = \frac{m_0c^2}{\sqrt{1-(\frac{v}{c})^2}} - m_0c^2$$

(1) lim $v \ll c$

$$\frac{1}{\sqrt{1-(\frac{v}{c})^2}} \simeq \frac{1}{1-\frac{1}{2}(\frac{v}{c})^2} \simeq 1 + \frac{1}{2}(\frac{v}{c})^2$$

$$K \simeq m_0c^2 + \frac{1}{2}m_0c^2\frac{v^2}{c^2} - m_0c^2$$

$$K \simeq \frac{1}{2}m_0v^2 \rightarrow NR$$

(2) Meaning of m_0c^2

Idea: $E_{rest} = m_0c^2$

mass = energy/c^2

1 kg? $E_{rest} = 1\,kg \cdot (3\cdot10^8)^2 \left(\frac{m^2}{s^2}\right)$

$E_{rest} \simeq 9\cdot10^{16}$ Joules

$\simeq 7\cdot10^8$ gallons of gas

$\simeq$ 22 million barrels of oil

World consumes $\simeq$ 85 million barrels of oil per day

Energy $\longleftrightarrow$ mass

Equivalent Energy of various particles due to their rest masses

Appropriate Energy Unit $\rightarrow$ 1 eV $\cong$ (energy released in chemical reaction) $1.6 \cdot 10^{-19}$ Joules

Electron $m_e c^2 \simeq 511{,}000$ eV

$\simeq 0.511$ MeV

Proton $\simeq$ 938.3 MeV ($\simeq 1840\, m_e c^2$)

Neutron $\simeq$ 939.6 MeV

$m_n \simeq m_p \simeq m_N$ (mass of a nucleon)

Binding Energy Changes Mass!

Hydrogen Atom

$m_H c^2 = m_p c^2 + m_e c^2 - B$

$B \simeq 13.6\ eV \ll m_p c^2$ so it's hardly noticeable

$p + n$ $\quad m_D = m_p + m_n - B$

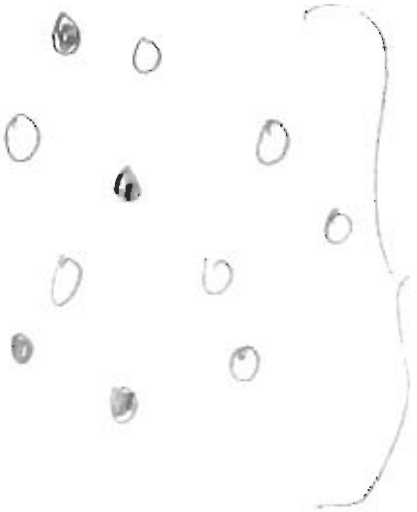
Deuteron
"Heavy Hydrogen"
Isotope
"H^2"

$B = 1.22\ MeV$

$\frac{B}{m_D} \simeq 0.06\%$ easily measured

More Complex Nuclei:

A = # nucleons
$\simeq$ "Atomic Weight"
not exactly, because of B!
($m_n \neq m_p$ a little)



A nucleons all apart $\Rightarrow$ two

↑ Binding Energy

$B = (A-1)b$

b = binding energy/nucleon.
(really, added nucleon)

b depends on A...

"The curve of binding energy"

Light Elements
H → Li

→ Stars → Up to Iron

"Fusion"

Heavy Elements
→ Uranium
Made (at a small) rate in neutron star explosions

→ Fission → Lighter (≈ ½ A)

↑ total surprise!
1930's

termi → Ausenium, Hesperium } Wrong Nobel Prize

Lise Meitner → Figured out fission
No Nobel Prize