

NUCLEAR PHYSICS

STRONG NUCLEAR FORCE

- ATTRACTIVE BETWEEN NUCLEONS
- ACTS ONLY WITHIN $\sim 10^{-15}$ m

COULOMB REPELSION

- ACTS ONLY ON PROTONS
- RAISES ENERGY LEVELS OF p^+

PAULI EXCLUSION & SYMMETRY

- NO TWO p^+ OR n^0 CAN OCCUPY SAME QUANTUM STATE

\Rightarrow ENERGY SHELLS FILL SEPARATELY FOR p^+ n^0
 MOST STABLE ELEMENTS HAVE EVEN NUCLEI

NUCLEAR PROPERTIES

MASS

$$m_{\text{NUC}} = Zm_p + Nm_n - \frac{B^2}{c^2} \approx Zm_p$$

SIZE

$$R_{\text{NUC}} = R_0 A^{1/3} \quad V = \frac{4}{3} \pi R_0^3 A, \quad R_0 = 1.07 \text{ fm}$$

BINDING ENERGY

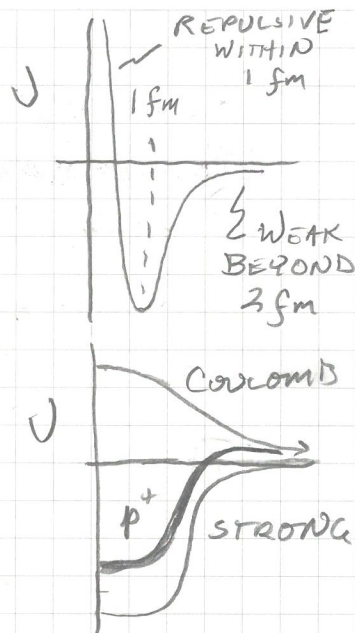
FROM MASSES

$$B = (Zm_H + Nm_n - m_{\text{ATOM}}) c^2$$

NEUTRON SEPARATION ENERGY

$$S_n(Z, N) = B(Z, N) - B(Z, N-1)$$

$\leftarrow \quad \quad \quad \rightarrow$ BINDING ENERGIES



NUCLEAR SHELL MODEL

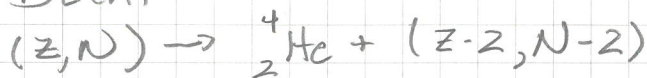
MOST STABLE NUCLEI HAVE FILLED SHELLS
 QUANTUM NUMBER FILLING

l, m, s + SPIN-ORBIT COUPLING

NUCLEAR PHYSICS CONTINUED

RADIOACTIVE DECAY

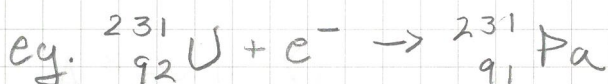
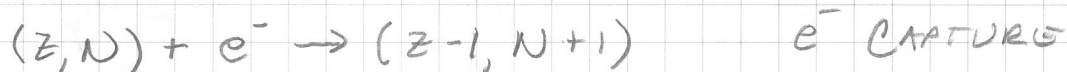
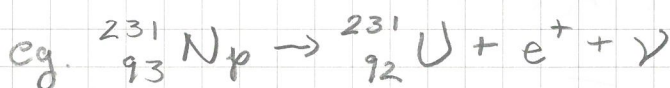
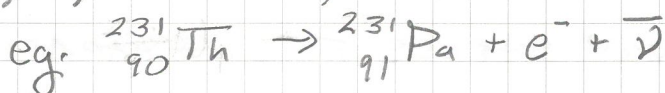
α -DECAY



β -DECAY

- YIELDS AN ELECTRON OR A POSITRON

PLUS A NEUTRINO (DISCOVERED IN β -DECAY)



γ -DECAY

- PHOTON RELEASED IN NUCLEAR TRANSITION

DECAY LAW

NUMBER OF NUCLEI DECREASES EXPONENTIALLY

$$N = N_0 e^{-\lambda t} = N_0 e^{-t/T_{1/2}}$$

RATE OF DECAY: $R(t) = \lambda N(t)$

HALF LIFE $N(t = t_{1/2}) = \frac{1}{2} N_0$

$$\Rightarrow t_{1/2} = \frac{\ln 2}{\lambda}$$

FISSION & FUSION - KNOWN PROCESSES