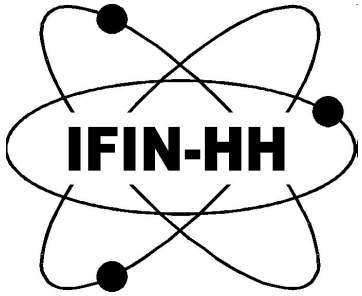

Lecture II.1
The basics of nuclear reactions

Alexandru Negret

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Outline

- Writing a nuclear reaction as X(a,b)Y
- Q value
- Coulomb Barrier
- Cross section
- Angular distribution

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The Q value

X(a,b)Y

$$^{2} + m_X c^2 = m_Y c^2 + m_b c$$

Q-value (reaction energy)

Q > 0 exothermal reaction

Q < 0 endothermal reaction

The Coulomb barrier

X(a,b)Y

$$V_{Coul} = k\frac{Q_a Q_X}{r} = ke^2\frac{Z_a Z_X}{r}$$

$ke^2 = 1.44$ MeV·fm

$r = r_0 A^{1/3}$; $r_0 \approx 1.2$ fm

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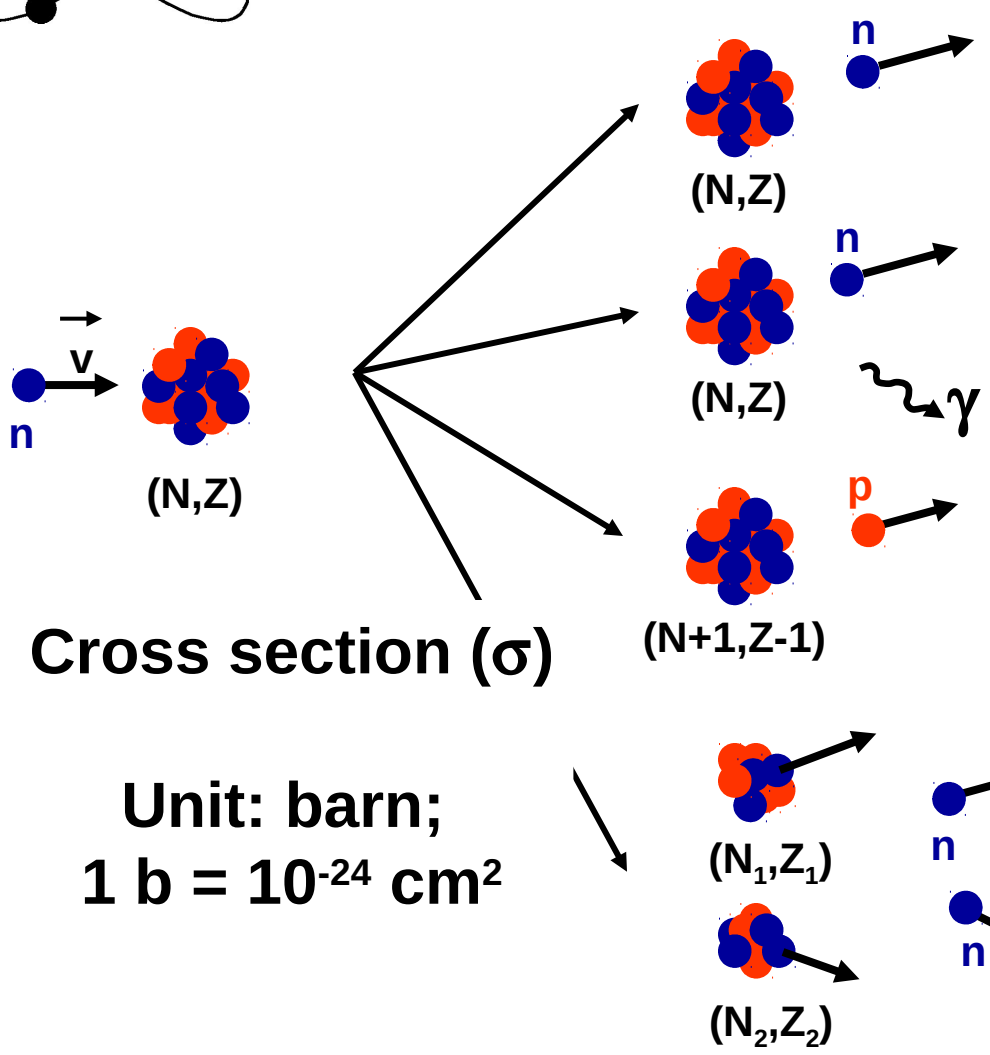
Cross section



Cross section (σ)

Unit: barn;
1 b = 10^{-24} cm^2

Cross section – the barn

The Uranium nucleus is “big as a barn”.

The total cross section n+^{235}U at En=1 MeV is ~7 b

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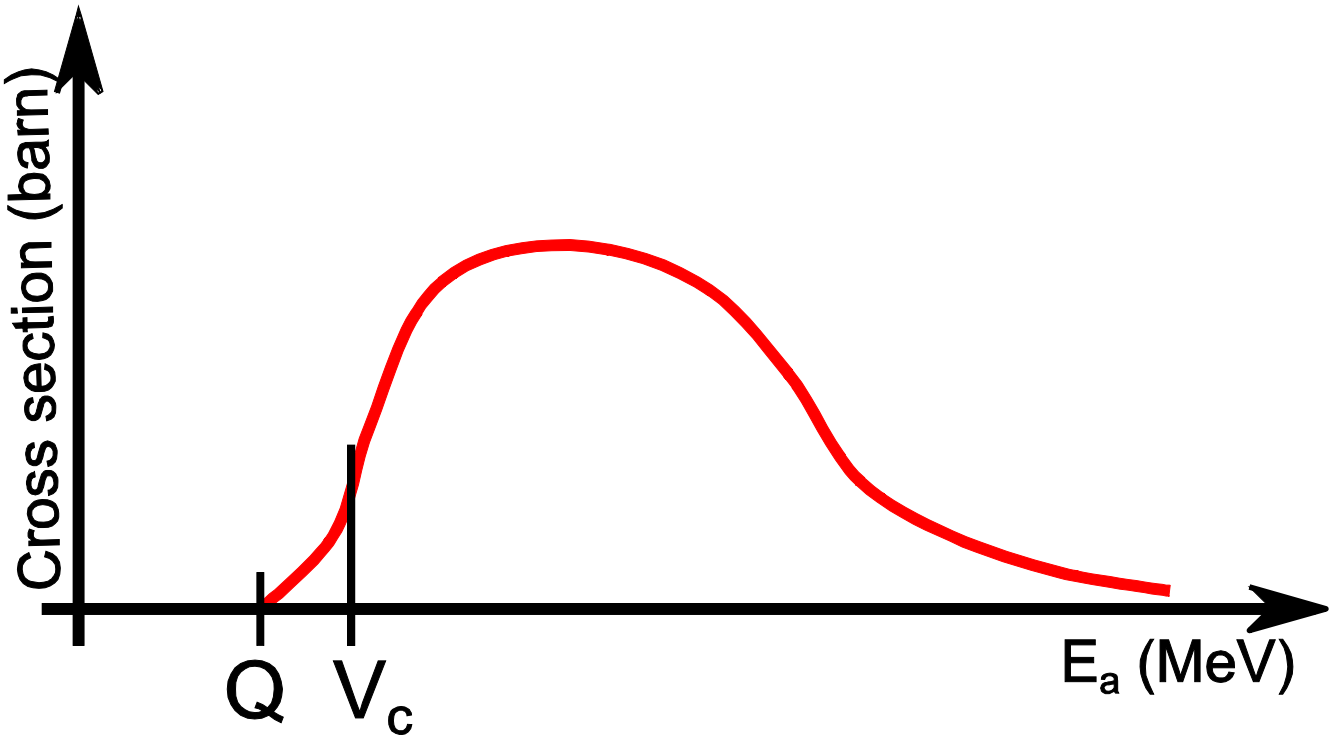
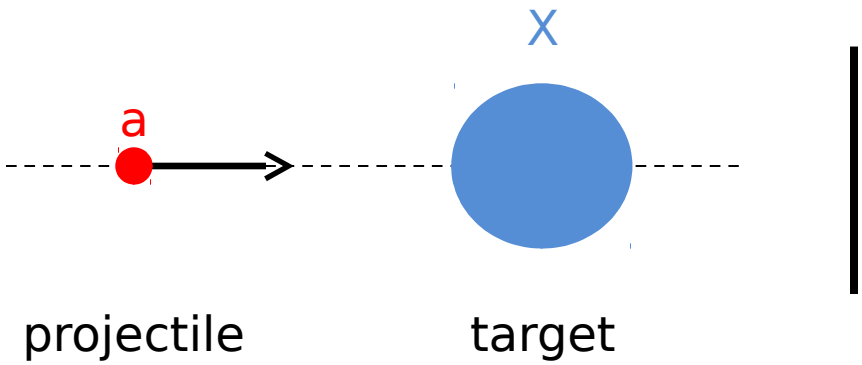
Cross section

X(a,b)Y



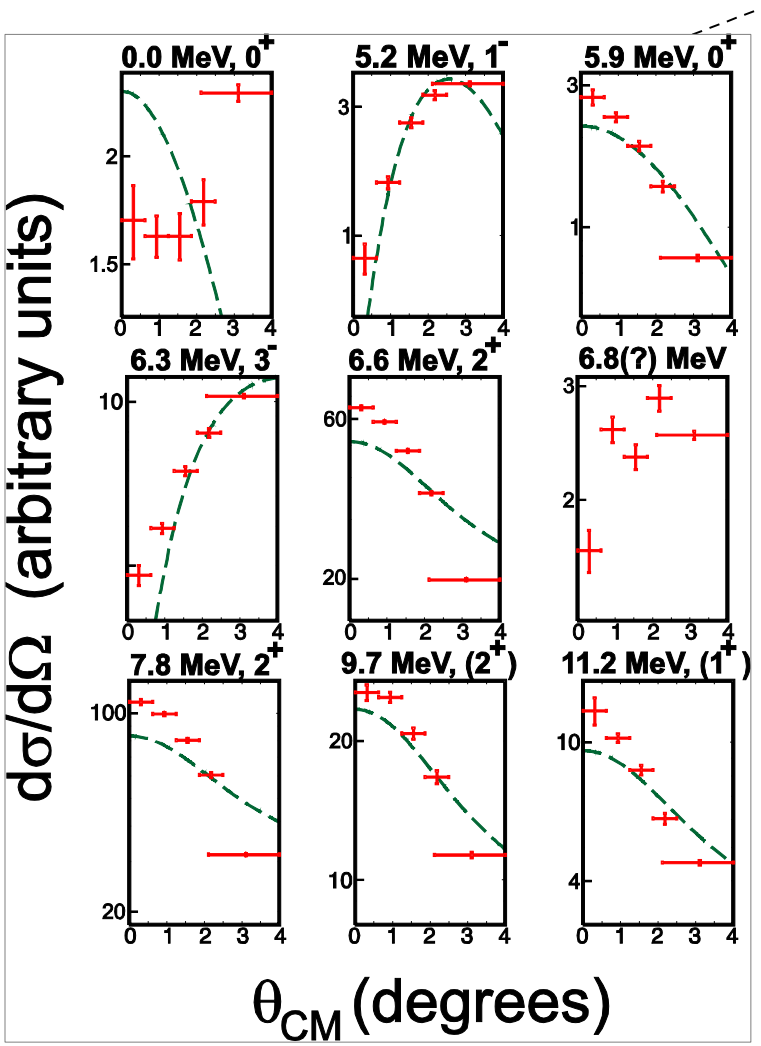
Angular distribution



X(a,b)Y

$\sigma = \sigma(\theta)$

The angular momentum transferred determines the angular distribution of the ejectile.



Exercise 1: ^{194}Pt(^{6}Li, d)^{198}Hg

- Compute Q value

  $m(^{6}Li) = 6.015122\ u$ $\quad$ $m(d) = 2.014102\ u$

  $m(^{194}Pt) = 193.962681\ u$ $\quad$ $m(^{198}Hg) = 197.966769\ u$

  $uc^2 = 931.5\ MeV$

- Compute the Coulomb barrier

$$V_{Coul} = k\frac{Q_a Q_X}{r} = ke^2\frac{Z_a Z_X}{r}$$

$ke^2 = 1.44$ MeV·fm

$r = r_0 A^{1/3}$; $r_0 \approx 1.2$ fm

Exercise 2: ^{28}Si(n, n')^{28}Si

- Compute Q value

  m(n) = 1.008665 u
  m(^{28}Si) = 27.976926 u

  uc^2 = 931.5 MeV

- Compute the Coulomb barrier

$$V_{Coul} = k\frac{Q_a Q_X}{r} = ke^2\frac{Z_a Z_X}{r}$$

ke^2 = 1.44 MeV·fm
r = $r_0 A^{1/3}$; $r_0 \approx 1.2$ fm

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Summary

- Writing a nuclear reaction as X(a,b)Y
- Q value
- Coulomb Barrier
- Cross section
- Angular distribution