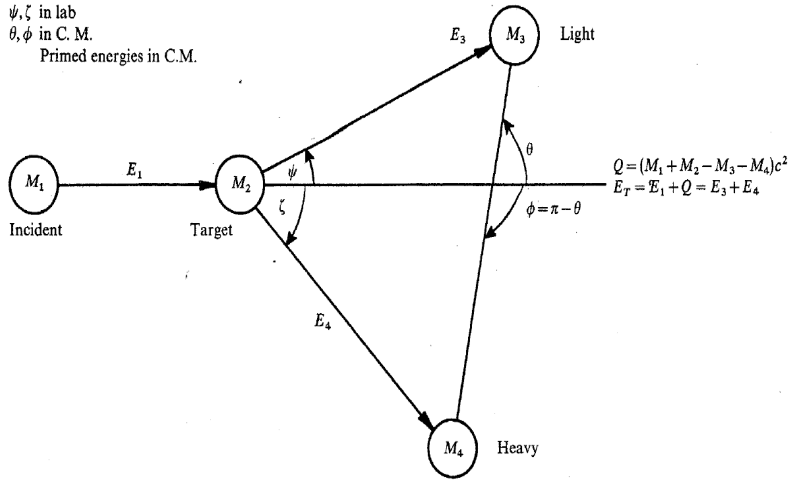
Nuclear Reaction Analysis - J. B. Marion & F. C. Young

TABLE 5

Kinematics of nuclear reactions and scattering (continued)



Define:

$$A = \frac{M_1 M_4 (E_1/E_T)}{(M_1+M_2)(M_3+M_4)}, \qquad C = \frac{M_2 M_3}{(M_1+M_2)(M_3+M_4)}\left(1+\frac{M_1 Q}{M_2 E_T}\right) = \frac{E'_4}{E_T}$$

$$B = \frac{M_1 M_3 (E_1/E_T)}{(M_1+M_2)(M_3+M_4)}, \qquad D = \frac{M_2 M_4}{(M_1+M_2)(M_3+M_4)}\left(1+\frac{M_1 Q}{M_2 E_T}\right) = \frac{E'_3}{E_T}$$

Note that $A+B+C+D=1$ and $AC=BD$

Lab energy of light product:	$\frac{E_3}{E_T} = B + D + 2(AC)^{1/2}\cos\theta$ $= B[\cos\psi \pm (D/B - \sin^2\psi)^{1/2}]^2$	Use only plus sign unless $B > D$, in which case $\psi_{max} = \sin^{-1}(D/B)^{1/2}$	
Lab energy of heavy product:	$\frac{E_4}{E_T} = A + C + 2(AC)^{1/2}\cos\phi$ $= A[\cos\zeta \pm (C/A - \sin^2\zeta)^{1/2}]^2$	Use only plus sign unless $A > C$, in which case $\zeta_{max} = \sin^{-1}(C/A)^{1/2}$	
Lab angle of heavy product:	$\sin\zeta = \left(\frac{M_3 E_3}{M_4 E_4}\right)^{1/2}\sin\psi$	C.M. angle of light product:	$\sin\theta = \left(\frac{E_3/E_T}{D}\right)\sin\psi$
Intensity or solid-angle ratio for light product:	$\frac{\sigma(\theta)}{\sigma(\psi)} = \frac{I(\theta)}{I(\psi)} = \frac{\sin\psi\, d\psi}{\sin\theta\, d\theta} = \frac{\sin^2\psi}{\sin^2\theta}\cos(\theta-\psi) = \frac{(AC)^{1/2}(D/B - \sin^2\psi)^{1/2}}{E_3/E_T}$		
Intensity or solid-angle ratio for heavy product:	$\frac{\sigma(\phi)}{\sigma(\zeta)} = \frac{I(\phi)}{I(\zeta)} = \frac{\sin\zeta\, d\zeta}{\sin\phi\, d\phi} = \frac{\sin^2\zeta}{\sin^2\phi}\cos(\phi-\zeta) = \frac{(AC)^{1/2}(C/A - \sin^2\zeta)^{1/2}}{E_4/E_T}$		
Intensity or solid-angle ratio for associated particles in the lab system:	$\frac{\sigma(\zeta)}{\sigma(\psi)} = \frac{I(\zeta)}{I(\psi)} = \frac{\sin\psi\, d\psi}{\sin\zeta\, d\zeta} = \frac{\sin^2\psi\cos(\theta-\psi)}{\sin^2\zeta\cos(\phi-\zeta)}$		

Colisões binárias

$$p_1 = p_3\cos(\psi) + p_4\cos(\varsigma)$$

$$p_3\sin(\psi) = p_4\sin(\varsigma)$$

$$\frac{(p_1)^2}{2M_1} = \frac{(p_3)^2}{2M_3} + \frac{(p_4)^2}{2M_4}$$

3 equações e 4 incognitas

$$p_3 : p_4 : \Psi : \varsigma$$

$$dado\, \Psi\, determina-se: E_3, E_4, e\, \varsigma$$