9. Hafta

12)ALFA BOZUNMASI

Alfa parçacıkları iki kere iyonlaşmış (He^{++}) atomlarıdır.

$$_{Z}X^{A} \rightarrow {}_{Z-2}Y^{A-4} + {}_{2}He^{4} \qquad (\alpha)$$

$$E_i = E_f$$

$$M_X c^2 = M_Y c^2 + K_Y + M_\alpha c^2 + K_\alpha$$

Parçalanma enrjisi

$$Q = K_Y + K_\alpha = (M_X - M_Y - M_\alpha)c^2$$

$$Q \rangle 0$$

Alfa parçacığının kinetik enerjisi,enerji ve momentumun korunumundan ;

$M_\alpha V_\alpha = M_Y V_Y$

$$Q = K_Y + K_\alpha = \frac{1}{2} M_Y V_Y{}^2 + \frac{1}{2} M_\alpha V_\alpha{}^2$$

$$V_Y = \frac{M_\alpha}{M_Y} V_\alpha$$

$$Q = \frac{1}{2} M_Y \left(\frac{M_\alpha}{M_Y} V_\alpha\right)^2 + \frac{1}{2} M_\alpha V_\alpha{}^2$$

$$= \frac{1}{2} M_Y \frac{M_\alpha{}^2}{M_Y{}^2} V_\alpha{}^2 + \frac{1}{2} M_\alpha V_\alpha{}^2$$

$$Q = \frac{1}{2} M_\alpha V_\alpha{}^2 \frac{M_\alpha}{M_Y} + \frac{1}{2} M_\alpha V_\alpha{}^2$$

$$Q = \frac{1}{2} M_\alpha V_\alpha{}^2 \left(\frac{M_\alpha}{M_Y} + 1\right)$$

$$Q = K_\alpha \left(\frac{M_\alpha}{M_Y} + 1\right)$$

$$K\alpha = \frac{Q}{\frac{M_\alpha}{M_Y} + 1} = \frac{Q}{1 + \frac{A+4}{A-4}} = \frac{A-4}{A} |Q|$$

ÖRNEK: $Po^{210} \rightarrow Pb^{206} + \alpha$ reaksiyonundan çıkan alfa parçacığının ve ürün çekirdeğinin kinetik enerjisi nedir?

$$Q_\alpha = (Po^{210} \rightarrow Pb^{206} + He^4)c^2$$
$$= (209{,}982866 - 205{,}974446 - 4{,}002603) \times 931{,}5 \quad Mev$$
$$= 5{,}41 \quad Mev$$

$$K_\alpha = \frac{Q_\alpha}{\frac{M_\alpha}{M_Y}} = \frac{5{,}41}{1 + \frac{4}{206}} = 5{,}31 \quad Mev$$

$$K_Y = Q_\alpha - K_\alpha$$
$$= 5{,}41 - 5{,}31 = 0{,}10 \quad Mev$$

Alfa Parçacıklarının Enerji Tayini:

1) Manyetik Sapma:

Vα hızı ile H manyetik alana giren alfa parçacığının yörüngesi eğer, $v_\alpha \perp H$ ise,

$E_{merkezcil} = E_{manyetik}$

$$\frac{m_\alpha v_\alpha}{r} = v_\alpha H$$

$$v_\alpha = \frac{qHr}{m_\alpha}$$

$$K_\alpha = \frac{1}{2} m_\alpha v_\alpha{}^2 = \frac{1}{2} m\alpha \frac{(qHr)^2}{m_{\alpha 2}}$$

$$K_\alpha = \frac{(qHr)^2}{2m_\alpha}$$

2-) Puls Yükseklik Analizi

i) İyon Odaları

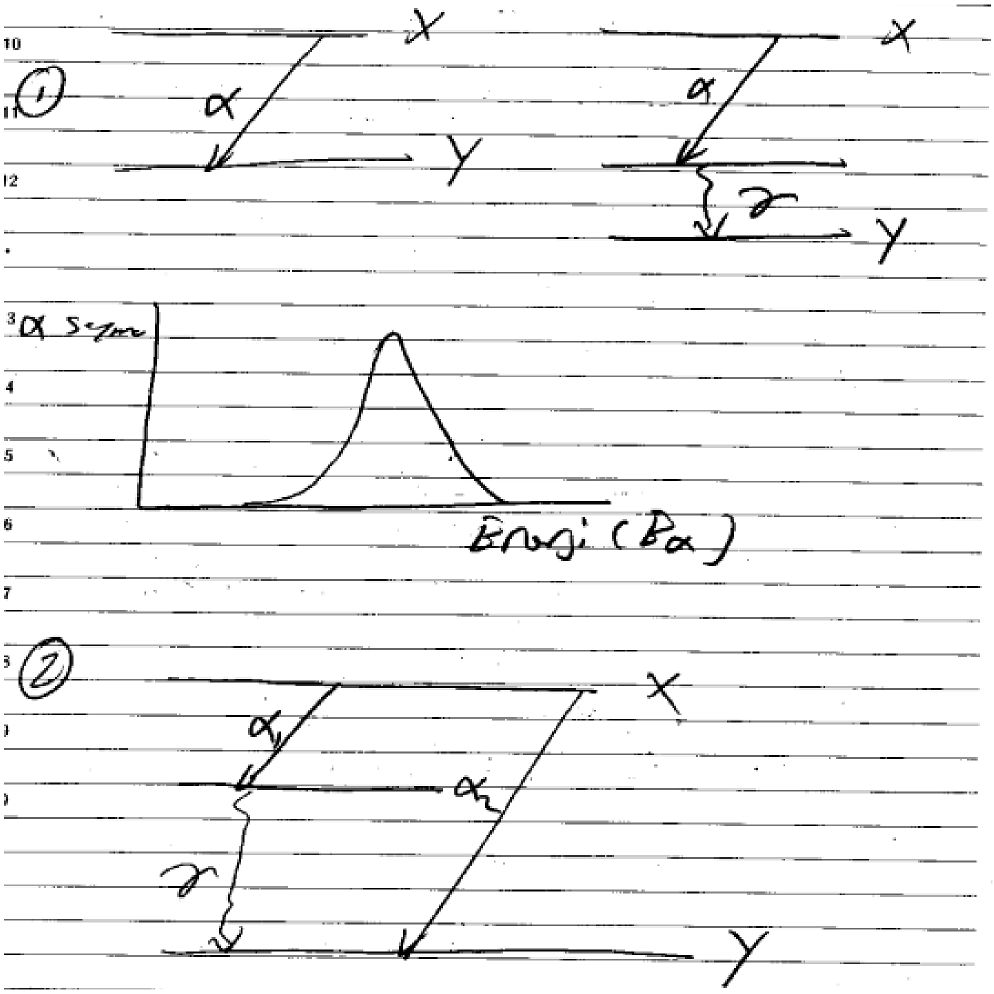
ii) Sintilasyon Dedektörleri

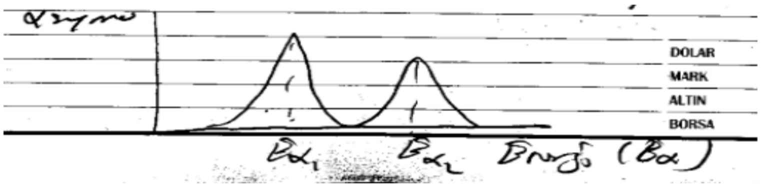
iii) Katıhal Dedektörleri

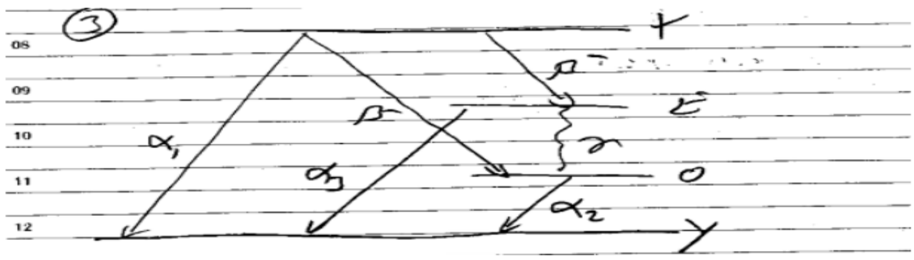
3) Menzil Enerji Bağıntıları

Alfa Spektrumları:

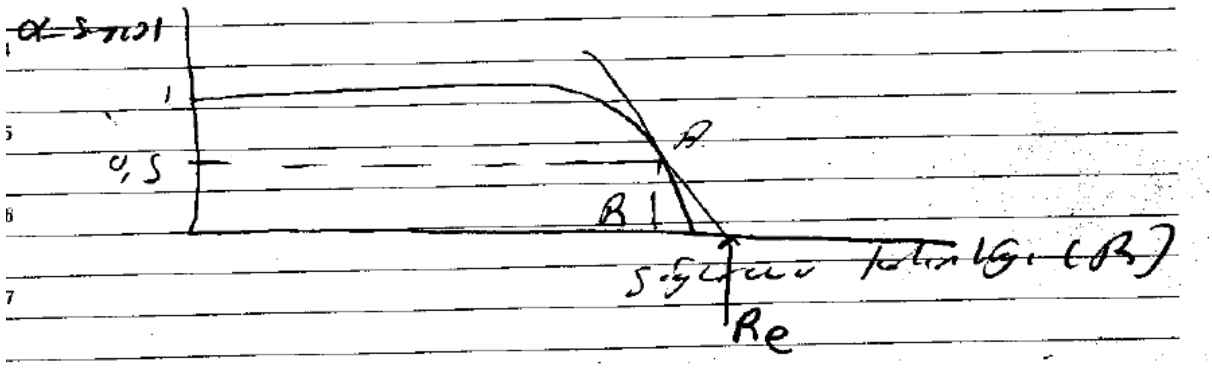
Üç tür alfa spektrumu vardır.


1
X
α
Y
γ
α sayımı
Enerji (Eα)
2
α1
α2


α sayımı
DOLAR
MARK
ALTIN
BORSA
Eα1
Eα2
Enerji (Eα)



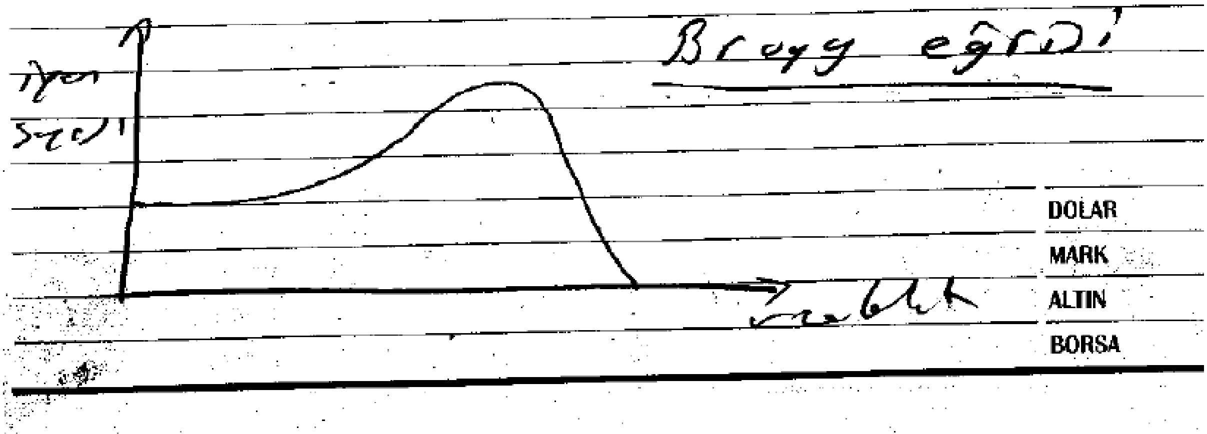
Alfa parçacıklarının yolları menzil (Menzil):



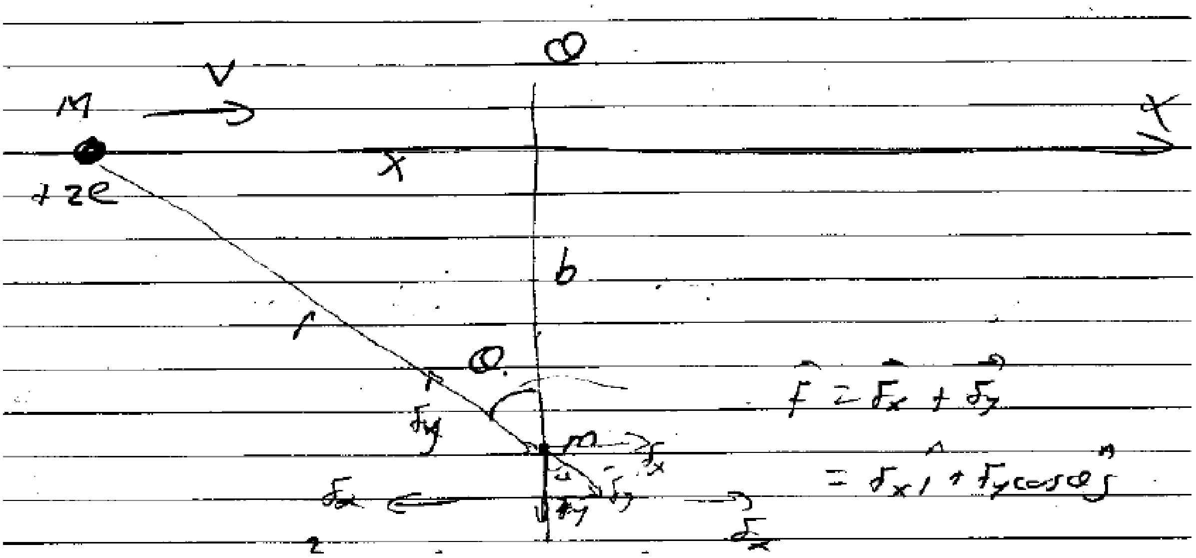
a) Extropole edilmiş menzil (Re)

b) Ortalama menzil ($\overline{R}$)

Özgül iyonizasyon:



Madde ile ağır yüklü parçacıkların etkileşmesi:



F= $\frac{k.z.e^2}{r^2} = \frac{k.z.e\ \ .e}{r^2}$

$$\int_{\infty}^{0} Fxdt = \int_{0}^{\infty} Fxdt$$

Py= $\int_{-\infty}^{\infty} Fydt = \int_{-\infty}^{0} \frac{k.z.e^2}{r^2} \cos\theta dt$ $\qquad \cos\theta = \frac{b}{r} \qquad \tan\theta = \frac{x}{b} = \frac{\sin\theta}{\cos\theta}$

$$dx/dt = v$$

$$\sec^2\theta d\theta = \frac{dx}{b} \qquad = \frac{v}{b} dt$$

$$\frac{1}{\cos^2\theta} = \frac{vdt}{b}$$

$$dt = \frac{bd\theta}{v\cos^2\theta}$$

$$r = \frac{b}{\cos\theta}$$

$$\frac{db}{r^2} = \frac{bd\theta}{v\cos^2\theta} \cdot \frac{\cos^2\theta}{b^2} = \frac{d\theta}{vb}$$

$$Py = kze^2 \int_{-\infty}^{+\infty} \cos\theta \frac{dt}{r^2} \quad = kze^2 \int_{-\theta/2}^{+\theta/2} \cos\theta \frac{d\theta}{vb} = \frac{kze^2}{vb} 2 = \frac{2kze^2}{vb}$$

$$r_0 = \frac{ke^2}{m_0 c^2} \qquad\qquad ke^2 = r_0 . m_0 . c^2$$

$$Py = \frac{2Zm_0c^2r_0}{Vb}$$

$$E = \frac{P_y^2}{2m} = \frac{4z^2 r_0^2 m_0^2 c^4}{V^2 b^2 2m}$$

$$E = \frac{2z^2 r_0^2 m_0 c^4}{V^2 b^2} -$$

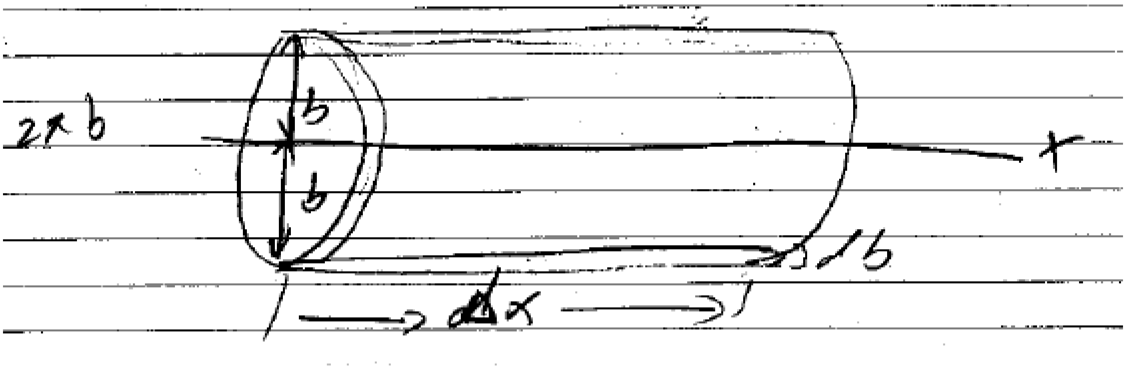
Ağır Parçacıklara Elektron Trasnfer Eden Enerji

$$E = \frac{1}{2} m V^2 \qquad V^2 = \frac{2E}{m}$$

$$E(b) = \frac{z^2 r_0^2 m_0 c^4}{b^2} \frac{M}{E}$$

M → α kütlesi

E → α enerjisi



$\Delta n = 2\pi db \Delta x \rho N$

Δn=silindirin kabuğundaki elektron sayısı

N=gram başına elektron sayısı

$$\frac{dE}{dx} = \int_{b\min}^{b\max} DE(b)\frac{\Delta n}{\Delta x}$$

$$\frac{4\prod z^2 q^2 Nz(3x10^4)^4}{Mv^2(1.6x10^{-24})^{-6}}[\ln\frac{2Mv^2}{\bar{I}} - \ln(1-\frac{v^2}{c^2}) - \frac{v^2}{c^2}]\frac{meV}{cm}$$

Z= İyonize parçacığın atom numarası

q= elektrik yükü

M=iyonize parçacığın durgun kütle(gram)

V= İyonize parçacığın hızı (cm/sn)

N= Maddenin 1 cm^3 hacmindeki atom sayısı

Z= Maddenin atom numarası

C= ışık hızı

$\bar{I}$ = Bir iyon çifti için gereken enerji

MADDE	$\bar{I}$ (eV)
H	15.6
Li	34
Al	150
Fe	241
Hava	80.5

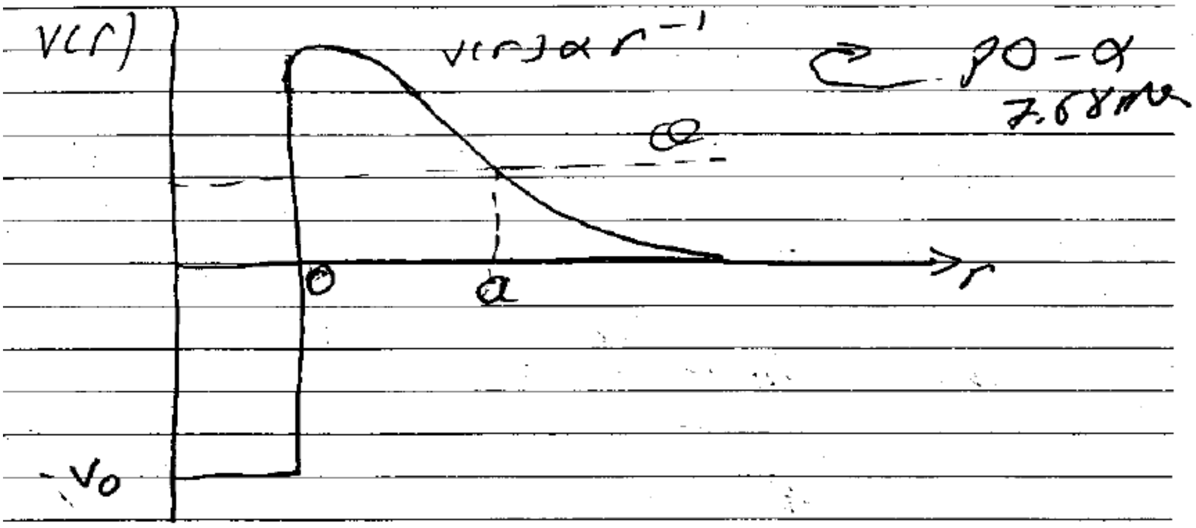
$$S(E) = \frac{1}{\rho}\frac{dE}{dX}$$

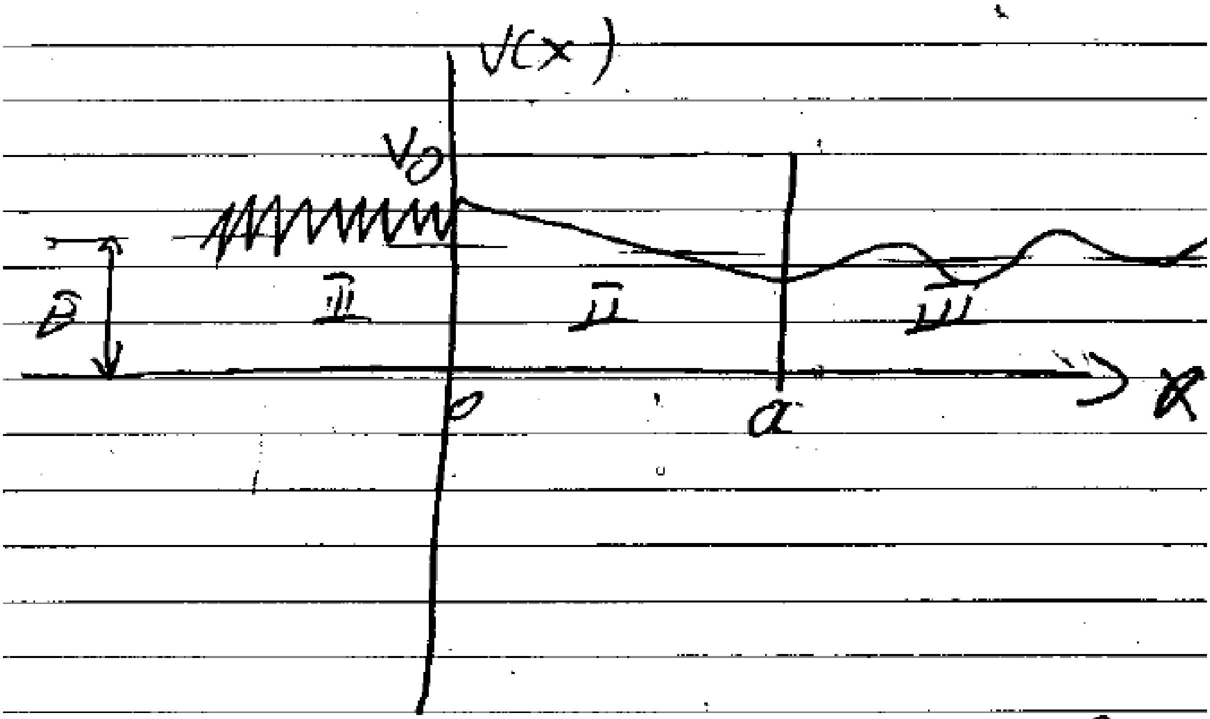
$$\bar{R} = \int_0^{\bar{R}} dx = \int_0^{E} \frac{dE}{\rho S(E)}$$

$$E = \int_0^{E} dE = \int_0^{\bar{R}} \rho S(E)$$

Alfa Bozunma Teorisi

${}^{238}_{92}U \longrightarrow \qquad \alpha = 4.20$ Mev





$$V(x)=\begin{cases} 0 & x<0 \\ V_0 & 0<x<a \\ 0 & x>a \end{cases}$$

$$\frac{-\hbar^2}{2m}\frac{d^2\varphi(x)}{dx^2}+V(x)\varphi(x)=E\varphi(x)$$

$$\frac{d^2\varphi(x)}{dx^2}-\frac{2m}{\hbar^2}(V_0-E)\varphi(x)=0$$

$$\frac{d^2\varphi}{dx^2}+\frac{2mE}{\hbar^2}\varphi=0 \qquad K^2=\frac{2mE}{\hbar^2}$$

$$\varphi_I(x)=\underbrace{Ie^{ikx}}_{GelenDa\lg a}+\underbrace{Re^{-ikx}}_{yansıansıy\ da\lg a}$$

$$\varphi_{III}(x) = Te^{ikx}$$

$$\frac{d^2\varphi}{dx^2} - \frac{2m}{\hbar^2}(V_0 - E)\varphi = 0$$

$$K^{I} = \sqrt{\frac{2m((V_0 - E)}{\hbar}} = \frac{q}{\hbar}$$

$$\varphi_{II}(x) = A\ e^{k^I x} + \mathrm{B}\ e^{-k^I x}$$

Süreklilik : φ ve $\frac{d\varphi}{dx}$ x=0 , α da sürekli olmalı

$$\varphi_I(0) = \varphi_{II}(0) \qquad \frac{d\varphi_I(\alpha)}{dx} = \frac{d\varphi_{II}(\alpha)}{dx}$$

$$\varphi_{II}(\alpha) = \varphi_{III}(\alpha) \qquad \frac{d\varphi_{II}(\alpha)}{dx} = \frac{d\varphi_{III}(\alpha)}{dx}$$

$$\mathrm{I} + R = A + B$$

$$\mathrm{A}\,e^{k^I\alpha} + \mathrm{B}\ e^{-k^I\alpha} = \mathrm{T}\,e^{ik\alpha}$$

$$\text{İk}((\mathrm{I} - R) = k^I(A - B)$$

$$k^I(\mathrm{A}\,e^{k^I a} \text{-B}\,e^{k^I a}) = \mathrm{ikT}\,e^{ika}$$

$$\mathrm{I} = \frac{1}{2}(1 + \frac{k^I}{ik})A + \frac{1}{2}(1 - \frac{k^I}{ik})B$$

$$A = \frac{T\, e^{ika}\left(1 + \frac{ik}{k^{1}}\right)}{2\, e^{k^{\prime} a}}$$

$$B = \frac{T e^{ika}\left(1 - \frac{ik}{k^{l}}\right)}{2^{-k^{l} a}}$$

$$I = \frac{T}{4} e^{ika}\left[\left(1+\frac{q}{i\rho}\right)\left(1+\frac{i\rho}{q}\right)e^{-(aq/h)} + \left(1-\frac{q}{i\rho}\right)\left(1-\frac{i\rho}{q}\right)e^{\left(\frac{qa}{h}\right)}\right]$$

$$\frac{\rho}{q} = \sqrt{\frac{2mE}{2m(\upsilon_0 - E)}} = \sqrt{\frac{E}{\upsilon_0 - E}}$$

Şeffaflık: $\dfrac{|T|^2}{|I|^2} \approx e^{-(2qa)/h} \approx e^{-2\sqrt{\frac{2m(\upsilon_o - E)}{\hbar^2}}\, a}$

Rasgele sürekli bir enerji için:

$$\approx e^{-2\int_a^b \sqrt{2m[\upsilon(x) - E]/\hbar^2}\, dx}$$

$$\rho = e^{-2\gamma}$$

$$\lambda = \mathrm{w}\,\rho = \frac{V_{in}}{R}.\rho$$