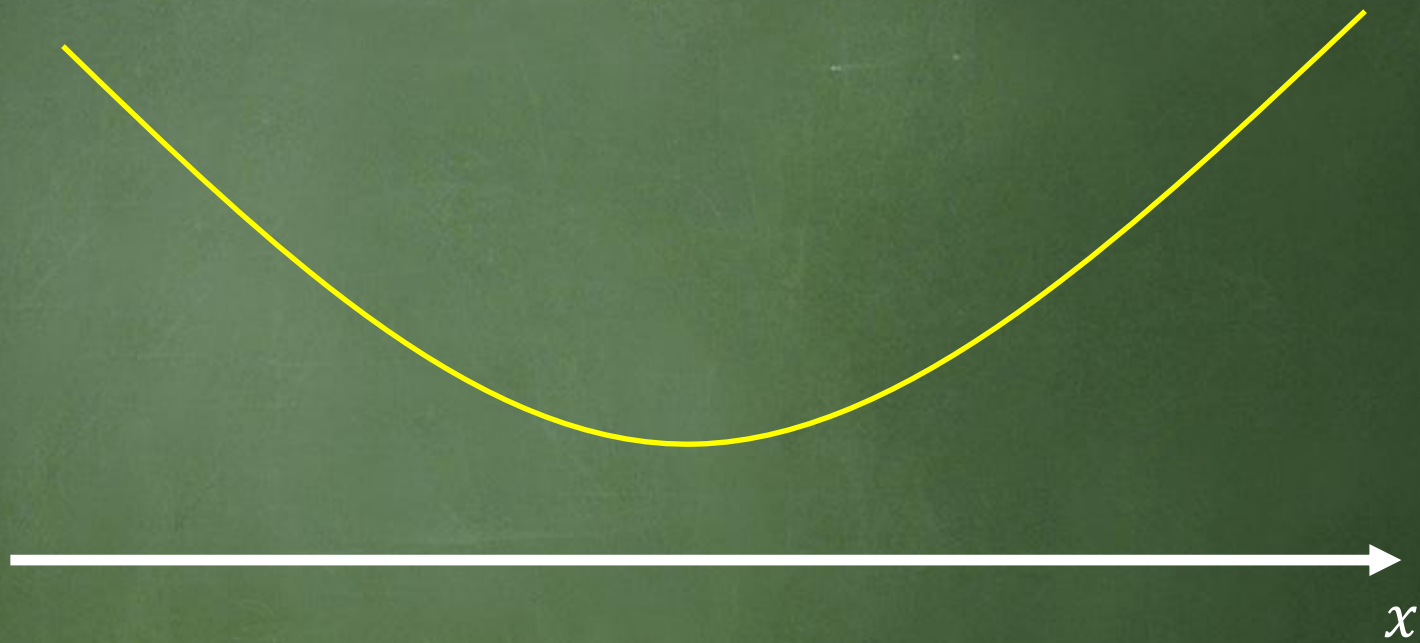


7장 터널링 현상



속박 bound 과 산란 scattering 상태

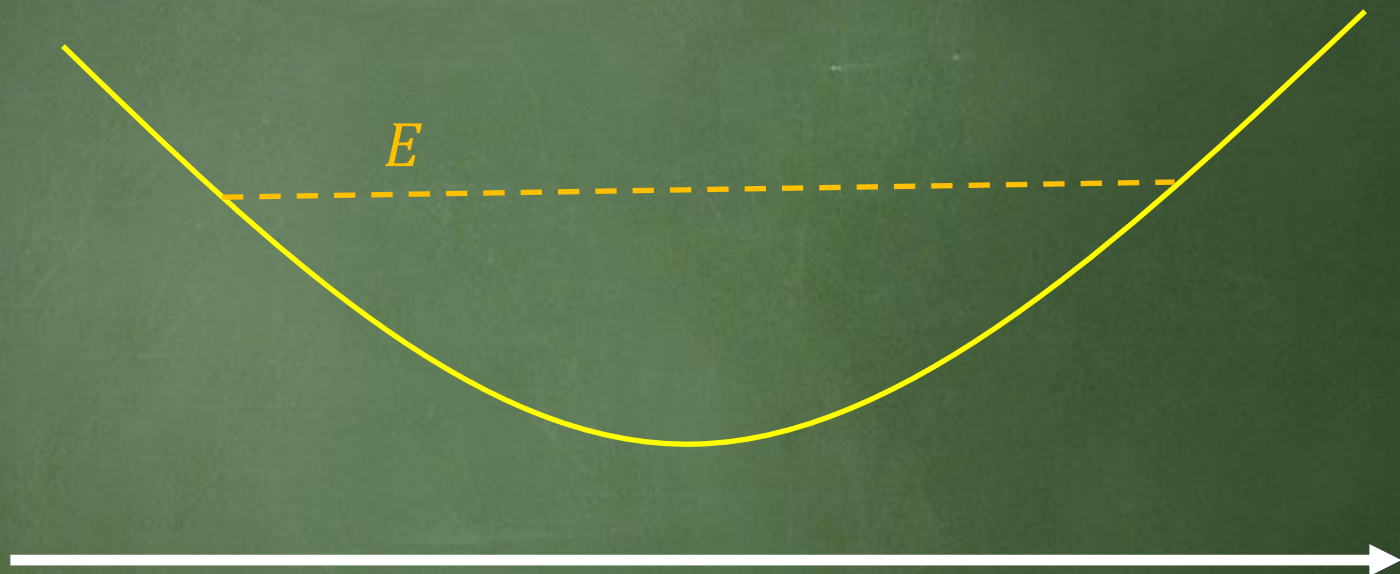
$V(x)$



$V(x)$

E

x

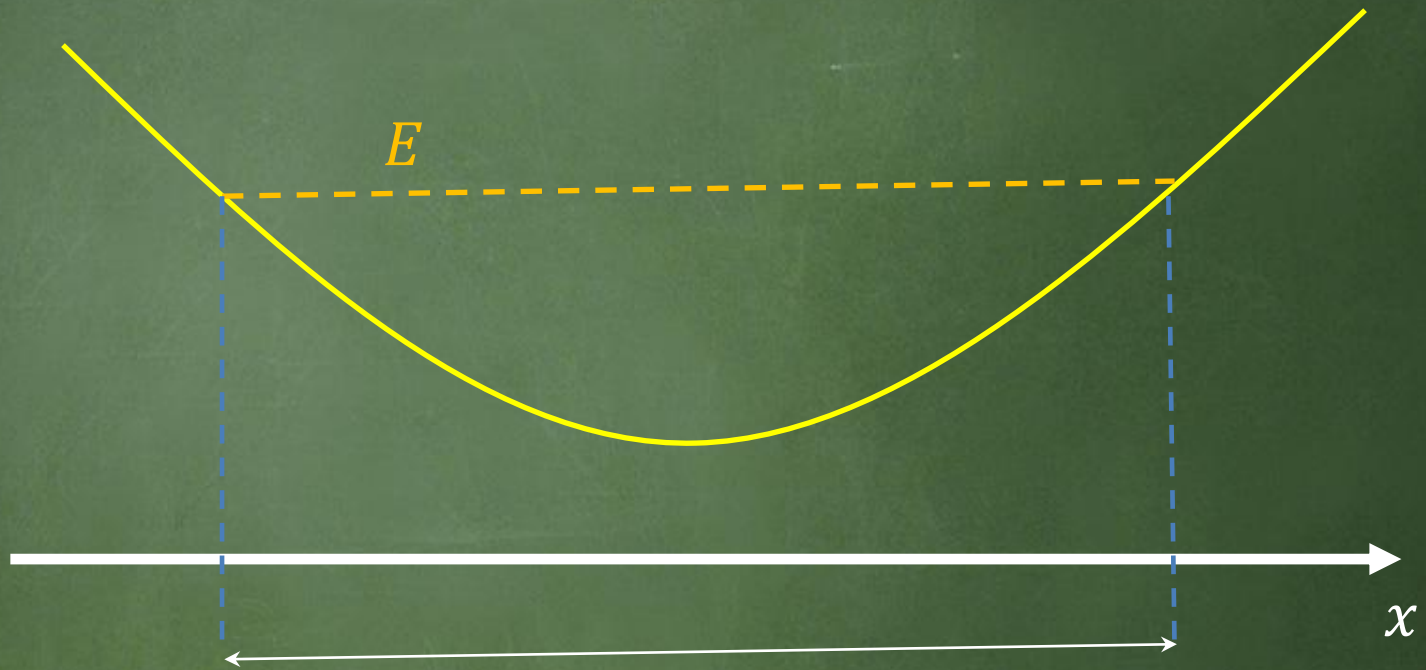


$V(x)$

E

x

고전적으로 허용된 영역



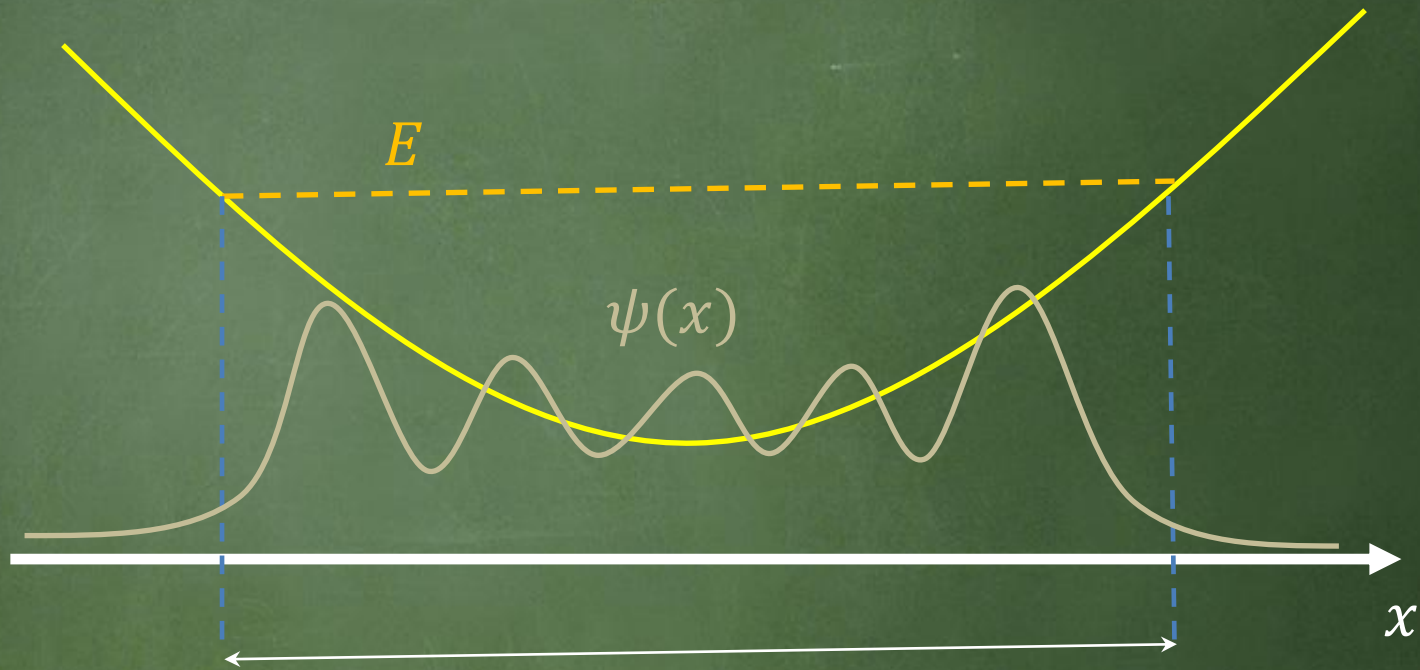
$V(x)$

E

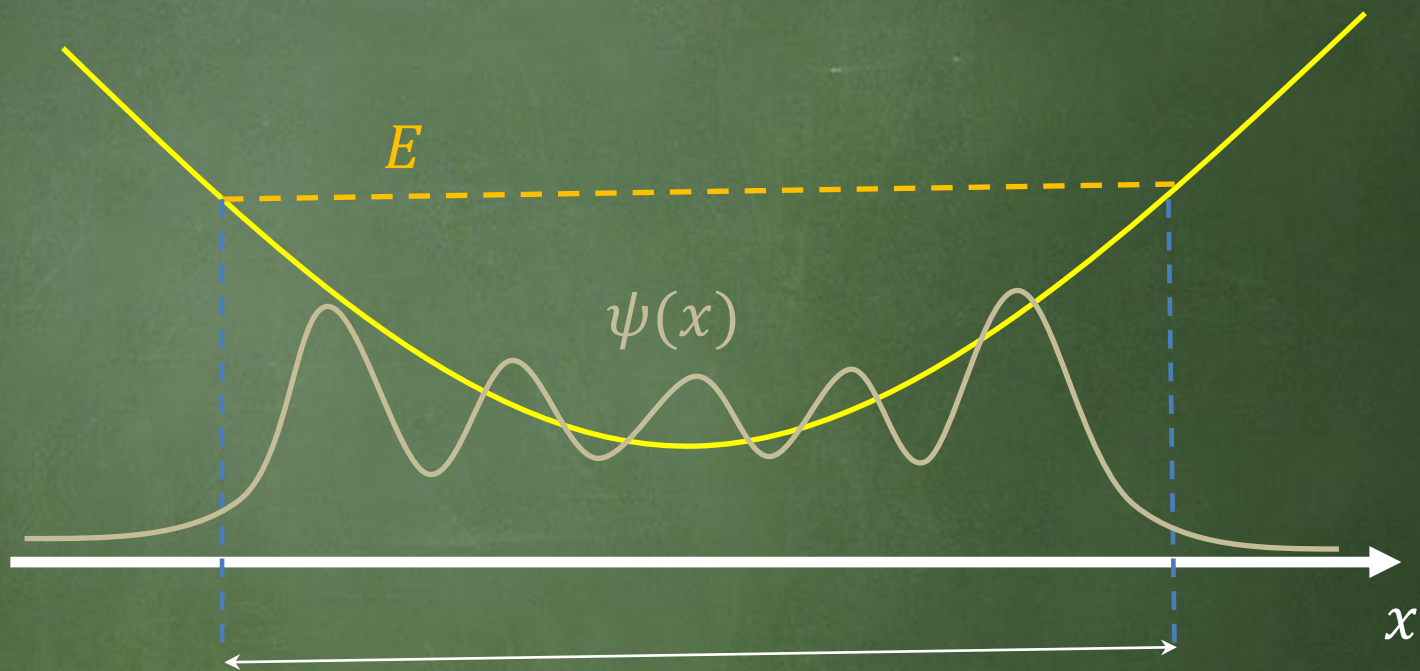
$\psi(x)$

x

고전적으로 허용된 영역

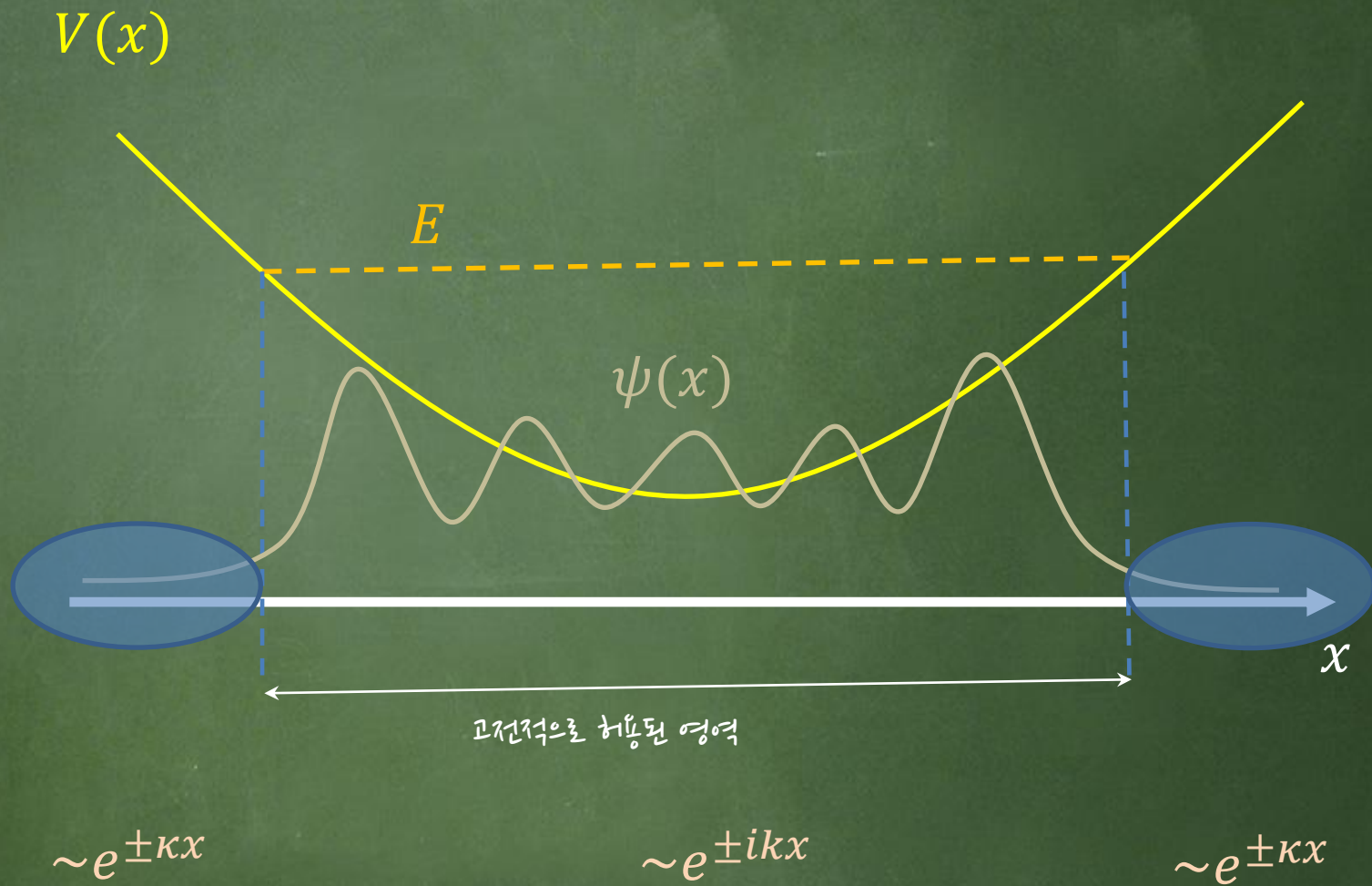


$V(x)$



고전적으로 허용된 영역

$$\sim e^{\pm ikx}$$



$V(x)$

E

$\psi(x)$

x

양자역학적으로
가능한 영역

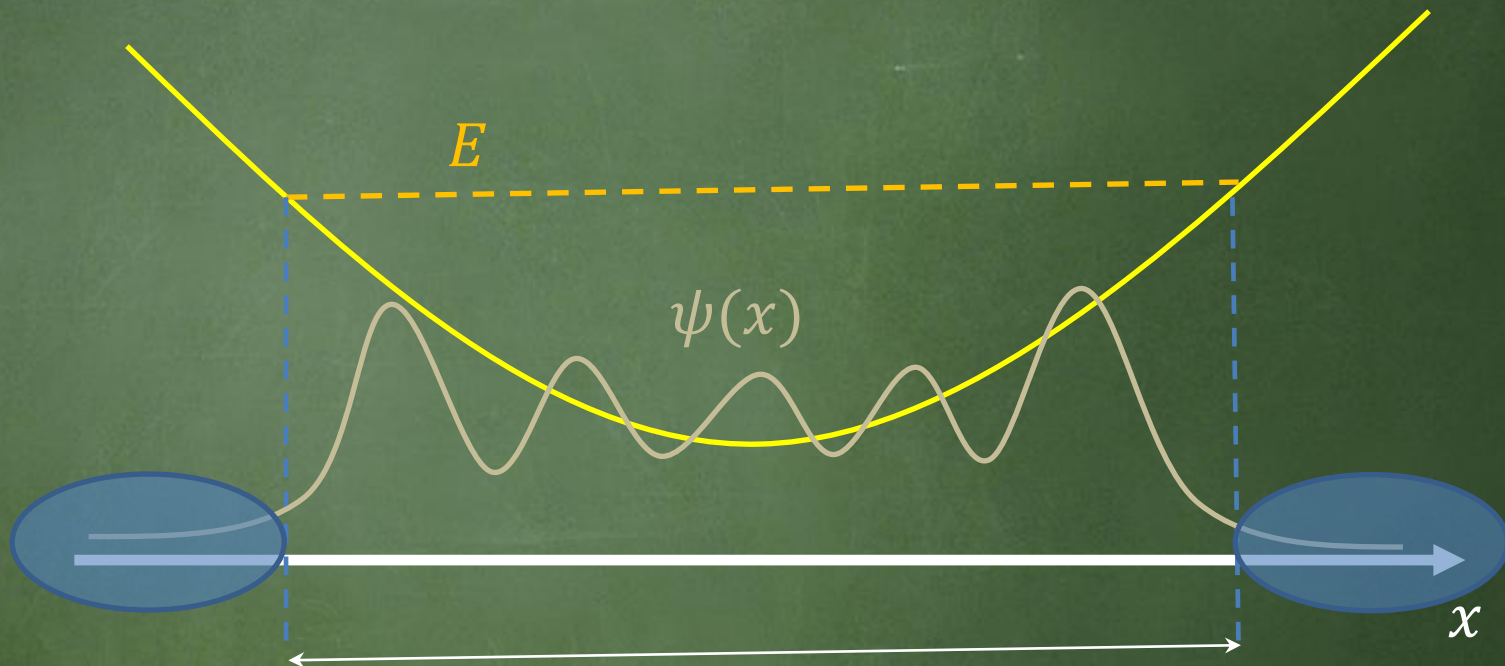
$\sim e^{\pm \kappa x}$

고전적으로 허용된 영역

$\sim e^{\pm i k x}$

양자역학적으로
가능한 영역

$\sim e^{\pm \kappa x}$



$V(x)$

E

$\psi(x)$

x

양자역학적으로
가능한 영역

$$\sim e^{\pm \kappa x}$$

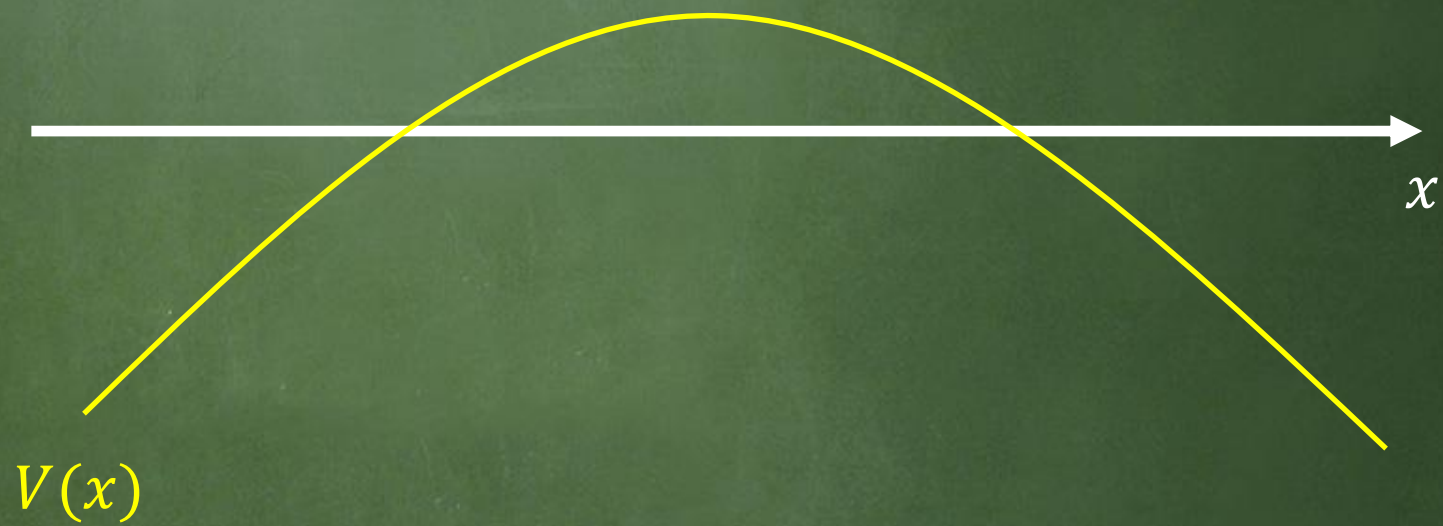
고전적으로 허용된 영역

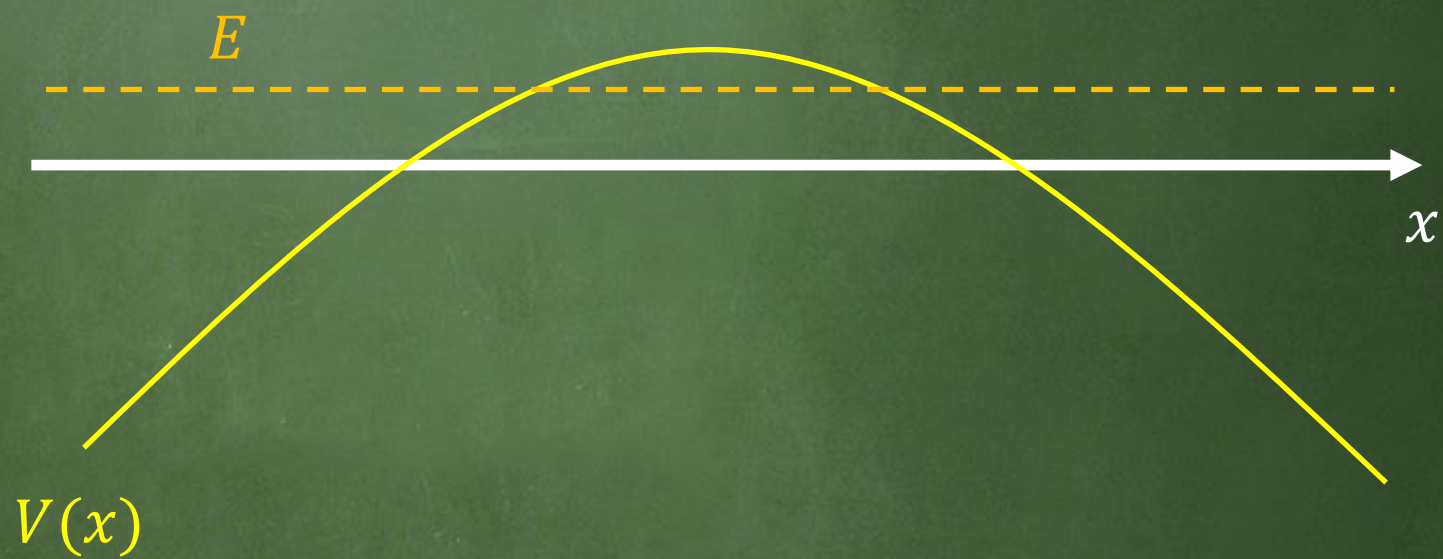
$$\sim e^{\pm i k x}$$

양자역학적으로
가능한 영역

$$\sim e^{\pm \kappa x}$$

속박 상태 bound state





고전적으로 허용된 영역

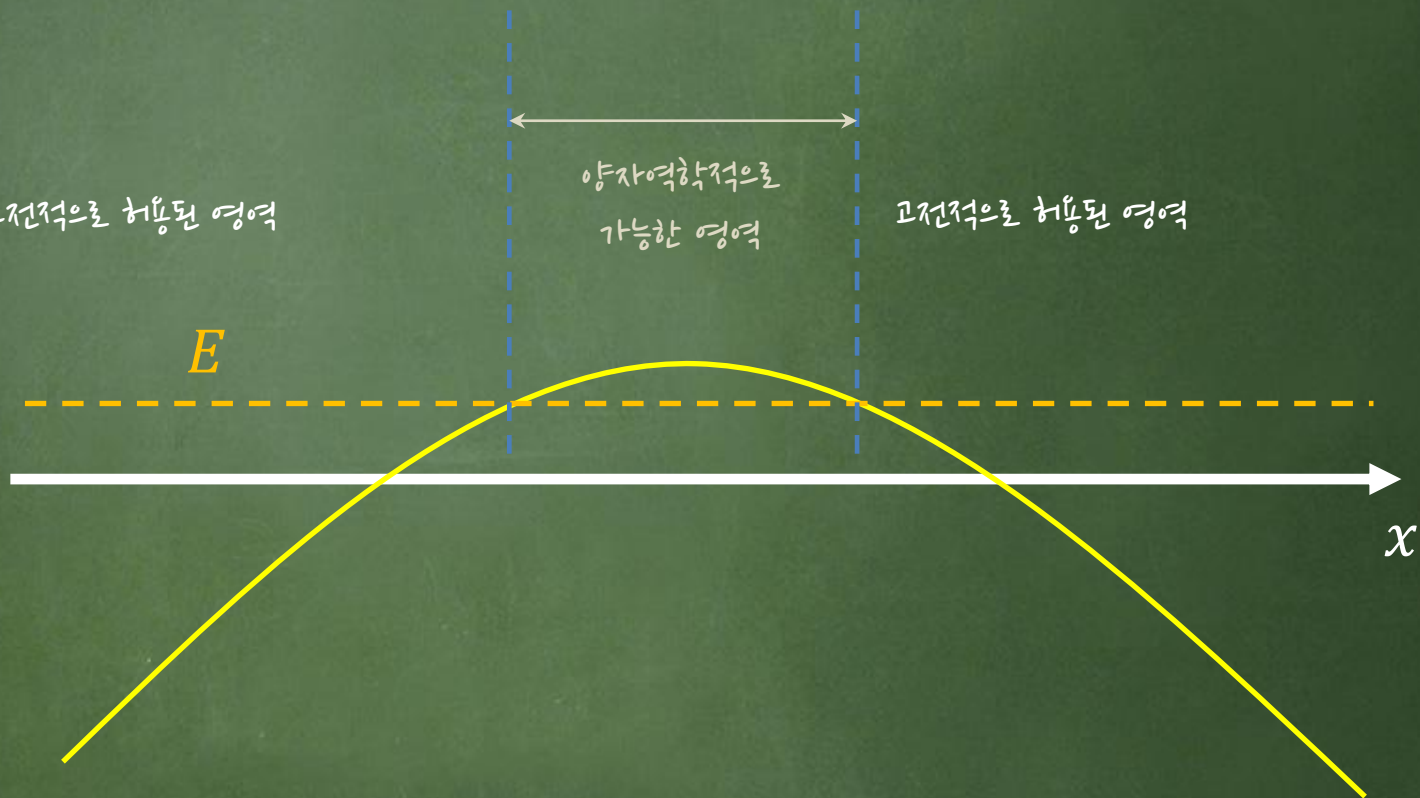
양자역학적으로
가능한 영역

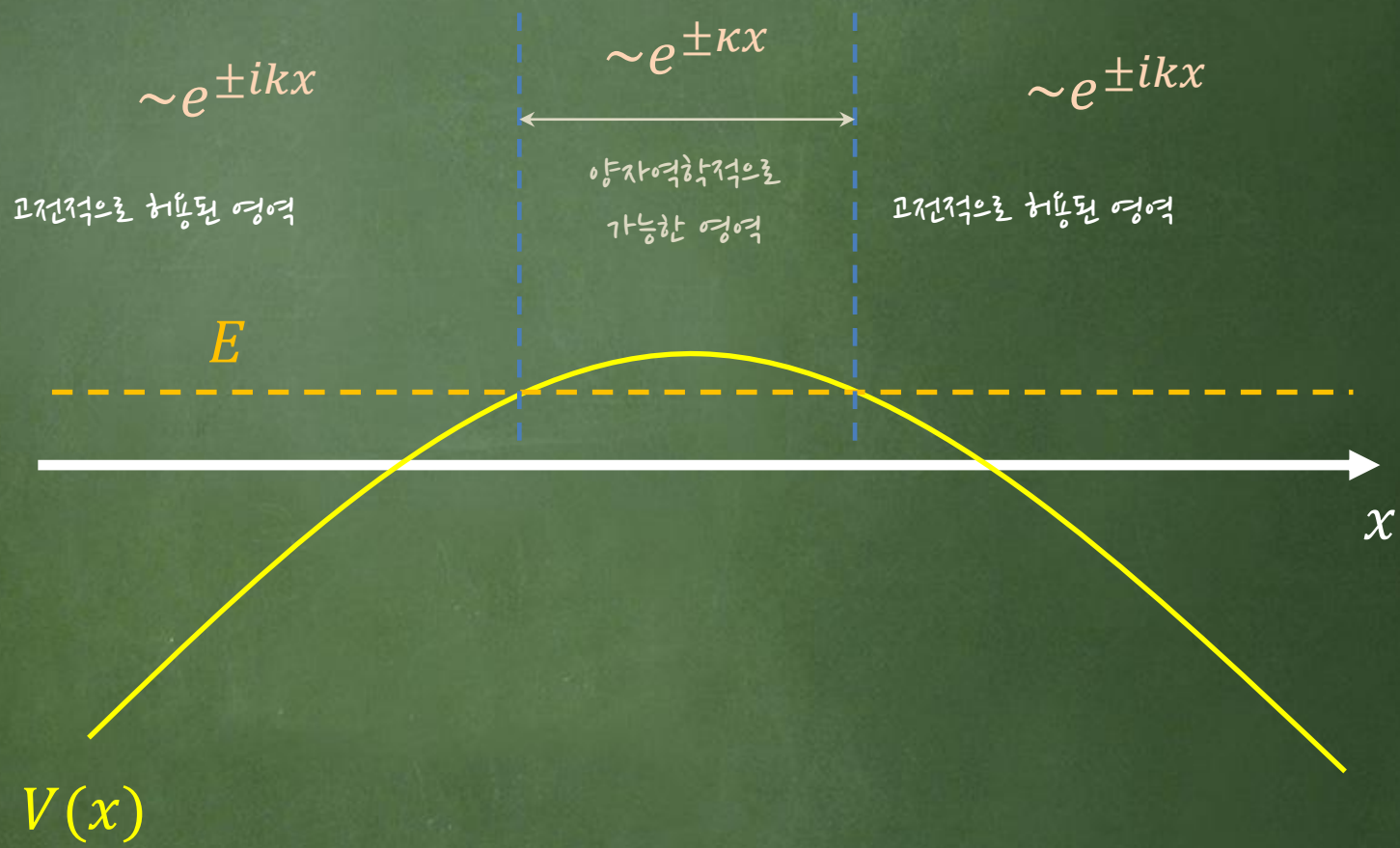
고전적으로 허용된 영역

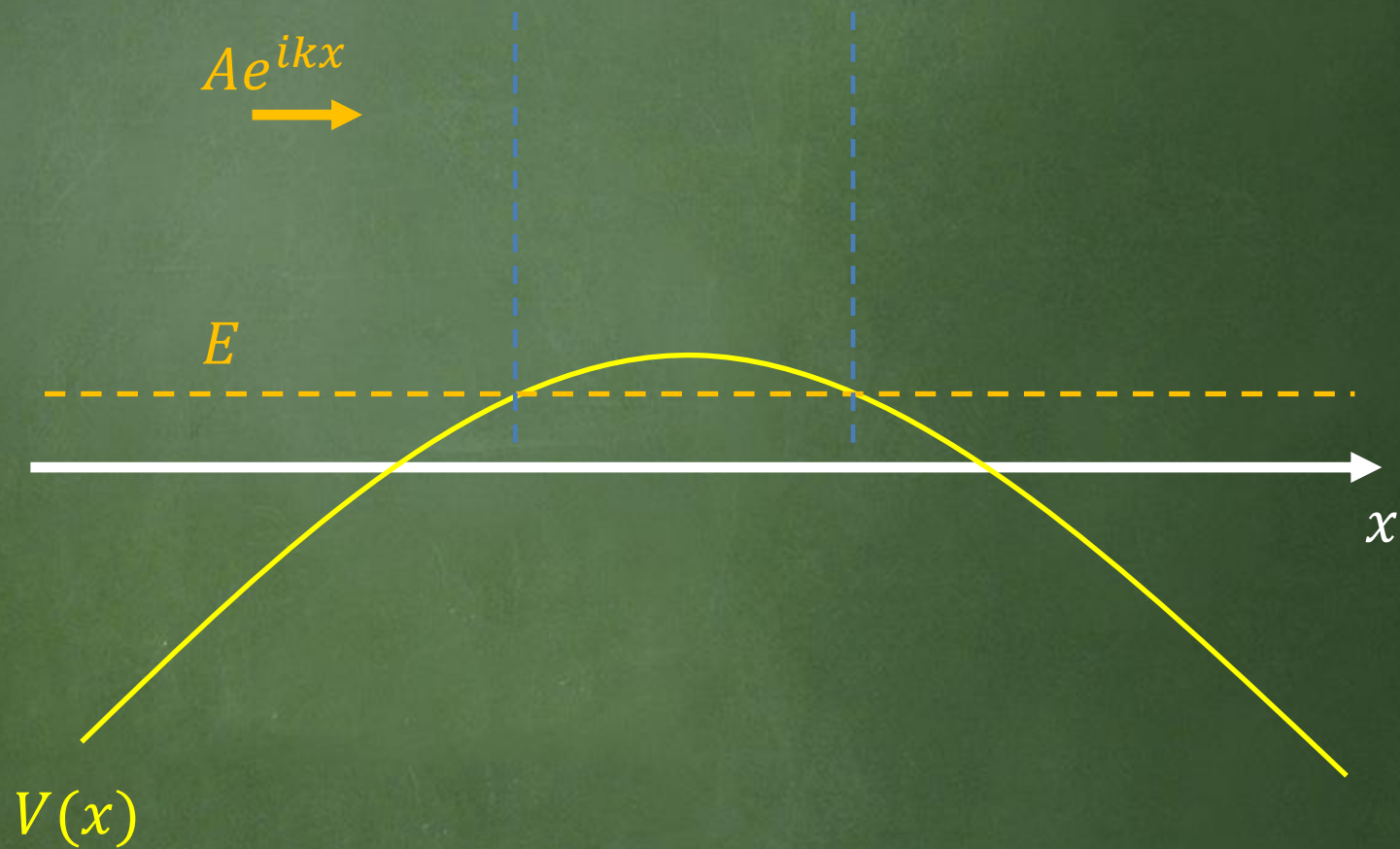
E

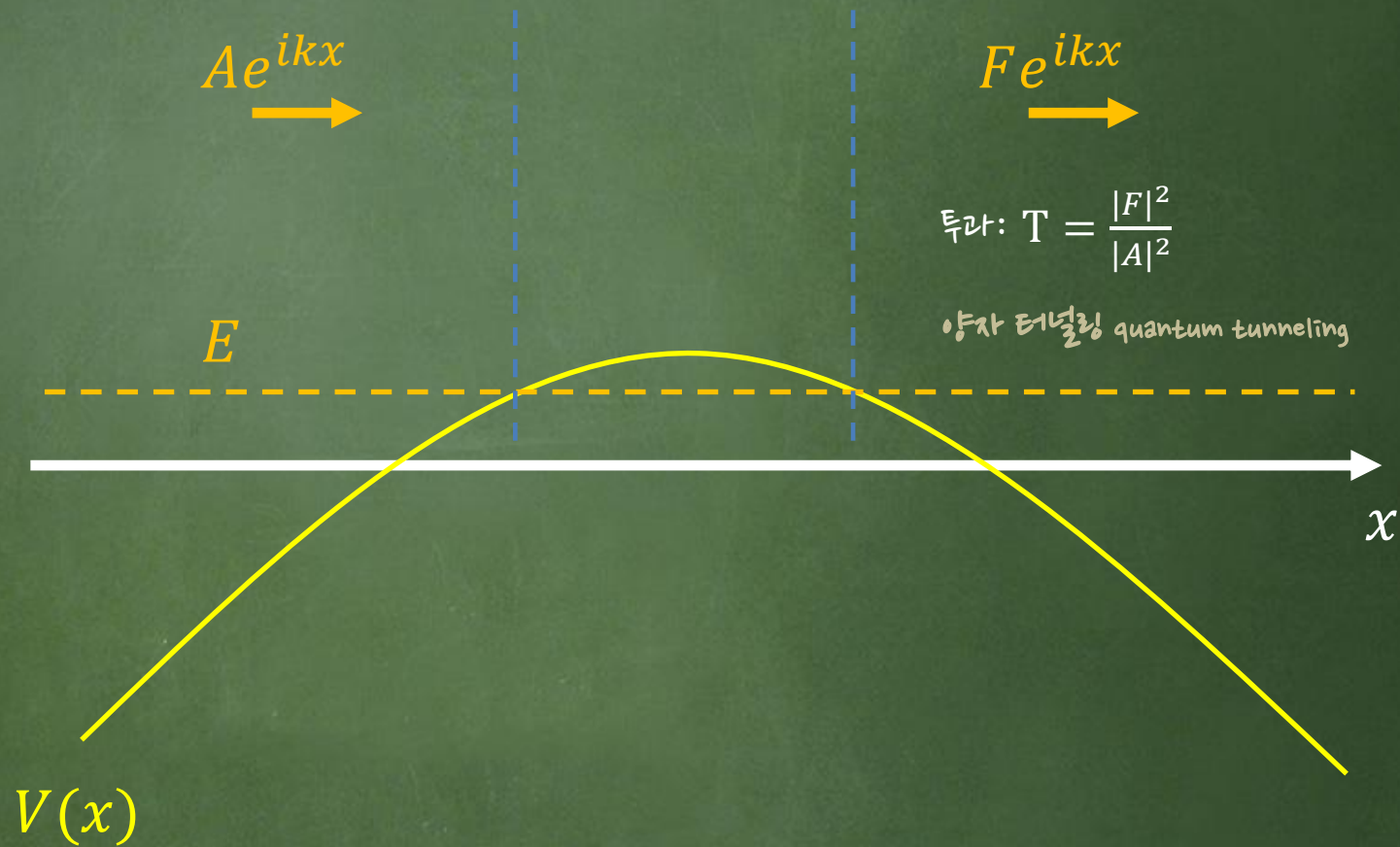
$V(x)$

x









반사: $R = \frac{|B|^2}{|A|^2}$

Ae^{ikx}
→

Be^{-ikx}
←

Fe^{ikx}
→

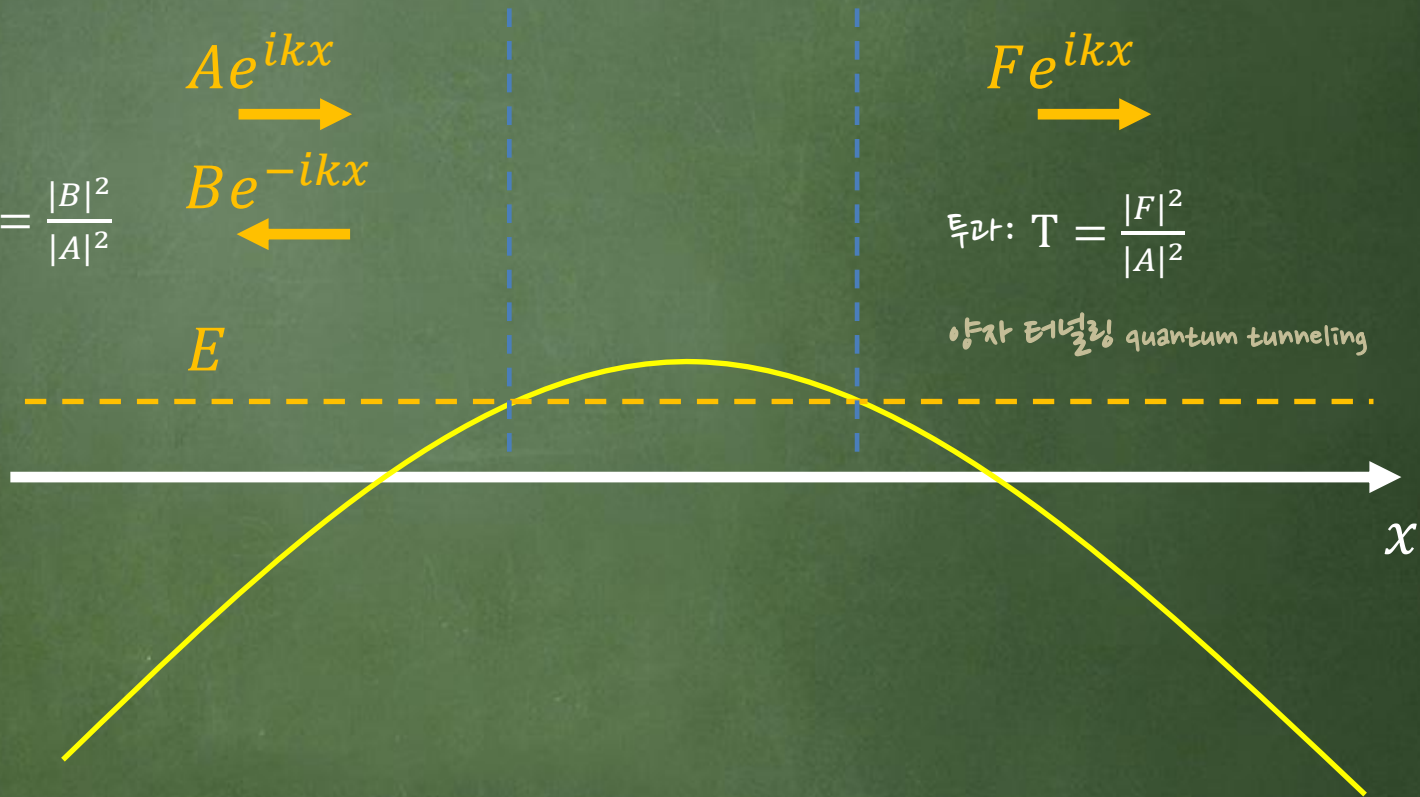
투과: $T = \frac{|F|^2}{|A|^2}$

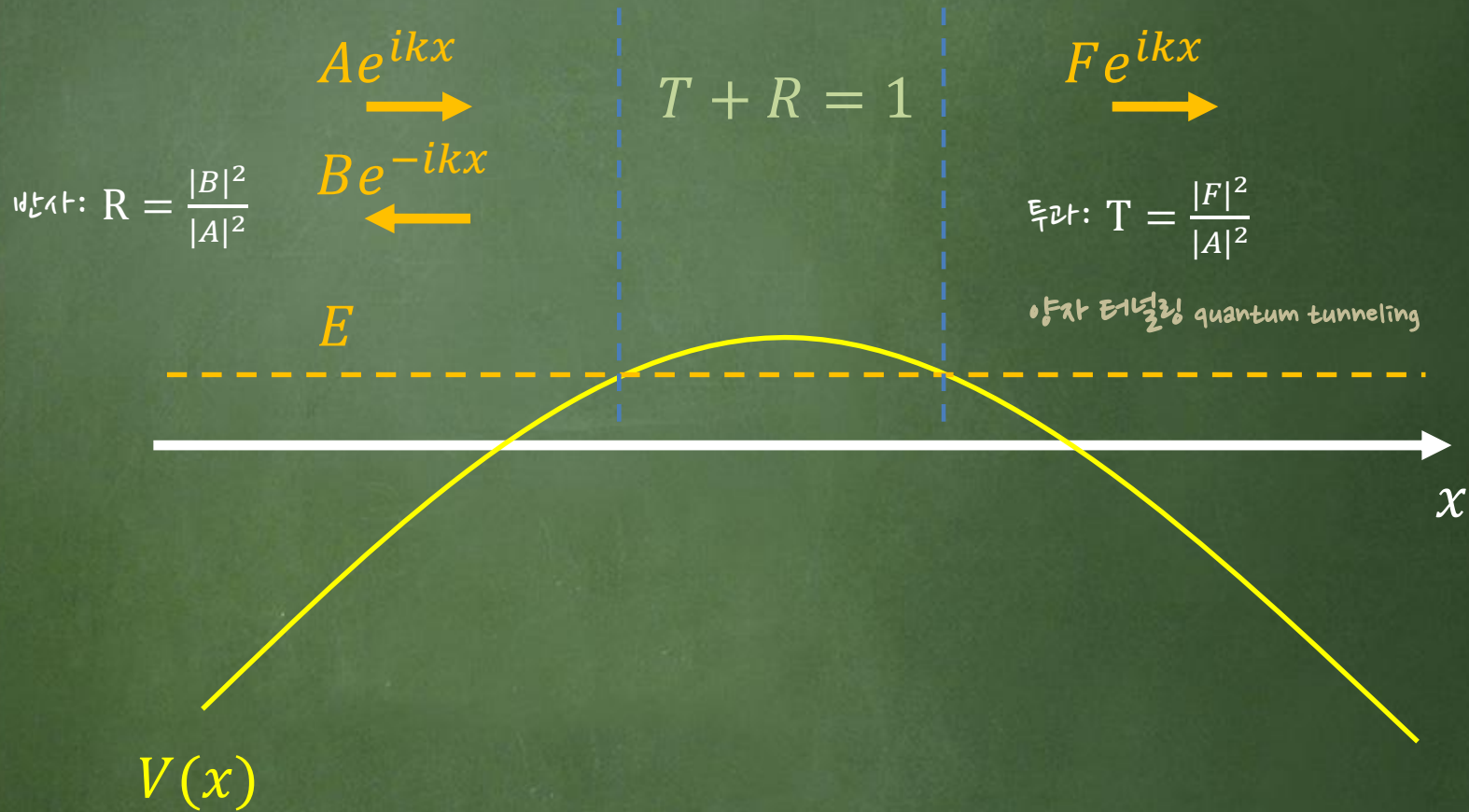
양자 터널링 quantum tunneling

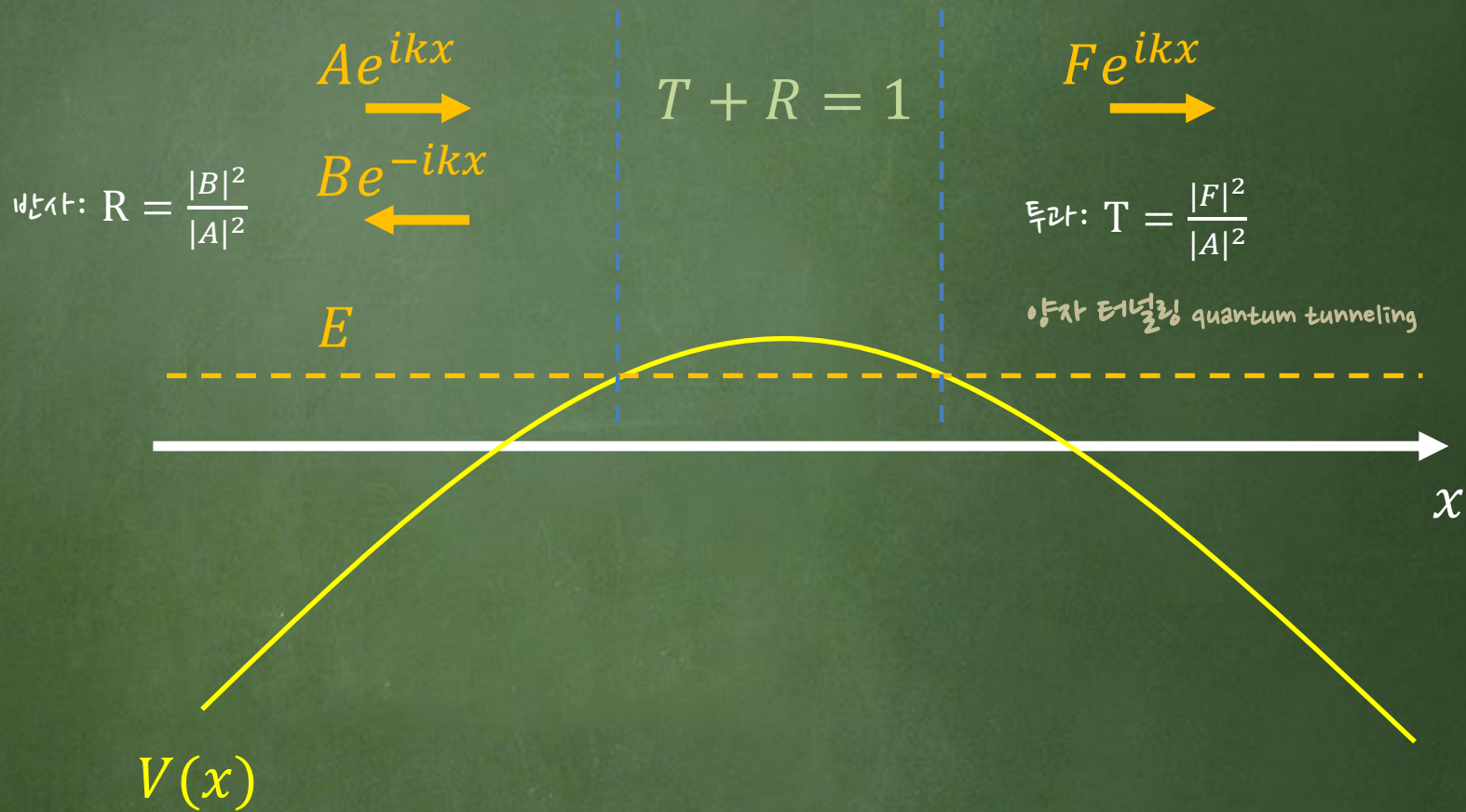
E

$V(x)$

x

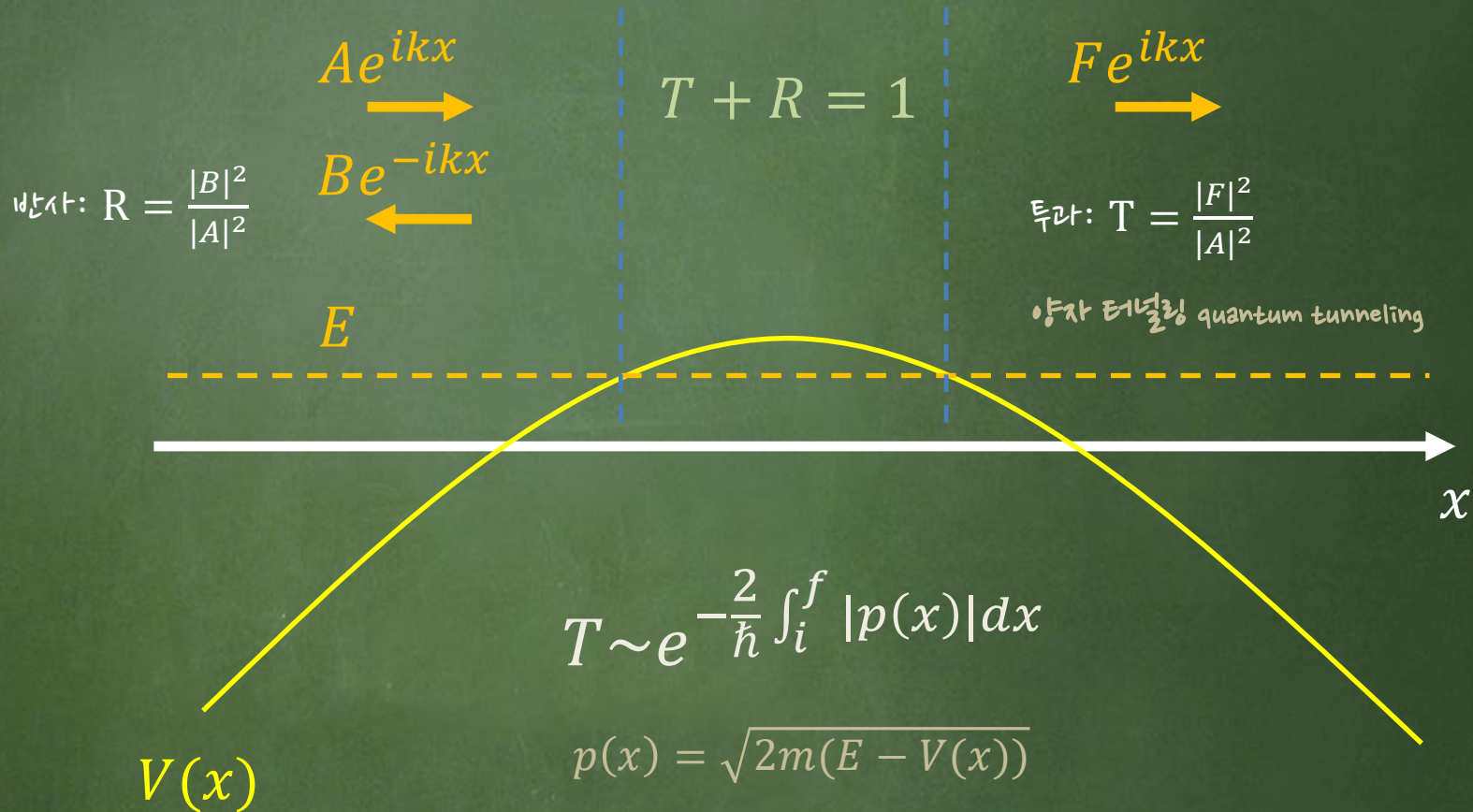




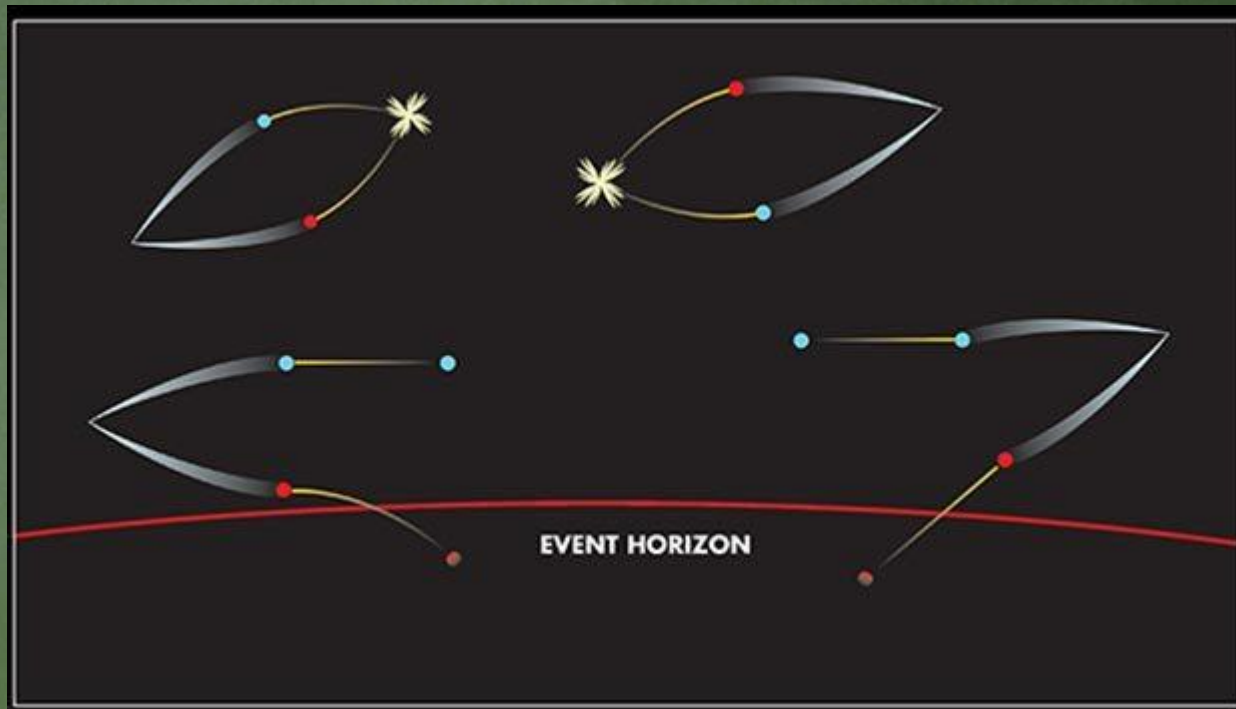


산란 상태 scattering state

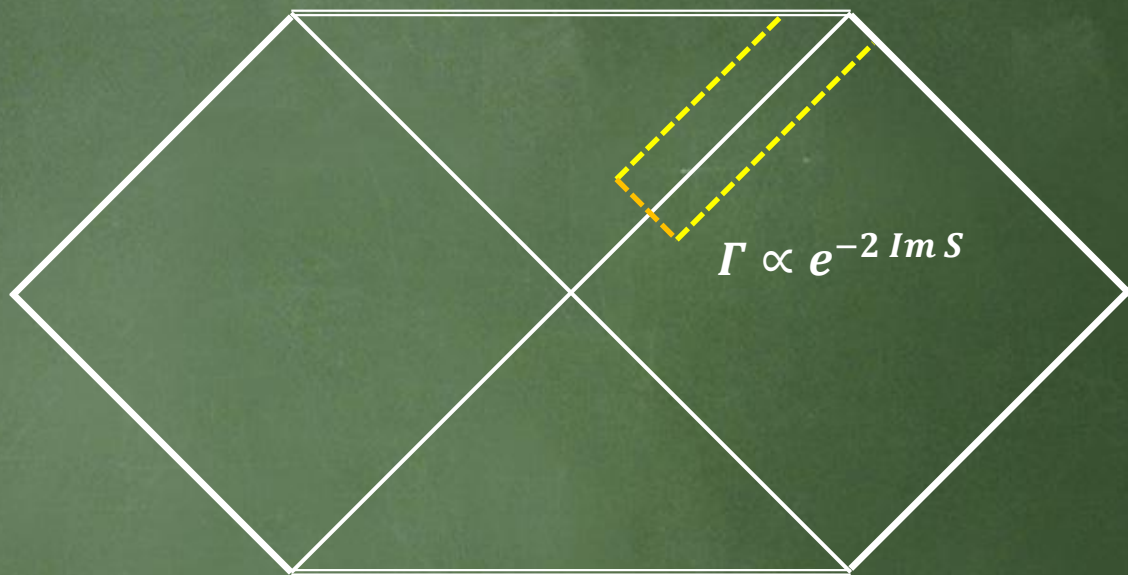
WKB 근사



산란 상태 scattering state



블랙홀의 사건 지평선 근처에서는
 진공 요동 quantum fluctuation에 의해 입자 Hawking radiation가
 생성될 수 있다.



$$Im S = Im \int_{r_{in}}^{r_{out}} p_r dr = Im \int_M^{M-\omega} \int_{r_{in}}^{r_{out}} \frac{dr}{\dot{r}} dH = 4\pi\omega \left(M - \frac{\omega}{2} \right)$$

($H = M - \omega'$)

이것은 블랙홀 내부에서 외부로
입자가 터널링하는 것으로 해석할 수 있다.
이 확률은 WKB 근사로 쉽게 계산할 수 있다.