

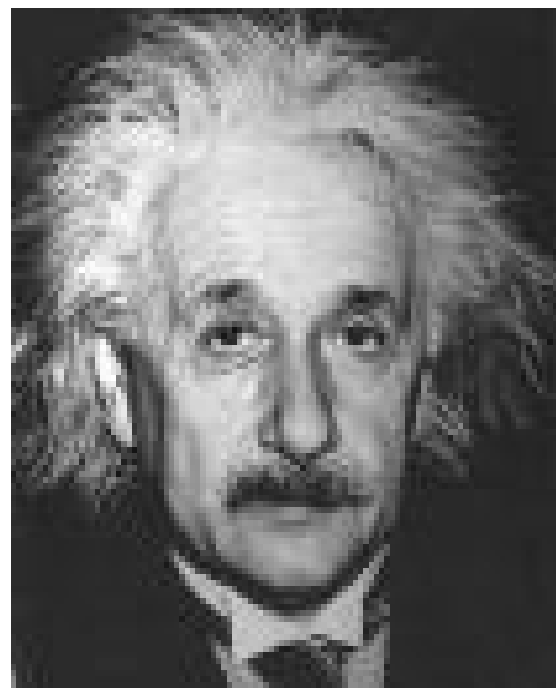
# New Mechanism of Pair creation from Vacuum

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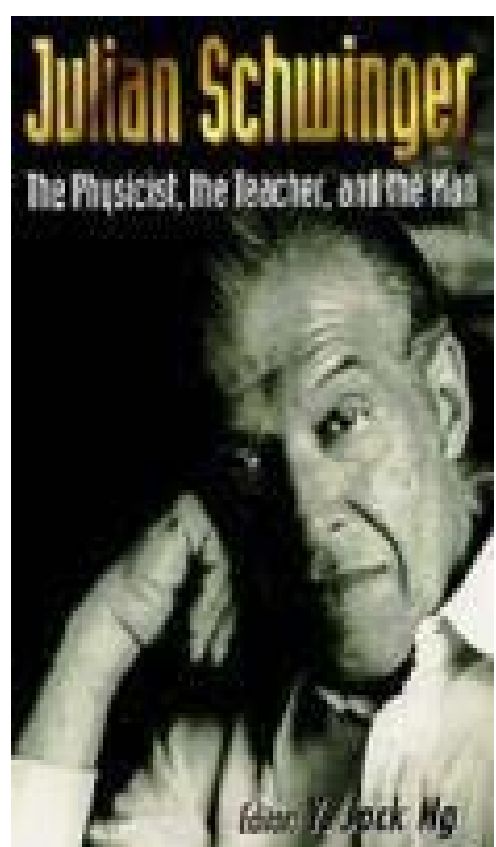
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## 1. Introduction



1905

$$E = mc^2$$



PHYSICAL REVIEW

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On Gauge Invariance and Vacuum Polarization

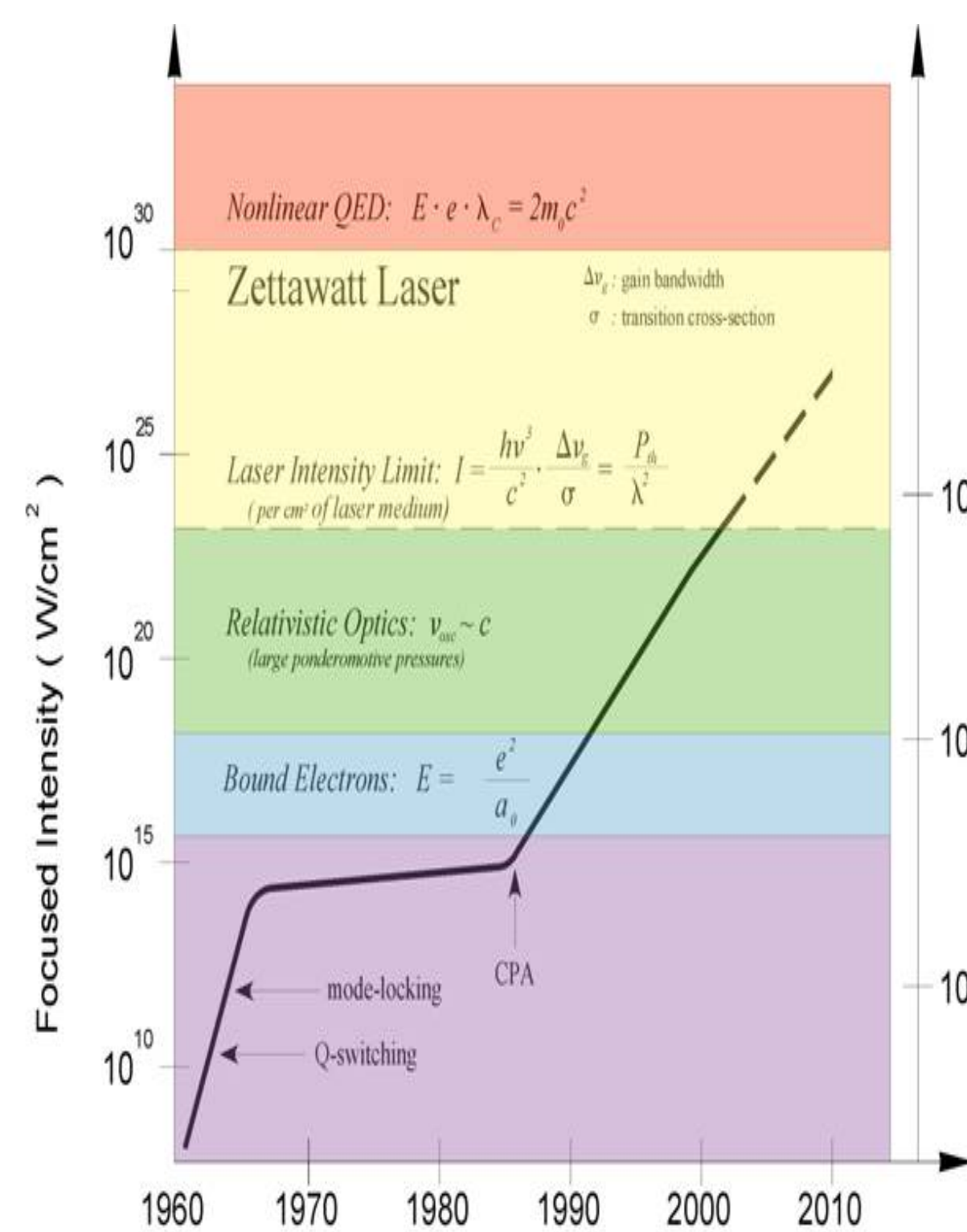
JULIAN SCHWINGER  
Harvard University, Cambridge, Massachusetts  
(Received December 22, 1950)

$$2 \operatorname{Im} \mathcal{E} = - \sum_{n=1}^{\infty} s_n^{-2} \exp(-m^2 s_n) = - \frac{\alpha^2}{\pi^2} \sum_{n=1}^{\infty} n^{-2} \exp\left(\frac{-n\pi m^2}{e\mathcal{E}}\right)$$

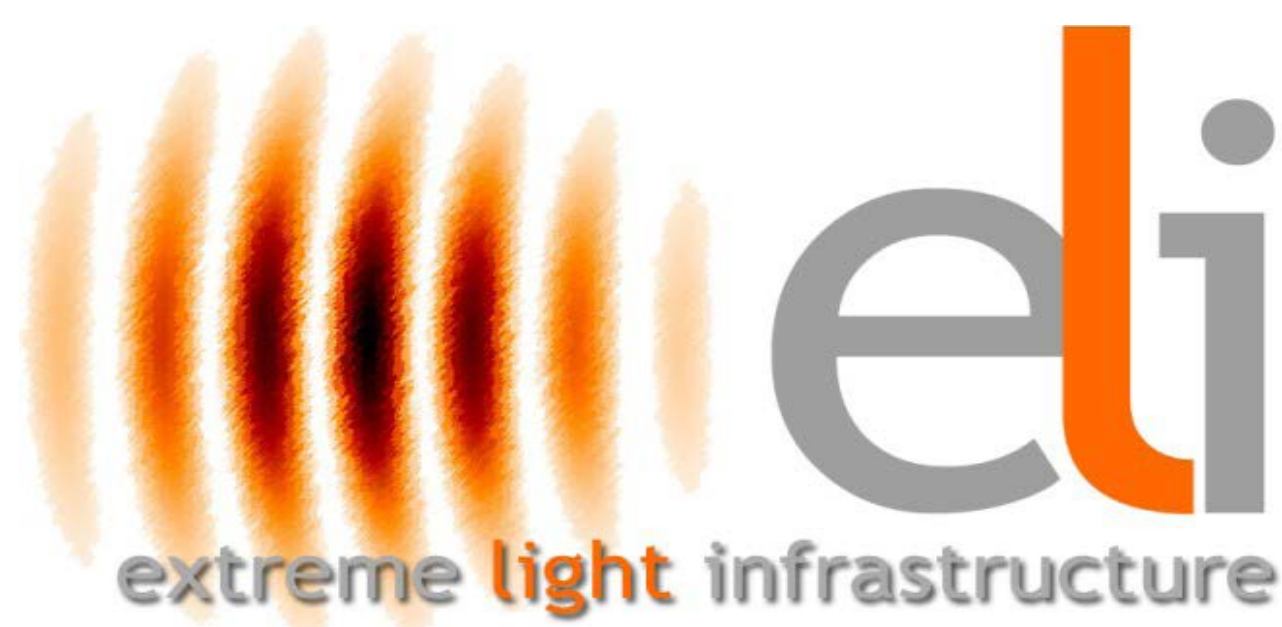
1951

Schwinger critical field:  
 $E \sim 10^{16} \text{V/cm}$

corresponding intensity:  
 $I \sim 10^{29} \text{W/cm}^2$

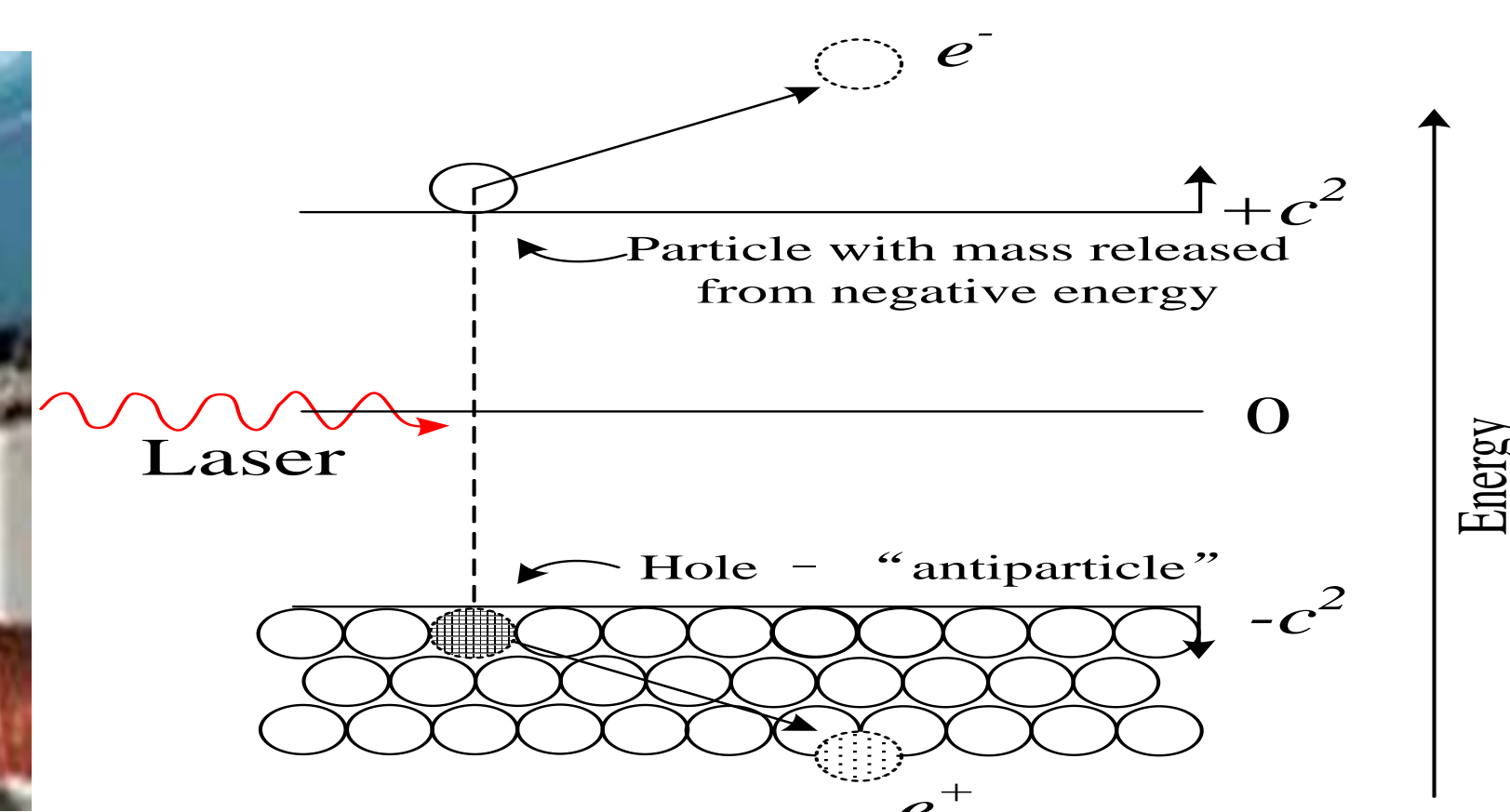


Early studies have focused on the role of homogeneous electric field



localized electric field:  
 $z_R \sim 2.426 \times 10^{-12} \text{m}$   
magnetic field magnitude:  
 $B \sim 1 \text{GG} - 100 \text{GG}$

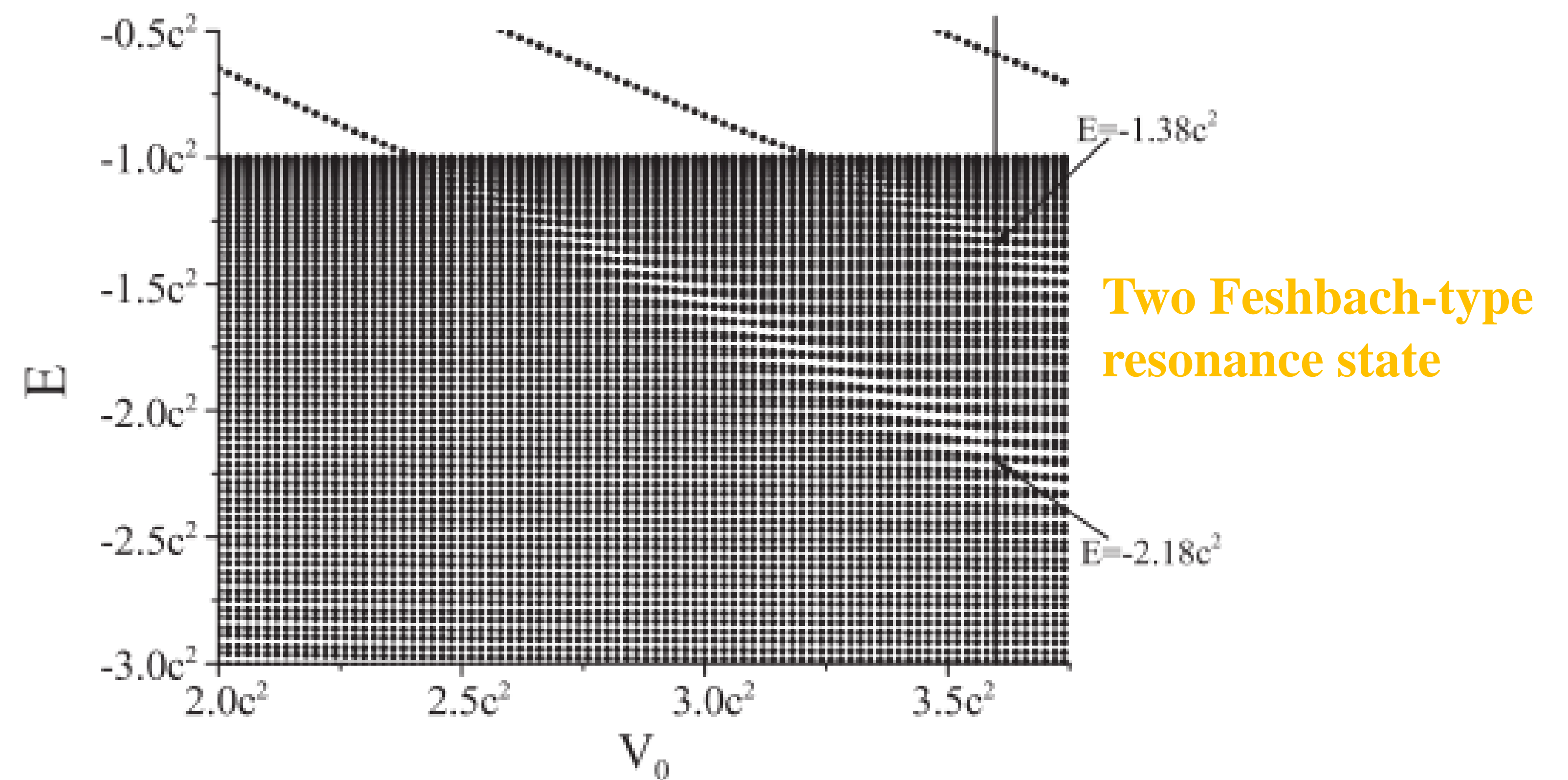
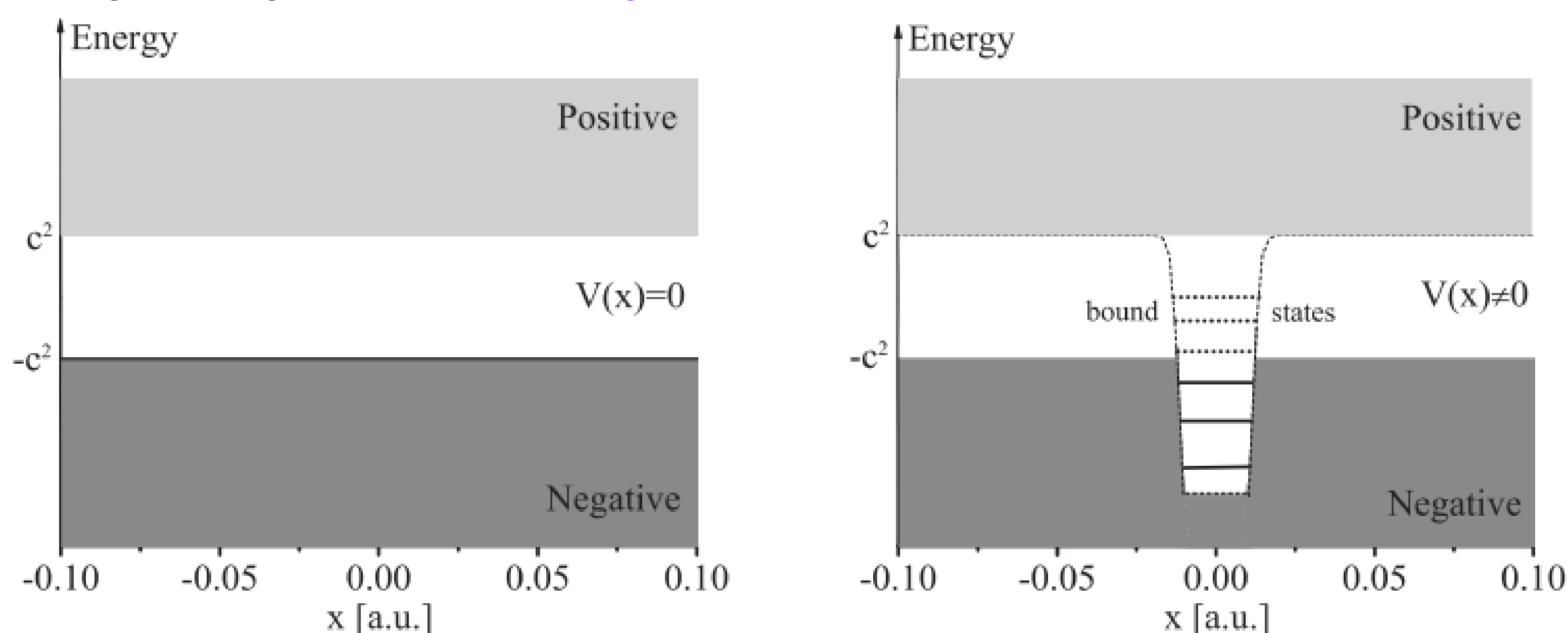
Physical intuition for  $e^+e^-$  pair production from vacuum



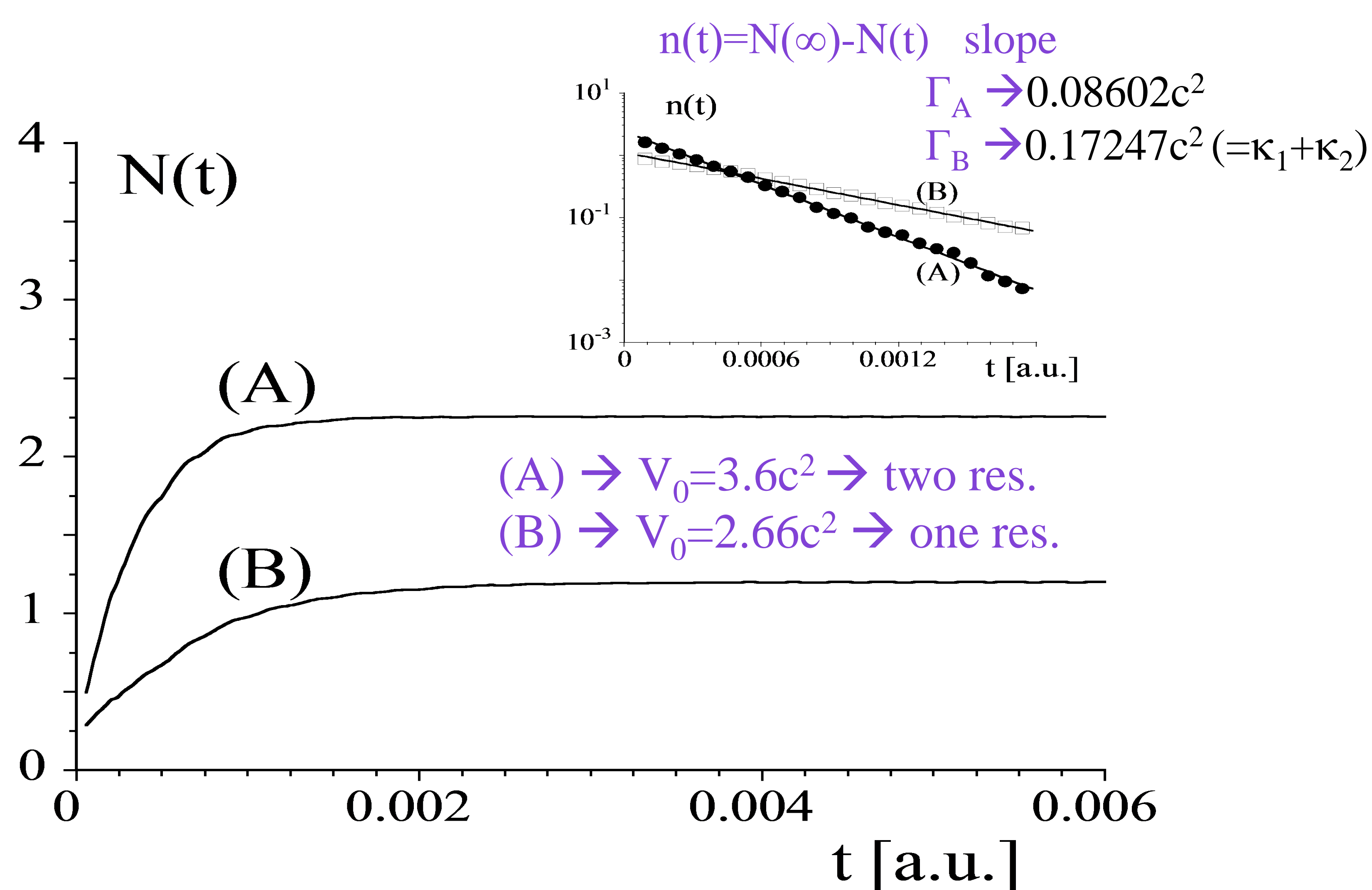
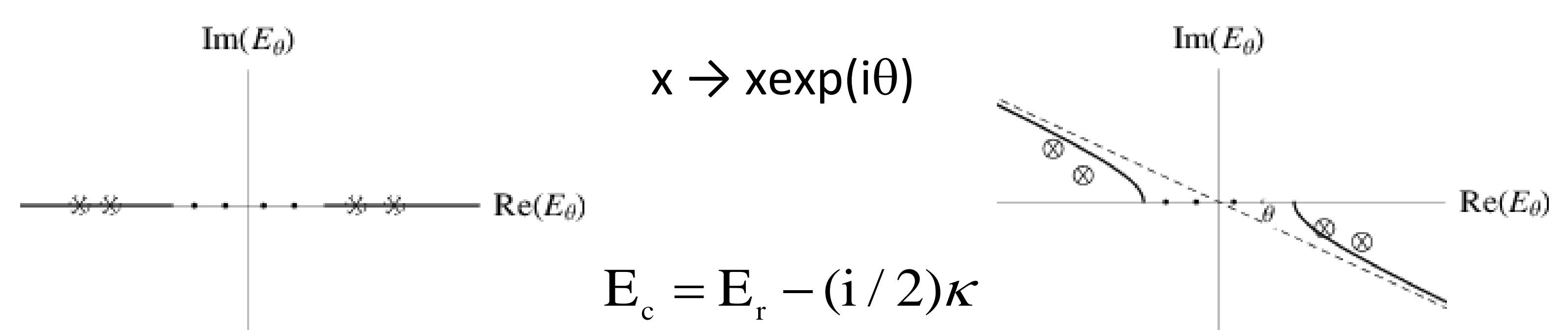
Build a general framework to calculate and study the pair creation process in localized EM fields.

## 2. Non-competing mechanism

Physical picture for **supercritical resonance states**



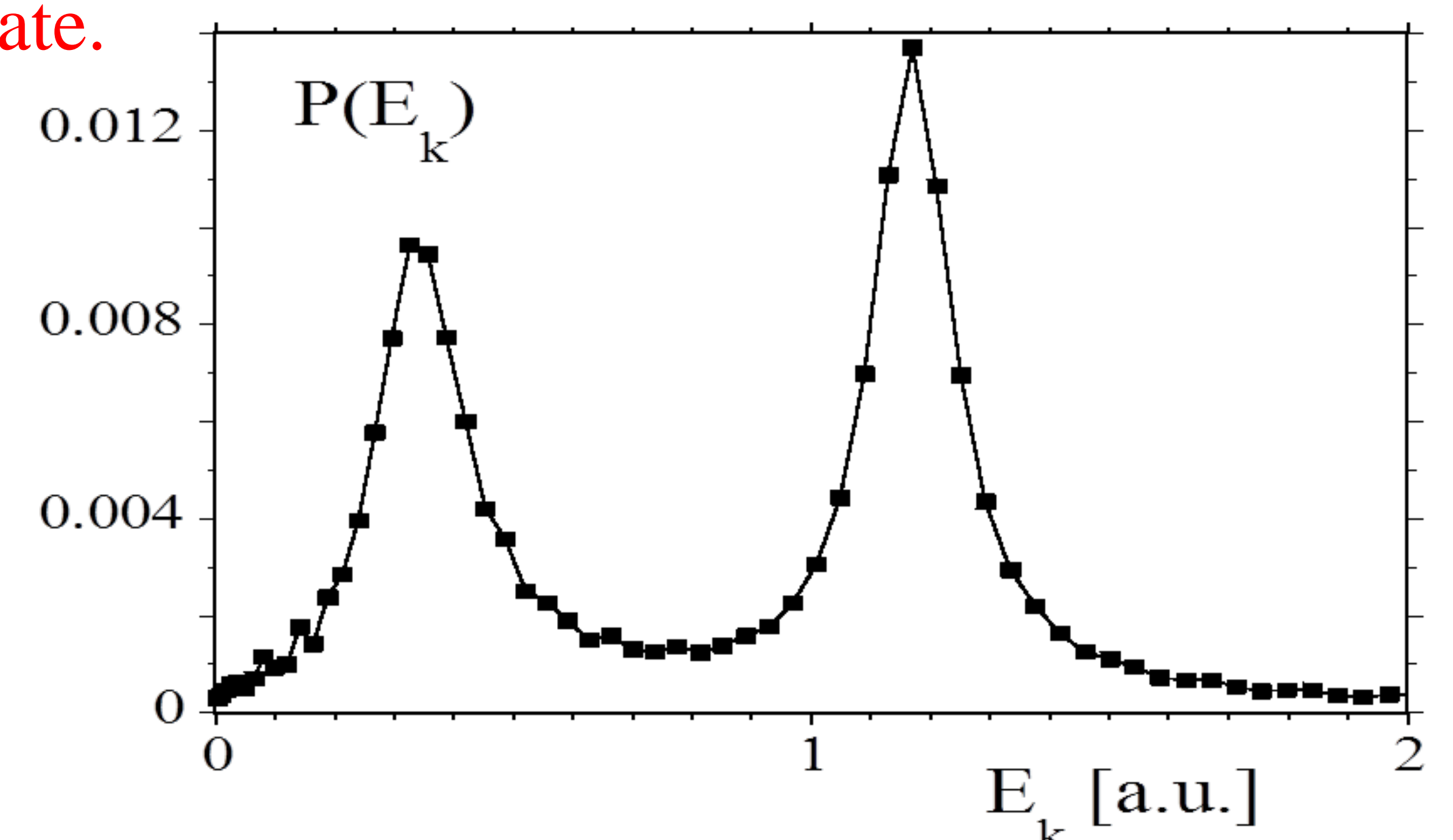
## 3. Pair creation from different channel



## 3. Conclusion and Significance

**Conclusion:**

- **particle number** :  $N(t) = N_0 [1 - \exp(-\kappa_1 t) \exp(-\kappa_2 t)]$
- **collective creation** : two channels have the same creation rate.



**Significance:**

- **new way of simulation** the pair creation process  
*Employing the complex rotation method to study resonance behavior*
- **new way to control** the production in laboratory  
*Using bound state to precisely control the created particle number*