The Puzzle of Excess Heat with No Strong Nuclear Radiation

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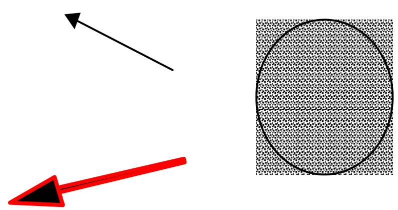
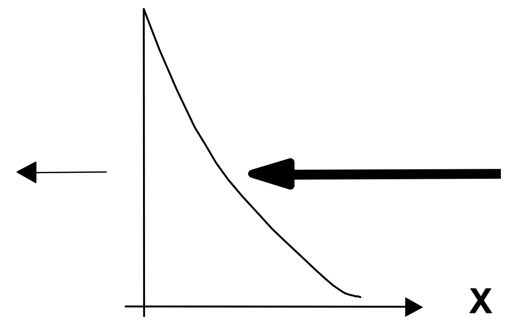
Answers to Prof. J. Huizenga’ Miracles

1. Penetration of Coulomb Barrier
2. No Strong Neutron
3. No Strong γ Radiation





Compound Nucleus Decays to Fastest Channel (Shortest Lifetime)

One Dimensional Penetration

Selective Resonant Tunneling Model

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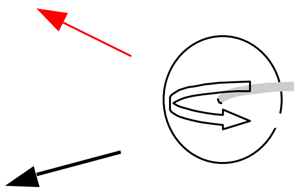
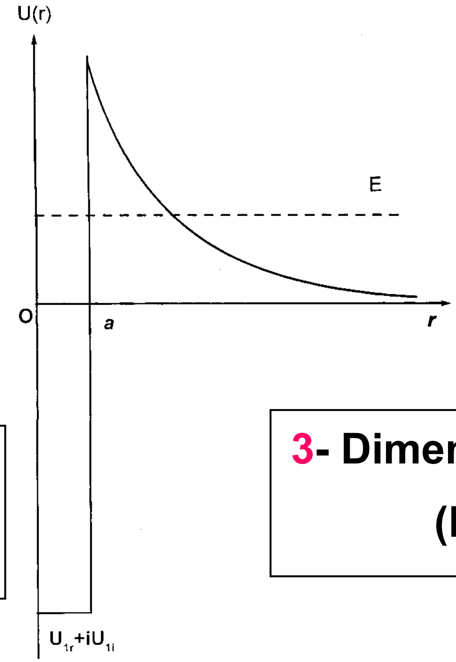
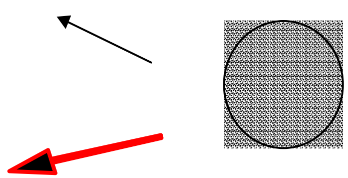


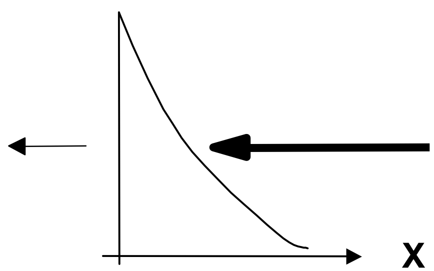


- Energy Level
- Damping

Compound State Decays to Matching Channel
(Longer Lifetime for Higher Barrier)

3- Dimensional Penetration
(Reflection)

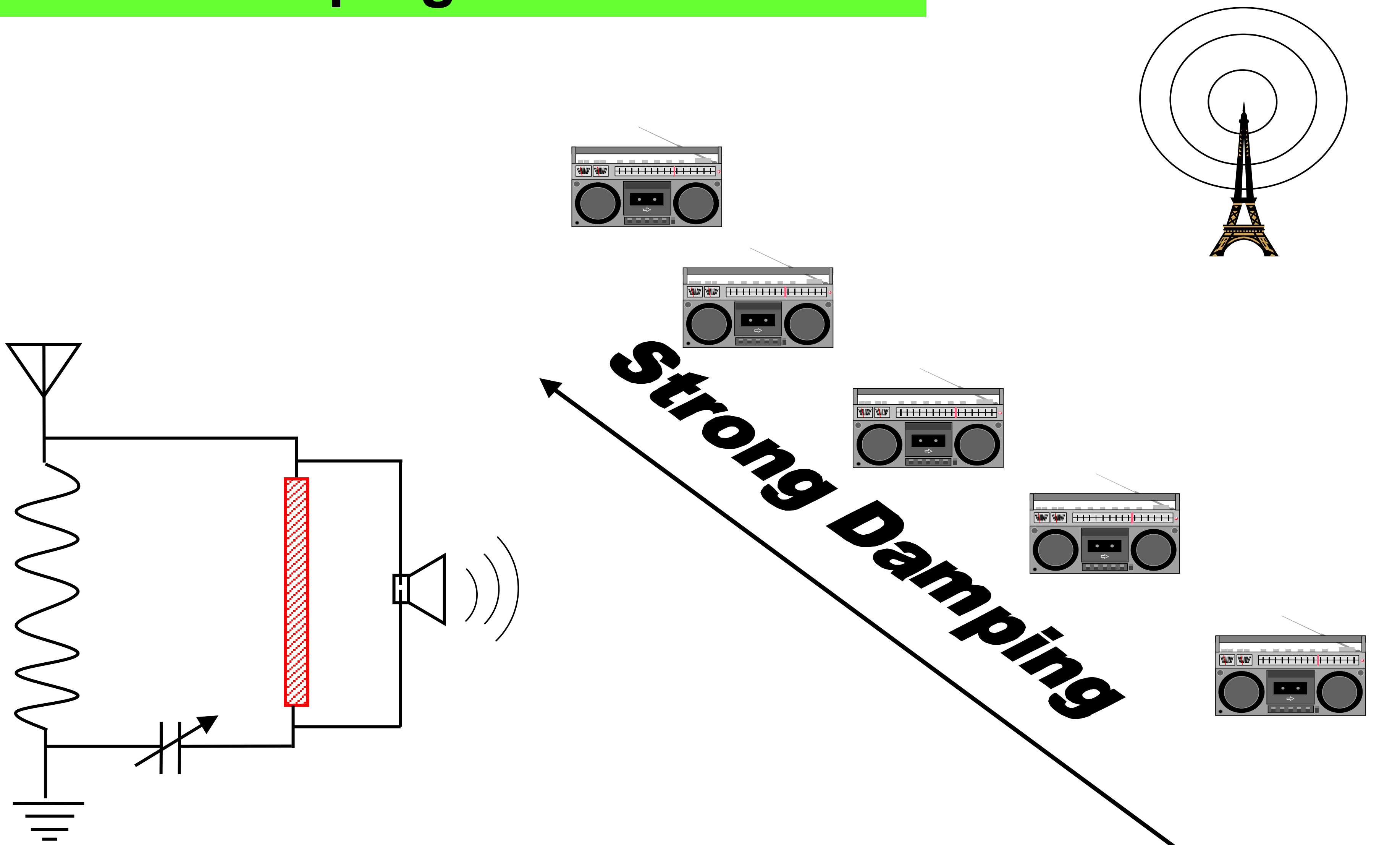




Compound Nucleus Decays to Fastest Channel
(Shortest Lifetime)

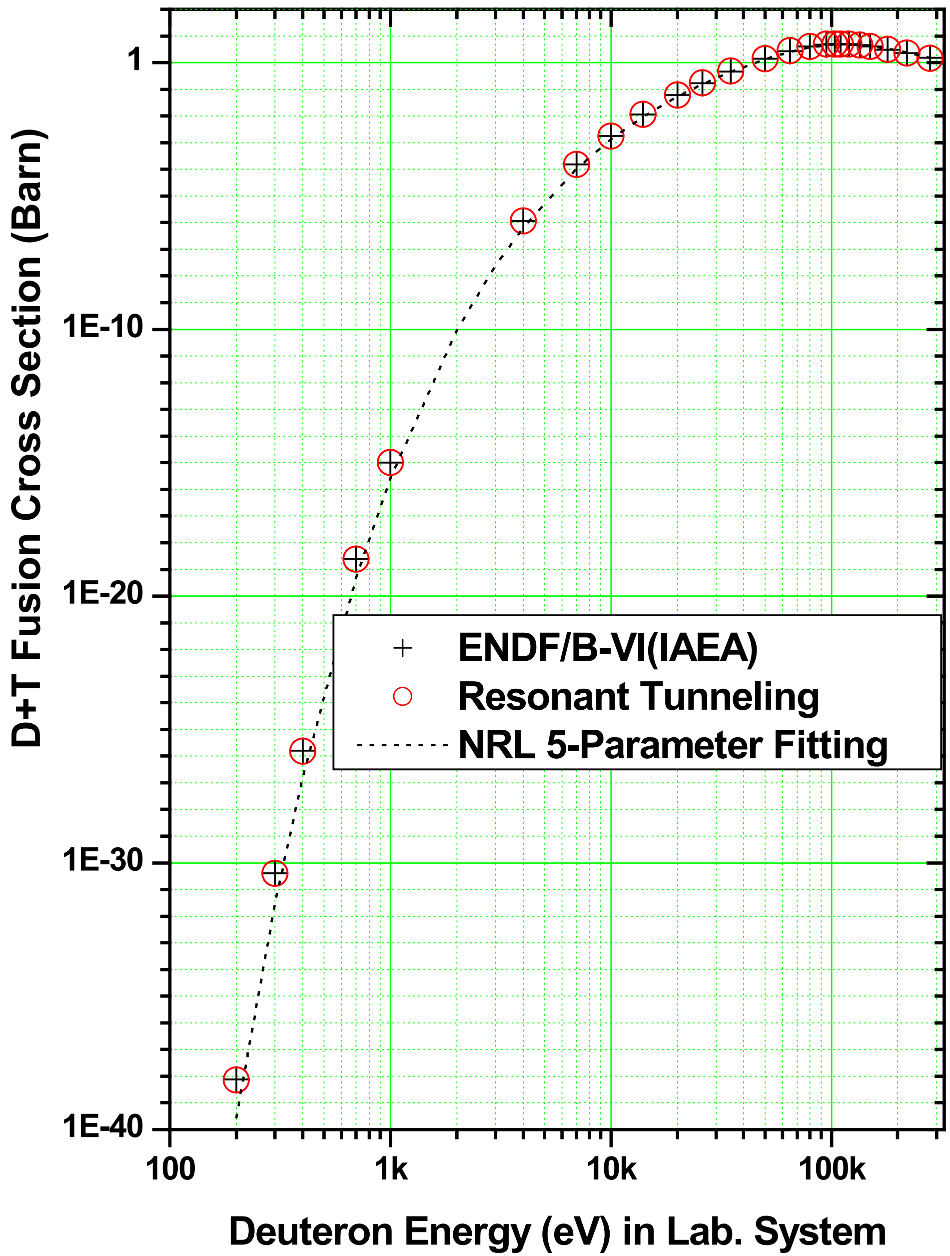
1- Dimensional Penetration

Select Damping in Resonance



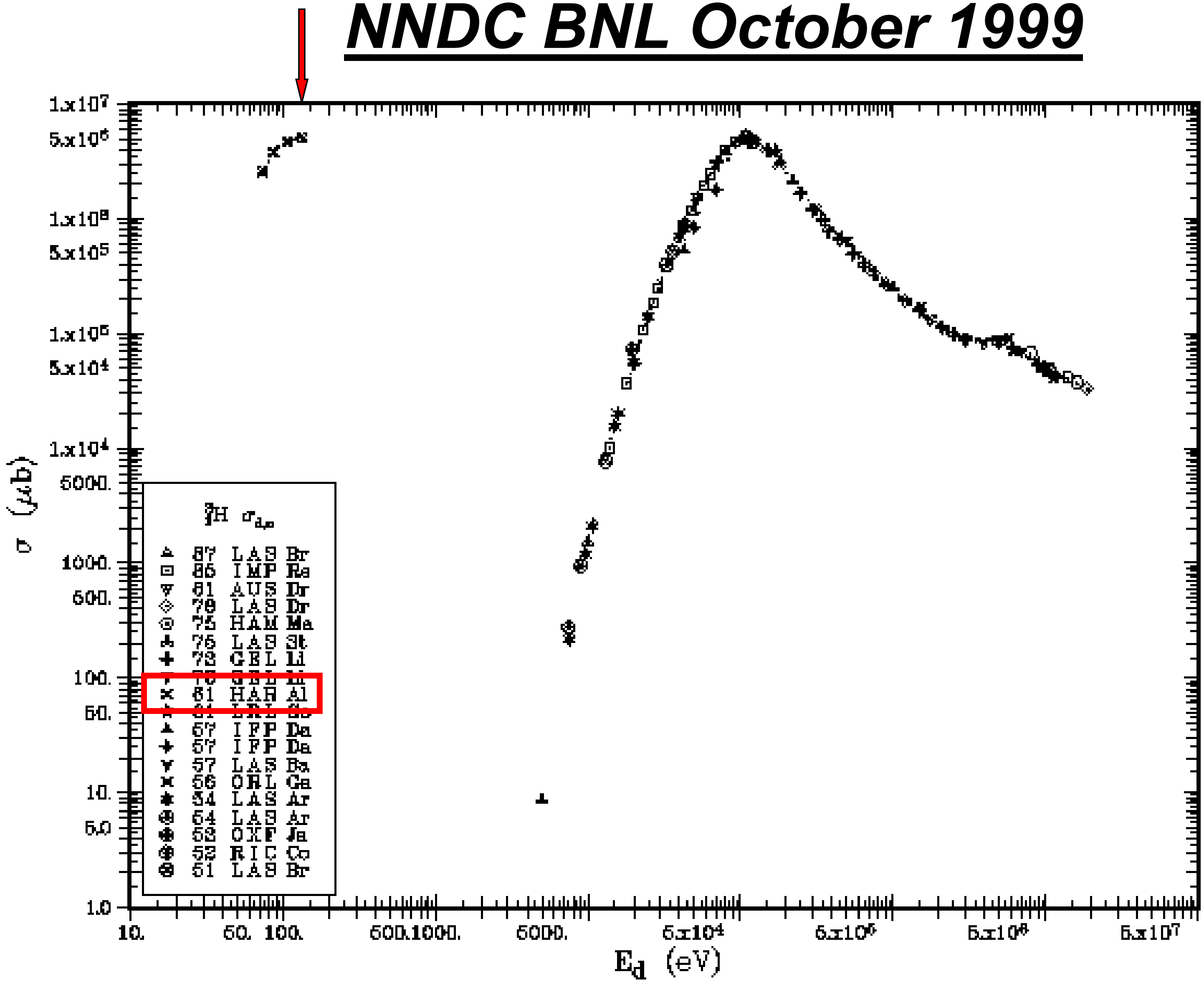
$$\tau_{damping} \approx \theta \cdot \tau_{oscillation}$$

Phys. Rev. C, 61 (2000),024610

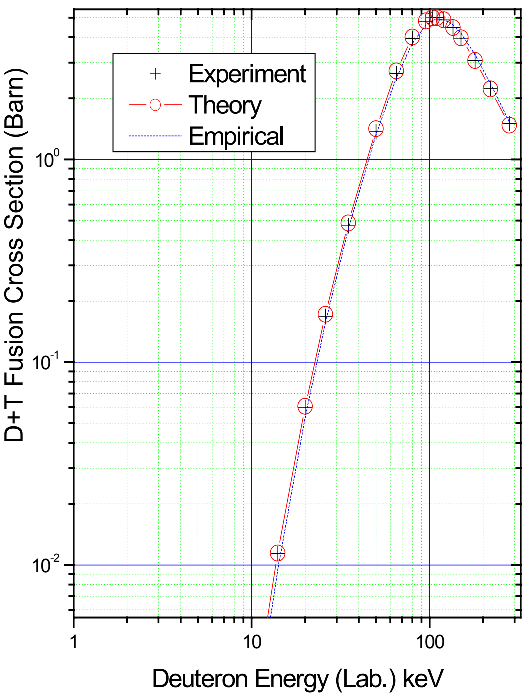


Fusion Science & Technology 41(2002) 63

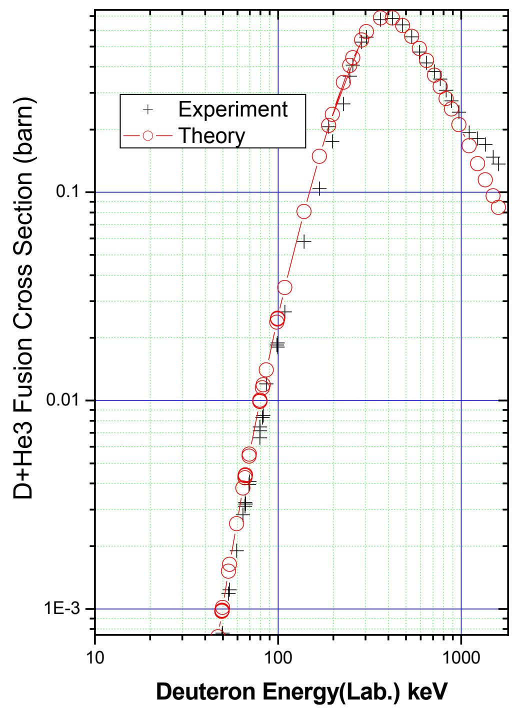
NNDC BNL October 1999



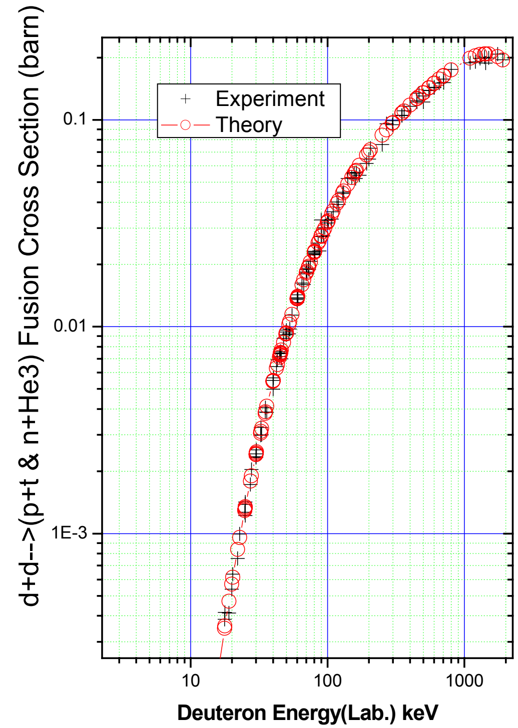
Selective Resonant Tunneling ○ & NNDC Data +



D+T



D+He3



D+D

X. Z. Li, H.Hora, et al., *Laser and Particle Beam*, 22 No.4 (2004)

5-Parameter Empirical Fit

$$\sigma = \frac{A_5 + \dfrac{A_2}{(A_4 - A_3 E)^2 + 1}}{E[\exp(\dfrac{A_1}{\sqrt{E}}) - 1]}$$

$$A_1 = 45.95$$

$$A_2 = 50200$$

$$A_3 = 1.368 \times 10^{-2}$$

$$A_4 = 1.076$$

$$A_5 = 409$$

B.H.Duane, "Fusion Cross Section Theory,"
BWNL-1685,(1972).
Naval Research Lab. Plasma Formulary

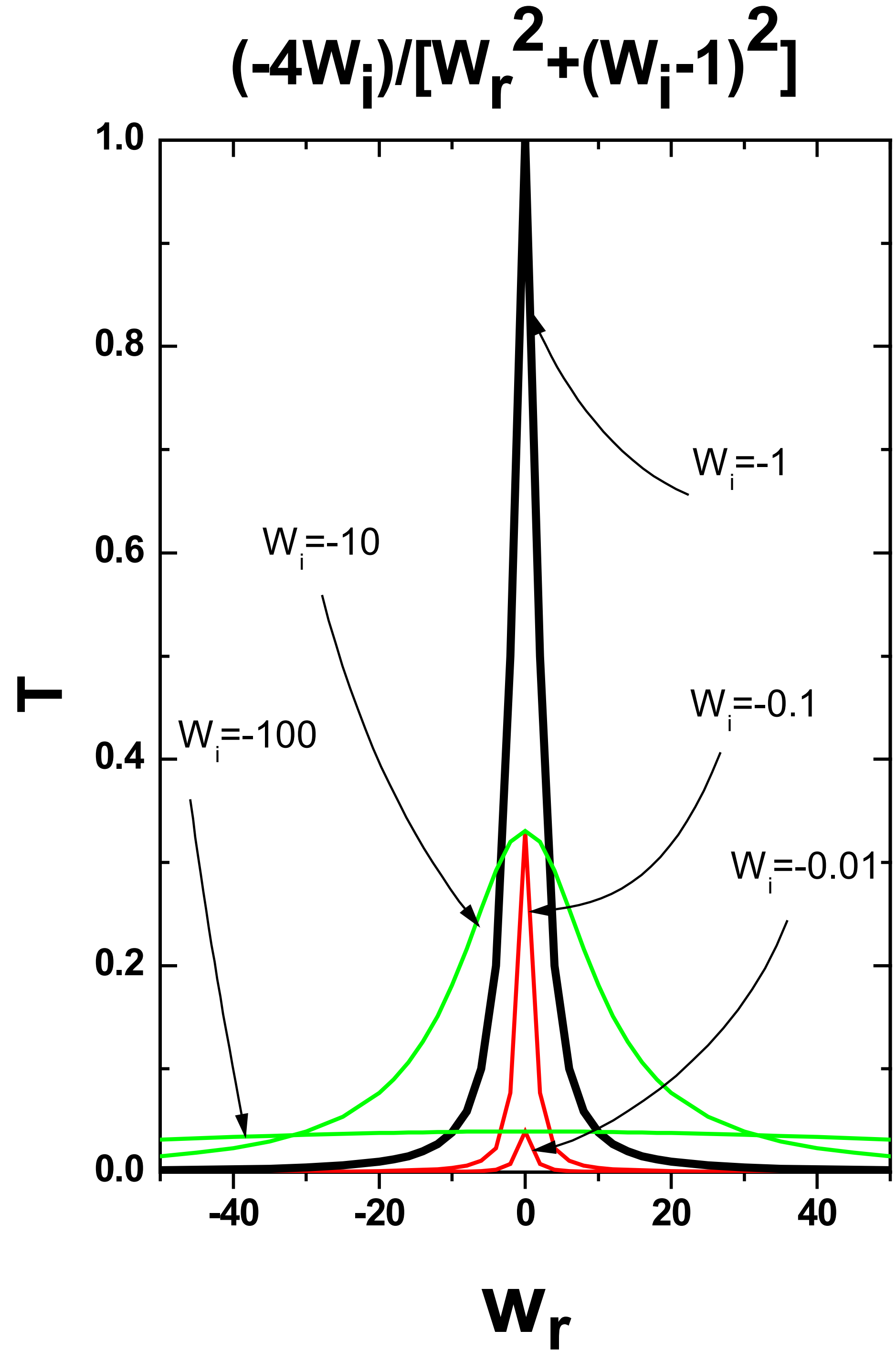
$$S_0 = e^{i2\delta_0} \qquad Cot(\delta_0) = W_r + iW_i$$

$$\sigma_r^{(0)} \approx \frac{\pi}{k^2}(1-|S_0|^2) \equiv \frac{\pi}{k^2}\left\{\frac{-4W_i}{W_r^2+(W_i-1)^2}\right\}$$

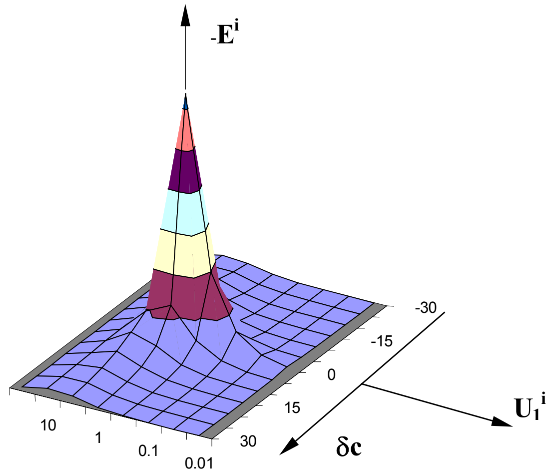
$$\begin{cases} W_r = 0 \\ W_i = O(-1) \end{cases}$$

$$\begin{cases} E = 110\,\text{keV} \\ \sigma_r^{(0)} = 5.01\,\text{b} \end{cases} \qquad \begin{cases} U_{1r} = -47.33\ MeV \\ U_{1i} = -115.25\ keV \end{cases}$$

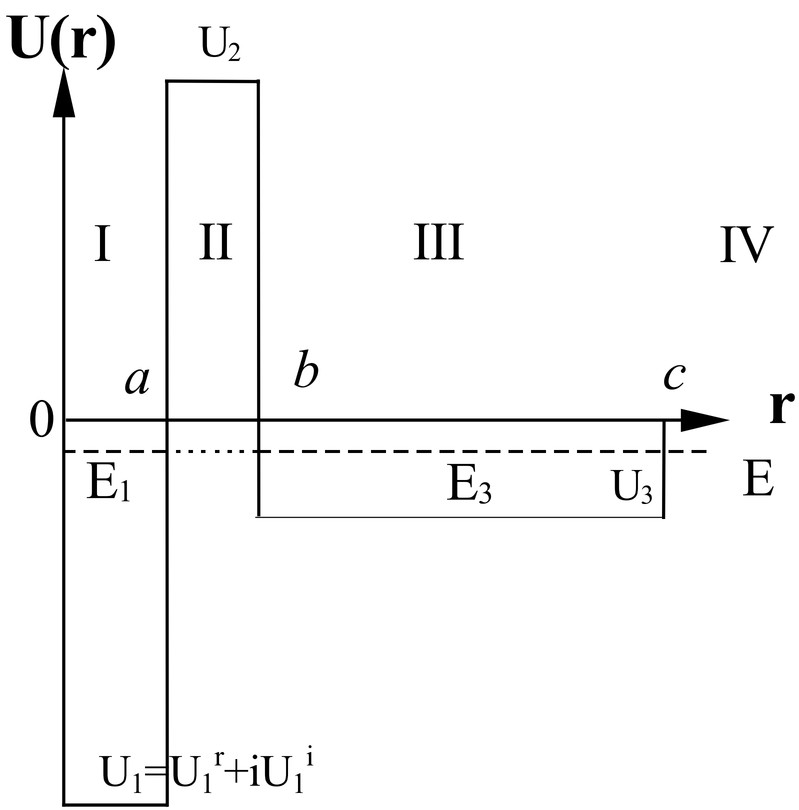
$$a = 1.746\times 10^{-13}(A_1^{1/3} + A_2^{1/3})\ cm$$



$(-4W_i)/[W_r^2+(W_i-1)^2]$
T
1.0
0.8
0.6
0.4
0.2
0.0
-40
-20
0
20
40
W_r
W_i=-1
W_i=-10
W_i=-0.1
W_i=-100
W_i=-0.01



$$\tau_{life} \approx \frac{\hbar}{|E_i|}$$



$$\tau_{life} \approx \theta \cdot \tau_{flight} \ (lattice)$$

$$\tau_{life} \approx \theta^2 \cdot \tau_{flight} \ (beam)$$

$$\theta^{-2} \text{ -- } Gamow\ Factor$$

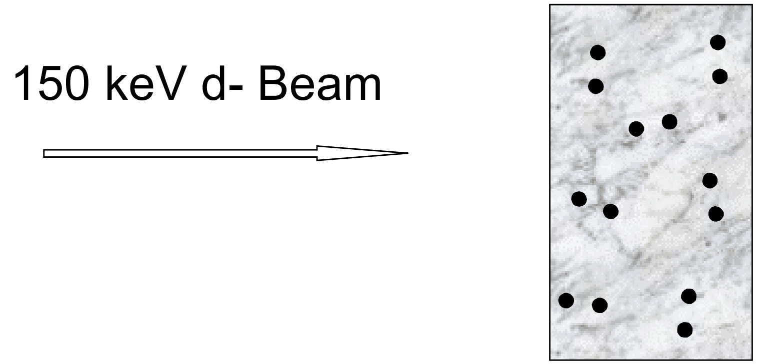
Czechoslovak Journal of Physics, 49 (1999) 985.
Fusion Technology, 36 (1999) 324.

Experimental Evidences for Selective Resonant Tunneling

1. 3—Deuterons Fusion Reactions

2. Tritium Production without n & γ

Identification of d+d Resonant State



TiD_x Target
(5~15°C, x~1.4)

d+(d+d)→T(4.75 MeV)+^{3}He(4.75 MeV)

$$R(3d) = N_b V_b \sigma(d+2d) N(2d)$$

$$N(2d) = R(2d)\tau(2d)$$

$$\frac{R(3d)}{R(2d)} = N_b V_b \sigma(d+2d)\tau(2d)$$

$$\tau(2d) \approx 10^4 \sec. \qquad \tau_{life} \approx \theta \cdot \tau_{flight} \approx 10^{27} \cdot 10^{-23} \sec.$$

Tritium Production Mechanism

$$d + d \rightarrow \begin{cases} T + p & (1) \\ {}^{3}He + n & (1) \\ {}^{4}He + \gamma & (10^{-6}) \\ {}^{4}He + Heat & \end{cases}$$

$$p + d \rightarrow {}^{3}He^{*} \rightarrow$$

$$\rightarrow \begin{cases} {}^{3}He + \gamma \\ T + e^{+} + \nu_{e} (\beta^{+} - decay, \quad 1) \\ {}^{3}He^{*} + e^{-} \rightarrow T + \nu_{e} (\text{K-Capture}, 10^{-6}) \end{cases}$$

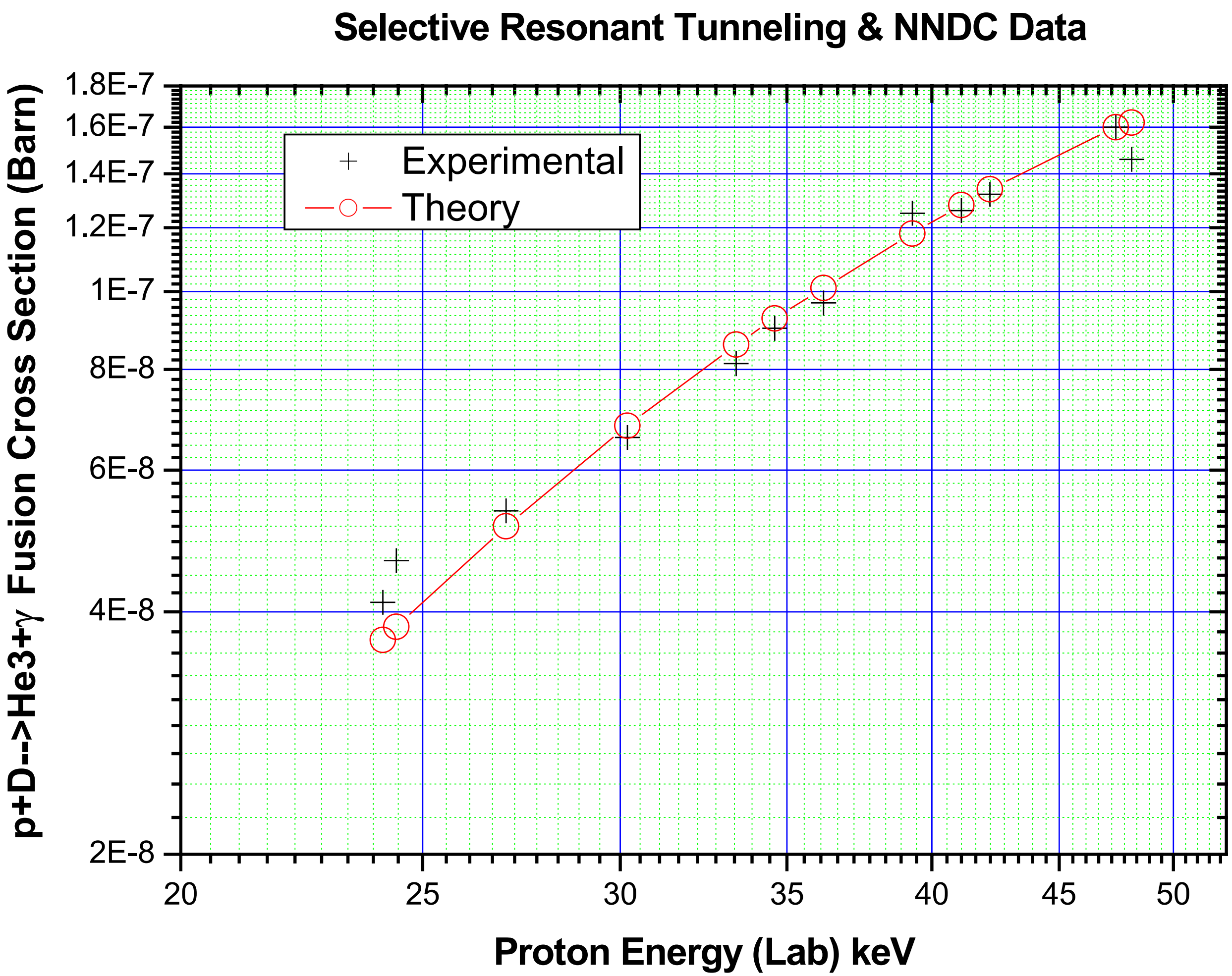
Tritium Production in D(H)/Pd Systems

$$d + d \rightarrow T + p \qquad \text{(Strong)}$$

$$p + d \rightarrow He^{3} + \gamma \qquad \text{(E - M)}$$

$$p + d \rightarrow T + e^{+} + \nu_{e} \qquad \text{(Weak)}$$

$$p + d + e^{-} \rightarrow T + \nu_{e} \qquad \text{(Weak)}$$



Selective Resonant Tunneling & NNDC Data
p+D-->He3+γ Fusion Cross Section (Barn)
Proton Energy (Lab) keV
Experimental
Theory
1.8E-7
1.6E-7
1.4E-7
1.2E-7
1E-7
8E-8
6E-8
4E-8
2E-8
20
25
30
35
40
45
50

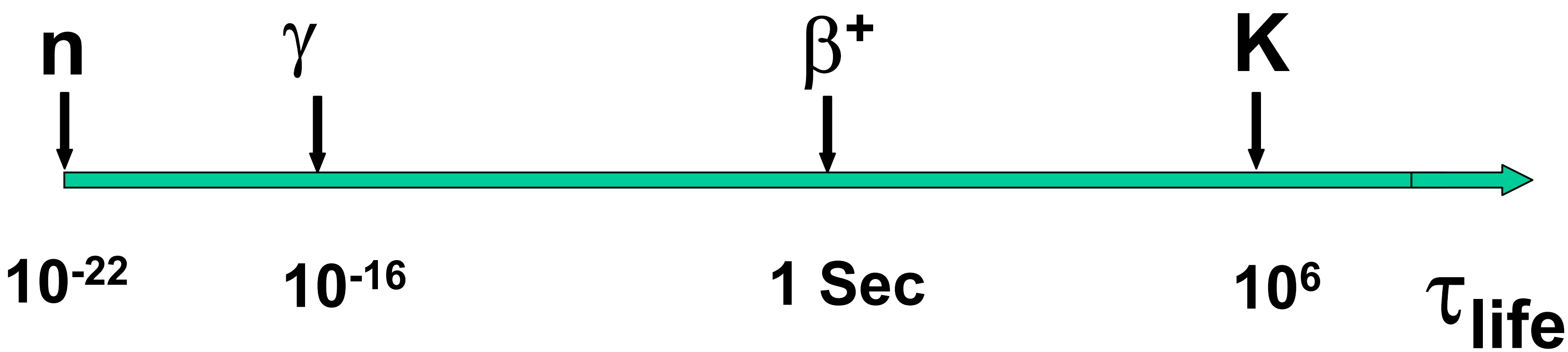
P+d ⟶ ^{3}He + Gamma

$$\frac{K-Capture\ Lifetime}{\beta^{+}-Decay\ Lifetime} \approx \frac{10^{6}\ \mathrm{sec}}{1\,\mathrm{sec}}$$

$$\theta \cdot \tau_{flight} \approx \tau_{K-capture}$$

$$10^{25-31} \cdot 10^{-23}\ \mathrm{sec} \approx 10^{2-8}\ \mathrm{sec}$$

Selectivity of Resonant Tunneling



$P + d \rightarrow T + e^{+} + \nu_e$

$\theta\ \tau_{flight}$

$\tau_{K\text{-}capture} \sim 10^6$ sec.

$\theta\ \tau_{flight} > 100$ Sec.

Conclusion

1. Excess Heat with No Strong Nuclear Radiation is Feasible. ----- WHY ?

2. Deuterium Flux may form a self-sustaining Reactor in Pd.------ HOW ?

Multiple Scattering Theory—Fine Tuning

Fission Reactor—Neutron Diffusion — Escaping Res.

CMNS Reactor—Deuteron Wave—Lock in Resonance

Fine Tuning Mechanism

- **Temperature Variation: 11.8×10^{-6} /K**

- **Loading Ratio: D/Pd 0.58→0.78**

Lattice Constant 4.025Å→4.050Å

$5\times10^{-3}/0.2$ in 8×10^{5} seconds