UF UNIVERSITY of FLORIDA

Blockage of the first excited state of ^{198}Hg

Hans Leuenberger, PhD,

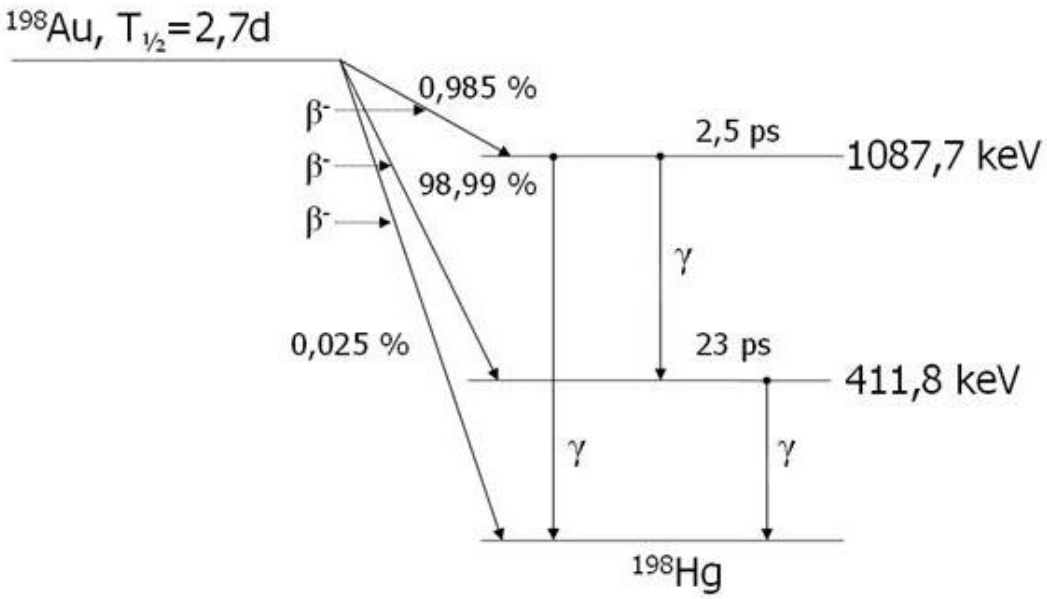
Prof. emeritus Pharmaceutical Technology University of Basel;

Adjunct Professor,

University of Florida, College of Pharmacy, Lake Nona Campus.

hans.leuenberger@ufl.edu;

The first excited state of ^{198}Hg at 411.8 keV



Nuclear Activation Analysis NAA

A. Comunetti prepared with an A.C. Oscillator described in the Proceedings two identical samples of Au NP solutions in water to detect Au by NAA, since chemically it was only possible to detect Au in the sample heated > 60 ˚ C !

For detecting Au he used the 411.8 keV γ transition.

Interestingly & as a surprise, nobody could understand, A. C. confirmed the chemical result, since he only could show the presence of Au in the Au water sample heated above 60 ˚ C !

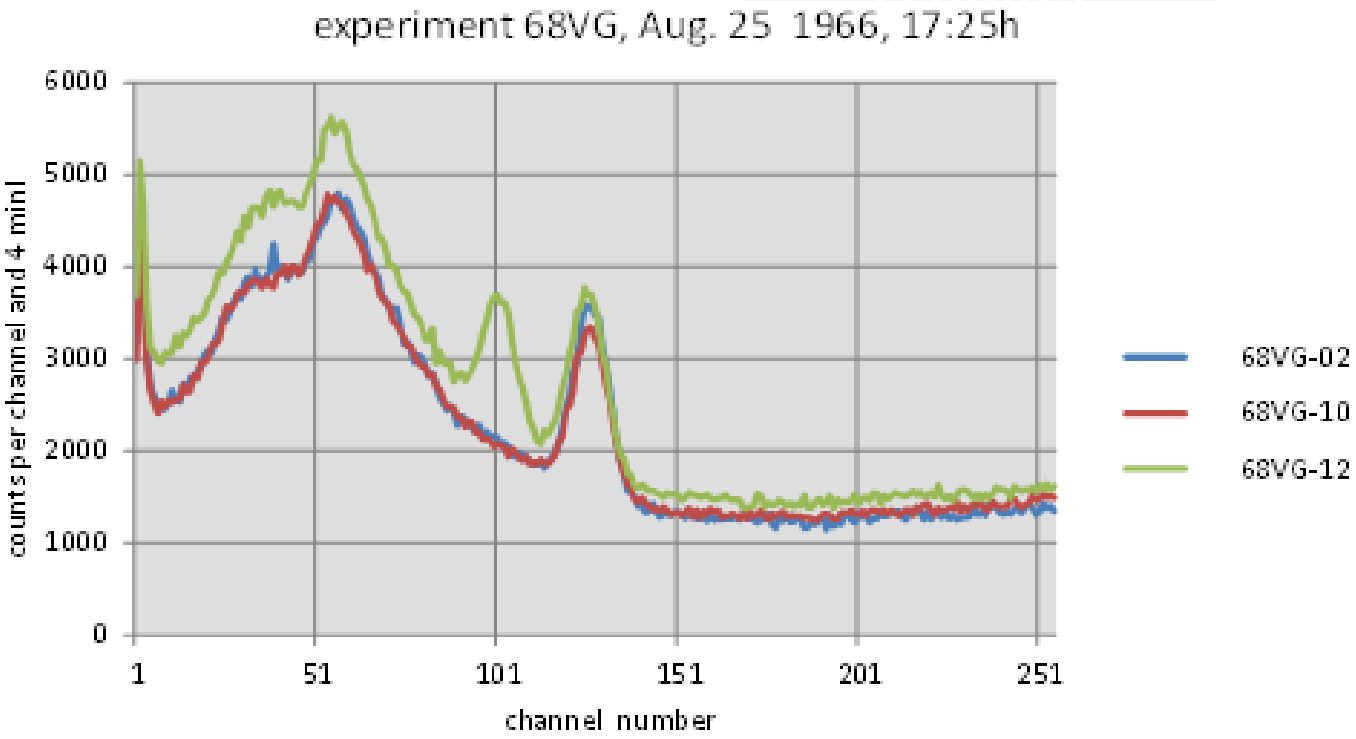
The first excited state of ^{198}Hg at channel 101 incl. background radiation of ^{24}Na (^{24}Na / ^{24}Na at channel 125).

Green = heated sample > 60 ° C (68VG-10)

-> Missing peak of sample 68VG-10 at channel 101

= sample kept at room Temperature!

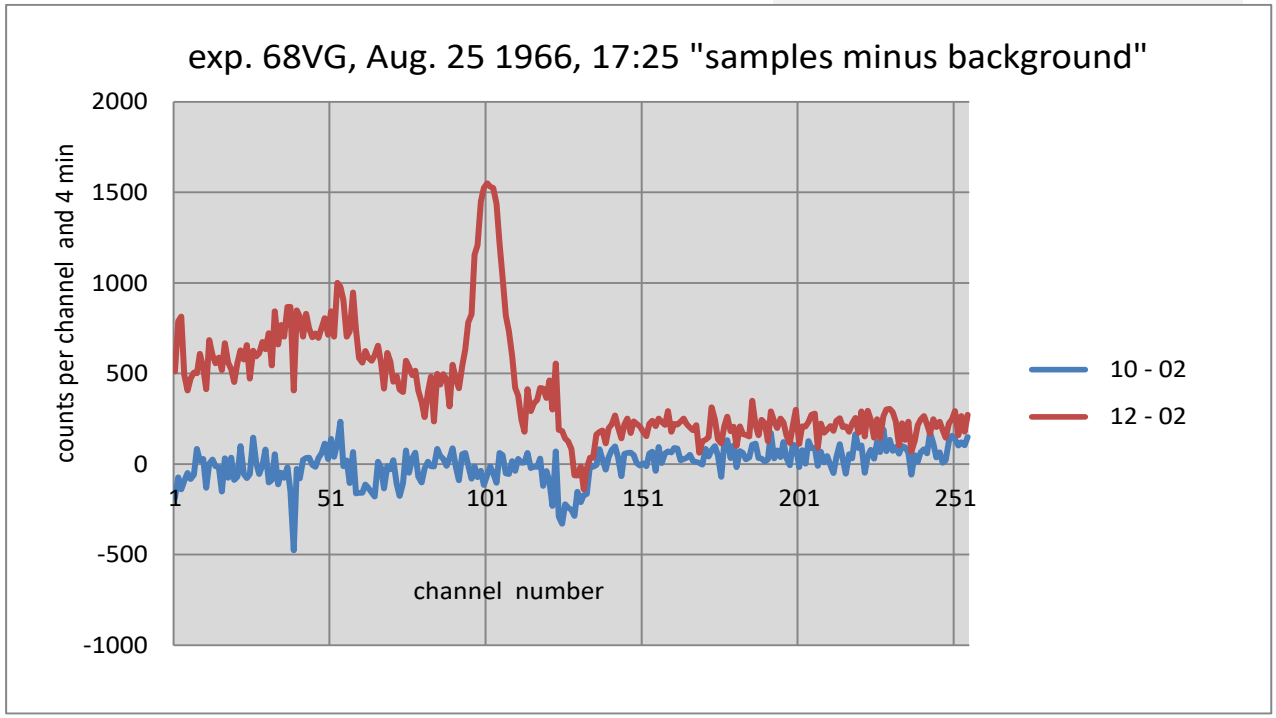
68VG-02 = Control = Background



The first excited state of ^{198}Hg at 411.8 keV:

-> Red peak of sample 12-02 (heated > 60 ° C)

-> Missing blue peak of sample 10-02 (at room temperature):



The first excited state of ^{198}Hg at 411.8 keV:
-> Red peak of sample 12-02 (heated > 60 ° C)

-> Missing blue peak of sample 10-02 (at room temperature):

Conclusion: Only the heated sample shows the presence of Au! Complying with the chem. Analysis!

What happened with the cold sample that also must contain Au!!!

Why was blocked the excited state of ^{198}Hg at 411.8 keV?

Photonic Bandgaps*

Photonic band gap materials semiconductors of light

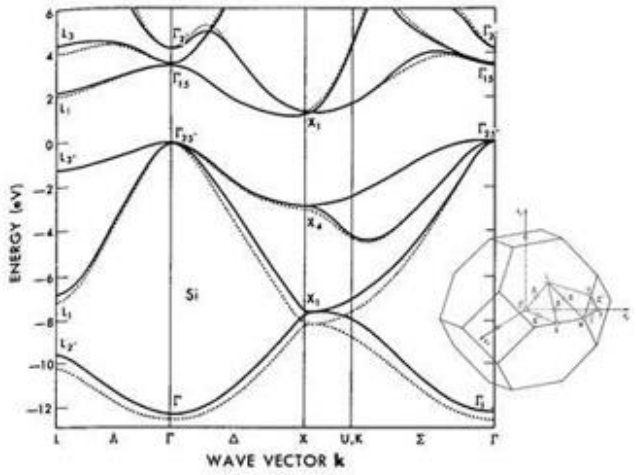
* https://www.youtube.com/watch?v=C7xdgR4D4jw

Correlation between Electronic & Photonic Bandgaps*

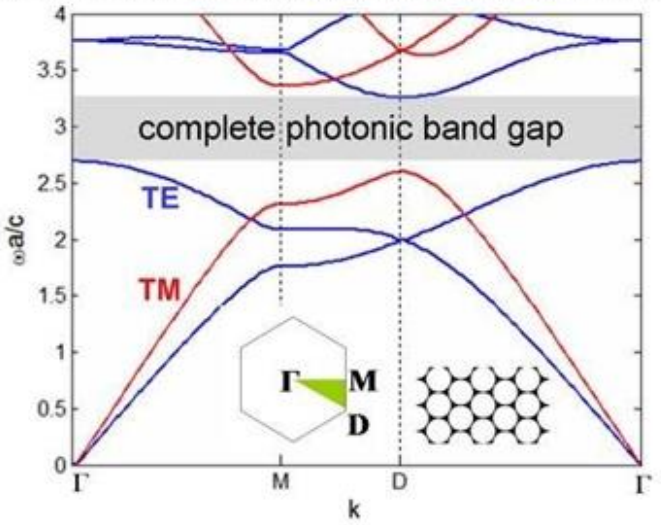
$$-\frac{\hbar^2}{2m}\nabla^2\psi(\vec{r})+V(\vec{r})\psi(\vec{r})=E\psi(\vec{r})$$

$$\nabla^2\vec{E}(\vec{r})-k^2\vec{E}(\vec{r})=\vec{E}_{src}(\vec{r})$$

Electronic Band Diagram for Silicon



Photonic Band Diagram for Dielectric Lattice



The identical form of the Schrödinger eq. (left) and the Wave equation of Maxwell explains this correlation.

* https://www.youtube.com/watch?app=desktop&v=dEIKecMDHiM

Correlation between Electronic & Photonic Bandgaps*

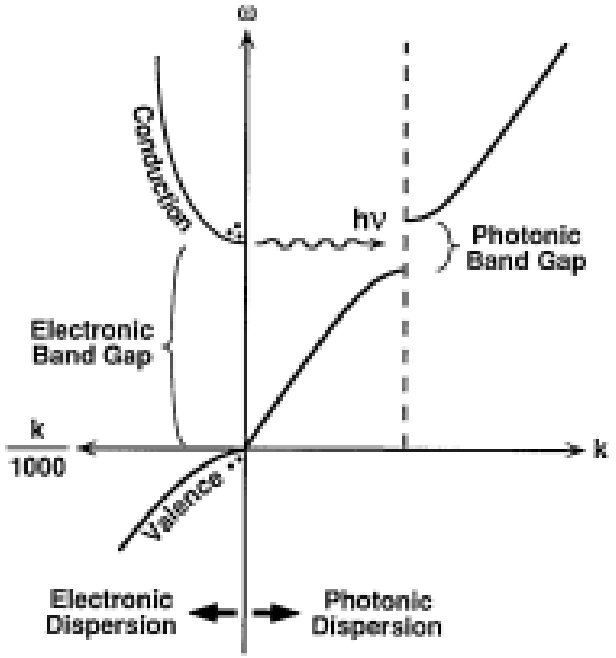


Fig. 3. Right-hand side, the electromagnetic dispersion, with a forbidden gap at the wave vector of the periodicity. Left-hand side, the electron wave dispersion typical of a direct-gap semiconductor; the dots represent electrons and holes. Since the photonic band gap straddles the electronic band edge, electron–hole recombination into photons is inhibited. The photons have no place to go.

Table 1. Summary of Differences and Similarities between Photonic and Electronic Band Structures

Characteristic	EBS	PBS
Underlying dispersion relation	Parabolic	Linear
Angular Momentum	Spin 1/2 scalar wave approximation	Spin 1 vector wave character
Accuracy of band theory	Approximate owing to electron–electron interactions	Essentially exact

* Eli Yablonovitch, J.Opt.Soc.Am.B /Vol.10, N0 2/February 1993

Localization of Light in 3D*

GaAs (Band gap value: 1.43 eV)

Wiersma D S et al. Letters to Nature (1997) Vol.390, p.671-673.

Experimental evidence of localization of light in a disordered medium.

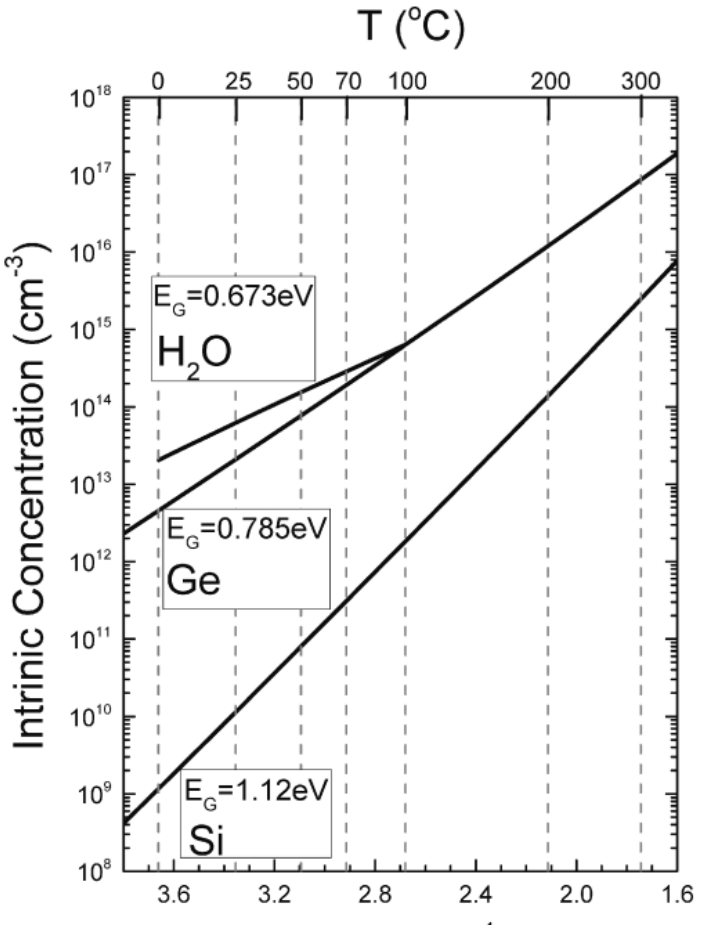
TiO_2 (Band gap value: 3.2 eV)

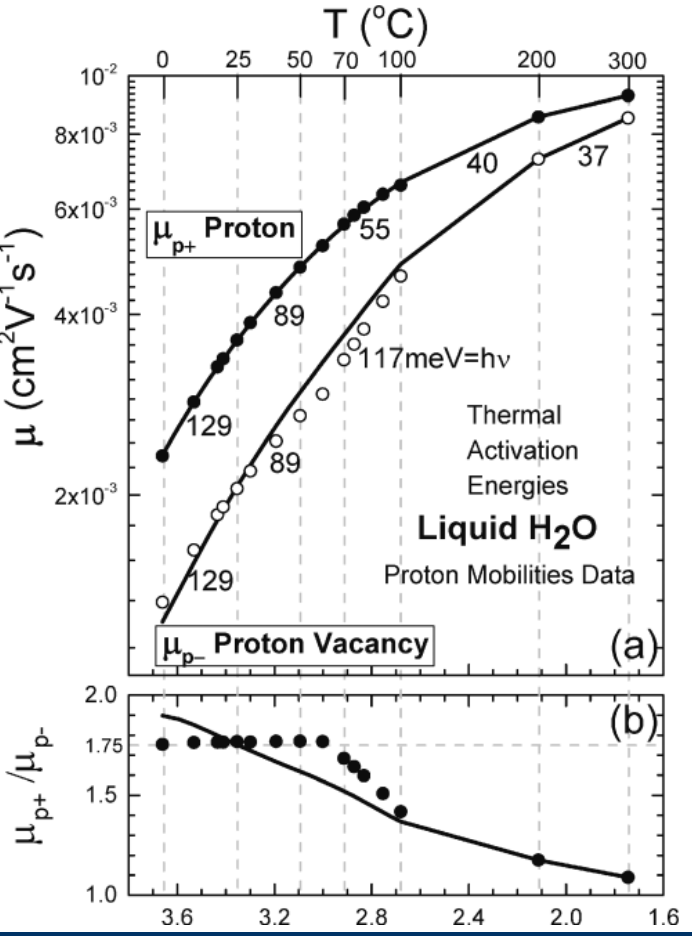
Störzer, Martin et al., 2006, Phys. Rev. Lett. **96**,p.063904-1 /-4.

Observation of the Critical Regime Near Anderson Localization of Light

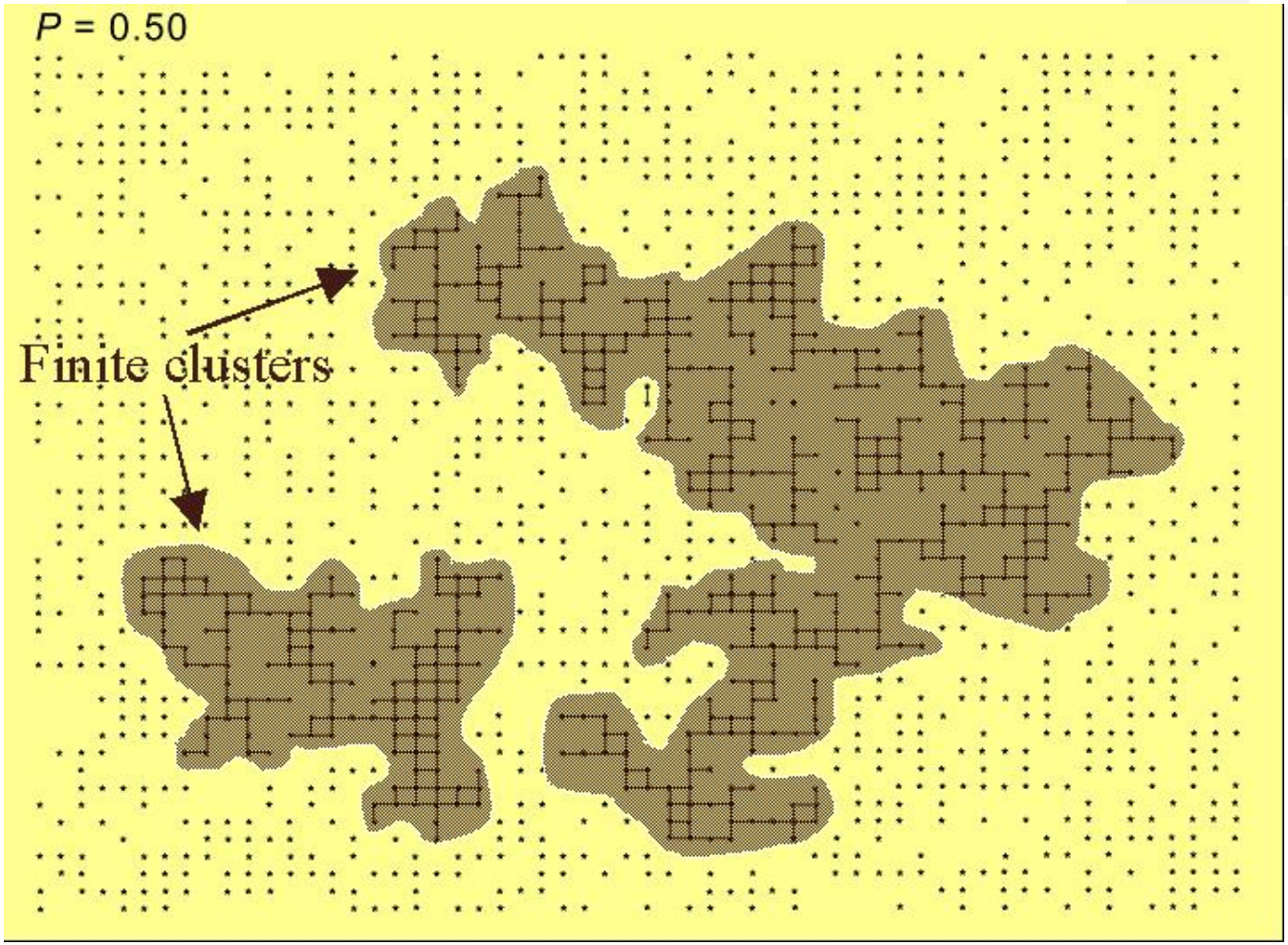
* Band gap (https://en.wikipedia.org/wiki/Band_gap)

Water as semiconductor compared to Ge & Si for water temperatures 25 ˚C to 55 ˚C:





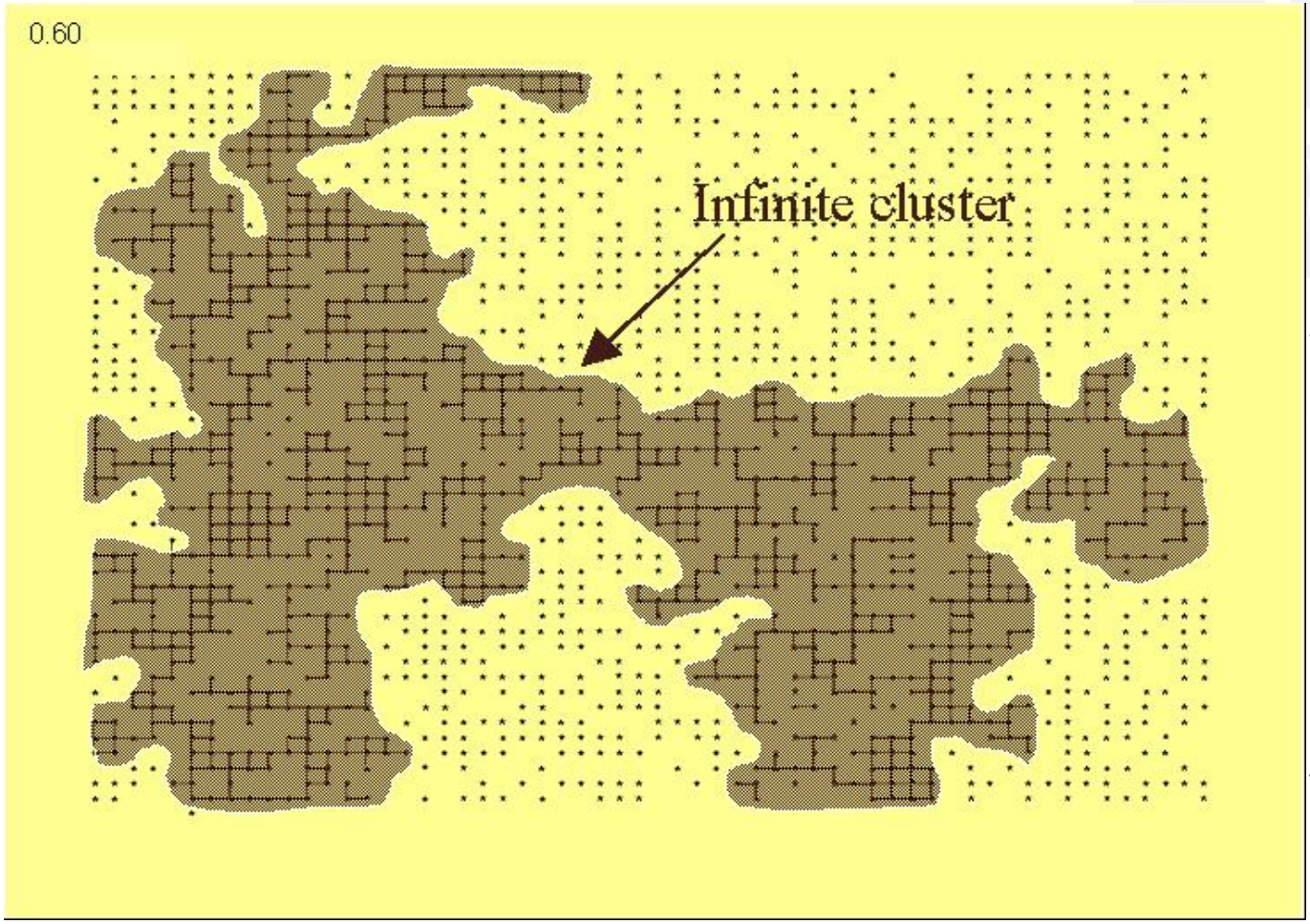
Stauffer &Aharoni: Introduction to PERCOLATION THEORY: 2-dimensional square lattice occupation probability P = 0.50



Excursion to Percolation Theory

2-dimensional square lattice

with an occupation probability P = 0.60 , i.e. above percolation threshold!



Infinite cluster = **Percolating cluster** = **Water Model** with Occupied sites = H_2O Molecules. Empty sites = Vacancies

Ants in a Labyrinth
(NL De Gennes P-G)

UF UNIVERSITY of FLORIDA

STATEMENTS I:

1. **Water can be considered as a disordered medium consisting of water molecules and vacancies in a percolating cluster (Ref. Stanley & Texeira).**
2. **Water can be considered as a semi-conductor in the temperature range 25 ˚C to 55 ˚C with a constant ratio r $r = m_+/m_- = 1.75$ with + for protons and – for proton vacancies (Ref . Jie and Sah, 2013*).**
3. **Thus, water has a valence & conduction band as well as a corresponding photonic band gap.**
4. **For a percolating cluster with P=1 (= regular lattice), the root mean square displacement R of the ant after the time t corresponds to $R^2 = t$, respectively, R = square root (t).**

---

* J. Semicond. Volume 34, p. 212001(1)-212001(8).

STATEMENTS II:

5. In a percolation cluster with disorder R(t) can be described as follows

$$R = a\, t^{k}$$

with $k \neq 0.5$ (often called *anomalous* diffusion).

6. For values p far above the percolation threshold p_c , k is close to 0.5 for large times. However, for $p < p_c$ the value R approaches a constant for large times t. In other words, k = 0. Interestingly, $\tilde{k} \approx 1/3$ for $p = p_c$, at the percolation threshold for two dimensions (2D). In 3D, k-value = 0.2.

7a. According to Stauffer & Aharoni quantum percolation is governed by the Schrödinger equation for a particle on the lattice, with hopping coefficients σ_{ji}, is equal to

$$E\,\psi_j = \Sigma_J\, \sigma_{ji}\text{-}\psi_j$$

Ants in a Labyrinth
(NL De Gennes P-G)

UF UNIVERSITY of FLORIDA

STATEMENTS III:

7b. According to Stauffer & Aharoni σ_{ji} corresonds to an ant in a labyrinth hopping from site j to the nearest neighboring site i in a time step. Thus, a disturbance can be created by an alternative current in an ***oscillator network*** with the capacitor C, voltages V_i , V_j and current I_i :
$C\, dV_i/dt = \Sigma_j\, \sigma_{ij}\, (V_j - V_i) - I_i$ in analogy to Kirchhoff eq.

8. On a regular lattice with p=1 the solution leads to Bloch waves, which can be represented by quantum particles moving in a semiconductor such as Ge, Si or water.

9. On the percolation cluster (= a disordered system) the Bloch functions can be *localized*. Stauffer and Aharoni call this case *super localization*, but a light localization also is *known as Anderson localization.*

Ants in a Labyrinth
(NL De Gennes P-G)

UF UNIVERSITY of FLORIDA

STATEMENTS IV:

- On the percolation cluster (= a disordered system) the Bloch functions can be *localized*. Stauffer and Aharoni call this case *superlocalization*, but it is also known as *Anderson localization.*
- Anderson localization of waves in disordered systems originates from interference in multiple elastic scattering.
- In other words, the Bloch functions are confined within the disordered medium and cannot escape.

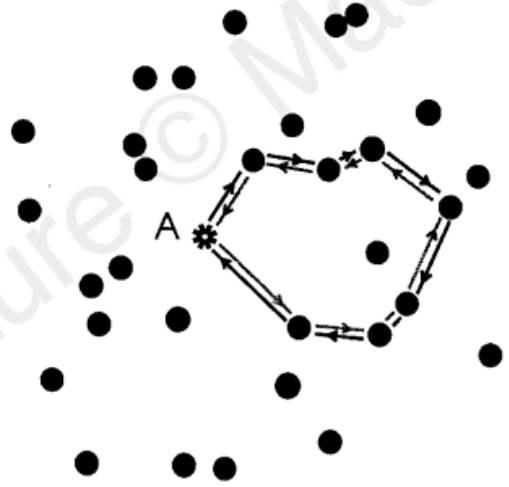


Fig. Anderson localization

STATEMENTS V:

- **In other words, the Bloch functions are confined within the disordered medium and cannot escape.**
- **Thus, a specific electromagnetic wave of a radioactive substance, and its energy can be stored, if the wave functions are localized.**
- **In other words, Angelo M. Comunetti used his home-made oscillator to induce a disturbance, respectively the wave localization on a percolating cluster. Evidently, this localization phenomenon can be stopped by heating the Au solution above 60˚ C. Thus, the stored electromagnetic energy is immediately released, and a mirrorless type of γ laser action occurs leading to the following results:**

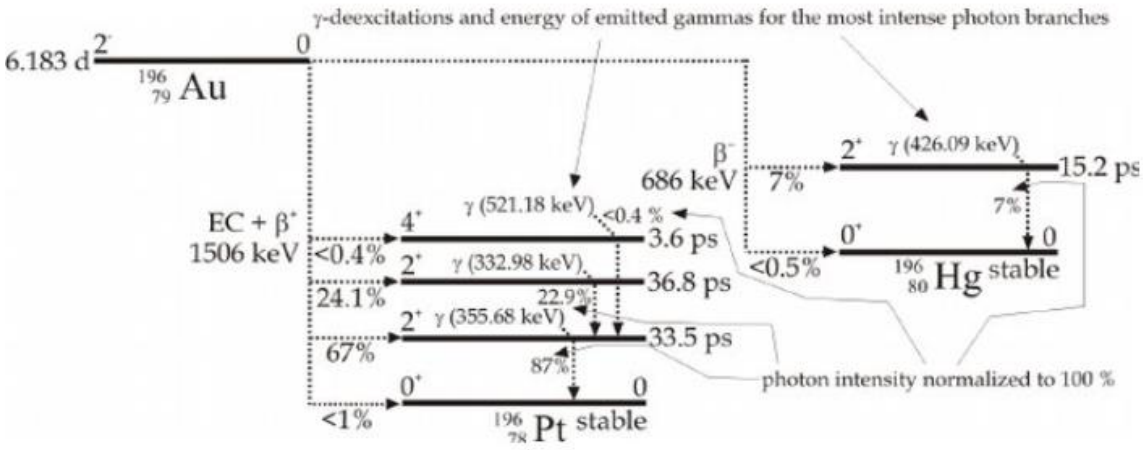
STATEMENTS VI:

- **Thus, the stored electromagnetic energy is immediately released, and a mirrorless type of γ laser action occurs leading to the following results:**
- **In a first step the initial ^{197}Au (n, γ) ^{198}Au reaction is reversed.**

- **Thus, the photonuclear effect leads to ^{198}Au (γ, n) ^{197}Au.**

- **Since the subsequent (second) neutron activation analysis (NAA) showed no trace of Au, the following photonuclear reaction must have occurred ^{197}Au (γ, n) ^{196}Au leading to ^{196}Pt (stable) by EC decay at an extent of 93%, respectively of 7% to ^{196}Hg (stable) by β^- decay with a half-life of 6.2 d.**

^{196}Au Decay scheme



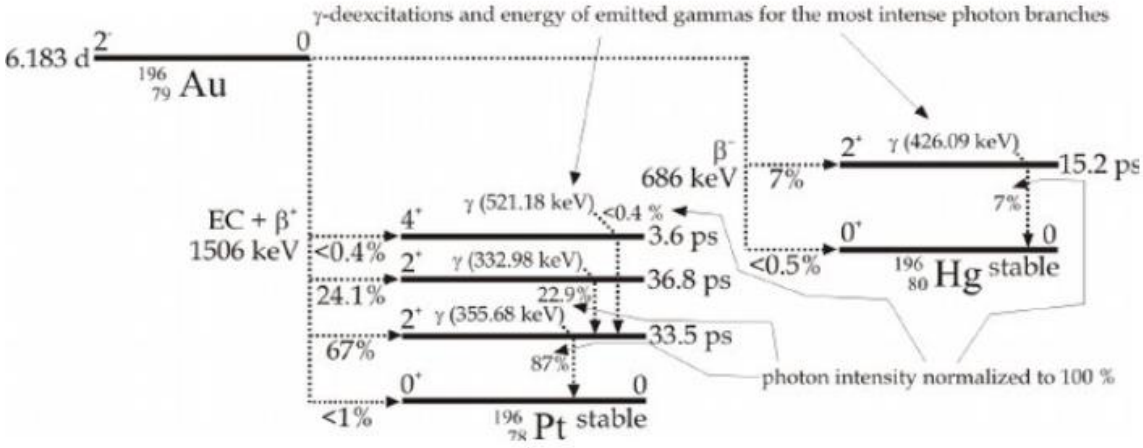
Ref: Ikegami H. et al. Structure of Platinum Nuclei, Nuclear Physics 41 (1963): 130 -158.

Abstract (extract):

Nuclear structure of ^{196}Pt has been investigated from the decay of ^{196}Au. New weak γ rays of 312, 444, 522, 568, 977 and 1090 keV were found in the analysis of conversion electron spectra. Angelo Comunetti was not equipped for such an analysis. In addition, the ratio between EC/β^+ = 10^6 . Thus, the β^+ annihilation peak at 510 keV cannot be detected. Hirose* et al. obtained ^{196}Au by the (γ, n) reaction for precision measurement of the half-life of ^{196}Au.

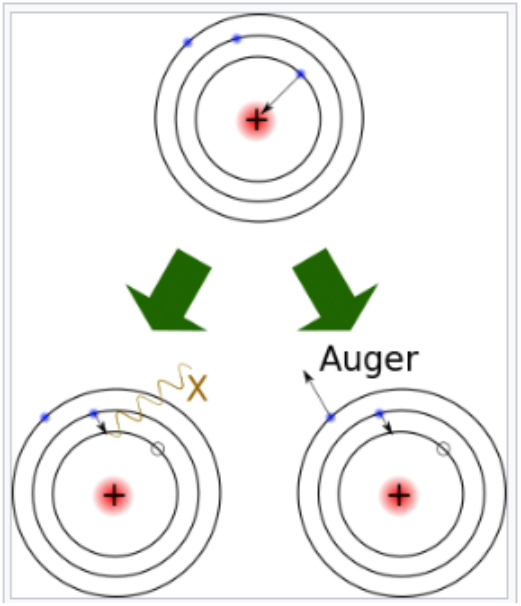
* **Hirose et al.** Proc. Radiochim. Acta 1, 109–111 (2011)

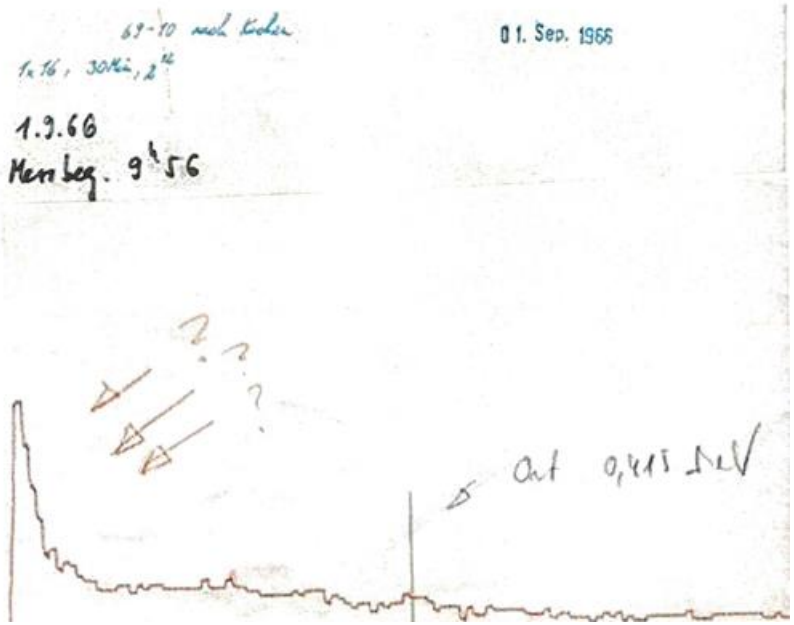
^{196}Au Decay scheme



Below Fig.12 of the Publication in the 2023 SIPS Proceed. 69VG10: X-Rays as result of Electron Capture EC.

X-Rays as Result of Electron Capture:

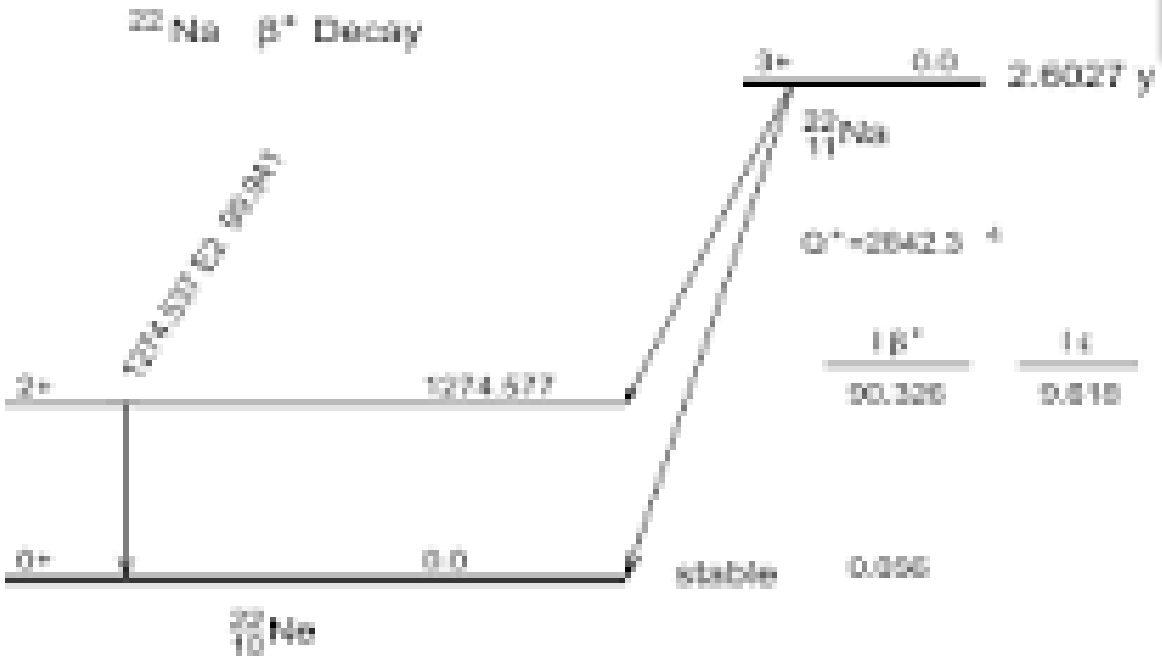




STATEMENTS VIII:

- It is evident that Angelo M. Comunetti could not detect this event, since β^+ decay leads to the 511 keV γ-line, which is the result of the electron positron pair annihilation. However, this peak cannot be separated from the same γ-line showing the contamination of the original water solution by ^{24}Na.
- In this context, it is surprising that Angelo M Comunetti did not "detect" a higher amount but a *reduced amount* of ^{24}Na in his second NAA.
- In other words, the mirrorless γ - laser also leads to the following photonuclear reactions ^{24}Na (γ, n) ^{23}Na, which is stable, and to ^{23}Na (γ, n) ^{22}Na, which decays by β^+.

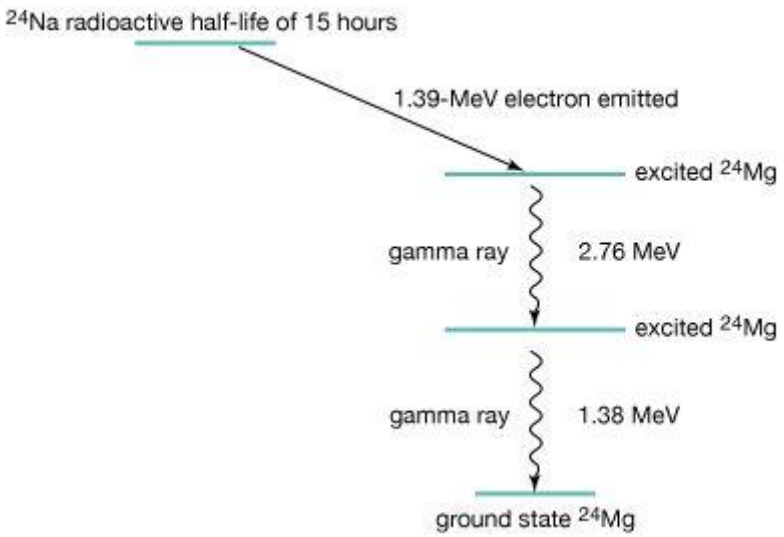
^{22}Na Decay scheme



The decay of ^{22}Na leads to the stable isotope ^{22}Ne being volatile as noble gaz.

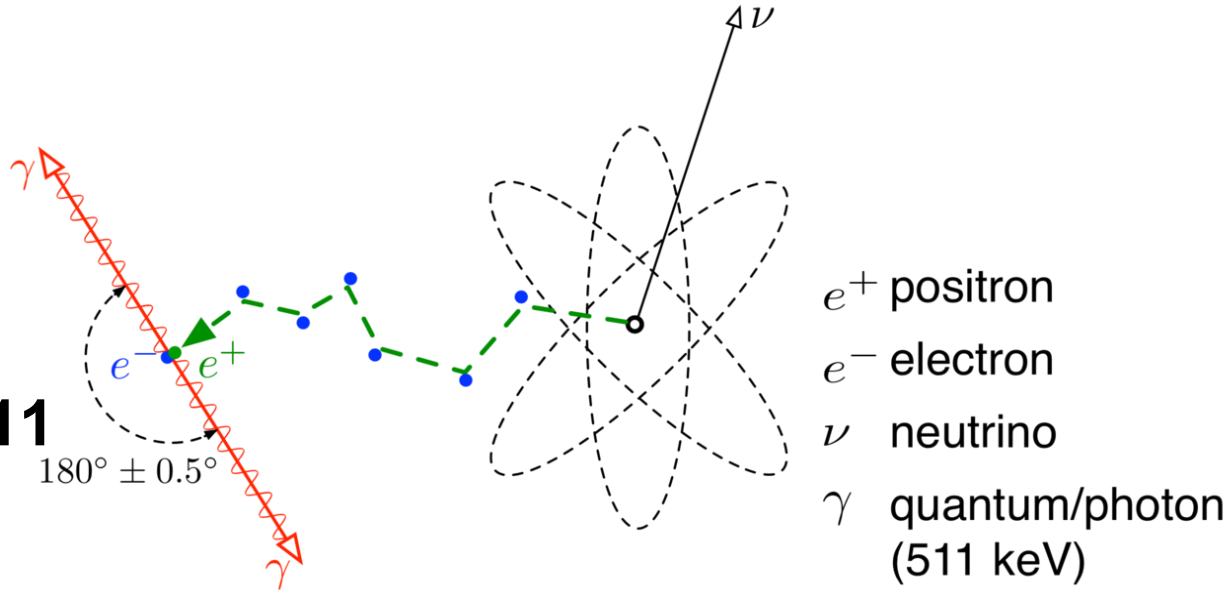
The half-life of ^{22}Na is **2.6 years** leading to a **weak** source of radiation. Thus, the annihilation peak at 510 keV is not so important as in case of the ^{24}Na Decay scheme with a half-life of 15 h by β^- decay leading to the excited state of ^{24}Mg emitting the γ rays of 2.76 MeV and 1.38 MeV able to create electron-positron pairs! (positron= antimatter)

^{24}Na Decay scheme



^{24}Na leads to the excited ^{24}Mg by β^- decay, emitting powerful γ rays! This high energy is able to create antimatter of electrons = positrons= β^+ particles!

A positron and an Electron annihilate each other like all Matter meeting Antimatter, emitting Two γ rays of 511 keV.



STATEMENTS VII:

- It is evident that Angelo M. Comunetti could not detect this event, since β^+ decay leads to the 511 keV γ -line, which is the result of the electron positron pair annihilation. However, this peak cannot be separated from the same γ - line showing the contamination of the original water solution by ^{24}Na.
- In this context, it is surprising that Angelo M Comunetti did not "detect" a higher amount but a *reduced amount* of ^{24}Na in his second NAA.
- In other words, the mirrorless γ - laser also leads to the following photonuclear reactions ^{24}Na (γ, n) ^{23}Na, which is stable, and to ^{23}Na (γ, n) ^{22}Na, which decays by β^+.

STATEMENTS VII:

- In other words, the mirrorless γ - laser also leads to ^{23}Na (γ, n) ^{22}Na, which decays by β^+.
- It is evident that Angelo M Comunetti could not detect this event since the decay of ^{22}Na leads to the volatile stable ^{22}Ne.
- In case of 69VG-10 the γ energy released after 5 instead of 11 days corresponds to about 46 % in comparison with 68VG-10.
- Thus, it is possible that only the reaction ^{198}Au (γ, n) ^{197}Au was induced since no annihilation γ peak at 511keV due to ^{197}Au (γ, n) ^{196}Au is visible.
- However, in case of No 69VG-10 no second NAA was performed for an additional validation.