The Mössbauer effect: a new theory.

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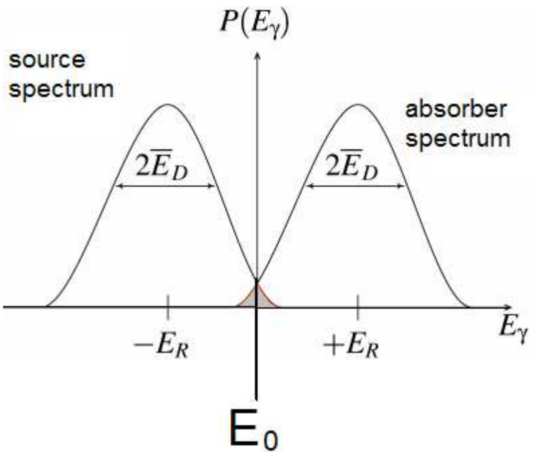
Part 1 Up until now explaining the Mössbauer effect is impossible

Sixty years have passed since the discovery of the Mössbauer effect [1]. It is known that Mössbauer was intent on preparing his doctoral thesis on the gamma radiation emitted by radioactive elements. He obtained an unexpected absorption peak lowering the temperature. Until now the nature of the phenomenon is unexplained. The Mössbauer effect occurs only if the atom that emits or absorbs is embedded in a lattice.
From the fortuitous discovery of the Mössbauer effect, it was thought that the rigidity of the crystal was due to a kind of sudden *coalescence* of all the atoms of the lattice around the atom emitter or absorber of the single gamma quanta. But the nature of this coalescence has never been found.

The emission and absorption energy ranges widen as the temperature increases due to the motion of the atoms in the lattice. Partially the intervals overlap (Fig. 1). To separate the two intervals he thought to reduce the thermal motion of the atoms by cooling both the source and the absorber. Instead he obtained an absorption peak
From [2] (**"***The beginnings of Mössbauer spectroscopy***"**, Alan Dronsfield et al.): "*… we read that in 1958 Rudolf L. Mössbauer published the results of an experiment which gave rise to the branch of spectroscopy, that now bears his name.*" The simplified and incomplete spectrum of emitted and absorbed gamma radiation con be represented by the following diagram (Fig. 1) in the E_γ , P_γ plane, where E_R is the recoil energy and E_γ , P_γ are the gamma energy and gamma counting respectively.

At ambient temperatures, thermal broadening and recoil associated with, both γ-emitting and receiving atoms, give minimal resonance fluorescence around E_0. The two spectrum (Fig. 1) overlap is increased by increasing the temperature both of source and absorber.



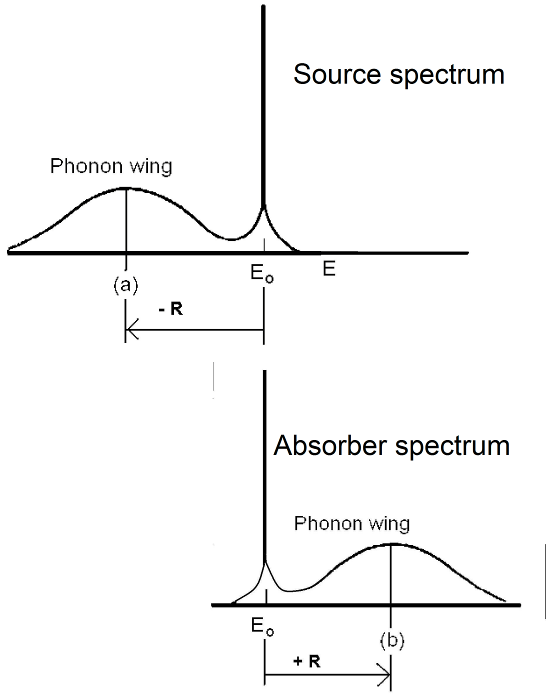


Fig. 1 - This is the incomplete spectrum of . emitting and absorbing gamma radiation with a little overlap around E_0

Fig. 2 - These are the true emission (a) and absorber (b) gamma spectrum at low temperature. The E_0 peaks are enhanced lowering the temperature both of the emitter and absorber. At energy E_0 there is a strong overlap.

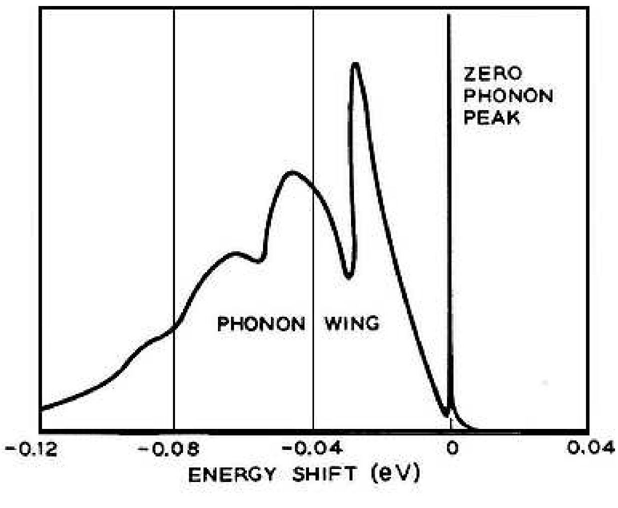


Fig. 3. The theoretical spectrum of 129 keV gamma ray **Ir**^{191} emitted by an atom in iridium bulk metal at low temperature. The Mössbauer spectrometer is sensitive only to the narrow, recoil-free line at zero energy shift, which contains 5.7% of the total area under the curve. (Philipp Gütlich, *Mössbauer Spectroscopy, Principles and Appilcations*, Universit□t Mainz)

But the real behavior of gamma radiation emission and absorption cannot be explained with a semi-classical mechanical analogy. The Mössbauer effect exists because the true spectrum have a very narrow spike (until then unknown) with energy E_0 that is equal for both emitter and absorber (Fig. 2, 3). This spectrum cannot be explained in terms of classical analogy.

Absorber. The overlap of the two incomplete spectra (see Fig. 1) should increase with increasing temperature. The opposite should happen by lowering the temperature of the source and the absorber (Fig. 2). Due to the fact that the true emission and absorption spectra both have a peak, hitherto unknown (fig. 2, 3), the opposite has occurred. The peaks are in correspondence with the initial energy $\mathbf{E_0}$ (not affected by the recoil energy). So by lowering the temperature the absorption by resonance of the gamma radiation increases, because the area of the peaks increases. As known this increase of peaks area was found accidentally when Mössbauer, by lowering the temperature, tried to separate the emission spectrum from the absorption spectrum. Mössbauer: "*decreasing the temperature should give a reduced overlap of emission and absorption lines, resulting in an increase in transmitted gamma radiation*". … "*The observation yielded the opposite result*". Increased resonance fluorescence was occurring. Initially he was perplexed by the apparently anomalous result, but he soon realized that he was observing a form of recoilless emission and absorption of γ-ray photons. He described the phenomenon picturesquely "... *This situation (is)... like a person throwing a stone from a boat. The majority of the energy is submitted to the stone, but a small amount goes into the kinetic energy of the recoiling boat. During the summer time, the boat will simply pick up this recoil energy. If, however, the person throws the stone during winter time, with the boat frozen into the lake, then practically all energy is going into the stone thrown and only a negligible amount is submitted to the boat. The entire lake will, thus, take up the recoil and this procedure occurs as recoilless process.*" Mössbauer's analogy is illustrated in Fig 4, with the *lake frozen(c)*. This represents the solid γ-ray emitter. For some elements the recoil energy, associated with the γ-ray photon emission, disappear and absorption happen even at room temperature.

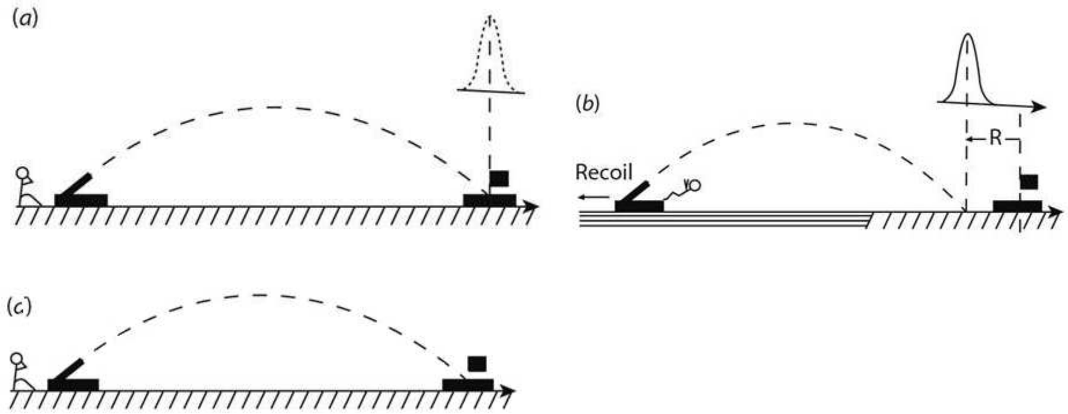


Fig. 4 **– Mössbauer initially imagined an analogy according to classical mechanics**

A cannon on firm ground firing at target (a). The bell-shaped curve represents the distribution of the shells around the target. Cannon is now on the lake (b). Recoil makes the shots fall short of target by the recoil distance, R.

Here (c) the **lake is frozen**. The cannon cannot recoil, and all the hits are on target, subject to the same distribution as in (a). This represents the γ-emitter at a low temperature. Recoil and thermal broadening are now minimized.

This first “picturesque” description [2] has negatively influenced all those who then dedicated themselves to clarifying the "mystery" of the Mössbauer effect. This similarity helped to create the idea that the Mössbauer effect was interpreted as a phenomenon of semi-classical mechanics.

So this first description is responsible for the fact that the nature of the Mössbauer effect has not yet been clarified after sixty years.

We are facing another example of how quantum phenomena cannot be assimilated and described with classical or semi-classical mechanics phenomena.

A very important question:

following the hypothesis that the whole lattice absorbs momentum and energy of the gamma photon, the question is: **what is the minimum lattice mass M_t necessary to hide the recoil** [5] (for emitting and absorbing nuclei)**?** The recoil energy [6] equation is:

$$E_R = E^2_\gamma /(2\cdot M_t\cdot c^2) \qquad (1)$$

Where E_R is the recoil energy, E_γ is the gamma quantum energy. We see that E_R depends on the total mass M_t of the lattice that contains the atom, whose nucleus has irradiated or absorbed a gamma quantum of energy E_γ , plus the mass of the connected (N-1) atoms. M_t is given by: $M_t = N\cdot M_{Fe}$ (2)

where M_{Fe} is the mass of one atom of ^{57}Fe, N is the number of atoms in the particle. The total mass M_t is given by the condition: $E_R \leq E_{lim}$, where E_{lim} is the Mössbauer spectrograph sensitivity limit. The recoil energy E_R must have a value just below E_{lim} so that E_R cannot be detected by the same Mössbauer effect. E_R, if it exists, could be measured by a shift of the Mössbauer diagram with low M_t, when $E_R > E_{lim}$.

To answer this question several authors gave similar but not equal answers. It is essential to maintain the hypothesis that all the lattice is involved in the recoil absorption. To give the answer to the question it is necessary to investigate nano particles with a mass that is less than M_t. Theories have been created to justify this sort of supposed coalescence phenomenon of lattice atoms. A theory that has found a certain consensus has been that of the **superradiance** [3] with which one supposes an electromagnetic field confined within the solids. With this theory the mechanical action that would make the crystal rigid (remember *… the boat frozen into the lake-* according to the first *“picturesque”* description [2]) would travel with the speed of light and not with that of sound as in the theory in which only the transmission of a mechanical action would exists.

Preparata et al. [3] obtained **$N \geq 1.5\cdot 10^8$** for the minimum number of nuclei to cancel the recoil: “*We conclude by stressing that the mysterious nature of the Moessbauer effect, that engenders a strong violation of «asymptotic freedom» in a crystal, has been resolved by assuming that the plasma of nuclei undergoes a "superradiant" dynamical evolution. We believe that this is a further piece of the jig-saw puzzle of coherent electromagnetism in condensed matter that goes into place.*”…. **“***We show that the difficulties of interpreting the Moessbauer effect as a coherent lattice (phononic) phenomenon can be surmounted by relating it to a* *"superradiant" behavior of the plasma of nuclei of a crystal. As a result a "generalized" Debye-Waller factor is seen to emerge for determining the intensity of the effect…. The presently accepted theoretical understanding goes back to Lamb* [W.E. Lamb, Jr., Phys. Rev. **55**. 190 (1939)] and Dicke [R.H. Dicke, Phys, Rev. 89, 472 (1953)], *and was worked out in great and effective detail in the few years following its discovery…. we obtain for the minimum number of nuclei the value of* $N \geq 1.5 \cdot 10^8$

From **V. N. Strel'tsov** [4]: the "*interaction time*" t of the radiating nucleus with a pattern (surrounding nuclei) must be considerably smaller than the time characteristic of radiation presented by the period T. Strong contradiction are revealed calling at least in question the existing representation of the radiation mechanism. Whence using the Fe^{57} atom mass: $mc^2 = 5 \cdot 10^7$ [keV], we get that the number of atoms in the given pattern must be: $\mathbf{N_1 \geq 4 \cdot 10^6}$. Knowing the linear pattern sizes and the propagation time of interaction (on condition that t=0,1T), one can estimate the speed of its transmission. It is $v_1 = 2 \cdot 10^4$ c. (See the article ref. 4)

From our paper: [5] (R. Giovanelli and A. Orefice**, "***Quantum Elasticity in Debye Solids***"…**):

"*The rigid behaviour of a crystal lattice submitted to sudden and localized events (such as emission, absorption and scattering of quanta and/or light particles) is currently treated in terms of the well known Debye-Waller expression. Referring to solids described according to the Debye model, we have presented a rigorous and general expression of the fraction of recoilless events, of which the Debye-Waller form is shown to represent only a first approximation, holding in the case of very low temperature solids*. …. Conclusion - *It is clearly seen that the D-W expression, beacause of its limitation to the (mechanical) ground state of the emitting nuclei, systematically underestimates the fraction of events leaving the lattice in the same initial energy level, thus underestimating the quantum rigidity of the solid. The differences between P_{el} and P_{DW}, almost negligible at low values of the emissive shock, are seen to become increasingly appreciable with increasing values of both ε_D and T: …., providing a new and more general approach to the problem of quantum rigidity.*"

Since the discovery of the Mössbauer effect, it has been thought that all the crystal *mechanically* took part in the absorption of the momentum and energy of the gamma emitted or absorbed. But for many reasons this turned out to be a wrong idea.

Although in reality we have not been able to find a way in which energy and momentum are transferred to the lattice atoms, however with this physical model it will be essential that the number of atoms involved must reach a certain minimum threshold. It should be of paramount importance that the number of lattice atoms reach a minimum value depending from the sensibility of the Mössbauer spectrograph.

If indeed the recoil were really absorbed by many lattice atoms, the total mass of these atoms would fall under a certain limit so that the recoil would not be revealed by the same Mössbauer spectrograph.

For a most sensitive Mössbauer effect based on Zn isotopes, the recoil momentum should be taken up by at least 2×10^9 nuclei, so that the ZnO crystallites should have dimensions greater than 0.4 micron. Since commercial ZnO would normally possess average grain sizes

smaller than one micron, care must be exercised to ensure a grain size much larger than the above nominal requirement.
P.P. Craig, et al. [7] estimate that at least crystallites with **2.10^9** nuclei (i.e. a domain of the size of 0.4μ) could take up the recoil in a ZnO crystal. But with lower nuclei number, or lower domain size, no trace of recoil in their Mossbauer spectrum was found.

A mechanical action between the atoms of a lattice travels with the speed of sound. In the model of solid according to Preparata [3], any mechanical action at most would travel with the speed of light. Always an insufficient speed [4] to create the Mössbauer effect.

A LOOK AT THE MÖSSBAUER SPECTROMETER TO FIND THE MINIMUM MASS M_t (2) THAT COULD HIDE THE RECOIL

We take account of the Mossbauer spectrometer based on ^{57}Fe, where the gamma photon energy is: $E\gamma = 1.44 \cdot 10^4$ [eV]. We shall call, in the following:

$\hbar = 0.658 \cdot 10^{-15}$[eV/s] $= 1.055 \cdot 10^{-27}$[erg/s] Planck constant divided by 2π

1 [eV] $= 1.602 \cdot 10^{-12}$[erg]

$E_\gamma = 1.44 \cdot 10^4$[eV] $\cdot 1.602 \cdot 10^{-12}$[erg/eV] $= 2.30688 \cdot 10^{-8}$[erg]

$\tau_N = 1.4 \cdot 10^{-7}$ [s] → life time of nuclear excited state

$\Gamma = \hbar/\tau_N = 4.7 \cdot 10^{-9}$ [eV] natural gamma emission linewidth for ^{57}Fe: $\Gamma \approx 10^{-8}$[eV]

$M_{Fe} = 9.4576335 \cdot 10^{-23}$[gr] - one F_e atom mass.

$\Gamma/E\gamma = 4.7 \cdot 10^{-9}$ [eV]/14400[eV] $= 3.26 \cdot 10^{-13}$; $c \approx 2.998 \cdot 10^{11}$[mm/s] speed of light

If v [mm/s] is the velocity between gamma source and absorber. For ^{57}Fe the minimum Doppler gamma energy shift available ΔE_D shall be:

$\Delta E_D = v \cdot E_0/c = 1 \cdot 10^{-1}$[mm/s]$\cdot 1.44 \cdot 10^4$[eV]/$2.998 \cdot 10^{11}$[mm/s] $= 0.48 \cdot 10^{-8}$ [eV]

v = 0.1 ÷ 0.2 [mm/s] is the minimum velocity for Doppler shift.

So we have that v ≈ 0.3 mm/s produce enough Doppler shift of the emitted gamma to detune the resonant absorption: $\Delta E > \Gamma$.

Limit energy E_{lim} for Mössbauer spectrometer:
$\Delta E = 4.8 \cdot 10^{-9}$[eV] – gamma quantum minimum energy shift. It is equivalent to the width Γ of the emission line.
Minimum energy detectable E_{lim} by the Mössbauer ^{57}Fe spectrometer:
$E_{lim} \approx 5 \cdot 10^{-9}$ [eV] ; with: $v \approx 10^{-1}$[mm/s]
The hypothesis from which we started was that the mass M_t (equations (1), (2)), mechanically connected to the atom that emits or absorbs the gamma photon, is increased to make E_R negligible and not measurable. This is the accepted theory today, with some distinction on the way the whole lattice should work together. With a simple check we see that the analyzes on the nano particles would already make E_R measurable in the Mössabauer spectrum.
Using the Mössbauer spectrometer, we could verify the existence or not of the collaboration between the atoms to create the rigidity necessary to absorb energy

and momentum of gamma photons. We see that the number N of atoms, with the total mass M_t of the nano particles (eq. 2), can fall below the minimum required by the theory (eq.1). In fact E_R for a single free atom, not inserted in a lattice network, is of the order of $10^{-2} \div 10^{-3}$ [eV]. For a single ^{57}Fe atom the recoil energy E_R is: **$1.957 \cdot 10^{-3}$** [eV] (approximately $2 \cdot 10^{-3}$ [eV]). The sensitivity of a Mössbauer spectrometer is of the order of $10^{-9} \div 10^{-8}$ [eV]. We can therefore obtain the minimum value of the total mass M_t (eq. 2) which, if it were really connected to the atom whose nucleus emits or absorbs, it would make the recoil energy E_R (1) negligible.

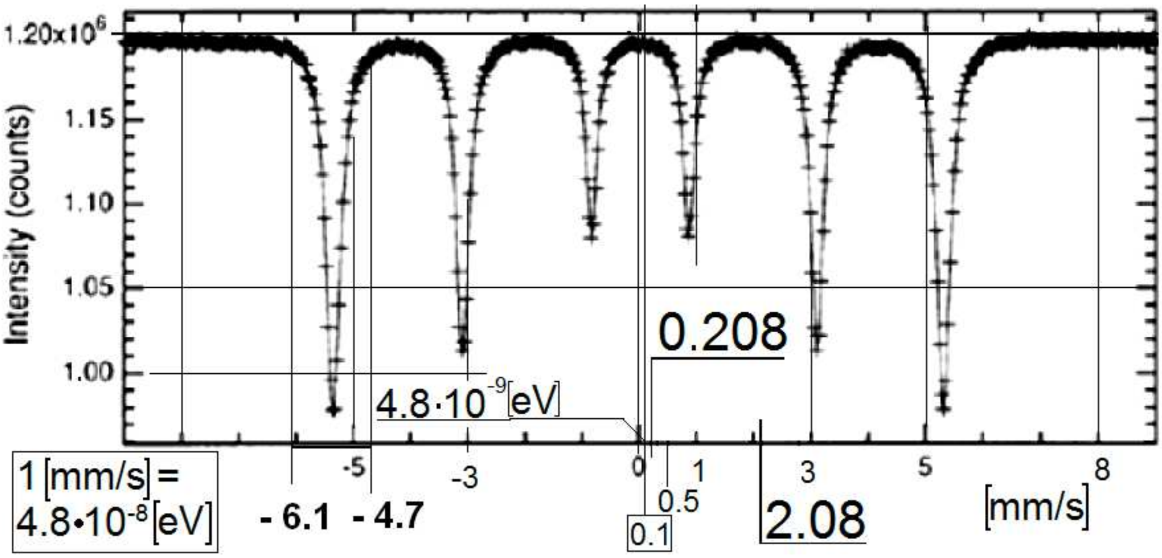


Fig 4 The line spread is: $\Delta v = 6.1- 4.7=1.4$[mm/s] $= 6.72 \cdot 10^{-8}$[eV]. The supposed recoil shift is calculated for different number N of Fe atoms in the lattice in a high-resolution Mössbauer spectrum. The energy is given in v[mm/s]. Where $v=E_R \cdot c /E_\gamma$;

For **$N = 2 \cdot 10^5$ - $E_R = 1 \cdot 10^{-8}$ [eV]; $v = 0.208$** [mm/s]

For $N = 2 \cdot 10^4$ - $E_R = 1 \cdot 10^{-7}$ [eV]; $v = 1 \cdot 10^{-7} \cdot 3 \cdot 10^{11}$[mm/s]$/1.44 \cdot 10^4$[eV] $= 2.08$ [mm/s]

For $N = 2 \cdot 10^3$ - $E_R = 20.8$ [mm/s].

Mössbauer spectrum from bcc Fe. Data were acquired at 300 K. Brent Fultz, "Mössbauer Spectrometry", in *Characterization of Materials.* Elton Kaufmann, Editor (John Wiley, New York, 2011).

From eq. (1), placing the constraint of $E_R \leq E_{lim}= 1 \cdot 10^{-8}$[eV],, we have a condition that allows us to calculate M_t from:

$E_R = E^2_\gamma /(2 \cdot M_t \cdot c^2)$ $\approx 10^{-8}$ [eV] $= 1.602 \cdot 10^{-20}$[erg] this being the minimum recoil energy (in erg) detectable by a Mössbauer spectrometer.

$M_t = M_{Fe} \cdot N = E^2_\gamma / (E_R \cdot 2 \cdot c^2)$ $= 5.3217 \cdot 10^{-16}/(1.602 \cdot 10^{-20} \cdot 2 \cdot 8.988 \cdot 10^{20}) =$ $1.848 \cdot 10^{-17}$[gr]. $N = M_t/M_{Fe} = 1.848 \cdot 10^{-17}/9.457335 \cdot 10^{-23} =$ **$1.954 \cdot 10^5$**

$N \approx 2 \cdot 10^5$; $E_R = A/N$; $A=E_R \cdot N \approx 10^{-8}$ [eV] $\cdot\ 2 \cdot 10^5$; $A \approx 2 \cdot 10^{-3}$

How many atoms are contained in a 9 [nm] diameter sphere?

$\pi \cdot 4r^3/3 = \pi \cdot 4 \cdot 4.5^3/3 = 381.51$ [nm^3] –

0.14 [nm] diameter of a single atom; atom volume 2.744 10^{-3} [nm^3]

729 [n^3] volume of a cube with side: 9 [nm]. The sphere: 381.7 n^3. In a sphere the atoms are: $1.8 \cdot 10^5$ atoms a number that is near the limit of detection: $2 \cdot 10^5$

Dimension of Fe atom: $1.4 \cdot 10^{-8}$[cm] –> a chain long 1.4[nm] contains 10 aligned atoms --- 10^3 atoms are contained in a cube of 1.4 [nm] side. A 10 [nm] cube contains about 10/1.4 = 7.143 for each side we have about 71 atoms. In the volume: 71^3 = **$3.58 \cdot 10^5$ atoms.**

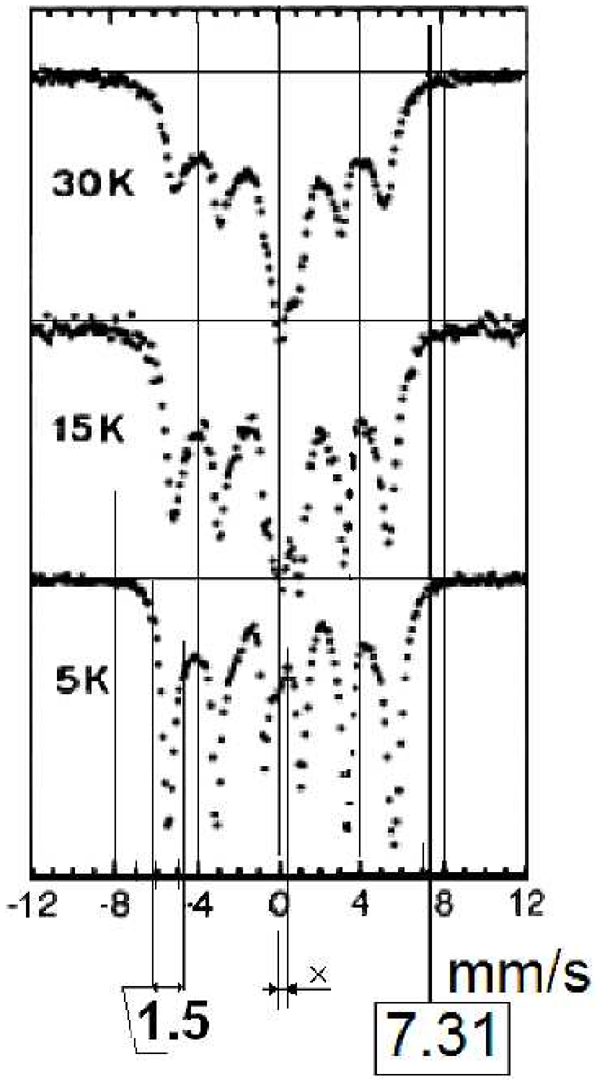


Fig. 5 (ref.(*)) The Mössbauer spectra of iron particles with mean diameters of **2.4** [nm] at various temperatures (Fig.18 of ref. [8]). the shift of the absorption diagram by Mossbauer effect should be 7.31 [mm/s]. The absorption curves show a little displacement x which is of the order of 0.4 [mm/s], it is the isomer shift.
(*) Bodker F., Morup S., and Linderoth S., Phys. Rev. Lett., 72, p. 282 (1994)

For dimensions smaller than 5 [nm] the recoil should appear in the Mössbauer absorption diagram. For a cube of 5 [nm] side the number of atoms would be: $4.47 \cdot 10^4$. For a side of 2.5 [nm] we have $5.587 \cdot 10^3$ atoms. The recoil shall be: $3.51 \cdot 10^{-7}$[eV] that is equivalent to 7.31[mm/s]. See Fig.5 [8].

In the work (*) the oxidized and not oxidized ultrafine metal iron particles [8] with **average diameters of 2 [nm]** were investigated. The Mössbauer spectra of particles with diameters of **2.4 ± 0.3 [nm]** are presented in Fig. 5.

$E_R = \mathbf{E^2_\gamma /(2 \cdot M_t \cdot c^2)} = 5.3217 \cdot 10^{-16}/(5.385 \cdot 10^{-19} \cdot\ 2 \cdot 8.8988 \cdot 10^{20} =$
$0.988 \cdot 10^{-16}/177.8 = 5.557 \cdot 10^{-19}$ [erg] $= 6.242 \cdot 10^{11} \times 5.557 \cdot 10^{-19} =$
$3.47 \cdot 10^{-7}$[eV]; $3.47 \cdot 10^{-7}/ 4.8 \cdot 10^{-8} = 7.23$ [mm/s] shift that should appear in the Mössbauer diagrams of Fig. 5.
A chain of 2.5 [nm] contains: $0.14 \cdot 10^{-7}$ [cm] 18 atoms, the cube contains: 2.5/0.14 = $17.86^3 = 5.694 \cdot 10^3$ atoms are contained in a cube with 2.5 [nm] side
$N=5.694 \cdot 10^3$; $M_t= 5.694 \cdot 10^3 \times 9.4576335 \cdot 10^{-23} = 5.385 \cdot 10^{-19}$[gr]

They all swear that the rigidity of the Moössbauer effect can be explained by some quantum effect, but the theories have followed one another until the topic has been deepened so that everything was clear, also because the Debye-Waller law had been taken up again. This law perfectly predicted the experimental results even if it does not explain its physical origin. But advances in laboratory techniques have removed the experimental basis from current theory: the sudden solidarity of a large number of lattice atoms with the gamma emitting or absorbing atom.

Further consequences of the "coalescence"

There are many experiments that belie the fact that the disappearance (or reduction) of the energy and the recoil momentum are due to the mechanical collaboration between the lattice atoms.

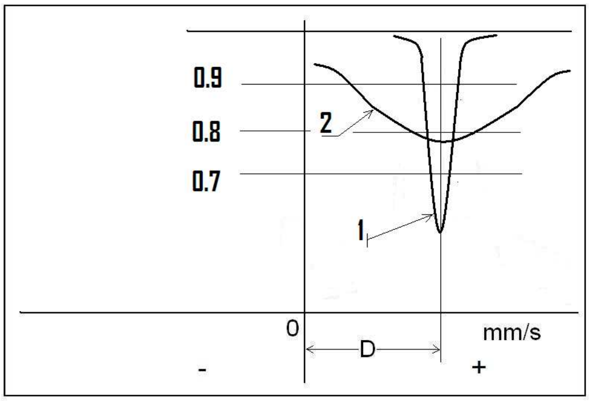


Fig.6 Hypothetical displacement D of the absorption curve (1) if a loss of energy exists because of the recoil for a number N of atoms of the nanoparticle where is the atom whose nucleus has absorbed a gamma quantum. The number N is not the same for all the nano particles, so N will be a mean and consequently the absorption curve will widen (2). But even this phenomenon has never been revealed. The number N of atoms will be different in the different particles and the effect on the recoil will be different.

Among others there is the fact that, since the nano particles are not exactly the same size (therefore each with a different number N of atoms), in any case they would not give the same effect of reducing the recoil. In this way, the shapes of the absorption spectrum (line 2 of Fig.6) of the gamma quanta would widen to the point of canceling the forms it assumes when operating on a massive target (bulk target). In other words the Mossbauer diagram should disappear. Nanoparticles have been studied using Mossbauer spectrometers for many years. No comparison has ever been made of the number of atoms included on average in individual particles

The hypothesis was that the mass M_t, bound to the atom that emitted or absorbed the gamma, thanks to the action of other lattice atoms, was increased to make negligible and non-measurable E_R. But if we verify that (with low M_t) already in the measurements carried out it would have been possible to find E_R in the Mössbauer spectrum. E_R has not been found because it does not exist.
All the Mössbauer diagram don't shows the minimum displacement from zero of the center of the gamma absorption diagram (Fig. 5) (apart from the isomer shift, which is of the order of 1 ÷ 3 [mm/s], an effect that depends on the molecular structure in which the atom, inserted in the lattice, absorbs the gamma quanta radiation)

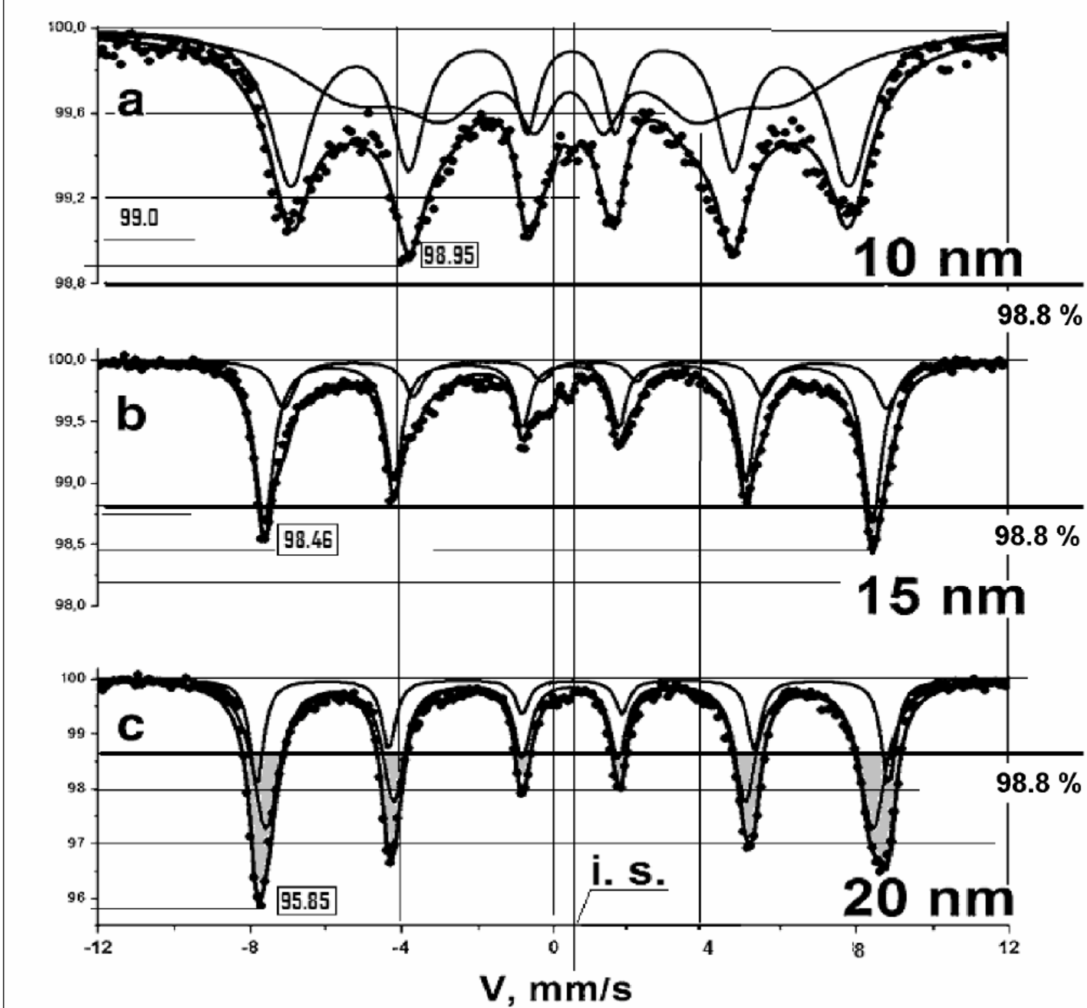


Fig. 7 **Mössbauer spectra of 10, 15, 20 [nm] nanoparticles measured at 78 K. The area of the diagrams decreases with the size of the particles. The three diagrams refer to the three different particle sizes. The diagrams have different scales highlighted by the position of the line for 98.8% of gamma radiation attenuation [9].**

CONCLUSIONS In any Mössbauer spectrum is no trace of displacement due to the recoil, however small the lattices are where the atoms absorbing the gamma radiation are inserted. Analyzing lattices with an insufficient number of atoms we will not have a displacement of the area due to the recoil effect. By reducing the mass of the examined lattice, the area of absorption of gamma photons is progressively reduced. Therefore it must be assumed that the Mössbauer effect is a phenomenon

due to the behavior of the single atom whose links with the rest of the lattice we find only in the spectrum of its zero point oscillations [5].
Therefore the effect is not due to an increase in mass due to a direct bond with the atoms around the one that emits or absorbs a gamma photon, but to a reaction of that single atom.

Note – References

1) R.L. Mössbauer, Z. Physik, 1958, 151, 124.; Naturwissenschaften, 1958, 45, 538
2) Alan Dronsfield, Jacob Adetunji, "*The beginnings of Mössbauer spectroscopy*". 1 July 2002.
3) G. Preparata, T. Bressani, E. Del Giudice, "WHAT MAKES A CRYSTAL *STIFF* ENOUGH FOR THE MOESSBAUER EFFECT?", MITH 90/4
4) **V. N. Strel'tsov**, "*A Mysterious Consequence of Moessbauer's Effect*", *Journal of Theoretics,* Vol. 6-6, Dec. 2004**,** Laboratory of High Energies, Dubna, Moscow Region 141980, RUSSIA

Abstract: The monochromatics of the Moessbauer radiation is ensured by that the totality of nuclei recoiling upon itself. The estimation of the transmission speed of the corresponding interaction from a radiating nucleus to surrounding ones gives a value considerably exceeding the light velocity. **Moessbauer's effect** (ME), discovered in the middle of the past century is now an important method of research (the Moessbauer spectroscopy). ….Recall that the ME is elastic emission or γ-quanta absorption by atomic nuclei bound in a rigid body (crystal). This is achieved by that the recoil momentum is transmitted not to a individual nucleus but to all the crystal (or its part - "pattern"). The exceptional narrowness of the Moessbauer lines allows one to say about the monochromatics of this radiation. The γ-quanta with energy E_0 of the corresponding nuclear transition and inverse frequency (period) $f^{-1} = T = h/E_0$ form it. $\mathbf{E_0 = hf_0}$ In order to ensure the radiation monochromatics, the "*interaction time*" **t** of the radiating nucleus with a pattern (surrounding nuclei) must be considerably smaller than the time characteristic of radiation presented by T: $t \ll T$ (1) It is evidently that one can say about the radiation without recoil (since all the pattern takes recoil upon itself). For this, the very duration of radiation can anyhow exceed t. At the same time, in order that ME may take place the recoil kinetic energy (R) transmitted to the pattern must not exceed the width of the emission line (Γ) since the energy of the radiated γ-quantum is: $hf = hf_0 - R$. (2) Based on the value of Γ, we estimate the mass of the corresponding pattern (on condition that R=0.1 Γ). For example, for γ-radiation of Fe^{57} with hf_0=14.4 KeV, we obtain: $M_1 c^2=(hf_0)^2/(2(0.1T)) = 2\cdot10^{13}$ [keV] (3)
$R = (hf_0)^2/(2 M_1c^2) = 0.1\cdot\Gamma$; $M_1= m\cdot N_1$; $\mathbf{N_1 = M_1 \cdot c^2/m\cdot c^2}$
Whence using the Fe^{57} atom mass: $mc^2 = 5\cdot10^7$ KeV, we get that the number of atoms in the given pattern must be: $\mathbf{N_1 = 4\cdot10^6}$. (4) $(2\cdot10^{13})/5\cdot10^7 = 4\cdot10^6$. Leaned upon the lattice parameters (d), for the linear size of (spherical) pattern we obtain: $D_1= (3N/4\cdot\pi)^{1/3} = 290$ Å (5). For γ-rays of Ag^{107} with the energy hf_0=93 KeV we have: $D_2 = 4\cdot10^5$ [Å]. (5') Knowing the linear pattern sizes and the propagation time of interaction (on condition that t=0,1T), one can estimate the speed of its transmission.
It is $v_1 = 2\cdot10^4$ c and $v_2 = 2\cdot10^7$ c. (6) These velocities are involuntarily associated with the known hypothetical particles: tachyons. They exceed significantly the top speed of light c, and all the more the sound velocity with which, as we know, elastic waves propagate in a rigid body. To the point, in this case for the propagation time of interaction we respectively get: $t_1 = 1.4\cdot10^8\ T_1$, $t_2 = 4\cdot10^{13}\ T_2$. (7) As seen, the necessary condition of the radiation monochromatics (1) is considerably violated. **Conclusion**. The revealed contradiction calls at least in question the existing representation of the radiation mechanism. And may this phenomenon give us a new surprise as at the beginning of the past century? In any case, the considered problem is worthy of the very great attention.

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