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ON THE WIDTH OF γ-LINE AND THE PHOTON STRUCTURE

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The reason to turn once again to the question of the natural width Γγ of the
γ-radiation line of nuclei is provided by the discovery of an increase in the half-life T1/2 for nuclear isomers in a metal matrix (see ref. [1] and references therein). For nuclei in such a matrix, a decrease in the width Γγ can be expected, since, according to generally accepted concepts, Γγ ⊠⊠ / T1/2 for the emission of photons in a nuclear transition from an excited state E*of a half-life T1/2 to the ground state.*
However, even in early Mössbauer experiments with the 57mFe isomer, a decrease in Γγ was observed with an increase in the age of the E level (see, e.g., ref. [2]), which could be interpreted as a result of a decrease in the level width with its age. But such an interpretation is not allowed by the experiment [3] with the 181mTa isomer (T1/2 ≈ 6 μs), in which broadening of the 6.2 keV γ-line was observed due only to the shading of the absorber from the emitter by a mechanical chopper, which opened their mutual visibility for a time of 1 μs without referencing by the time the isomer was formed. Hence it follows that the width Γγ is determined not by the value of T1/2, but only by the time Tγ, which in the Mössbaur experiments the absorber nucleus sees the emitter before the emission of an energy quantum. Of course, if there are no restrictions on the measurement time of the width Γγ, then the average value Tγ is proportional to T1/2.
Then, taking into account that the energy of the γ-transition is emitted in less than 1 ns – this can be seen, for example, from the duration of the γ-signal in the scintillator, we can assume the following photon structure. Immediately after the formation of the excited state E*, the nucleus begins to emit an electromagnetic wave of frequency ω that does not carry energy – abbreviated as a 0-wave. The duration of this 0-wave determines the width Γγ. The energy quantum ⊠ω is emitted at the end of the 0-wave. The energy ⊠ω may not be emitted at all if the state E* decays via another channel, and then the 0-wave will exist on its own, without an energy quantum. A possible source of the 0-wave is the virtual transitions from the E* level to the ground state and back before the emission of an energy quantum.
The 0-wave with a quantum ⊠ω "on its tail" resembles a pilot wave introduced by De Broglie to explain the wave-particle duality of electrons. It is interesting to study effect of 0-waves on absorber nuclei, for example, to search for the modulation of the Γγ value via an additional resonance irradiation of the absorber in Mössbaur experiments.

1. V.V. Koltsov, Bull. Russ. Acad. Sci.: Phys. 83, 1144 (2019).
2. W. Triftshauser, P.P. Craig, Phys. Rev. Lett. 16, 1161 (1966).
3. V.K. Voitovetsky, I.L. Korsunsky, Yu.F. Pazhin et al., Yad. Fiz. 38, 662 (1983).

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No

Section

1. Experimental and theoretical studies of nuclear reactions

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