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Gravitational gamma-resonance spectrometry of long-lived isomers and the possibility of its application for study of subtle gravitational effects

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Messbauer effect – the emission/absorption of gamma-quantum with the momentum transfer of the impact to the kernel source/absorber and the crystal as a whole, allows, among other things, to study gamma line of long-lived isomers[1]. Theoretically, the natural width of/the gamma line of the kernel is determined by the ratio of $\Gamma_{natur} = \hbar/\tau$, where $\hbar$ - Planck's constant divided by 2π , τ - the average lifetime of nuclear level (line).

The isomer ^{109m}Ag emits gamma line with $E_\gamma = 88.03 \cdot 10^3$ eV and $\tau = 57.7$ sec. Natural width of this line is $\Gamma_{natur} = 1.14 \cdot 10^{-17}$ eV. The isomer ^{103m}Rh emits gamma line with $E_\gamma = 39.75 \cdot 10^3$ eV and $\tau = 80.9$ [2, 4, 5]. Natural width of this line of $\Gamma_{natur} = 1.3 \cdot 10^{-19}$ eV, which is nearly 85 times more than the the investigated silver[1].

In the case of studying the gamma resonances of the long-lived isomers with the measurement of the shape resonance by scanning of the peak of resonance absorption of gamma-line Doppler shift method is very difficult, because it would take the device generates the speed of the source relative to the absorber $\propto 10^{-12} - 10^{-13}$ cm/sec that cannot a mechanical device.

If the gamma quantum moves in the gravitational field and the point of emission and absorption have the height difference Δh , it will have a shift of energy at the point of absorption relative to its energy at the point of emission $\Delta E_\gamma = E_\gamma g \Delta H/c^2$, where E_γ - is the energy of the gamma quantum at the point of emission, g - is the gravitational acceleration, Δh - is the difference between points of emission and absorption, c - is the speed of light. The typical difference in height to shift the energy of the gamma quantum on the value of the width of the resonance peak of long-lived isomers ^{109m}Ag and ^{103m}Rh will be $\propto 10^{-4} - 10^{-3}$ cm, which is easy possible.

Experimental measurement of the natural width of the gamma-resonance peak of the isomer ^{109m}Ag is $\propto 10^{-17}$ eV [1]. The expected natural width of the gamma resonance of ^{103m}Rh must be $\propto 10^{-19}$ eV [1, 2]. This means that experimentally establish at resonance, the energy applied to the experimental setup width of the resonance peak scale can partially or completely disrupt resonant conditions. $\Delta E_\gamma/E_\gamma$ will be $\propto 10^{-22}$, typical height difference Δh, needed to shift the energy of the gamma quantum on the width of the resonance peak of long-lived isomers are micrometers. To the same energy shift causes a change in the gravitational potential $\Delta g_\gamma/g \propto 10^{-13}$ [3]. This evaluation of the sensitivity of the gravitational gamma-ray spectrometer for weak gravitational interactions.

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