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Why is the low-energy ion beam fluence to induce cell mutation orders higher than the cell lethal dose? –A puzzle

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Experimental facts have showed that in application of low-energy ion beam for biological living materials modification, the ion beam fluence required to induce cell mutation is orders higher than the cell lethal dose. This seems contradictory with common perception that the DNA modification should be proportional to radiation dose so that high dose radiation could cause high-degree damage in DNA to lead to cell death, while limited DNA damage produced by relatively low dose radiation would facilitate cell mutation. The author provides an answer to the puzzle from both physics and biology. Key points include the difference in physics between high-energy ionizing radiation and low-energy ion beam irradiation and the cell's non-linear behavior of responding to exogenous actions in biology.

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