Alpha-DaRT: A game-changer in radiation therapy?

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Abstract:

The aim of radiation therapy is to maximize the dose to the tumor while minimizing the dose to healthy tissue. Collateral damage to adjacent organs inevitably limits the tumor dose, which often leads to local recurrence of the disease and precludes re-irradiation. Even in the absence of tumor recurrence, healthy tissue irradiation regularly results in severe side effects with major impact on the patient’s quality of life.

Alpha particles could, in principle, be the ideal tool for radiation therapy. They are deadly to cancer cells: a single alpha particle hit to a cell’s nucleus can lead to its death with high probability, and unlike electrons, their effect is insensitive to biological conditions which increase the resistance of cells to conventional radiation. Their short range in tissue – only a few tens of microns – can guarantee that nearby healthy organs are spared. However, this very same property has so far prevented their use in the treatment of solid, macroscopic, tumors, because no practical way has been found to effectively cover the entire tumor volume with alpha emitting atoms.

Diffusing Alpha-emitters Radiation Therapy (‘Alpha DaRT’) is a new idea, which enables – for the first time – the treatment of solid tumors by alpha particles. The basic principle is to insert into the tumor an array of implantable sources (as in Brachytherapy), whose surface is embedded with a low activity of radium-224. Each source continuously emits into the tumor a chain of short-lived alpha emitting atoms (progeny of radium) which spread by diffusion and convection over several mm around it, creating a continuous ‘kill region’ of high alpha-particle dose. After many years of basic work on the technology and the associated physics, as well as an extensive campaign of preclinical studies in mice, Alpha DaRT has recently entered clinical trials. First results, on non-resectable tumors which have already failed radiation, are remarkable, with dramatic response and negligible side effects. This talk outlines Alpha DaRT’s basic principle, physics and safety, presents the status of current clinical trials and discusses its planned application in future ones.

Bio: Dr. Lior Arazi is a senior lecturer in the Unit of Nuclear Engineering at Ben-Gurion University, focusing on two very distinct aspects of ionizing radiation: the use of alpha particles for the treatment of solid tumors (Alpha-DaRT), and the development of new concepts for radiation detection and imaging in nuclear, particle and astroparticle physics experiments. He did his PhD in Tel Aviv University in applied nuclear physics under the supervision of Prof. Itzhak Kelson, where he co-invented and developed the Alpha-DaRT concept. He then moved to the Weizmann Institute for a postdoctoral fellowship on radiation detection physics. He is a member of the NEXT experiment searching for neutrinoless double beta decay and the DARWIN collaboration developing a future multi-ton liquid xenon dark matter detector.

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