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TRACK STRUCTURE MODELLING IN RADIOBIOLOGY AND RADIATION DETECTION

An energetic charged particle (such as a proton or heavier ion) travelling through an absorber, (such as nuclear emulsion) leaves a track of energy deposition events (detected, e.g., by developed grains in the emulsion). Using Poisson statistics of energy deposition in the target (e.g. grain) for its activation, of the radial distribution of delta-ray dose and of action cross section, the Track Structure Theory (TST) was introduced by Robert Katz in 1968 as a theory of RBE and applied in modelling the response of physical and biological detectors after ion irradiation. The ion beam radiation field is specified by the charge Z, speed β (or energy), fluence, and LET of the ion. The detector is represented by radiosensitive elements of size a0 and radiosensitivity D0, its gamma-ray response being represented by c-hit or multi-target expressions. Key to TST is the radial distribution of delta-ray dose (RDD) around the ion path. Radial integration of the RDD folded with the gamma-ray dose response of the physical detector (or cellular line) yields the action cross-section, σ. In its application to radiobiology, four-parameters represent the given cell line (m, D0 , a0 , and σ0). Track Structure Theory enables quantitative and predictive modelling of the response of physical detectors (such as nuclear emulsion, TLDs or alanine) and of in vitro RBE-LET dependences in cellular lines (such as V79, CH3H10T1/2 or HSG) after ion irradiation, to be performed. It has also been used to model carbon beam radiotherapy.
In two lectures, the principles of the Track Structure Theory and its application in radiation dosimetry, radiobiology and radiotherapy, will be outlined.

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