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Application of the BIANCA biophysical model to space radiation research: latest updates

Space radiation poses a major challenge for human exploration beyond Earth orbit, requiring biophysical models capable of accurately predicting biological effects under both chronic and acute exposure conditions. In this work, we present recent updates to the BIANCA model, focusing on the incorporation of dose-rate effects through the Lea-Catcheside formalism. This extension modifies the quadratic component of the linear-quadratic model by introducing the G factor, enabling the description of sublethal damage repair during low-dose-rate or protracted irradiations. The updated model was validated using experimental proton-irradiation survival data from both fractionated and acute exposures. Subsequently, BIANCA was coupled to the FLUKA transport code to simulate a major solar particle event, evaluating RBE-weighted doses in a voxelized human phantom under different shielding and irradiation durations. These results highlight the significant impact of dose rate on predicted biological effectiveness and strengthen the model's applicability for space radiation risk assessment.

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