Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

A unified description of biological effects caused by radiation exposure: Whack-a-mole (WAM) model TAKAHIRO WADA, Department of Pure and Applied Physics, Kansai University, YUICHIRO MANABE, Graduate School of Engineering, Osaka University, ISSEI NAKAMURA, State Key Laboratory of Polymer Physics and Chemistry, Changchun Institute of Applied Chemistry, MASAKO BANDO, Research Center for Nuclear Physics (RCNP), Osaka University — We present our novel rate equations to study DNA mutation in cells caused by artificial radiation exposure, accounting for the DNA damage and repair simultaneously. In our theory, the dependence of mutation frequencies on the dose rate is critically important to predict both the time course and the stationary effect of the DNA mutation in cell cycles. Experimentally, irradiation at high dose rates causes linear increases in the mutation frequency with total dose, whereas the saturation of the mutation frequency is observed at low dose rates. We demonstrate that this fact arises from counteracting effects among the DNA damage and mutation, the DNA repair, and the proliferation and apoptosis of cells. Our theory thus captures observed quantities at both high and low dose rates, marking a substantial difference from conventional theories based only on the total dose. Importantly, we have derived a scaling function from our rate equations that predicts a universal feature in the mutation frequency of living organisms. In this study, we have analyzed the experimental data of five species; mouse, drosophila, chrysanthemum, maize, and tradescantia. Despite the difference between animal and plant, all these data reasonably fall on a single line for our scaling function.

Takahiro Wada
Department of Pure and Applied Physics, Kansai University

Date submitted: 13 Nov 2014 Electronic form version 1.4