New Insight into Electromagnetic Field Enhanced Magnetic Isotope and Nuclear Spin Effects on Biological Systems

Yanyu Xiong
University of Colorado Boulder, Boulder, CO, USA

Exploration and innovation in magnetic field enhanced magnetic isotope effects is needed for opening new approaches to controlling life-reproducing and life-supporting biochemical reactions though external magnetic fields, which have potential to signal the biological system, excite the immune system, and stimulate healing processes. Procedures like these are able to perform functions that are currently either done by injection drugs or not at all.

A series of conspicuous results have been convincingly shown by Buchachenko and Kouznetsov (BK) that the rate of ATP production, DNA synthesis, and enzymatic phosphorylation of proteins could be modified though exposure to magnetic fields. External electromagnetic fields cause the hyperfine coupling of unpaired electrons with the magnetic nuclei ^{25}Mg, ^{43}Ca, and ^{67}Zn in the Mg^{2+}, Ca^{2+}, and Zn^{2+} ions. The fields then stimulate singlet-triplet spin conversion of the primary ion-radical pair and transform it into a triplet pair. Because back electron transfer is spin forbidden in a triplet pair, $^{25}Mg^{2+}$ opens up an additional forward reaction pathway and increases the rate of ATP production by shifting the chemical equilibrium in the forward direction. BK believe this mechanism has potential to be an efficient remedy for the treatment of cardiac diseases, cancer, and cognitive diseases by eliminating ATP deficiency, controlling cell proliferation, and trans-cranial magnetic stimulation, respectively. (Buchachenko AL & Kuznetsov DA, J Phys Chem Biophys. 4:142.)

In my presentation, I will show that experimental conditions widely used in recent studies in the area of magnetic isotope bio-effects do not match realistic biological conditions, and that when the experiments are adjusted for typical biological conditions the inconsistencies between experiments may be explained. (Crotty et al., Proc. Natl Acad. Sci. USA 2012;109:1437-1442.) I propose some experiments that can be used to illuminate the conditions where nuclear spins modify the chemical reaction rates for ATP, and will reference other papers that show the potential significance of nuclear spin effects on biological systems when exposed to weak RF magnetic fields.