J. Chem. Chem. Eng. 9 (2015) 71-74
doi: 10.17265/1934-7375/2015.01.011

Neutron (Magnetic Isotope) Catalysis for Example Isotopes ^{24,25,26}Mg in Cells E. Coli

Aibassov Yerkin Zhakenovich*, Yemelyanova Valentina, Tussupbayev Nessipbay, Shakieva Tatyana and Yerzhanova Zhadyra

Research Institute of New Chemical Technologies and Materials, Kazakh National University, Almaty 005012, Kazakhstan

Abstract: We offered the new theory of neutron (magnetic isotope) catalysis. For the first time it was shown that the number of neutrons in the atom, which have anomalous magnetic effect, have a great influence on the chemical properties. Our proposed theory of neutron (magnetic isotope) catalysis takes into account the influence of the magnetic field on the catalytic processes.

Key words: Neutron (magnetic isotope) catalysis, magnetic field, catalytic processes.

1. Introduction

The basic theory of catalysis include: multiplicity, ensembles, semiconductor, chain, compensation and other. Basic theory of catalysis have a common drawback, determined the futility of this area a better understanding of catalysis.

There are many mass-dependent isotope effects, manifested as a change in the rate of chemical reactions. There is currently no explanation for isotope effects in catalysis.

We have attempted to examine the effect of the neutron and the magnetic field on catalysis in terms of relativistic quantum chemistry.

2. Theory

As is well known Dirac equation describes the motion of particles with spin 1/2. It applies not only to the electron, but also to the protons and neutrons.

In the presence of an electromagnetic field may be present only in charge of the proton, and the presence of a special innate magnetic moment of the proton and neutron, which was called anomalous.

The Dirac equation for an electron in a magnetic field has the form:

$$H = \alpha_0 mc^2 + \sum_{j=1}^{3} \alpha_j \left[p_j - eA_j(\mathrm{x},t) \right] c + e\varphi(\mathrm{x},t)$$

where, e—electric charge of the electron, A and φ—electromagnetic vector and scalar potentials, respectively.

Assuming $\varphi = 0$ and working in the non-relativistic limit, Dirac found for the top two components in the positive energies wave functions:

$$\left(\frac{1}{2m} \sum_j \left| p_j - eA_j(\mathrm{x},t) \right|^2 - \frac{\hbar e}{2mc} \sum_j \sigma_j B_j(\mathrm{x}) \right) \begin{bmatrix} \Psi_1 \\ \Psi 2 \end{bmatrix} = \left(E - mc^2 \right) \begin{bmatrix} \Psi_1 \\ \Psi 2 \end{bmatrix}$$

where, $B = \nabla \times A$—the magnetic field acting on the particle. It Pauli equation for non-relativistic particles with half-integer spin, magnetic moment $\hbar e/2mc$ (g-factor is equal to 2). Actual magnetic moment is greater than this value, though only about 0.12%.

Within a few years after the discovery of the Dirac equation, most physicists believed that it also describes the proton and neutron, which are fermions with half-integer spin. However, since the experiments Stern and Frisch in 1933, found the magnetic moments of these particles do not coincide significantly with the predicted values of the Dirac equation. The proton has a magnetic moment 2.79 times larger than predicted, i.e., g-factor is 5.58.

*Corresponding author: Aibassov Yerkin Zhakenovich, Professor, research field: organic chemistry of U, Th, As, Sb and Bi. E-mail: erkin53@mail.ru.

Neutron, which is electrically neutral, has a g-factor 3.83. These "anomalous magnetic moments" were the first experimental indication that the proton and neutron are not elementary (a compound having a certain internal structure) particles. Later it turned out that they can be regarded as consisting of smaller particles called quarks bound is believed to be the gluon field. Quarks have half-integer spin and, as far as we know, are accurately described by the Dirac equation.

3. Results and Discussion

We have attempted to explain the magnetic isotope effects in catalysis with the anomalous magnetic moment of the neutron, as most of the chemical elements have stable isotopes, and different mass and magnetic properties of atomic nuclei. Some isotopes, for example, ^{1}H, ^{13}C, ^{15}N, ^{25}Mg, ^{31}P, characterized by the presence of the nuclear spins and nuclear magnetic moments are called magnetic. All isotopes of spinless are nonmagnetic.

Different atomic mass isotope of the magnetic properties cause mass-dependent magnetic and isotopic effects, respectively. There are many mass-dependent isotope effects, manifested as a change in the rate of chemical reactions [1-2]. Magnetic isotope same effects in chemistry is typical only for radical reactions [3]. They are caused mainly by the influence of the nuclear magnetic moment of the spin evolution of the RP (radical pair), whose fate (intracellular or extracellular recombination reaction) is determined by the action of the spin selection rules and prohibitions.

Opening the magnetic isotope effect on ATP synthesis magnetic isotope magnesium $^{25}Mg^{2+}$ [4-6], also for $^{67}Zn^{2+}$ [7] and $^{43}Ca^{2+}$ [8] showed that the rate of enzymatic reaction depends on the presence of the nuclear magnetic moment of the metal ion in the active phosphorylation site of the enzyme.

Until the discovery of magnetic isotope effects in biochemistry [4] in the enzymatic phosphorylation— the possible influence of magnetic isotopes on living organisms is not expected.

Authors [9] set the influence of the magnetic and non-magnetic ^{25}Mg, ^{24}Mg, ^{26}Mg isotope of magnesium on the life of the whole organism by the example of prokaryotic bacterial cells *Escherichia coli* and theoretically justify the possibility of the appearance of magnetic isotope effects in living organisms.

Authors [9] received magnetic field dependence of the rate constants of enzymatic ion-radical reactions for Δg-mechanism and the hyperfine interaction of the nuclear spin and electron spin inducing singlet-triplet conversion.

The authors [9] considered two mechanisms of singlet-triplet conversion of radical ion pairs formed in the active site of the enzyme during the reaction: g-mechanism due to the difference between the g-factors of radical ions, and TSP (triplet-singlet pair) mechanism due to the hyperfine interaction of the unpaired electron spins with nuclear spins.

It is shown that the spin-dependent ion-radical enzymatic reactions in different parts of the body may be "primary magnitoretseptorom" in living organisms that do not require the creation of a special body. The products of these reactions are "converted" the effects of the nuclear spin and the magnetic field in the "biochemical response" of living organisms. The dependences of the rate of enzymatic reactions on the value of the hyperfine interaction constant, the magnetic field and the rate constants of the elementary acts of enzymatic reactions.

The first experimental reliably and unambiguously proved that the magnetic isotope ^{25}Mg, while in a living cell, affects their growth, development and livelihoods, and its biological effects are different from non-magnetic isotope effects ^{24,26}Mg. These data confirm our theory of neutron (Magnin isotope) catalysis.

The experimental data and theoretical calculations carried out by the effect of magnetic fields on living

organisms opens wide horizons for the study of the action of many vital elements with natural stability of the magnetic isotopes in the intracellular processes. Such studies will provide the basis for new research directions within biophysics, physical and chemical molecular and cell biology—Spin Biochemistry and Spin Microbiology.

In Ref. [9] showed the results of quantum mechanical theoretical calculations. Considered Δg- and STV- mechanisms spin conversion of IRP (ion-radical pair), formed in the active site of the enzyme.

To analyze the effect of a magnetic field on the enzymatic reactions used idealized kinetic scheme of this reaction.

$$A, B \leftrightarrow [A^+, B^-]^S \leftrightarrow [A^+, B^-]^T \rightarrow \text{products}$$

where, A and B—original diamagnetic particles that result from electron transfer converted into a single radical ion pair $[A^{\bullet +}, B^{\bullet -}]^S$ with a rate constant k_1. For the singlet radical ion pair $[A^{\bullet +}, B^{\bullet -}]$ there are three possible channel of evolution:

(1) Reverse electron transfer to the acceptor with a rate constant k_{-1};

(2) A further electron transfer or transformation of the substrate, leading to the formation of products with a rate constant k;

(3) Spin evolution that takes singlet to the triplet state IRP in the triplet state $[A^{\bullet +}, B^{\bullet -}]^T$ with frequency ωST, determined by the magnetic interaction of the unpaired electron spins.

Thus, it is shown that the magnetic isotopes ^{25}Mg are more active than non magnetic isotopes ^{24}Mg and ^{26}Mg.

4. Conclusions

Thus, it is shown that the spin-dependent ion-radical enzymatic reactions can be "primary magnitoretseptorom" in living organisms without creating a special body. The products of these reactions are "converted" the effects of the nuclear spin and the magnetic field in the "biochemical response of" living organisms.

The dependences of the rate of enzymatic reactions on the value of the hyperfine interaction constant, the magnetic field and the rate constants of the elementary acts of enzymatic reactions for two mechanisms of spin conversion: g-mechanism, due to the difference between the g-factors of radical ions, and PTS mechanism caused by hyperfine interactions unpaired electron spin with the nuclear spins.

External constant magnetic field should increase the amount of effect of magnetic isotopes of chemical elements at the expense of the hyperfine interaction in weak fields.

Obtain reliable experimental data showing the influence of the magnetic moments of nuclei of isotopes of magnesium on biological processes in cells of Escherichia coli. A constant growth rate and colony forming ability of the bacteria in the presence of the above magnetic isotope magnesium ^{25}Mg compared with nonmagnetic isotopes.

Unequivocally proven magnetic origin detected magnetic isotope effects: they are all due to the differences of the magnetic properties of the nuclei of isotopes of magnesium rather than differences in their masses.

Neutron (magnetic isotope) catalysis opens a new page in the field of catalysis and the creation of new types of catalysts.

Acknowledgments

The authors would like to thank Lynn C. Francesconi (Hunter College CUNY), Ruben M. Savizky (Columbia University, New York), Peter C. Burns (Notre Dame University, Indiana) and Chistopher L. Cahill (George Washington University) for discussion of the results.

References

[1] Griffiths, H. 1998. *Stable Isotopes. Integration of Biological, Ecological and Geochemical Processes.* Griffiths, H. Oxford, UK: Bios Scientific Publishers.

[2] Melander, L., and Saunders, J. W. 1980. *Reaction Rates of Isotopic Compounds.* N.Y.: Wiley.

[3] Buchachenko, A. L., Sagdeev R. Z., and Salikhov K. M. 1978. *Magnetic and spin effects in chemical reactions.* Novosibirsk: Nauka.

[4] Buchachenko, A. L, Kouznetsov, D. A., and Arkhangelsky S. E. 2004. "Dependence of Mitochondrial ATP Synthesis on the Nuclear Magnetic Moment of Magnesium Ions." *Doklady Biochem. Biophys* 396: 197.

[5] Buchachenko, A. L., Kouznetsov, D. A., and Arkhangelsky, S. E. 2005. "Magnetic Isotope Effect of Magnesium in Phosphoglycerate Kinase Phosphorylation." *Proc. Nat. Acad Sci.* 102: 10793.

[6] Buchachenko, A. L. 2009. *Magnetic Isotope Effects in Chemistry and Biochemistry*. Buchachenko, A. L. New York: Nova Science Publishers, Inc., p 105.

[7] Buchachenko, A. L., Chekhonin, V. P., and Orlov A. P. 2010. "Zincrelated Magnetic Isotope Effect in the Enzymatic ATP Synthesis: a Medicinal Potential of the Nuclear Spin Selectivity Phenomena." *Int. J. Mol. Med. Adv. Sci.* 6 (3): 34.

[8] Buchachenko, A. L., Kouznetsov, D. A., and Breslavskaya, N. N. 2011. "A Specific Role of ^{43}Ca in the Enzymatic ATP Synthesis." *Am. J. Biotechnol. Mol. Sci.* 1 (1): 30.

[9] Shevchenko. U., Avdeeva. E., and Berdinsky, V. 2011. *Proc. 4d Conf. (Intern.) on Magneto-Science.* Shanghai: Shanghai University.