DOI: http://dx.doi.org/10.21123/bsj.2016.13.1.0146

The Nuclear Structure for Exotic Neutron-Rich of $^{42, 43, 45, 47}$K Nuclei

Ban S. Hameed

Department of Physics, College of Science for Women, University of Baghdad, Baghdad, Iraq.

E-mail: banalqazaz@yahoo.com

Received 18, February, 2015
Accepted 6, April, 2015

Abstract:

In this paper the proton, neutron and matter density distributions and the corresponding root mean square (rms) radii of the ground states and the elastic magnetic electron scattering form factors and the magnetic dipole moments have been calculated for exotic nucleus of potassium isotopes K (*A*= 42, 43, 45, 47) based on the shell model using effective W0 interaction. The single-particle wave functions of harmonic-oscillator (HO) potential are used with the oscillator parameters b. According to this interaction, the valence nucleons are asummed to move in the *d3f7* model space. The elastic magnetic electron scattering of the exotic nuclei ^{42}K ($J^{\pi}T= 2^{-}$ 2), ^{43}K($J^{\pi}T=3/2^{+}$ 5/2), ^{45}K ($J^{\pi}T= 3/2^{+}$ 7/2) and ^{47}K ($J^{\pi}T= 1/2^{+}$ 9/2) investigated through Plane Wave Born Approximation (PWBA). The inclusion of core polarization effect through the effective g-factors is adequate to obtain a good agreement between the predicted and the measured magnetic dipole moments.

Key words: Exotic nucleus, proton, neutron and matter density, magnetic dipole moments, elastic magnetic form factors

Introduction:

One of the key issues in current nuclear physics research is to investigate the properties of so-called `exotic nuclei' and of `exotic nuclear structures'. Exotic nuclei are nuclei with a proton-to-neutron ratio that is very different from the proton-to-neutron ratio in stable nuclei (a technical term related to this ratio is the `isospin'). The exotic nuclear structures can be defined as excitation modes of nuclei that have a very different structure than the structure (or shape) of the nuclear ground state [1]. Because of the rapid decay of exotic nuclei, it is rather difficult to make targets with them, therefore, experiments have been done in inverse kinematics with a beam of exotic nuclei incident on a target.

The electron scattering from exotic nuclei is not presently available; the technical proposal for an electron-ion collider has been incorporated in the GSI/Germany physics program at FAIR [2]. A similar program exists for RIKEN/Japan facility [3]. In both cases the main purpose is to study the structure of nuclei far from the stability line. Such facilities in future will explore the charge density distributions for nuclei far from the valley of stability line, having skins or halos. Therefore, the halo nuclei are an extreme case of exotic nuclei with almost zero binding energy.

The electric and magnetic properties of a nuclear state, namely on what the static magnetic dipole and electric quadrupole moments can teach us about the nucleus as a system of independently moving particles in a central potential or as a system of collectively moving nucleons.The magnetic moment is very sensitive to the single particle orbits occupied by the unpaired nucleons, while the quadrupole moment is a unique instrument to study the deformation and collective behavior of nuclei both at low and high excitation energy. Both quantities can be directly compared with the predicted values in different nuclear models. Consequently, the magnetic moment may also give a means to distinguish between spherical and deformed states [4, 5].

Karataglidis and Amos [6] presented elastic and inelastic electron scattering form factors for several neutron-rich exotic nuclei. The results have been obtained using large space no-core shell models. While the elastic scattering form factors are insensitive to the details of the neutron density, it is found that inelastic scattering may be influenced by extensive neutron distributions

Sieja and Nowacki [7] investigated the neutron rich nuclei which can be described by shell model calculations in the *p–sd* and *sd–pf* model spaces. They quantified the effects of the core polarization on the multipole part (pairing and quadrupole) of the effective Hamiltonians. They showed that proton core polarization contributions are responsible for the reduction of the neutron–neutron nuclear matrix elements which, in the recent shell model studies, appeared necessary between *p–sd* carbon and oxygen and *sd–pf* silicon and calcium nuclei.

Neyens [8] measured the ground state magnetic moments and spins of the exotic isotopes ^{49,51}K at the ISOLDE facility at CERN using bunched-beam high-resolution collinear laser spectroscopy. The re-inversion of the ground state spin from I = 1/2 in ^{47,49}K back to the normal I = 3/2 in ^{51}K. At GANIL (Caen, France) the quadrupole moment of the ^{33}Al ground state has been measured using the continuous-beam -nuclear magnetic resonance method applied to a spin-polarized beam produced at the LISE fragment separator. The large value establishes a very mixed wave function with about equal amounts of normal and neutron particle-hole excited configurations contributing to its ground state wave function.

Kreim et al., [9] reported and deduced on the measurement of optical isotope shifts for $^{38,39,42,44,46–51}$K relative to ^{47}K from which changes in the nuclear mean square charge radii across the N=28 shell closure. The investigation was carried out by bunched-beam collinear laser spectroscopy at the CERN-ISOLDE radioactive ion-beam facility. Mean square charge radii are now known from ^{37}K to ^{51}K, covering all $\nu f_{7/2}$-shell as well as all $\nu p_{3/2}$-shell nuclei. These measurements, in conjunction with those of Ca, Cr, Mn and Fe, provide a first insight into the Z dependence of the evolution of nuclear size above the shell closure at N=28.

The aim of the present work is to study the magnetic elastic electron scattering form factors and to calculate the magnetic dipole moments of exotic nucleus ^{42,43,44,45}K (neutron-rich) using W0 interaction [10] in *d3f7* -model space. The elastic magnetic electron scattering of the exotic ^{42,43,45,47}K nuclei are investigated through Plane Wave Born Approximation (PWBA).

Also the proton, neutron and matter density distributions and the corresponding root mean square (rms) radii of the ground states are calculated. Calculations are presented with model space and with core-polarization (CP) effects by using effective g-factors.

Theory:

The interaction of the electron with the spin and currents distributions of nuclei can be considered as an exchange of a virtual photon with angular momentum ± 1 along momentum transfer $\vec{q}$ direction. This is called transverse scattering [11]. From the parity and angular momentum selection rules, only electric multipoles can have longitudinal components, while both electric and magnetic multipoles can have transverse components [11, 12].

The squared magnetic form factors for electron scattering between nuclear states J_i and J_f involving angular momentum transfer J are given by [13]:

$$\left|F_J^{\eta}(q)\right|^2 = \frac{4\pi}{Z^2(2J_i+1)}\left|\sum_{T=0,1}(-1)^{T_f-T_{zf}}\begin{pmatrix} T_f & T & T_i \\ -T_{zf} & M_T & T_{Zi}\end{pmatrix}\left\langle \Gamma_f \left\| \hat{T}_{J,T}(q) \right\| \Gamma_i \right\rangle\right|^2 \quad ...(1)$$

where $\hat{T}_J(q)$ is the magnetic electron scattering multipole operator. For a magnetic operator T_{JT} the reduced matrix elements are written as the sum of the product of the one-body density matrix elements (OBDM) times the single-particle transition matrix elements [14]:

$$\left\langle \Gamma_f \left\| \hat{T}_\Lambda \right\| \Gamma_i \right\rangle = \sum_{\alpha,\beta} OBDM\left(\Gamma_i, \Gamma_f, a, b\right)\left\langle a \left\| \hat{T}_\Lambda \right\| b \right\rangle ...(2)$$

where $\Lambda = JT$ is the multipolarity and the states $\Gamma_i \equiv J_i T_i$ and $\Gamma_f \equiv J_f T_f$ are initial and final states of the nucleus. While α and β denote the final and initial single-particle states, respectively (isospin is included). The nuclear shell model calculations were performed using the OXBASH Shell model code [15], where the one body density matrix (OBDM) elements given in eq. (2) were obtained.

The single-nucleon form factor [16] and the center-of-mass form factor [17] are given by:

$$F_{fs}(q) = [1 + (q/4.33)^2]^{-2},$$

$$F_{cm}(q) = e^{q^2 b^2 / 4A} \quad ...(3)$$

where A is the nuclear mass number and b is the harmonic-oscillator size parameter, for halo nuclei b equal to the average of b_{core} and b_{halo}. Introducing these corrections into Eq. (1), we obtain:

$$\left|F_J^M(q)\right|^2 = \frac{4\pi}{Z^2(2J_i+1)}\left|\sum_{T=0,1}(-1)^{T_f-T_{zf}}\begin{pmatrix} T_f & T & T_i \\ -T_{Zf} & M_T & T_{Zi}\end{pmatrix}\left\langle \Gamma_f \left\| \hat{T}^M_{J,T}(q) \right\| \Gamma_i \right\rangle\right|^2 \quad ...(4)$$

$$\times \left|F_{c.m}(q)\right|^2 \times \left|F_{f.s}(q)\right|^2$$

The single particle matrix element in spin- isospin state is given by [14]:

$$\left\langle a \left\| \hat{O}_T(m1) \right\| b \right\rangle = \left\langle n_a l_a \left| r^{J-1} \right| n_b l_b \right\rangle f_T^{m1}(a,b) ...(5)$$

where

$$f_T^{m1}(a,b) = (-1)^{\ell_a}(2J+1)\sqrt{\frac{J(2J-1)(2\ell_a+1)(2\ell_b+1)(2j_a+1)(2j_b+1)}{4\pi}}$$
$$\times\begin{pmatrix} \ell_a & J-1 & \ell_b \\ 0 & 0 & 0 \end{pmatrix}\sqrt{2T+1}[\frac{g_p^{\ell}+(-1)^T g_n^{\ell}}{J+1}(-1)^{\ell_b+j_b+1/2}\sqrt{2\ell_b(\ell_b+1)(2\ell_b+1)} \quad \ldots(6)$$
$$\times\begin{Bmatrix} \ell_a & \ell_b & J \\ j_b & j_a & 1/2 \end{Bmatrix}\begin{Bmatrix} J-1 & 1 & J \\ \ell_b & \ell_a & \ell_b \end{Bmatrix}+\frac{1}{2}\{g_p^s+(-1)^T g_n^s\}\sqrt{3}\begin{Bmatrix} \ell_a & 1/2 & j_a \\ \ell_b & 1/2 & j_b \\ J-1 & 1 & J \end{Bmatrix}]\mu_N$$

for $J=1$ equation (5) become:

$$\left\langle a \left\| \hat{O}_T(m1) \right\| b \right\rangle = f_T^{m1}(a,b)$$
…(7)

The reduce matrix element of the magnetic transition operator $\hat{O}_k(m1)$ is expressed as the sum of the product of the elements of the one-body density matrix (OBDM) times the single-particle matrix elements, and is gives by:

$$\left\langle J_i \left\| \sum_{k=1}^{n} \hat{O}_k(m1) \right\| J_i \right\rangle = \sum_{a,b,T}(-1)^{T_i-T_z}\begin{pmatrix} T_i & T & T_i \\ -T_z & 0 & T_z \end{pmatrix} OBDM \quad (a,b,J=1,T)\left\langle a \left\| \hat{O}_T(m1) \right\| b \right\rangle \quad \ldots(8)$$

The magnetic dipole moment μ of a state of total angular momentum J is given by [14]:

$$\mu = \sqrt{\frac{4\pi}{3}}\begin{pmatrix} J_i & 1 & J_i \\ -J_i & 0 & J_i \end{pmatrix}\left\langle J_i \left\| \sum_{k=1}^{n} \hat{O}_k(m1) \right\| J_i \right\rangle \quad \ldots\ (9)$$

The neutron skin occurs as a consequence of the neutron excess in heavy nuclei. The neutron skin in general is defined as the radial difference (root-mean square-radius difference) of the neutron and proton distributions with surface thickness (t) [18]: $t = R_n - R_p = \langle r \rangle_n^{\frac{1}{2}} - \langle r \rangle_p^{\frac{1}{2}}$ … (10)

Where $R_n \equiv \langle r \rangle_n^{\frac{1}{2}}$ and $R_p \equiv \langle r \rangle_p^{\frac{1}{2}}$ are the neutron and proton root mean square radius, respectively.

Results and Discussion:

The radial wave functions for the single-particle matrix elements were calculated with harmonic oscillator (HO) potential with size parameters b are adjusted for each isotope of potassium to reproduce the measured root mean square matter radius (R_m). The calculations of the proton, neutron, and matter rms radii and magnetic form factors are carried out using *d3f7*-shell model space with effective W0 interaction [10] in OXBASH code [15]. The core polarization (CP) effect is included by using effective g-factors.

The values of calculated matter (R_m), proton (R_p) and neutron (R_n) rms radii, magnetic dipole moments (μ), and oscillator size parameter (b) of potassium isotopes nuclei are displayed in table 1.

1.^{42}K nucleus ($J^{\pi}T = 2^-\ 2, \tau_{1/2} = 12.36$ h)

Calculations are performed with *d3f7*-shell model space including core-polarization effects. The configurations $(1s_{1/2})^4\ (1p_{3/2})^8(1p_{1/2})^4(1d_{5/2})^{12}\ (2s_{1/2})^4\ (1d_{3/2})^7(1f_{7/2})^3$ are used for ^{42}K. The oscillator size parameter is taken to be 2.073fm,which gives the rms matter radius equal to 3.4467fm in agreement with the measured value 3.4467(34)fm [19]. The difference between the neutron and proton rms radii is $R_n - R_p = 3.5505 - 3.3166 = 0.2339$ fm, which provides an additional evidence for the exotic structure of this nucleus.

The calculated total magnetic form factors for ^{42}K ground state ($J^{\pi}T= 2^{-}\ 2$) using W0 interactions in *d3f7*-model space and with free g_s-factors are shown in Fig.(1). Unfortunatly, there are no experimental data to compare with it. The individual multipoles contributions M1 and M3 are denoted by dashed and dashed-dot curves respectively, while the E2 and E4 multipoles are disappeared because it has negligible contributions. The diffraction minimum for M1 component located at momentum transfer q=2.1fm^{-1}, but for M3 component the diffraction minimum located at q=1.4 and 2.35 fm^{-1}. The total form factors in *d3f7*-shell model space are included by solid curve.

The calculated magnetic dipole moments (μ) of ^{42}K isotope are tabulated in table 1 together with the available experimental data. The calculated magnetic dipole moment of g(free) is $\mu = -1.3594\ n.m$. The inclusion the effective g-factors with g(eff)=0.9 g(free) decreased the magnetic moment value by $-1.22352\ n.m$ which is in a good agreement with the measured value $\mu_{\exp.} = -1.1425\ (6)\, n.m$ [20].

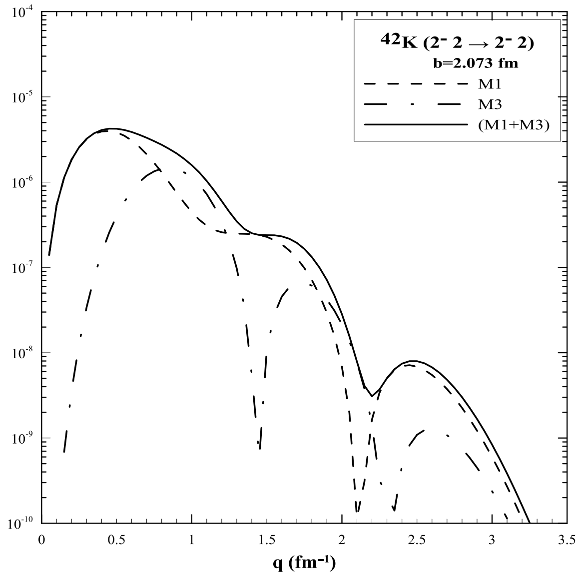

Fig. (1): The magnetic form factors for ground state of ^{42}K calculated in *d3f7*-model space. The individual multipoles contributions of M1 and M3 are shown.

2.^{43}K nucleus ($J^{\pi}T=3/2^{+}5/2, \tau_{1/2}$ = 22.3 h)

Calculations are performed with *d3f7*-shell model space including core-polarization effects. The configurations $(1s_{1/2})^4\ (1p_{3/2})^8(1p_{1/2})^4(1d_{5/2})^{12}\ (2s_{1/2})^4\ (1d_{3/2})^7(1f_{7/2})^4$ are used for ^{43}K.The oscillator size parameter is taken to be 1.916fm,which gives the rms matter radius equal to 3.4489fm in agreement with the measured value 3.4489(42)fm [19]. The difference between the neutron and proton rms radii is $R_n - R_p = 3.5261 - 3.3488 = 0.2095$ fm, which provides an additional evidence for the exotic structure of this nucleus.

The calculated total magnetic form factors for ^{43}K ground state ($J^{\pi}T= 3/2^{+}\ 5/2$) using W0 interactions in *d3f7*-model space and with free g_s-factors are shown in Fig.(2). The individual multipoles contributions M1 and M3 are denoted by dashed and dashed-dot curves respectively, while the E2 is disappeared because it has negligible contribution. The diffraction minimum for M1 component located at momentum transfer q=1.9fm^{-1}, but for M3 component the diffraction minimum located at q=0.6 fm^{-1}. The total form factors in *d3f7*-shell model space are included by solid curve.

The calculated magnetic dipole moments (μ) of ^{43}K isotope are tabulated in table 1 together with the available experimental data. The calculated magnetic dipole moment of g_s(free) and inclusion the effective g-factors with g(eff)=0.9 g(free) are $\mu = 0.17642\ n.m$ and $0.15878\ n.m$, respectively, which is in a good agreement with the measured value $\mu_{\exp.} = 0.1633\ (8)\, n.m$ [20].

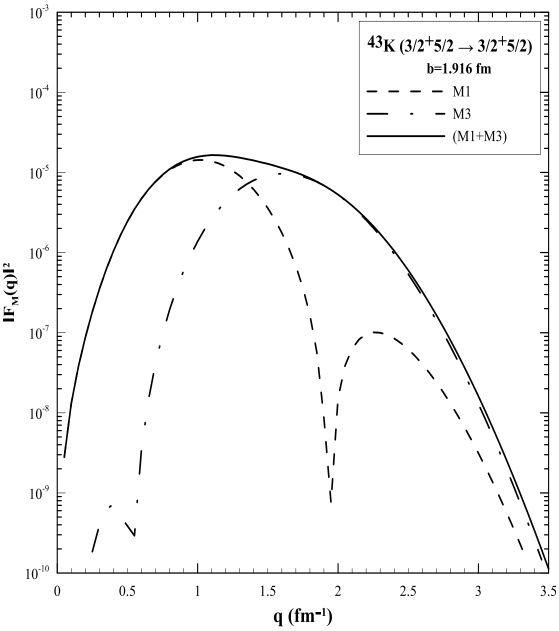

Fig. (2): The magnetic form factors for ground state of^{43}K calculated in *d3f7*-model space. The individual multipoles contributions of M1 and M3 are shown.

3. ^{45}K nucleus ($J^{\pi}T$ = 3/2$^+$ 7/2, $\tau_{1/2}$ = 17.3 m)

The configurations $(1s_{1/2})^4$ $(1p_{3/2})^8$ $(1p_{1/2})^4(1d_{5/2})^{12}$ $(2s_{1/2})^4$ $(1d_{3/2})^7(1f_{7/2})^6$ are used for ^{45}K. The single – particle wave functions of harmonic oscillator potential are used with oscillator size parameter b=1.849fm chosen to reproduce the experimental matter rms radius 3.4523(45) fm [19]. The difference between the neutron and proton rms radii is $R_n - R_p = 3.5113 - 3.3698 = 0.1415$ fm, which provides an additional evidence for the exotic structure of this nucleus.

The calculated total form factors for the ground state of unstable nucleus ^{45}K with ($J^{\pi}T$= 3/2$^+$ 7/2) with free spin g_s-factors are shown in Fig.(3). The individual multipoles contributions M1 and M3 are denoted by dashed and dashed-dot curves, respectively, while the E2 multipole is disappeared because it has a negligible contribution. The diffraction minimum for M1 component located at momentum transfer q= 2.0fm^{-1}.

The different values of g_s-factors, which give different values for magnetic dipole moment. The choice for free g-factors gives $\mu = 0.19753\ n.m$. The inclusion the effective g-factors with g(eff)=0.9 g(free) decreased the magnetic moment value by $0.17778\ n.m$, which is a good agreement with the measured value $\mu_{exp.} = 0.1734\ (8)\,n.m$ [20].

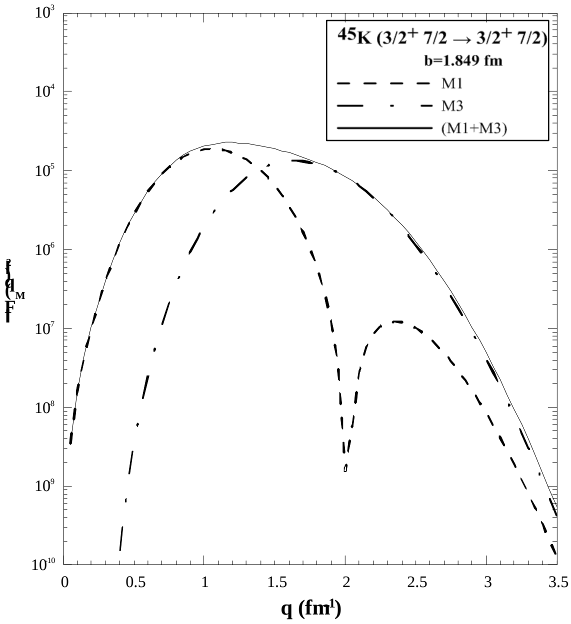

Fig. (3): The magnetic form factors for ground state of ^{45}K calculated in *d3f7*-model space. The individual multipoles contributions of M1 and M3 are shown.

3. ^{47}K nucleus ($J^{\pi}T$ = 1/2$^+$ 9/2, $\tau_{1/2}$ = 17.50 s)

Calculations are performed with *d3f7*-shell model space including core-polarization effects. The configurations $(1s_{1/2})^4$ $(1p_{3/2})^8(1p_{1/2})^4(1d_{5/2})^{12}$ $(2s_{1/2})^4$ $(1d_{3/2})^7(1f_{7/2})^8$ are used for ^{47}K. The oscillator size parameter is taken to be 1.898 fm,which gives the rms matter radius equal to 3.4418fm in agreement with the measured value 3.4418(32)fm [19]. The difference between the neutron and proton rms radii is $R_n - R_p = 3.5150 - 3.309 = 0.1841$ fm, which provides an additional evidence for the exotic structure of this nucleus.

The calculated total magnetic form factors for ^{47}K ground state ($J^{\pi}T$= 1/2$^+$ 9/2) using W0 interactions in *d3f7*-model space and with free g_s-factors are shown in Fig.(4). The individual multipole contribution M1 is denoted by solid curve. The diffraction minimum for M1 component located at momentum transfer q=0.7 and 1.9 fm^{-1}.

The calculated magnetic dipole moment of g(free) and of inclusion the effective g-factors are $\mu = 1.61367\ n.m$ and $1.4523\ n.m$, respectively, which are less than the measured value $\mu_{exp.} = 1.933\ (9)\ n.m$ [20].

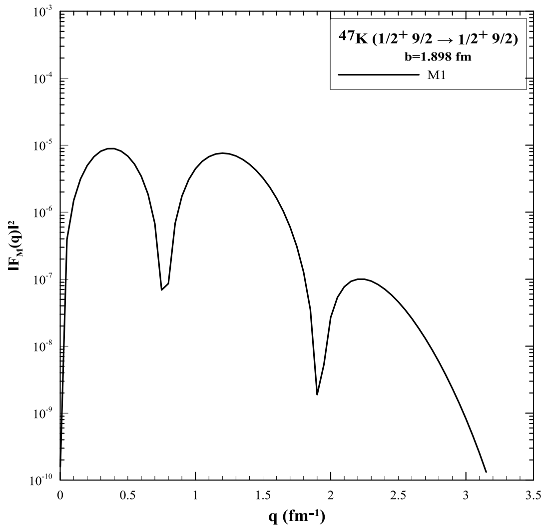

Fig. (4): The magnetic form factors for ground state of ^{47}K calculated in *d3f7*-model space. The individual multipole contribution of M1 is shown.

Table 1: The calculated matter, proton and neutron rms radii, magnetic dipole moments (μ), and oscillator size parameter (b) of ^{42,43,45,47}K isotopes compared with experimental results.

A	$J^{\pi}T$ $\tau_{1/2}$	b (fm)	Rm (fm)		R_p(fm)	R_n(fm)	μ (n. m) Calc.		μ (n. m) Exp.[20]
			Calc.	Exp. [19]			g(free)	g(eff.)=0.9 g(free)	
42	2^- 2 12.36 h	2.073	3.4467	3.4467(34)	3.3166	3.5505	-1.35947	-1.22352	-1.1425(6)
43	$3/2^+$ 5/2 22.3 h	1.916	3.4489	3.4489(42)	3.3488	3.5261	0.17642	0.15878	0.1633(8)
45	$3/2^+$ 7/2 17.3 m	1.849	3.4523	3.4523(45)	3.3698	3.5113	0.19753	0.17778	0.1734(8)
47	$1/2^+$ 9/2 17.50 s	1.898	3.4418	3.4418(32)	3.3309	3.5150	0.161367	0.14523	0.1933(9)

Conclusions:

Shell-model calculations are performed for K isotopes including core-polarization effects through first-order perturbation theory. The magnetic dipole moments μ of the ^{42,43,45,47}K nuclei depend clearly on assigned configurations and their experimental data will be useful to determine the deformations of the ground states of nuclei near the neutron drip line. The inclusion of core polarization (the effective g-factors) is adequate to obtain a good agreement between the predicted and measured magnetic dipole moments. The elastic magnetic form factors are influenced by details of nuclear wave function and the center of mass correction which depends on the mass number and the size parameter b.

References:

[1]Neyens, G. 2003. Nuclear magnetic and quadrupole moments for nuclear structure research on exotic nuclei, Rep. Prog. Phys. 66: 633–689.

[2]Simon, H. 2005. Technical Proposal for the Design, Construction, Commissioning, And Operation of the ELISe setup, GSI Internal Report.

[3]Wakasugi, M.; Suda, T. and Yano, Y. 2004. A New Method for Electron-Scattering Experiment usin a Self-Confining Radioactive Ion Target in an Electron Storage Ring,

Nucl. Instrum. Methods Phys. A532: 216.

[4]Hagino, K.; Tanihata, I. and Sagawa H. 2013. Exotic nuclei far from the stability line, 100 Years of Subatomic Physics: 231-272.

[5]De Rydt, M.; Lozeva, R.; Vermeulen, N.; de Oliveira Santos, F.; Grevy, S.; Himpe, P.; Stodel, C.; Thomas, J.C.; Vingerhoets, P. and Neyens, G. 2009. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment. 612: 112-121.

[6]Karataglidis, S. and Amos, K. 2008. Charge densities and the electron scattering form factors of exotic nuclei, AIP Conf. Proc. 1012: 328-332.

[7]Sieja, K. and Nowacki, F. 2011. Core polarization effects in effective Hamiltonians far from stability, Nucl. Phys. A 857: 9–15.

[8]Neyens, G. 2013. Ground state moments and spins of neutron-rich K and Al isotopes as probes for changes in nuclear structure, Journal of Physics, Conference Series 445: 012007.

[9]Kreim, K.; Bissell, M.L.; Papuga, J.; Blaum, K.; DeRydt, M.; GarciaRuiz, R.F.; Goriely, S.; Heylen, H.; Kowalska, M.; Neugart, R.; Neyens, G.; Nörtershäuser, W.; Rajabali, M.M.; Sánchez Alarcón, R.; Stroke, H.H. and Yordanov, D. T. 2014. Nuclear charge radii of potassium isotopes beyond N = 28, Phys. Letts, B 731: 97–102.

[10] Seth, K. K.; Benenson, W.; Lanford, W. A.; Nann, H. and Wildenthal, B. H. 1974. Discovery of the Missing Two-Particle Two-Hole 0+ States in Ca40, Phys. Rev. Lett. 33:233.

[11] De Forest, T. and Walecka, J.D.1966. Electron scattering and nuclear structure, Adv. Phys.15:1-109.

[12] De Shalit, T. and Talmi, I. 1963. Nuclear Shell Theory. Acadimic New York.

[13] Donnelly, T. W. and Sick, I. 1984. Elastic Magnetic Electron Scattering From Nuclei. Rev. Mod. Phys. 56: 461-566.

[14] Brussaard, P. J. and Glademans, P. W. M. 1977. Shell-model Application in Nuclear Spectroscopy. North-Holland Publishing Company, Amsterdam.

[15] Brown, B. A.; Etchgoyen, A.; Godwin, N. S.; Rae,W. D. M. W.; Richter, A.; Ormand, W. E.; Warburton, E. K.; Winfield, J. S.; Zhao L. and Zimmerman, C. H. 2005. Oxbash for Windows. MSU-NSCL report number 1289.

[16] Glickman, J. P.; Bertozzi,W.; Buti,T. N.; Dixit, S. F.; Hersman,W.; Hyde-Wright, C. E.; Hynes, M. V.; Lourie, R. W.; Norum, B. E.; Kelly, J. J.; Berman, B. L. and Millener, D. J. 1991. Electron scattering from ^{9}Be, Phys. Rev. C43:1740.

[17] Tassie, T. and Barker, F. C. 1958. Application to Electron Scattering of Center-of-Mass Effects in the Nuclear Shell Model, Phys. Rev. 111: 940.

[18] Myers, W. D. and Swiatecki, W. J. 1969. Average nuclear properties, Ann. Phys. (N. Y.) 55: 395.

[19] Touchard, F.; Guimbal, P.; Büttgenbach, S.; Klapisch, De Saint Simon, M.; Serre, J.M.; Thibault, C., Duong, H.T.; Juncar, P.; Liberman, S.; Pinard, J. and Vialle, J. L.1982. Isotope shifts and hyperfine structure of $^{38–47}$K by laser spectroscopy, Phys. Lett. B 108(3):169-171.

[20] Stone, N. J. 2005. Table of nuclear magnetic dipole and electric quadrupole moments, Atomic Data and Nuclear Data Tables 90: 75-17.

التركيب النووي للنوى الغريبة الغنية- بالنيوترونات لـ $^{42,43,45,47}K$

بان صباح حميد

قسم الفيزياء ، كلية العلوم للبنات، جامعة بغداد، بغداد-العراق.

الخلاصة:

في هذا البحث تم حساب توزيعات الكثافة البروتونية والنيوترونية والمادة النووية بالأضافة الى أنصاف الأقطار للبروتونات والنيوترونات للحالات الأرضية و عوامل التشكل المغناطيسية للأستطارة الألكترونية المرنة والعزوم ثنائية القطب المغناطيسية للنوى الغريبة لنظائر البوتاسيوم K (A= 42, 43, 45, 47) المستندة على أنموذج القشرة بأستخدام تفاعل W0 الفعال. استخدمت الدوال الموجية للجسيمة المفردة لجهد المتذبذب التوافقي (HO) مع قيمة للثابت التوافقي b . بناءاً على هذا التفاعل، تم أفتراض نيكلونات التكافؤ تتحرك في فضاء *d3f7*. تم تحقيق عوامل التشكل المغناطيسية للأستطارة الألكترونية المرنة للنوى الغريبة ^{42}K ($J^{\pi}T= 2^{-}\ 2$) ^{43}K ($J^{\pi}T=3/2^{+}\ 5/2$), ^{45}K ($J^{\pi}T= 3/2^{+}\ 7/2$), و ^{47}K ($J^{\pi}T= 1/2^{+}\ 9/2$) بواسطة تقريب بورن للموجة المستوية (PWBA). تضمين تأثير أستقطاب القلب من خلال عوامل – g الفعالة كافية للحصول على أتفاق جيد بين القيم المتوقعة والمقاسة للعزوم ثنائية القطب المغناطيسية.

الكلمات المفتاحية: النوى الغريبة، كثافة البروتون والنيوترون والمادة النووية، العزوم المغناطيسية، عوامل التشكل المغناطيسية المرنة.