EVE

Theoretical Nuclear & Hadron Physics



 $\mathscr{L}_{M} = \frac{f_{\pi}^{2}}{4\pi} \operatorname{Tr}(\partial_{\mu}U^{\dagger}\partial_{\mu}U) + \cdots$

핵/강입자 이론물리 연구실

- ◎ 그룹 홈페이지: <u>http://sites.google.com/site/knuhadron</u>
- 연구구제: From quarks to nuclei and and neutron stars

◎ 관신분야;

강입자의 직냥 스펙트럯 분석
강입자의 전자기 구조
강입자의 생성 반응
핵의 구조악 반응
핵묵직 연구악 중성자벽의 구조

핵/강입자 이론물리 연구실

◎ 구성원: 오용석

(박사과정) 최용우(2021 졸업예정), Sakina(2021 입학예정) (석사과정) 권민수, 손상영

◎ 공동연구

- 중 국내
 천 호 명(경 북대), 이 수 형(연세대),…
- 3 vil 4

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QCD Effective Theories



연구실명 핵/강입자 물리 이론연구실 (Nuclear/Hadron Physics Theory Group)

오용석 교수

홈페이지: http://sites.google.com/site/knuhadron 연구실: 제1과학관 127호 전화번호: +82-53-950-7373 e-mail: yohphy@knu.ac.krr

핵/강입자 물리학은 원자핵에서부터 초기우주, 소립자의 세계까지 넓은 영역에 걸쳐 물질을 이루는 기본 입자에 대한 근본 이론에 대한 연구를 수행하는 학문이다. 현 표준 모형에서 물질 을 이루는 가장 기본적인 입자는 쿼크이며 이들 사이의 상호작용은 글루온이 매개한다. 핵/강 입자 물리는 원자핵과 원자핵을 이루는 핵자의 구조와 상호작용을 이런 근본입자를 통해 이해 하려고 한다. 핵물리의 연구 대상은 아주 넓지만 본 연구실에서는 핵자의 구조와 강한 상호작 용에 대한 이론적 연구, 고온, 고밀도 상태에서 핵물질의 성질 연구, 그리고 무거운 원자핵에 대한 이론 연구 등을 수행한다.

본 연구실에서 수행하는 연구는 위 분야에서 관찰되는 현상에 대한 모형 개발과 그 검증을 위 한 실험을 제안하고 그 결과를 예측하는 등의 활동을 포함하고 있으며 이론 계산과 함께 수치 계산을 통한 해석능력이 요구된다.



지도교수

연구실

소개

The Periodic Table of the El										Ele	eme	nts	18 4.002602 2 2372.3 2 Hee						
	6	6.941 3 9.012182 4 1st ionization energy			762.5	1.83 2		omic number ectronegativit	ty alkali	alkaline metals		nonmetals		12.0107 6	14.0067 7	15.9994 8	18.998403 9	20.1797 10	
	2	Li	Be	cher	in kJ/mo	- F	Fo #				other metals		halogens		C	N	0	F	Ne
		1/2/ 22.98976 1 1	24.3050 12	050_12 nome			J	+2 +1 -1	idation state	s lanth	I lanthanoids unknown eler		oses n elements	16 26 281 53 1 3 28.0855		30.97696 15 32.065 1	10/20/20 ⁴ 32.065 16	35.453 17	39.948 18
	3	Na	Mg	electron c	onfiguration	- [Ar] 3d	[Ar] 3d ⁶ 4s ²		t common are bol	actinoids		rodioactive elements have masses in parenthesis		AI S	Si	P	S	CI	Ar
	+	Sodium Nil 3r 39.0983 10	Mognetation PHI 34 40.078 20	3	47.867 22	50.9415 22	51.9962 24	7	55.845 26	9 58.93319 27	10	63.546 20	12	Aluminium P+(3x'3x' 69,723 21	Silicon 1 PHE 3/ 3// 72.64 30	Phosphorus :	Sulter	Chlorine :: 1941 307 307 79,904 25	Argon PHI 34' 34' 83.798 34
	4	K	Ca	Sc	Ti	V 143 20	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
		Potassium (4) 85 4678 27	Calcium (%) 4/1 87.62 20	Scondium (4) 34' 44' 88 90585 20	Titonium (H) 3# 4/ 91 224 40	Vonadium (4:13/2.4/2 92.90638 4.1	Chromium :; 3x[3x] 44	Mongonese	Iron :: jv(3#4# 101.07 4.4	Cobolt 40	Nickel (N(3#4/	Copper [4] 3/" 4/ 107 8682 47	Zinc (4)(3) ¹⁰ 40 ¹	Gallium (h) 34* 49* 49*	Germonium (4134*44*44*	Arsenic 34(34*4/4/	Selenium (h13/********	Bromine (h) 3/1° 4/1 4/1	Krypton J+154**44*44* 131.293 E.4
	5	Rh	Sr Sr	Y ::39	7r	Nh	Mo	Tc 43	R11	Rh	Pd	Aa	Cd 40	In :1	Sn II	Sh 31	Te 52	100E 4 2.64	Xe 1
		Rubidium Jii(54	Strontium 84.5e	Yttrium (K) 48° 58°	Zirconium (6) 4/ 5/	Niobium Jol 44" 54"	Molybdenum	Technetium	Ruthenium	Rhodium K 4/* 5e'	Pallodium Joi 44*	Silver poj 4il* 5a'	Codmium (6) 40° 54°	Indium (0) 4/* 54' 59'	Tin (10) 44** 5e* 5e*	Antimony 30146** 5e* 5e*	Tellurium (6) 46** 54* 54*	lodine (6) 4/* 5/* 5/*	Xenon K 4d ¹⁰ 5d ² 5g ⁴
		132.9054 55	137.327 56 502 # 0.89	174.9668 71 5233 1.27	178.49 72	180.9478 73	183.84 74	186.207 75	190.23 76	192.217 77 MED 2.20 77	195.084 78	196.9665 79	200.59 80	204.3833 81 547.4 1.42	207.2 82	208.9804 83	(210) 84	(210) 2.30 85	(220) 86
	°	Cassium Bill 4/	Barium Balan	LU Lutetium Jul et+ 5/t evi	Hofnium Pal 47* 547.64	Tontolum	Tungsten tul ett 5 tr 64	Rhenium	Osmium Bul el* Sut eut	Ir Iridium	Platinum Platinum	Gold	Mercury Bul et* 5d* 64*	Thollium	PD Lead	Bismuth pu(47+5d+6u*6u*	PO Folonium	At Astotine put et = 5 at 5 at 5 at	Kn Rodon Jul 47* 5d* 6d* 8d*
	I	(223) and 87	(226) 0.10 88	(262) 103	(261) 104	(262) 105	(266) 106	(264) 107	(277) 108	(268) 109	(271) 110	(272) 111	(285) 112	(284) 113	(289) 114	(288) 115	(292) 116	117	(294) 118
	7	Froncium	Radium	Lowrencium	Ref Rutherfordium	Dubnium	Sectorgium	Bh	Hs Hassium	M† Meitnerium	Dormstedium	Rg	Copernicium	Uut Ununtrium	Ununquediem	Ununpentium	Ununhexium	Ununseptium	Ununoctium
		<u>г</u> , •	lectron configurati	on blocks															
				P	138.90 536.1 1	54 57 140.11 16 57	6 58 140.90 5770 1	76 59 144.24	12 60 (145) 5460	61 150.36	17 62 151.96	4 63 157.25	364 158.92 541.8	53 65 162.50 5730 1	0 66 164.93	03 67 167.25 589.3 1	9 68 168.93	42 69 173.05 55 653.4	• 70

f notes • as of yet, elements 113-118 have no official name designated by the IUPAC. • 1 kJ/mal = 96.485 eV.

 all elements are implied to have an axidation state of zero.

Promethium No: 4P da? La Lonthon PHC Set Ad Cerium plej er 5/P 4 Neodyniur (Neodyniur (Ne) 41º 64¹ Sm Gadolinium pic et set av I D Terbium pui «P av Ytterbium EU ПО Erbium pluj 477.6 Im Dysprosiu . . traseodymium Europium pui en ar omorium Holmium NUSIUM 1.00 98 (227) 89 232.0380 90 231.0358 91 (495.0 1.10 89 232.0380 1.30 548.0 1.50 238.0289 92 (237) 93 (244) 94 (243) 95 5867 128 94 (243) 95 (247) 96 (247) 97 (251) set 0 1.30 96 (247) 1.30 97 (251) Pu Einstein Ac Th Pa Uraniu Np Curium Bb(15P 66' 7P Bk Cf Fm Am Md No Actinium No 641 7V horium rotocti Nobe

Chart of Nuclides



PHYSICAL REVIEW C 89, 034622 (2014)

Production cross section of neutron-rich isotopes with radioactive and stable beams

Myeong-Hwan Mun*

Department of Physics, Kyungpook National University, Daegu 702-701, Korea and Rare Isotope Science Project, Institute for Basic Science, Daejeon 305-811, Korea

> G. G. Adamian and N. V. Antonenko Joint Institute for Nuclear Research, 141980 Dubna, Russia

> > Yongseok Oh[†]

Department of Physics, Kyungpook National University, Daegu 702-701, Korea and Asia Pacific Center for Theoretical Physics, Pohang, Gyeongbuk 790-784, Korea

Youngman Kim Rare Isotope Science Project, Institute for Basic Science, Daejeon 305-811, Korea (Received 28 January 2014; published 26 March 2014)

The production cross section of neutron-rich isotopes of Ca, Zn, Te, Xe, and Pt are predicted in the diffusive multinucleon transfer reactions with stable and radioactive beams. With these isotopes one can treat the neutron shell evolution beyond N = 28, 50, 82, and 126. Because of the small cross sections, the production of nuclei near the neutron drip line requires the optimal choice of reaction partners and bombarding energies.

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PACS number(s): 25.70.Hi, 24.10.-i, 24.60.-k

I. INTRODUCTION

One of the primary issues of nuclear physics is an expansion of the present limits of the nuclear chart far from the line of stability. The neutron-rich isotopes located close to the neutron-drip line have attracted interests during the last few decades. In the study of exotic neuron-rich nuclei a variety of While one can reach only specific isotopes in the complete fusion reactions, the transfer-type reactions can yield a larger variety of isotopes because of the restrictions in the choice of the target. Note that the use of the beam of neutron-rich nuclei in the fragmentation reactions has no advantage compared with the beam of stable isotopes.

PHYSICAL REVIEW C 94, 024320 (2016)

Nuclear isospin asymmetry in α decay of heavy nuclei

Eunkyoung Shin,^{1,*} Yeunhwan Lim,^{2,†} Chang Ho Hyun,^{3,‡} and Yongseok Oh^{1,4,§} ¹Department of Physics, Kyungpook National University, Daegu 41566, Korea ²Rare Isotope Science Project, Institute for Basic Science, Daejeon 34047, Korea ³Department of Physics Education, Daegu University, Gyeongsan, Gyeongbuk 38453, Korea ⁴Asia Pacific Center for Theoretical Physics, Pohang, Gyeongbuk 37673, Korea (Received 11 November 2015; revised manuscript received 20 June 2016; published 12 August 2016)

The effects of nuclear isospin asymmetry on α -decay lifetimes of heavy nuclei are investigated within various phenomenological models of the nuclear potential for the α particle. We consider the widely used simple square-well potential and Woods-Saxon potential and modify them by including an isospin asymmetry term. We then suggest a model for the potential of the α particle motivated by a microscopic phenomenological approach of the Skyrme force model, which naturally introduces the isospin-dependent form of the nuclear potential for the α particle. The empirical α -decay lifetime formula of Viola and Seaborg [J. Inorg. Nucl. Chem. 28, 741 (1966)] is also modified to include isospin asymmetry effects. The obtained α -decay half-lives are in good agreement with the experimental data, and we find that including the nuclear isospin effects somehow improves the theoretical results for α -decay half-lives. The implications of these results are discussed, and the predictions on the α -decay lifetimes of superheavy elements are also presented.

DOI: 10.1103/PhysRevC.94.024320

I. INTRODUCTION

The nuclear α decay has been one of the most important tools to study nuclear forces and nuclear structure [1]. Even today, its role cannot be overemphasized in the investigation of nuclear properties and, in particular, in identifying syntheses of new elements (See for example Refs [2,3])

decay through spontaneous fission, β decay, nucleon, and α emissions, so the role of nuclear symmetry energy or the change in nuclear potential due to nuclear isospin asymmetry in these decay processes deserves to be studied.

In the standard approach, the α -decay lifetimes are governed by the effective potential for the nuclear force which

PHYSICAL REVIEW C 100, 014312 (2019)

Analysis of nuclear structure in a converging power expansion scheme

Hana Gil,^{1,*} Young-Min Kim,^{2,†} Chang Ho Hyun,^{3,‡} Panagiota Papakonstantinou,^{4,§} and Yongseok Oh^{1,5,∥} ¹Department of Physics, Kyungpook National University, Daegu 41566, Korea ²School of Natural Science, Ulsan National Institute of Science and Technology, Ulsan 44919, Korea ³Department of Physics Education, Daegu University, Gyeongsan 38453, Korea ⁴Rare Isotope Science Project, Institute for Basic Science, Daejeon 34000, Korea ⁵Asia Pacific Center for Theoretical Physics, Pohang, Gyeongbuk 37673, Korea

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Background: In the framework of the newly developed generalized energy density functional (EDF) called KIDS, the nuclear equation of state (EoS) is expressed as an expansion in powers of the Fermi momentum or the cubic root of the density ($\rho^{1/3}$). Although an optimal number of converging terms was obtained in specific cases of fits to empirical data and pseudodata, the degree of convergence remains to be examined not only for homogeneous matter but also for finite nuclei. Furthermore, even for homogeneous matter, the convergence should be investigated with widely adopted various EoS properties at saturation.

Purpose: The first goal is to validate the minimal and optimal number of EoS parameters required for the description of homogeneous nuclear matter over a wide range of densities relevant for astrophysical applications. The major goal is to examine the validity of the adopted expansion scheme for an accurate description of finite nuclei.

Method: We vary the values of the high-order density derivatives of the nuclear EoS, such as the skewness of the energy of symmetric nuclear matter and the kurtosis of the symmetry energy, at saturation and examine the relative importance of each term in $\rho^{1/3}$ expansion for homogeneous matter. For given sets of EoS parameters determined in this way, we define equivalent Skyrme-type functionals and examine the convergence in the description of finite nuclei focusing on the masses and charge radii of closed-shell nuclei.

Analyticity of the electromagnetic form factor and the longitudinal charge density in scalar ϕ^3 model

Yongwoo Choi,¹ Ho-Meoyng Choi,^{2, *} Chueng-Ryong Ji,^{3,†} and Yongseok Oh^{1,4,‡}

¹Department of Physics, Kyungpook National University, Daegu 41566, Korea ²Department of Physics, Teachers College, Kyungpook National University, Daegu 41566, Korea ³Department of Physics, North Carolina State University, Raleigh, NC 27695-8202 ⁴Asia Pacific Center for Theoretical Physics, Pohang, Gyeongbuk 37673, Korea

The concepts of causality, linearity, time symmetry, unitarity, and crossing symmetry and their relation to dispersion relations are discussed. Dispersion relations are applied for the analysis of pion form factor in (1+1) dimensions. [to be modified]

I. INTRODUCTION

The light-front (LF) formulation based on the light-front quantization has shown remarkable advantages for calculations in elementary particle physics, nuclear physics, and field theory. One of the advantages is that it allows a forthright application of the impulse and incoherence approximations intimate in nonrelativistic atomic and nuclear physics to relativistic field theory and bound-state problems [1].

As a prototype example of demonstrating the advantage

transform as the measure of the true size of the bound state without involving relativistic corrections.

Even though the DYW formulation is the most rigorous and well-established framework to compute the exclusive processes, its utility has been limited only to the spacelike region ($q^2 = q^+q^- - \mathbf{q}_{\perp}^2 < 0$) due to the intrinsic kinematic constraint $q^+ = 0$. While the $q^+ \neq 0$ frame can be used in principle to compute the timelike form factors, it is inevitable to encounter the nonvalence diagram arising from the quarkantiquark pair creation (the so-called "Z-graph"). The main