Editorial

In recent years several Large-Scale Scientific Facilities (LSSF) for nuclear, hadronic, and particle physics have been upgraded and constructed in China. The Cooling Storage Ring of Heavy Ion Research Facility in Lanzhou (HIRFL-CSR) was completed in 2007, which aims at the exploration of physics with radioactive ion beams (including the structure of unstable nuclei, isospin dependence of nuclear matter, heavy-ion fusion, superheavy nuclei synthesis), hadronic physics, physics of high-energy density matter, physics of highly charged ions, and applications. Being started operation in 2008, the updated Beijing Spectrometer III (BES-III) at Beijing Electron Position Collider II (BEPCII) is a unique and powerful facility for the study of charmonium physics, D-physics, spectroscopy of light hadrons and tau-physics in the energy range up to 4 GeV. Shanghai Synchrotron Radiation Facility (SSRF), which was finished and commissioned in April 2009, will also provide many opportunities for experimental nuclear physics. Based on these and many other facilities in the world, the Chinese scientists have made many important contributions to the understanding of atomic nuclei and hadrons from the theoretical side. In order to introduce the major achievements by Chinese scientists in the field of theoretical nuclear physics, *Science in China Series G: Physics, Mechanics &*

Meng Jie received a BS and a MS in physics from Southwest Univ. in 1986 and 1988. He got a PhD in physics in 1991 from Peking Univ. After several years of research experience in Institute of Theoretical Physics in CAS, Research Center Rossendorf in Germany, Technical University Munich in Germany, and the Institute of Physical and Chemical Research (Riken) in Japan, he became a full Professor of Physics at Peking University in 1997. His research interests range from nuclear structure to astrophysics and he is one of the pioneers in the study of the exotic halo phenomena, magnetic rotation and chiral doublets, etc.

Liu YuXin received a BS in physics from Henan Normal Univ. in 1984. He got his MS and PhD in physics from Tsinghua Univ. in 1989 and 1992, respectively. After having worked as a Postdoctoral Fellow in the Institute of Theoretical Physics, Chinese Academy of Sciences, he became an associate professor in 1994, and was promoted to be a full professor in 1999 in the Department of Physics, Peking University. His research focuses on the structure of exotic nuclei, phase transitions of strong interaction systems (including nucleus, QCD and strong interaction matter) and nuclear astrophysics. He accomplished some pioneering work on QCD phase transition with sophisticated non-perturbative QCD approaches.

Zhou ShanGui received a BS and a MS in physics from Jilin Univ. in 1992 and 1995. He got a PhD in physics in 1998 from Peking Univ. He then worked in Peking Univ. as an assistant professor and an associate professor up to 2004. He worked in Max-Planck Institute for Nuclear Physics in Heidelberg as a guest scientist in 2002 and 2003. In 2004, he moved to the Institute of Theoretical Physics, CAS and is currently a professor. His research focuses on the structure of exotic nuclei and superheavy nuclei and the synthesis mechanism of superheavy elements.

Astronomy editorial board has invited a number of the major players in the research of nuclear theory in China to contribute to this special issue. We hope that the publication of this issue could further promote the research on nuclear physics in China although this issue presents just a fraction of the progress in this active field due to the page limit.

The papers in this issue focus on the following topics.

(1) The equation of state and thermodynamics of nuclear matter and QCD. The isospin dependence of in-medium nuclear effective interactions and the equation of state (EOS) of isospin asymmetric nuclear matter, particularly its isospin-dependent term or the density dependence of the nuclear symmetry energy are very important for understanding not only the structure of radioactive nuclei, the reaction dynamics induced by rare isotopes, and the liquid-gas phase transition in asymmetric nuclear matter, but also many critical issues in astrophysics. Particularly, the investigation of EOS for cold and dense strongly interacting matter and its consequence for the possible phases of quantum chromodynamics (QCD) plays a crucial role in the study of neutron stars in astrophysics. In this special issue, several groups reported their recent results concerning the EOS and thermodynamics of nuclear matter and QCD. For examples, a phenomenological momentum-independent model is constructed to describe the EOS for isospin asymmetric nuclear matter; difficulties in probing density dependent symmetry potential with the HBT interferometry are discussed; the EOS of QCD at zero temperature and finite quark chemical potential under the hard-dense-loop approximation is calculated; the thermodynamics of strange quark matter with density dependent bag constant are studied selfconsistently in the framework of the general ensemble theory and the MIT bag model.

(2) Hadron spectroscopy and decay properties. Among the low-lying nucleon excitations, the S_{11} state $N^*(1535)$ plays a special role due to its large $N\eta$ decay rate, even though its mass is very close to the threshold of the decay. Recently it has been shown that the coupling of $N^*(1535)N\phi$ may be significant, which is consistent with the previous indications of the notable $N^*(1535)K\Lambda$ coupling deduced from BES data. We include in this issue a dedicated work to the study of the decay properties of the $N^*(1535)$ resonance. The authors investigated the strong decays of the $N^*(1535)$ resonance in an extended chiral quark model by including the low-lying $qqqq\bar{q}$ components in addition to the qqq component. It is shown that the description for the strong decays of $N^*(1535)$ is improved.

(3) Structure and reactions of exotic nuclei. Thanks to the development of radioactive ion beam (RIB) facilities, new exciting discoveries have been made by exploring hitherto inaccessible regions in the nuclear chart. Some of the recent theoretical developments in the study of exotic nuclear structure and reactions are collected in this special issue: the proton radioactivity, a phenomenon that occurs in proton-rich nuclei beyond proton drip-line, is investigated with a generalized liquid drop model; the direct proton capture and resonance proton capture properties of stellar reactions $^{22}\text{Mg}(p, \gamma)^{23}\text{Al}$ and $^{26}\text{Si}(p, \gamma)^{27}\text{P}$ are studied by employing a mean-field potential obtained from the Skyrme-Hartree-Fock model; the microscopic mechanism of four experimentally observed bands in ^{172}Tm is investigated using the particle-number conserving method in the framework of the cranked shell model with monopole and quadrupole pairing interactions; the relativistic mean field model is used to study the $N=Z$ nucleus ^{52}Fe , the magnetic moments of ^{33}Mg , octupole deformations in La isotopes, and deformed hypernuclei; the variation behaviors of energy ratios, the $B(E2)$ ratio, and the isomer shift sensitive to the shape phase transitions has been examined with respect to the interaction parameter and boson number.

(4) Synthesis of superheavy elements (SHE) via heavy ion fusion reactions. The synthesis of SHE has been a hot topic in nuclear physics for decades. Many isotopes of SHE with $Z = 103$ to 116 and 118 have been produced by heavy-ion fusion reactions in experiments and the elements below $Z = 112$ have been named. In China, two new super-heavy nuclides, ^{259}Db and ^{265}Bh , were also produced recently in HIRFL. The production cross section and the corresponding life time of SHE decrease rapidly as the charge number Z increases. To understand the mechanism of the heavy-ion fusion reaction and to guide future experiments,

many theoretical efforts have been made. Certainly we cannot cover all of break contributions made by Chinese scientists. Instead, the following topics are included: heavy-ion fusion reactions and large-angle quasi-elastic scattering studied with Skyrme energy density functional, the formation probability of the compound nucleus deduced from the measured evaporation residue cross sections for “cold” and “hot” fusion reactions by combining these studies and the HIVAP calculations for the survival probability; the fusion hindrance of mass-symmetric fusion reactions investigated by using the two-center liquid drop model, a systematic study of hot fusion reactions of the neutron-rich projectiles with ^{238}U target, the capture cross sections based on the improved isospin dependent quantum molecular dynamics model with shell effects included, etc.

(5) New models. We also invited several experts to present their recent important achievements concerning the shell model and the collective model, including the general behavior of matrix elements of the nuclear shell model Hamiltonian and the collective Hamiltonian derived for the first time up to the fourth order for a multi- $\text{O}(4)$ model based on the self-consistent collective-coordinate method.

In summary, theoretical nuclear physics based on LSSF is one of the fastest developing subjects. We believe that more important progress will be made in near future. Therefore, we hope that the scientists inside and outside China submit more of their own research results to this journal. The special issue will be a common platform to promote research in these studies in China. Finally, we would like to thank *Science in China Series G: Physics, Mechanics & Astronomy* for the publication of this issue.

(MENG Jie and LIU YuXin, School of Physics, Peking University, China;
ZHOU ShanGui, Institute of Theoretical Physics, Chinese Academy of Sciences, China)