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EDITORIAL

Simplicity, symmetry, and beauty of atomic nuclei

Professor Akito Arima is an internationally renowned scientist, a most treasured and beloved colleague, friend and teacher to many nuclear physicists worldwide. Many colleagues have learned from him and enjoyed his beautiful works in the nuclear structure theory.

The most important contribution to theoretical nuclear physics by Akito Arima, among his numerous contributions, is the Interacting Boson Model (IBM) which was founded in the early seventies. Even in the sixties (see the paper by Otsuka in this volume) Akito Arima had developed theoretical formulation of quadrupole collective motion in terms of d bosons which respects the SU(5) limit; he introduced s bosons, with the conservation of total boson numbers, and demonstrated the SU(3) limit of such sd bosons. The major development along this line, in collaboration with Franco Iachello, was the realization that these bosons are interpreted as, microscopically, valence nucleon pairs similar to Cooper pairs of metal superconductivity at low temperature. The well-known Otsuka-Arima-Iachello mapping provided us with the first approach to the microscopic foundation of the interacting boson model from the nuclear shell model. The relationships between the IBM and the geometric description were discussed independently by J. Ginocchio and M. W. Kirson, by A. E. L. Dieperink, O. Scholten, and F. Iachello, and also by A. Bohr and B. R. Mottelson. Today the IBM, together with the Mayer–Jensen shell model and the Bohr–Mottelson collective model, are fundamental frameworks in theoretical nuclear structure. The triad of these models are often referred to as the shell, geometric, and the algebraic models, each of which generated a family of offshoots. The IBM provides us with a unified view for a variety of collective motions in nuclei, e.g., anharmonic vibration, deformed rotation and γ-unstable rotation. One enjoys the elegance, simplicity and beauty (the theme of this Symposium) of the IBM theory. Two papers in the present volume, one by P. V. Isacker, and the other by Y. M. Zhao, apply this model to some interesting topics of nuclear structure.

One of very important works by Akito Arima is his explanation of the anomalous magnetic moment of nuclei with one valence nucleon outside (or one hole in) doubly closed shells. This breakthrough was made when he was only 24 years old. The magnetic moments of such nuclei were readily calculable from quantum mechanics, and are called the Schmidt values. On the other hand, the corresponding experimental data exhibit large deviations and are sandwiched between the two Schmidt values for $j = l \pm 1/2$. In collaboration with Hisashi Horie, Akito Arima proposed the configuration-mixing interpretation of the observed deviations, with emphasis on one-particle-one-hole configurations between the so-called spin-orbit partners. This mechanism is usually called the first order configuration mixing, and was further developed to the second order with K. Shimizu and M. Ichimura. In collaboration with T. Cheon, K. Shimizu, H. Hyuga, and T. Suzuki, and later with N. D. Dang, T. Suzuki, and S. Yamaji, he proposed that the configuration mixing (one-particle-one-hole and two-particle-two-hole excitations) plays a key role in the quenching phenomena of Gamow–Geller transitions. The configuration mixing effect based on Akito Arima's idea is one of the early driving forces which led to the concept of effective interactions including renormalization effects in nuclear physics. Those nuclear structure effects are closely interrelated with meson exchange currents and relativistic effects, as Akito Arima emphasized in collaboration with K. Shimizu, W. Bentz and H. Hyuga. The physics related to magnetic moments is discussed in the paper by Li and Meng, and is also briefly discussed in the paper by Otsuka, in this volume.

Professor Akito Arima is one of the pioneers who proposed the concept of pseudospin symmetry. In collaboration with M. Harvey and K. Shimizu, Akito Arima pointed out a quasidegeneracy between single-nucleon doublets, with quantum numbers $(n, l, j = l + 1/2)$ and $(n - 1, l + 2, j = l + 3/2)$, where n, l and j correspond to single-nucleon radial, orbital angular momentum, and total angular momentum quantum numbers, respectively. They defined a pseudo orbital angular momentum $\tilde{l} = l + 1$ and a pseudospin $\tilde{s} = 1/2$, and then the doublets can be formally treated as $\boldsymbol{j} = \tilde{\boldsymbol{l}} + \tilde{\boldsymbol{s}}$. A similar argument was proposed independently by K. T. Hecht and A. Adler. This discovery was explained by J. N. Ginocchio in terms of relativistic symmetries of the Dirac Hamiltonian, and continues to be an interesting topic nowadays. In collaboration with J. Meng, K. Sugawara-Tanabe, and S. Yamaji, Akito Arima studied the pseudospin symmetry based on the relativistic mean field theory.

Professor Akito Arima made essential contributions to many other problems of nuclear physics, such as clustering structure in nuclei, the origin of spin-zero ground states with random interactions and so on. He studied extensively the quartet models, α-clustering correlations, molecular structure in light nuclei, in collaboration with V. Gillet, H.

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Horiuchi, N. Takigawa, and others, in the early seventies, and studied the regularity of many-body systems with random interactions and formulas of nuclear masses in collaboration with Y. M. Zhao and N. Yoshinaga, and other collaborators, in the last ten years.

Professor Akito Arima supervised more than forty doctoral students and dozens of post-doc fellows. Many of them became very active researchers in various branches of nuclear science. He has held very important administrative positions including the Minister of Education, Culture, Sports, Science and Technology in Japan, the President of the University of Tokyo, the President of RIKEN (the Institute of Physical and Chemical Research), the Chairman of Japan Science Foundation, the Director of Tokyo Science Museum, the President of Musashi Gakuen, and so on. He fostered numerous international cooperations between Japan, China, the United States, and many other countries in his career. In addition, he is very famous for Haiku poetry in Japan.

Professor Akito Arima was awarded the Order of Culture (the highest honor in Japan), Grand Cordon of the Order of the Rising Sun, Prizes of Haiku Society, Honorary Citizen of Tokyo, National Friendship Award and International Science & Technology Cooperation Award (China), Knight Commander of the British Empire (UK), John Price Wetherill Medal and Bonner Prize (USA), Order Das Grosse Verdienstkreuz and Humboldt Award (Germany), Orden's Gravenhage (Netherlands), and many others, and dozens of honorary professorships and doctoral degrees from Universities and/or Institutes overseas. Here to honor Akito Arima Sensei's 88 year-old birthday (the rice age based on Chinese letters for 88), scientists from China, Japan, USA, Europe, and other countries, gathered at Tianping Hotel in Shanghai, from September 25th to 28th, 2018, for an International Symposium on Simplicity, Symmetry, and Beauty of Atomic Nuclei; and selected contributions were edited as a Birthday present to him, prior to the Symposium.

We are grateful to many colleagues in the Organizing Committee and Advisory Committee for their contributions to make the Symposium going smoothly. The Symposium is sponsored by Shanghai Jiao Tong University, the TD Lee Institute, Beijing Normal University, and CCAST (China Center of Advanced Science and Technology).

Jie Meng, Takaharu Otsuka & Yu-Min Zhao