

# BEAUTY IN PHYSICS: THEORY AND EXPERIMENT

In Honor of Francesco Iachello  
on the Occasion of his 70th Birthday

*Hacienda Cocoyoc, Mexico    14 – 18 May 2012*

## ***EDITOR***

Roelof Bijker  
*Instituto de Ciencias Nucleares*  
*Universidad Nacional Autónoma de México*  
*México D. F., México*

## **SPONSORING ORGANIZATIONS**

Consejo Técnico de la Investigación Científica, UNAM  
Instituto de Ciencias Nucleares, UNAM  
División de Física Nuclear, SMF



**Melville, New York, 2012**  
**AIP | CONFERENCE PROCEEDINGS ■ 1488**

**Editor**

Roelof Bijker

Instituto de Ciencias Nucleares  
Universidad Nacional Autónoma de México  
Ciudad Universitaria  
Circuito Exterior S/N  
A.P. 70-543  
04510 México, D.F.  
México

**E-mail:** bijker@nucleares.unam.mx

Authorization to photocopy items for internal or personal use, beyond the free copying permitted under the 1978 U.S. Copyright Law (see statement below), is granted by the American Institute of Physics for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$30.00 per copy is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923, USA: <http://www.copyright.com>. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Services is: 978-0-7354-1100-5/12/\$30.00.

© 2012 American Institute of Physics

No claim is made to original U.S. Government works.

Permission is granted to quote from the AIP Conference Proceedings with the customary acknowledgment of the source. Republication of an article or portions thereof (e.g., extensive excerpts, figures, tables, etc.) in original form or in translation, as well as other types of reuse (e.g., in course packs) require formal permission from AIP and may be subject to fees. As a courtesy, the author of the original proceedings article should be informed of any request for republication/reuse. Permission may be obtained online using RightsLink. Locate the article online at <http://proceedings.aip.org>, then simply click on the RightsLink icon/"Permissions/Reprints" link found in the article abstract. You may also address requests to: AIP Office of Rights and Permissions, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502, USA; Fax: 516-576-2450; Tel.: 516-576-2268; E-mail: [rights@aip.org](mailto:rights@aip.org).

ISBN 978-0-7354-1100-5 \* Qtkj kpcnRtkpv+

ISSN 0094-243X

Printed in the United States of America

***AIP Conference Proceedings, Volume 1488***  
**Beauty in Physics: Theory and Experiment**  
**In honor of Francesco Iachello on the occasion of his 70th birthday**

**Table of Contents**

<b>Preface: Beauty in Physics: Theory and Experiment in Honor of Francesco Iachello on the Occasion of His 70<sup>th</sup> Birthday</b>	
Roelof Bijker	3
 <b>Foreword</b>	
Igal Talmi	5
 <b>International Advisory Committee</b>	7
 <b>PLENARY TALKS</b>	
 <b>Symmetries of the neutrino interactions</b>	
A. B. Balantekin	9
 <b>Double-beta decay and algebraic models</b>	
Jonathan Engel	17
 <b>The moon as a detector of ultra-high-energy neutrinos</b>	
Olaf Scholten	27
 <b>The strange beauty of the proton</b>	
Roelof Bijker, Jacopo Ferretti, and Elena Santopinto	35
 <b>Nuclear charge radii and electric monopole transitions in the interacting Boson Model</b>	
P. Van Isacker	45
 <b>The beauty of good data: Unveiling the traces of mixed symmetry</b>	
N. Pietralla, T. Ahn, C. Bauer, L. Coquard, J. Leske, O. Möller, T. Möller, P. von Neumann-Cosel, G. Rainovski, and C. Walz	53

<b>From exact to partial dynamical symmetries: Lessons from the interacting boson model</b>	
A. Leviatan	61
<b>Interacting boson model from microscopic theory</b>	
K. Nomura	69
<b>Sensitivities of the r-process to nuclear structure</b>	
Ani Aprahamian	79
<b>Light nuclear clusters to look into the bright stars</b>	
A. Tumino, C. Spitaleri, S. Cherubini, M. Gulino, M. La Cognata, L. Lamia, R. G. Pizzone, S. M. R. Puglia, G. G. Rapisarda, S. Romano, M. L. Sergi, and R. Spartà	87
<b>The U(7) structure of <math>^{12}\text{C}</math> and the Hoyle <math>2^+</math> state</b>	
Moshe Gai	95
<b>The origin of order in random matrices with symmetries</b>	
Calvin W. Johnson	101
<b>Tomographic entropic inequalities in the probability representation of quantum mechanics</b>	
Margarita A. Man'ko and Vladimir I. Man'ko	110
<b>Trajectories of generalized quantum states for systems with finite discrete spectrum and classical analogs</b>	
M. Angelova, A. Hertz, and V. Hussin	122
<b>A new method for diagonalizing the nuclear shell model Hamiltonians with large dimensions</b>	
Akito Arima, J. J. Shen, and Y. M. Zhao	130
<b>Matter-field entanglement within the Dicke model</b>	
O. Castaños, R. López-Peña, E. Nahmad-Achar, and J. G. Hirsch	138
<b>A mini-Wigner effect in p-n interactions in heavy nuclei and the <math>0[110]</math> transformation in the Nilsson scheme</b>	
R. F. Casten, D. Bonatsos, S. Karampagia, R. B. Cakirli, and K. Blaum	150

<b>Relation of masses and spectroscopic observables to structure</b>	
R. B. Cakirli	156
<b>The master term in Duflo-Zuker inspired mass formulas</b>	
César Barbero, Jorge G. Hirsch, and Alejandro Mariano	162
<b>Relativistic symmetries</b>	
Joseph N. Ginocchio	174
<b>New realizations of the Richardson-Gaudin models in nuclear physics: The hyperbolic model</b>	
J. Dukelsky and S. Lerma H.	182
<b>Energy density functional for nuclei and the current status of the equation of state of nuclear matter</b>	
S. Shlomo and M. R. Anders	190
<b>Single-neutron excitations near <math>^{132}\text{Sn}</math></b>	
Jolie A. Cizewski, K. L. Jones, R. L. Kozub, B. Manning, F. Nunes, S. D. Pain, and RIBENS Collaboration	198
<b>Symmetry-adapted no-core Shell model for light nuclei - <math>^{12}\text{C}</math> and <math>^{16}\text{O}</math></b>	
Alison C. Dreyfuss, Kristina D. Launey, Jerry P. Draayer, Tomáš Dytrych, and Chairul Bahri	204
<b>Generalized seniority in a major shell with realistic interactions</b>	
M. A. Caprio, F. Q. Luo, K. Cai, Ch. Constantinou, and V. Hellmanns	212
<b>A study of pairing correlations for weakly-bound systems at the drip lines in a simple one-dimensional model</b>	
Andrea Vitturi and Francisco Pérez-Bernal	220
<b>Symmetries and hadron form factors</b>	
E. Tomasi-Gustafsson	228
<b>Conformal symmetry algebra of the quark potential and degeneracies in the hadron spectra</b>	
M. Kirchbach	236

<b>How to construct self/anti-self charge conjugate states for higher spins</b>	
Valeriy V. Dvoeglazov	248
<b>The hypercentral Constituent Quark Model</b>	
M. M. Giannini and E. Santopinto	257
<b>Unquenching the quark model using the beauty of symmetry</b>	
Elena Santopinto, Roelof Bijker, Jacopo Ferretti, and Giuseppe Galatà	266
<b>Diquarks in tetraquark spectroscopy</b>	
Giuseppe Galatà, Elena Santopinto, and Roelof Bijker	274
<b>Relativistic quark-diquark model of baryons: Nonstrange spectrum and nucleon electromagnetic form factors</b>	
M. De Sanctis, J. Ferretti, E. Santopinto, and A. Vassallo	280
<b>Microscopic description of quantum phase transitions in nuclei</b>	
P. Ring, G. A. Lalazissis, J. Meng, T. Niksic, D. Vretenar, and J. M. Yao	292
<b>Spherical to deformed shape transitions in the nucleon-pair shell model</b>	
S. Pittel, Y. Lei, Y. M. Zhao, and G. J. Fu	300
<b>Decoherence and quantum quench: Their relationship with excited state quantum phase transitions</b>	
J. E. García-Ramos, J. M. Arias, P. Cejnar, J. Dukelsky, P. Pérez-Fernández, and A. Relaño	309
<b>Excited state quantum phase transitions and chaos in the Dicke model</b>	
P. Pérez-Fernández, A. Relaño, P. Cejnar, J. M. Arias, J. Dukelsky, and J. E. García-Ramos	318
<b>Exotic weak decays of atomic nuclei</b>	
Jouni Suhonen	326

<b>Present status of the double beta decay calculations within the microscopic Interacting Boson Model</b>	
J. Barea and J. Kotila	334
<b>Advances in the calculation of double beta decay</b>	
J. Kotila and J. Barea	342
<b>Coupled molecular benders modeling within the vibron model 2D limit</b>	
Francisco Pérez-Bernal and Lorenzo Fortunato	350
<b>Quantum monodromy and quantum phase transitions in floppy molecules</b>	
Danielle Larese	358
<b>Symplectic <math>sp(4)</math> spectrum generating algebra for a large class of quantum three-body problems</b>	
Lorenzo Fortunato	366
<b>The geometric interpretation of the semimicroscopic algebraic cluster model and the role of the Pauli principle</b>	
H. Yépez-Martínez, P. O. Hess, P. R. Fraser, and G. Lévai	374
<b>Signatures of phase transitions in nuclei at finite excitation energies</b>	
Y. Alhassid, C. Özen, and H. Nakada	386
<b>Interacting electrons in a magnetic field: Mapping quantum mechanics to a classical ersatz-system</b>	
Tobias Kramer	394
<b>Beauty in nature: Symmetry</b>	
Francesco Iachello	402

## POSTERS

<b>Convergence in numerical solutions of the Dicke Hamiltonian</b>	
Miguel Angel Bastarrachea-Magnani and Jorge G. Hirsch	418
<b>Excited state properties of <math>^{176,177}\text{Hf}</math> nuclei</b>	
M. J. Ermamatov and A. Frank	422

<b>Generalized F-spin and correlations between one-nucleon transfer reactions</b>		
Ruslan Magaña Vsevolodovna and Roelof Bijker		426
<b>Large-scale shell-model calculations for <math>^{32-39}\text{P}</math> isotopes</b>		
P. C. Srivastava, J. G. Hirsch, M. J. Ermamatov, and V. K. B. Kota		431
<b>CONTRIBUTED PAPERS</b>		
<b>Stabilization method in two-body systems with core excitations</b>		
J. A. Lay, J. M. Arias, J. Gómez-Camacho, and A. M. Moro		436
<b>Regular and chaotic classical dynamics in the U(5)-SU(3) quantum phase transition of the IBM</b>		
M. Macek and A. Leviatan		441
<b>Interacting Boson Model and nucleons</b>		
Takaharu Otsuka		445
<b>Shape coexistence far from stability</b>		
Silvia M. Lenzi and Francesco Recchia		453
<b>Large scale shell model study of the evolution of mixed-symmetry states in chains of nuclei around <math>^{132}\text{Sn}</math></b>		
N. Lo Iudice, D. Bianco, F. Andreozzi, A. Porrino, and F. Knapp		457
<b>Fractals, logarithmic spiral and coherent states</b>		
Giuseppe Vitiello		461
<b>Author Index</b>		465