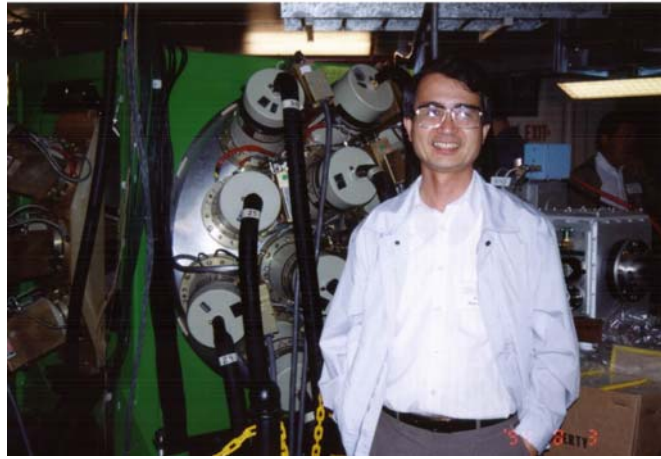
第２回JUSTIPENワークショップ報告



Kyoto-Oak Ridge交流の経緯

と

現在の米国の

核構造研究の動向

The 2nd LACM-EFES-JUSTIPEN Workshop

Joint Institute for Heavy Ion Research, Oak Ridge, Tennessee, USA
Oak Ridge National Laboratory
January 23-25, 2008

Overview

The second LACM-EFES-JUSTIPEN Workshop will be held on January 23-25, 2008 in Building 6025 of the Physics Division at Oak Ridge National Laboratory. The meeting is a merger of two workshops: (i) the US-Japan theory meeting under the auspices of the Japan-US Theory Institute for Physics with Exoctic Nuclei (JUSTIPEN) and (ii) the annual NNSA-JIHIR meeting on the nuclear large amplitude collective motion (LACM) with an emphasis on fission.

The purpose of the meeting, jointly organized by the JUSTIPEN Governing Board, by the UT/ORNL theory group, by the Todai-RIKEN Joint International Program for Nuclear Physics (TORIJIN), and by the JSPS Core-to-Core program "International Research Network for Exotic Femto Systems (EFES)", is to bring together scientists (theorists and experimentalists) with interests in physics of radioactive nuclei, LACM, and theoretical approaches related to the SciDAC-2 UNEDF project. As in the first Joint JUSTIPEN_LACM Meeting, one emphasis of the meeting will be on topics related to future collaborations between US and Japanese groups (under JUSTIPEN). We are looking forward to an exciting meeting with stimulating discussions. The program of the workshop will cover a number of topics, including:

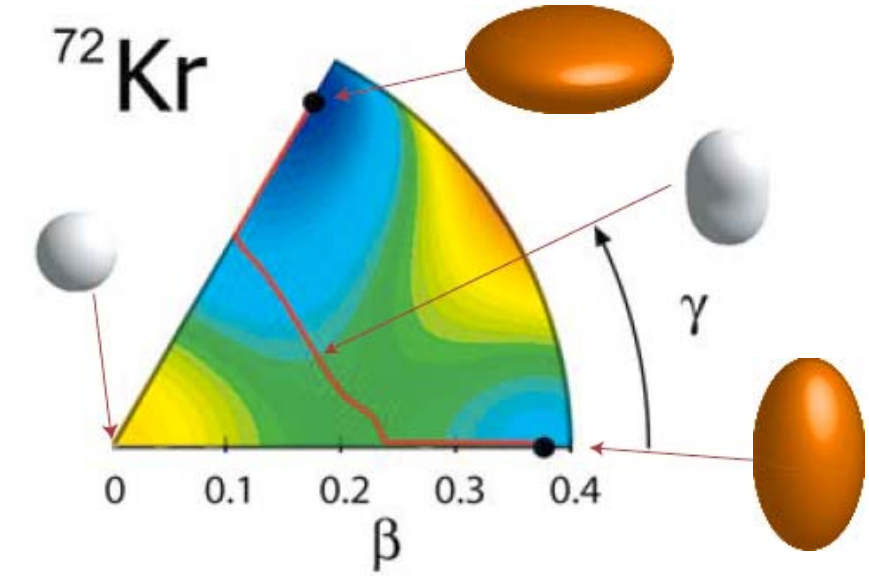
Program

Time	Speaker	Title
8:30	D. Dean, G. Young, and T. Otsuka	Opening
8:45-10:15	G. Hagen	Coupled-cluster Theory for Nuclei
	S. Fujii	Structure of sd- and pf-shell Nuclei with Microscopic Effective Interactions
	J. Vary	Full Configuration Interaction Studies of Light Nuclei – Opportunities and Challenges (ppt version)
	Y. Utsuno	Large-scale Shell Model Calculations for Exotic Nuclei
10:30-11:30	*Ceremony (JIHIR / JUSTIPEN) program to be announced*	
11:30	B. Shelton	Implementing Density Functional Theory based Electronic Structure Code on Advanced Computing Architectures (ppt version)
	D. Kothe	The National Center for Computational Sciences at Oak Ridge: overview and roadmap
12:30	*LUNCH*	
1:30	J. More	A Short Guide to Optimization Technology on High-Performance Architectures
	M. Stoitsov, N. Schunck	Large-scale mass table calculations with DFT (ppt version) Spectroscopy of Odd-Mass Nuclei (ppt version)
	Y. Kanada-En'yo	Cluster Model Calculations
2:45	*COFFEE*	
3:00	Tour of Jaguar	
4:00	A. Ono	Time-Dependent AMD Calculations for Reactions
	J. Rotureau	Density Matrix Renormalization Group Approach for Many-Body Open Quantum Systems
	T. Mezzacappa	When micro and macro worlds meet: modeling core collapse supernovae
5:00	Discussion on Supercomputing in low-energy nuclear physics (Leaders: D. Dean and T. Nakatsukasa)	

Thursday: LACM, NNSA, and Gamma-Ray Spectroscopy		
Time	**Speaker**	**Title**
9:00	W. Nazarewicz	Introduction and NNSA
9:05	A. Baran / A. Staszczak (by W. Nazarewicz)	Microscopic Description of Spontaneous Fission (ppt version)
	W. Younes	The LLNL Microscopic Fission Theory Program (ppt version)
	K. Matsuyanagi	Application of the Adiabatic Self-Consistent Collective Coordinate (ASCC) Method to Shape Coexistence/Mixing Phenomena (ppt version)
	S. Umar	Heavy-Ion Fusion Using Density-Constrained TDHF
10:35	*COFFEE*	
11:05	T. Uesaka	Spin-asymmetry Measurements at RIBF (ppt version)
	R. Casten	Equilibrium Structural Changes in Nuclei with N and Z (ppt version)
	J. Terasaki	QRPA Calculations in the Fitting Process of Functionals (ppt version)
12:10	*LUNCH*	
1:10	M. Niikura	Study of High-Spin States in 49-51 Ti (ppt version)
	P. Fallon	Lifetime measurement of the first excited 2+ state in 16C (ppt version)
	T. Glasmacher	Experiments with rare isotopes (ppt version)
	A. Afanasjev	Hyper-deformation: A Microscopic Outlook (ppt version)
	N. Aoi	Gamma Ray Spectroscopy at RIBF and future plan (ppt version)
3:05	*COFFEE*	
3:35	D. Radford	GRETINA: recent developments (ppt version)
	E. Ideguchi	Status of CNS GRAPE and Gamma-ray Spectroscopy Community in Japan (ppt version)
	P.-H. Heenen	Single-Particle Spectra in Heavy Nuclei: A Window on SHE Nuclei ? (ppt version)
	T. Koike , K. Shirotori	Gamma-ray Spectroscopy of Hyper-Nuclei at J-PARC: Hyperball-J (ppt version)
	R. Clark	Isomer Spectroscopy in the Heaviest Elements
5:30	Discussion on gamma-ray spectroscopy (Leaders: A. Macchiavelli and S. Shimoura)	
7:00	*Workshop Dinner: discussions on nuclear physics*	

Friday: Structure, Reactions, Nuclear Astrophysics, and Clusters		
Time	**Speaker**	**Title**
9:00	G. Colo	Constraints on Nuclear Functionals from Collective Vibrations (ppt version)
	B. Barrett	Standard shell model effective interactions from No-Core Shell Model calculations
	M. Ploszajczak	Aspects of degeneracy in the complex-energy plane
	N. Michel	Gamow HFB Description of Loosely Bound and Resonant Medium-Heavy Nuclei (ppt version)
10:30	*COFFEE*	
11:00	I. Thompson	Compound Nucleus Contributions to the Optical Potential (ppt version)
	E. Ormand	Auxiliary Field Monte-Carlo Methods for Nuclear Structure
	B. Balantekin	A Perspective On Understanding Fusion of Exotic Nuclei
12:05	*LUNCH*	

Application of the Adiabatic Self-Consistent Collective Coordinate (ASCC) Method to Shape Coexistence/ Mixing Phenomena



Nobuo Hinohara (Kyoyo)
Takashi Nakatsukasa (RIKEN)
Masayuki Matsuo (Niigata)
Kenichi Matsuyanagi (Kyoto)

After a long history (more than 30 years) , a way for wide applications of large-amplitude theory is now open.

$$\delta\langle\phi(q,p)|i\hbar\frac{\partial}{\partial t} - H|\phi(q,p)\rangle = 0.$$

SCC and quasiparticle SCC

Marumori-Maskawa-Sakata-Kuriyama, Yamamura, Matsuo, Shimizu-Takada, and many colleagues, reviewed in Prog. Theor. Phys. Supplement 141 (2001).

ATDHF and ATDHFB

Villars, Baranger-Veneroni, Brink, Rowe-Bassermann, Kerman-Koonin, Goeke-Reinhard, Bulgac-Klein-Walet, Giannoni-Quentin, Dobaczewski-Skalski and many colleagues, reviewed in G. Do Dang, A. Klein and N.R. Walet Phys.

$$|\phi(q,p)\rangle = e^{ip\hat{Q}(q)}|\phi(q)\rangle$$

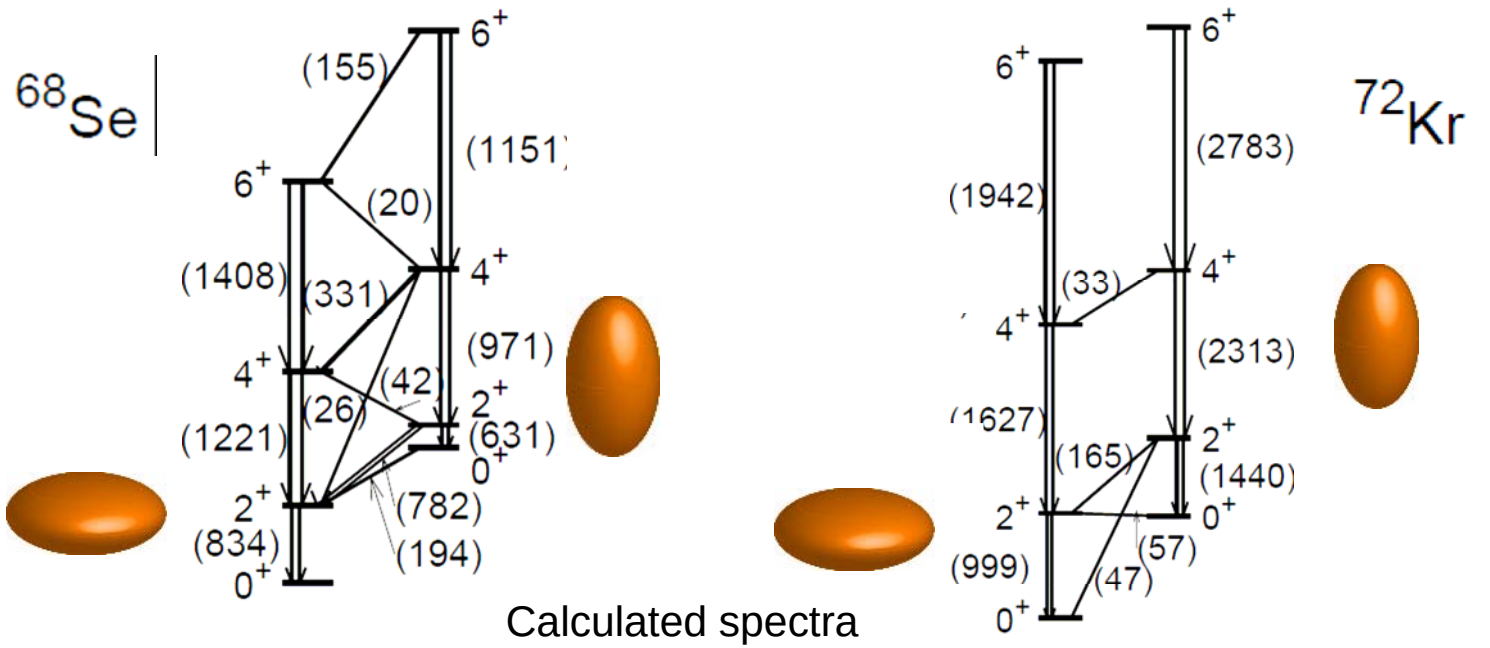
$$|\phi(q,p)\rangle = e^{i\hat{G}(q,p)}|\phi_0\rangle$$
$$\hat{G}(q,p) = \sum G_{mn}(\eta^*)^m\eta^n$$
$$\eta = q - ip$$

ASCC

Major conclusions

Excitation spectra and E2 transitions are evaluated by means of the ASCC method for the first time.

The result indicates some interesting properties of the oblate-prolate shape mixing dynamics, like weakenig of mixing with increasing angular momentum.



Calculated spectra

Wide applications can be envisaged

Determination of the Nuclear Energy functional: Optimization Strategy, Essential Experimental Data and Chi-Squared Metrics

Joint Institute for Heavy Ion Research, ORNL,
Oak Ridge, TN-37831, USA
January 22, 2008

Overview

The DFT-UNEDF meeting will be held at the Joint Institute for Heavy Ion Research, Bldg. 6025, at Oak Ridge National Laboratory on Tuesday, January 22, 2008. The meeting will be followed by the JUSTIPEN/LACM meeting on January 23-25, 2008.

The Universal Nuclear Energy Density Functional (UNEDF) is a nuclear theory SciDAC project. Its goal is to develop theory of nuclei and their low-energy reactions to a qualitatively new level of accuracy and reliability. It was recognized that the Density Functional Theory (DFT) would be the only possibility to meeting these goals. The mission of the project is:

- To find an optimal functional using all our knowledge of the nucleonic Hamiltonian and basic nuclear properties.
- To apply the DFT and its extensions to validate the functional using the relevant nuclear structure data.
- To apply the validated theory to properties of interest that cannot be measured, in particular the transition properties needed for reaction theory.

The National Center for Computational Sciences at Oak Ridge National Laboratory

Douglas B. Kothe

Director of Science

Leadership Computing Facility
National Center for Computational Sciences
Oak Ridge National Laboratory

SciDAC
Scientific Discovery through Advanced Computing

Office of Science

Building a Universal Nuclear Energy Density Functional

A Low-Energy Nuclear Physics National HPC Initiative

George F. Bertsch , University of Washington

The mission of the project is three-fold:

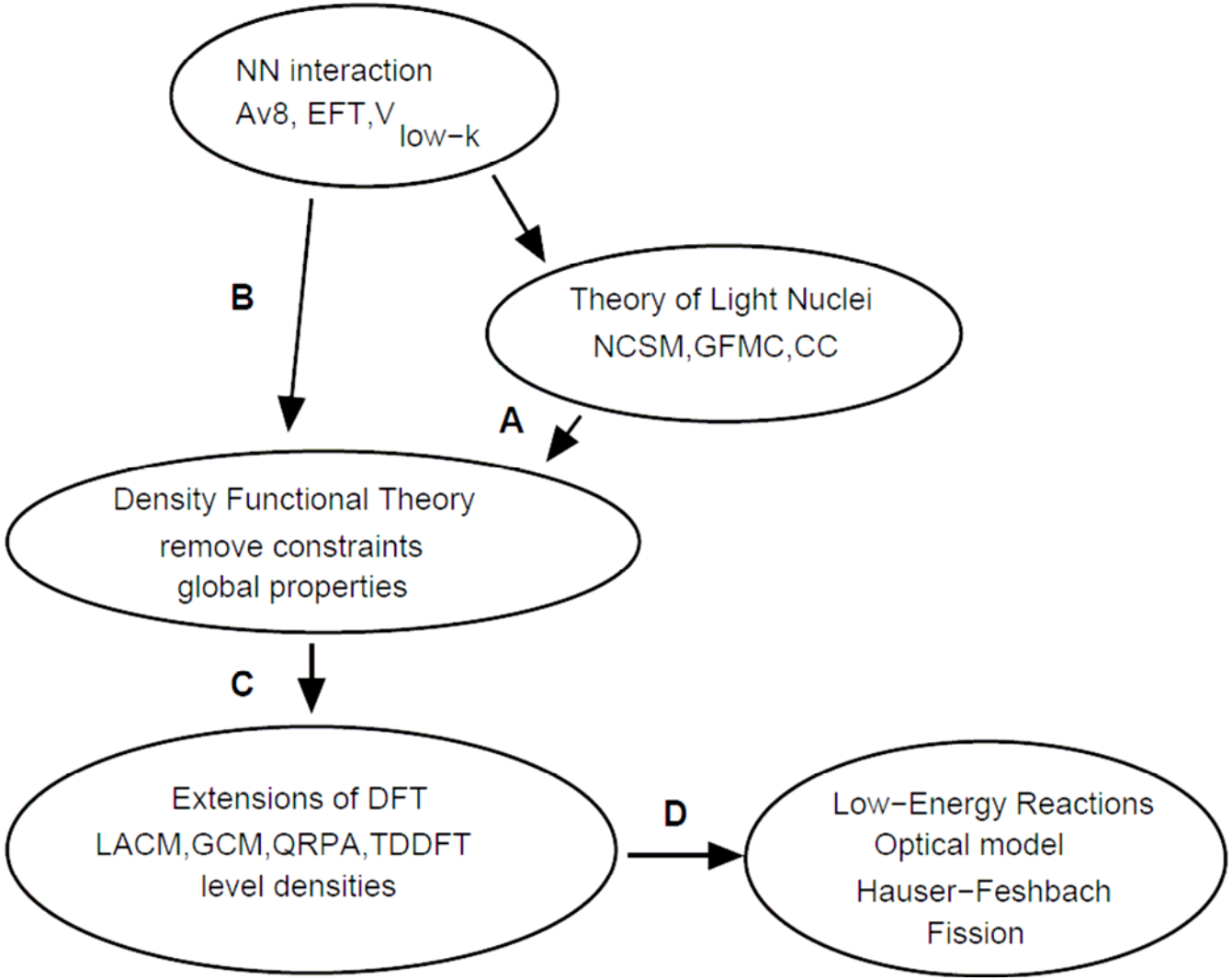
First, to find an optimal functional using all our knowledge of the nucleonic Hamiltonian and basic nuclear properties.
Second, to apply the EDF theory and its extensions to validate the functional using all the available relevant nuclear structure data.
Third, to apply the validated theory to properties of interest that cannot be measured, in particular the transition properties needed for reaction theory.

The activities to be supported fall into different areas of nuclear theory and computer science, but the goal can only be achieved by working at the interfaces among these areas. They are: ab initio theory of nuclear wave functions, Effective Field Theory (EFT) and its extensions, self-consistent mean-field description of ground and excited states, large amplitude collective motion, low-energy reaction theory and computer science.

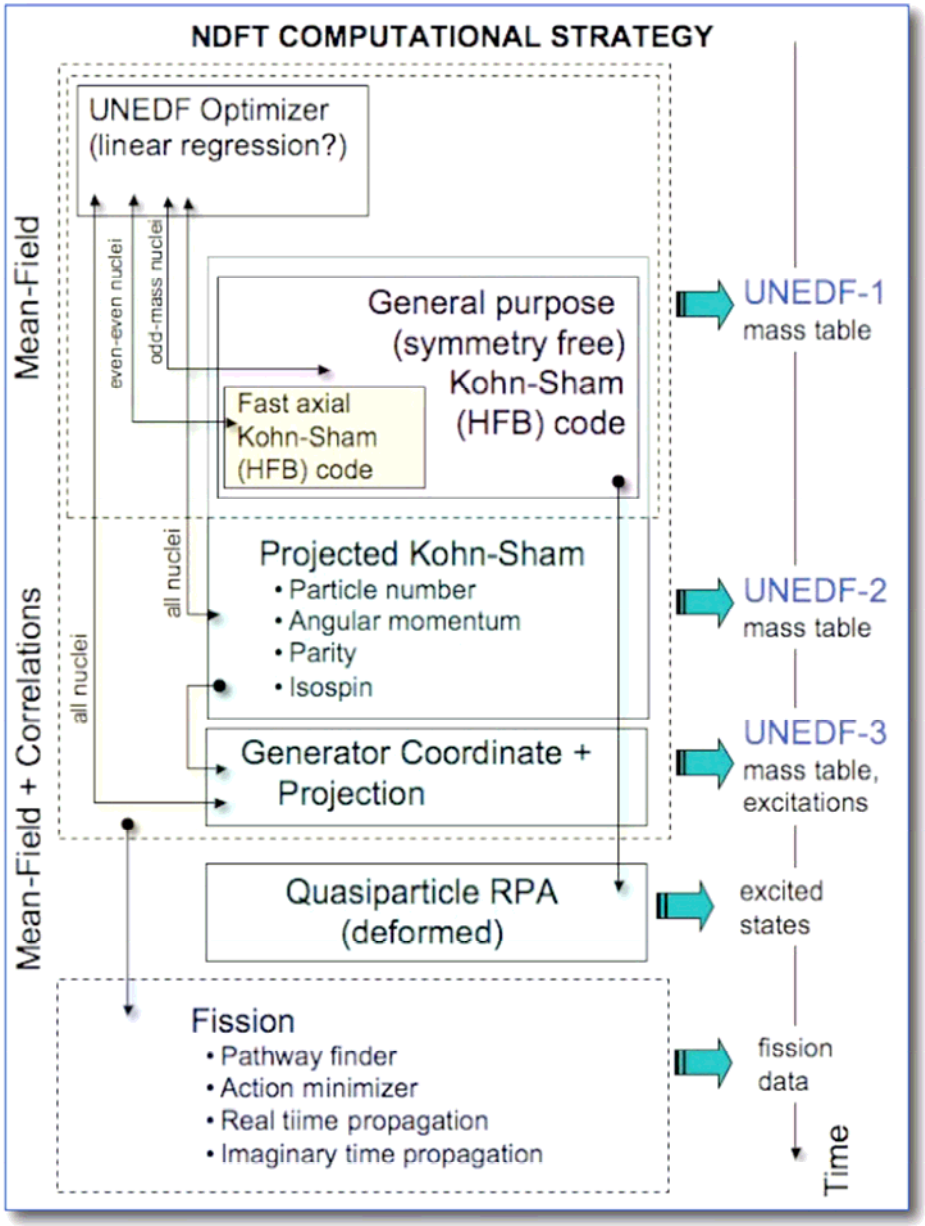
Science Application: Nuclear Physics
Project Title: Building a Universal Nuclear Energy Density Functional
Principal Investigator: George F. Bertsch
Affiliation: University of Washington
Funding Partners: Office of Science, Advanced Scientific Computing Research, and National Nuclear Security Agency
Budget and Duration: Approximately $3 Million per year for five years

Scientific strategy

G. Bertsch



Accomplishments



Physics

functionals benchmarked
- masses (even-even and odd-A/BCS)
- 2^+ excitations (in CSE, GCM, QRPA)

functional developed for finite superfluid system

odd-A HFB calculations initiated

ρ-dependence of EDF studied with DME

projected-DFT studied
- problems identified
- cure proposed

Computing

HFB solvers benchmarked

time, memory requirements, parameter variations

HFB solvers improved

HFODD (improvement in computation time, odd-A capability added, Lipkin-Nogami capability added)

HFBTHO (blocking added)

ev8 (blocking added)

New HFB solvers on the way

TD_SLDA (time dependent)

HFB_PTG (improved asymptotics)

Wavelets

benchmarked in a one-body case (no SO)

SO advanced

JUSTIPEN

Japan-U.S. Theory Institute for Physics with Exotic Nuclei

- JUSTIPEN Home
- JUSTIPEN Visit Application Form
- Conferences, Schools, and Seminars
- Visitors
- Visitor Information
- Publications
- Collaborations
- Job Postings
- JUSTIPEN Policies
- Governing Board
- RNB Resources
- Photo Gallery
- Links
- News

About JUSTIPEN

Purpose:
Deliver an international venue for research on the physics of nuclei during an era of experimental investigations on rare isotopes.

Location:
RIKEN, at the new RIB Factory

US Participation:
Provide travel and local support for U.S. visits to JUSTIPEN

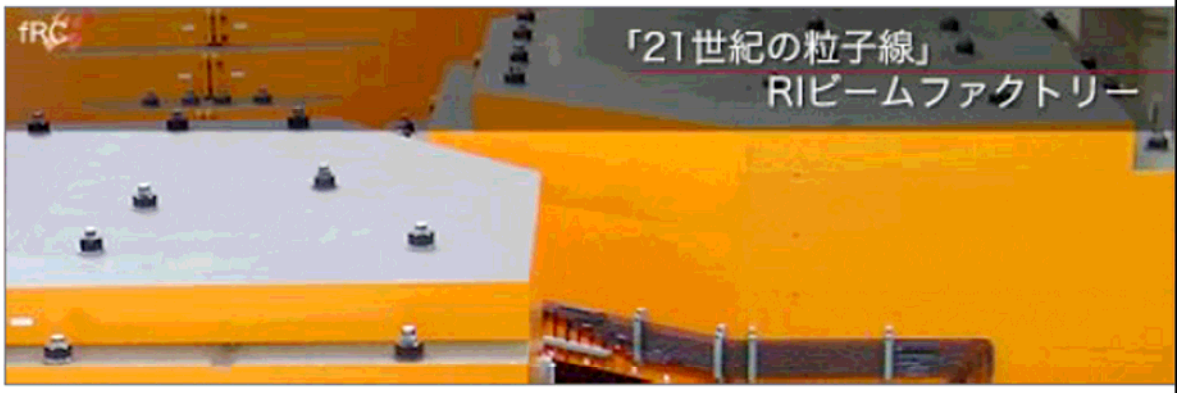
Synopsis:
The Japan-U.S. Institute for Physics with Exotic Nuclei (JUSTIPEN) has been established in order to facilitate collaborations between U.S. and Japanese scientists whose main research thrust is in the area of the physics of nuclei. JUSTIPEN is located at the RIKEN RIB Experimental Facility in Wako, near Tokyo, Japan. U.S. participation in JUSTIPEN is in the form of travel grants and subsistence grants to those individuals who are interested in collaborating with Japanese scientists. JUSTIPEN's purview is in the area of physics of or with exotic nuclei, including nuclear structure and reaction theory, nuclear astrophysics, and tests of the standard model using exotic nuclei. While JUSTIPEN primarily focuses on theory collaborations, experimentalists with theoretical collaborators in Japan are also encouraged to apply. Funding for JUSTIPEN is being provided by the Office of Nuclear Physics of the U. S. Department of Energy. Additional local support is provided by the University of Tokyo and RIKEN.

仁科加速器研究センターホームページ

RIKEN NiSHiNA CENTER

独立行政法人 理化学研究所
仁科加速器研究センター

仁科センター紹介 | 研究施設紹介 | 研究 | ギャラリー・パンフレット



一般
育てよう！世界で一つだけの花 あさがお 保護部

専門
RNC USER GUIDE
Info. on expeirments at RIBF is now available

専門
JUSTIPEN
日米研究者派遣事業

ORNL announces new partnership, research

By: **Katie Allison Granju**, Producer
Date created: 1/24/2008 9:26:53 AM
Last updated: 1/24/2008 9:27:52 AM

TalkBack: Post a comment

A birthday party at the Oak Ridge National Lab on Wednesday set the scene for a new collaboration.

Nearly 100 researchers and educators from ORNL, UT, Vanderbilt University and from Japan took part in the two-fold event.

The gathering recognized the 25-year anniversary of the Joint Institute for Heavy Ion Research. The partnership is now expanding with help of Japanese researchers. A new addition is being added to the program, with an emphasis on nuclear physics theory.

"It's why we went to the Moon in 1967," says UT Physics Professor Lee Riedinger. "It's why we are trying to go to Mars now its why the Hubble Telescope observes galaxies and stars at the edge of the universe. We need to understand who we are on Earth, but how stars and galaxies are made. That excites everyone, I think."

The new program addition will cost about $500,000 and is set to open in 2009.

Joint Institute for Heavy Ion Research

JIHIR is housed in two buildings: the building on the left constructed in 1982 by ORNL; that on the right constructed in 1984 by the State of Tennessee.

JIHIR was dedicated in 1984 (center) Attendees shown are Joe LaGrone (head of DOE in Oak Ridge), Joe Wyatt (Vanderbilt chancellor), Glenn Seaborg (Nobel Laureate and keynote speaker), Joe Hamilton (Vanderbilt), Herman Postma (ORNL director), Marilyn Lloyd (U.S. Congress), Jack Reese (UT Knoxville chancellor), Ed Boling (University of Tennessee president), and Wilmot Hess (Department of Energy).

The first JIHIR Policy Council at the dedication in 1984: (bottom L to R) Lee Riedinger (UT), Russell Robinson (ORNL), and Joe Hamilton (Vanderbilt).

History and Highlights 1982–2007

JIHIR major directions

1. Support programs of the Holifield facility
2. Foster close collaborations between academic and national laboratory nuclear scientists
3. Support nuclear structure theory and link to experiment
4. Develop the workforce in nuclear science through university – national laboratory connections
5. Develop new programs or major equipment involving university and ORNL leadership
6. Organize conferences and workshops to
   - define new directions in nuclear physics or astrophysics
   - discuss progress in Holifield-related research
7. Support short-term visitors to work on research or attend conferences or workshops
8. Support long-term visitors to work on research with Holifield-associated experimental or theoretical directions or to take the lead on new initiatives

Support programs of the Holifield facility at ORNL

- The Holifield facility and the Oak Ridge Isochronous Cyclotron were early examples of DOE user facilities. JIHIR has been important for building the bridges between academic users and ORNL nuclear physics facilities.
- The Joint Institute has worked with the UNISOR and UNIRIB user consortia in locating specialized user instrumentation and programs at Holifield.

JIHIR has twenty-five years' experience . . .

Developing a workforce in nuclear science through university—national laboratory connections

- The Joint Institute through its visitors program has sponsored hundreds of graduate students and young researchers for their work at ORNL
- JIHIR has sponsored postdoctoral appointments or long-term research leaves for many young nuclear physicists that are now leaders in this field, for example
  - Sven Åberg, now a chaired professor at the Lund Institute of Mathematical Physics in Sweden
  - Ricardo Broglia, now senior professor of Nuclear Theory at the University of Milan in Italy
  - Jerzy Dudek, now professor of Nuclear Theory at Strasbourg University in France
  - Tony Mezzacappa, now a corporate fellow and computational science leader at ORNL
  - Erich Ormand, now group leader at Lawrence Livermore National Lab
  - Mark Riley, now chaired professor at Florida State University
  - Michael Thoenessen, now professor at Michigan State University

Supported over 1200 visitors who . . .

- Performed experiments at Holifield facility
- Worked with nuclear theory groups
- Attended one of 100 conferences and workshops
- Assisted or led a Joint Institute initiative

Planned addition to the Joint Institute to house the JUSTIPEN program

Policy Council
Management of JIHIR

Professor Carrol Bingham
University of Tennessee

Professor Witek Nazarewicz
Oak Ridge National Laboratory

Professor Joseph Hamilton
Vanderbilt University

Publication # R01-1061-048-002-08

Scientific leadership

Nuclear structure theory

The Joint Institute leads the development of the theory of nuclear structure far from stability and has fostered strong interaction with experiment. Successes in these areas include:

- Changes in shell structure far from stability
- Calculations of Total Routhian Surfaces for high spin studies
- Prediction of nuclear hyperdeformed shapes
- Nuclei accessible by radioactive ion beams

Development of new programs or major equipment involving university and national laboratory leadership

- Nuclear theory - many JIHIR visitor and workshops
- Recoil Mass Spectrometer - $810K from State, Vanderbilt, and UT; JIHIR visitor leadership
- Ge detector array - $485K from UT and Vanderbilt
- Digital electronics for Silicon Box - JIHIR funds and visitor support
- MTOF - Mass Time of Flight spectrometer - JIHIR visitor leadership
- Liquid He diluton refrigerator - $90K from UT and Vanderbilt, JIHIR visitor leadership
- Development of radioactive ion beams - $200K from Vanderbilt and UT, JIHIR support for visitors and workshops

Joint Institute for Heavy Ion Research

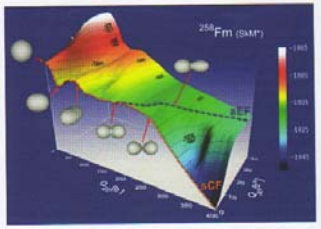
The opening of JUSTIPEN, July 11, 2006, RIKEN, Waco, Japan

JUSTIPEN
Japan-U.S. Theory Institute for Physics with Exotic Nuclei

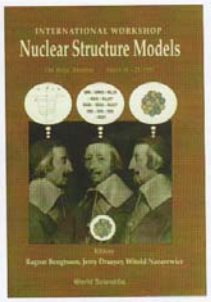
New collaboration in the theory of exotic nuclei

Visits by international distinguished theorists

- Akito Arima, Japan
- Jacek Dobaczewski, Poland
- Jerry Draayer, President, SURA
- Amand Faessler, Germany
- Walter Greiner, Germany
- Ikuko Hamamoto, Sweden
- Ben Mottelsen, Denmark - Nobel Laureate



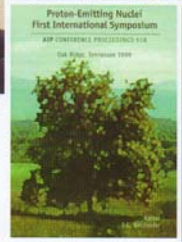
Shapes and decay modes of heavy nuclei



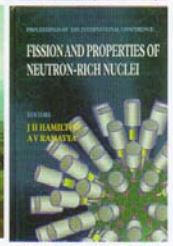
1992 workship at JIHIR (right)

Recoil Mass Spectrometer (RMS) (above) JIHIR played a leadership role in the construction of the RMS—an instrument that is now a critical part of HRIBF. Shown here are leaders in the RMS project in 1995: J.J. Das, Tom Ginter, Paul Mantica, and Joe Hamilton.

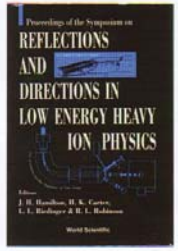
Silicon Box developed for proton and alpha radioactivity experiments at Holifield (left)



Proton Emitting Nuclei 1999

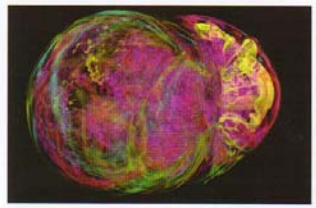


Fission and Properties of Neutron Rich Nuclei 1997, 1999, 2002, 2007

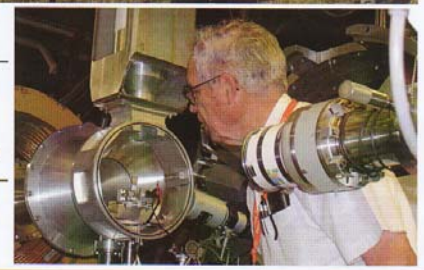


A conference marked the 10th anniversary of JIHIR in 1991—*Reflections and Directions*. Shown left to right are Joe Hamilton of Vanderbilt, Jim Ball (director of the ORNL Physics Division), Joe Johnson (president of the University of Tennessee), Vickie Nance (Senator Sasser's office), and Lee Riedinger (University of Tennessee).

Organization of conferences and workshops—over 100 attended by 4500 scientists and students



On the left, a calculated supernova explosion -- astrophysics program at JIHIR



Jim Johnson, JIHIR technical support (right)

実のある国際交流をするには長期に亘る地道な積み上げが必要

Kyoto-Oak Ridge交流の経緯

何故　Oak Ridge か ← 前史がある

1998　Nov.　Nazarewicz 来訪
2001　Nov.　YKIS01 京都
2002　Aug.　ORNL meeting
2002　Nov.　会津シンポ
2002　Dec.　京都 meeting
2003　Aug.　ORNL meeting
2003　Nov.　新潟シンポ
2003　Nov.　京都 meeting
2004　Sep.　ORNL meeting
2005　May　MF05 京都
2006　July　NS06　ORNL
2007　Mar.　1st JUSTIPEN, ORNL
2007　June　NS07　京都

学振・日米科学協力事業（共同研究）
Japan-US Cooperative Science Program on
Mean-field approach to collective excitations in unstable medium-mass and heavy nuclei

日本側　2003-2004
米国側　2002-2005

November 1998, Kyoto,
Witek Nazarewicz

1st Kyoto-Oak Ridge collaboration meeting, August 2002

J. Engel 来訪, December 2002

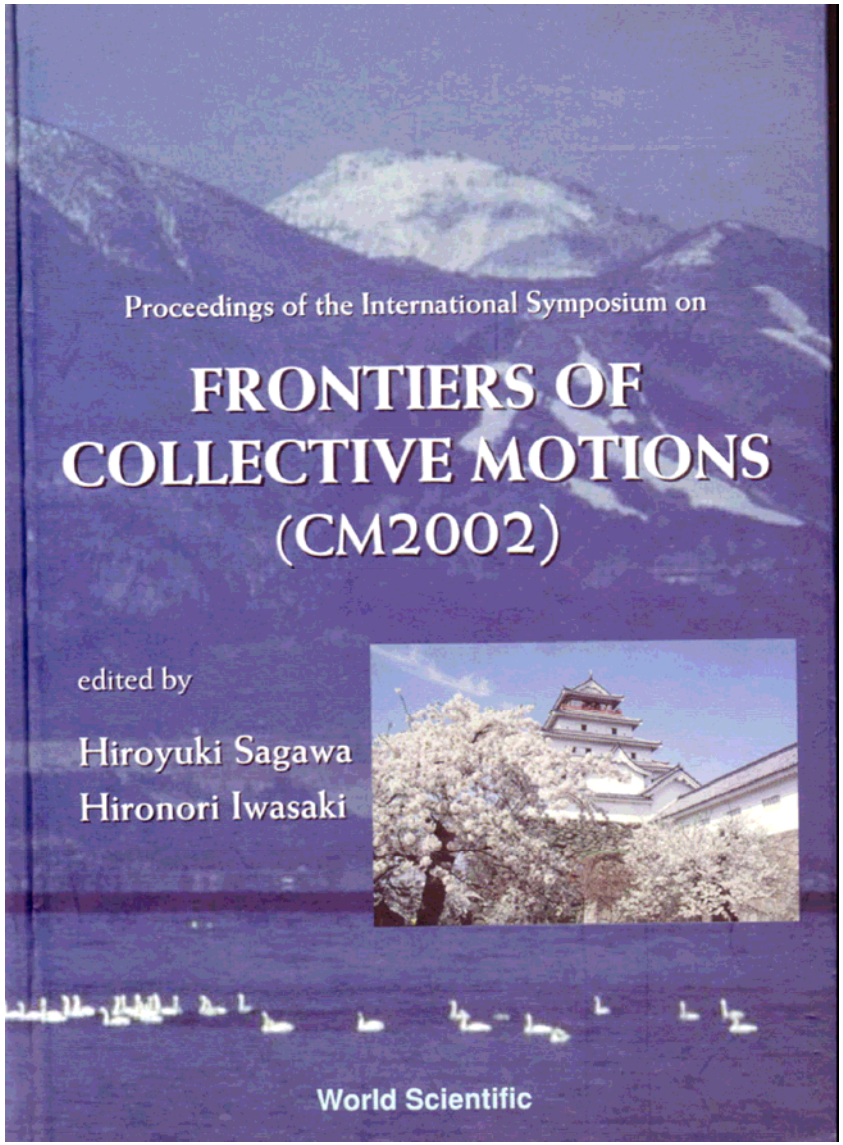
Oak Ridge, August 2003

Kyoto, November 2003

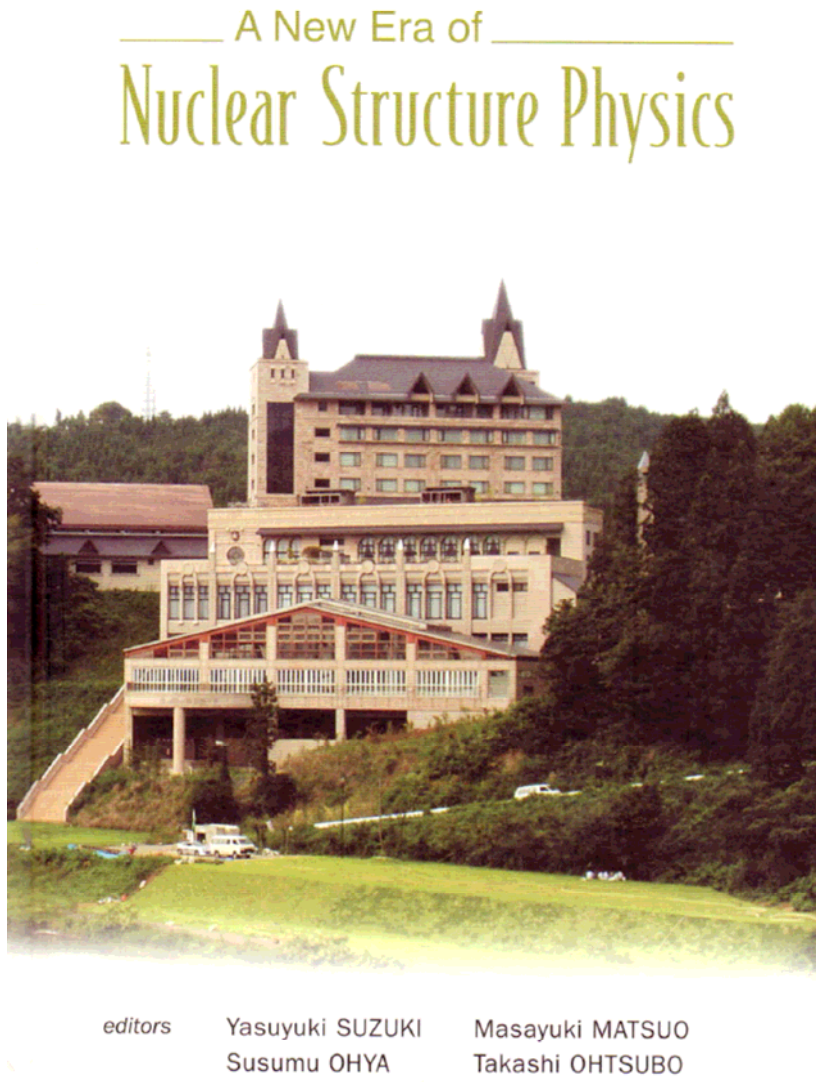
Oak Ridge , September 2004

Oak Ridge，September 2004（つづき）

会津シンポ, Nov. 2002



新潟シンポ, Nov. 2003



MF05, Kyoto

YITP Workshop on

New Developments in Nuclear Self-Consistent Mean-Field Theories (MF05)

Yukawa Institute for Theoretical Physics, Kyoto, Japan
May 30–June 1, 2005

Workshop Organizers
J. Engel (Univ. of North Carolina)
Y. Kanada-En'yo (YITP)
K. Hagino (Tohoku Univ.)
M. Matsuo (Niigata Univ.)
K. Matsuyanagi (Kyoto Univ.)
H. Nakada (Chiba Univ.)
T. Nakatsukasa (Univ. of Tsukuba)
W. Nazarewicz (Univ. of Tennessee)
H. Sagawa (Aizu Univ.)
Y. Shimizu (Kyushu Univ.)
N. Tajima (Fukui Univ.)
M. Tohyama (Kyorin Univ.)
M. Yamagami (RIKEN)
S. Yoshida (Housei Univ.)

Workshop Secretary
Y. Yagi (YITP)

Host Institute
YITP, Kyoto University

Nuclear Structure 2006

NS06 Nuclear Structure '06

CONFERENCE ON NUCLEI AT THE LIMITS

July 24 -28, 2006

OAK RIDGE NATIONAL LABORATORY

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Nuclear Structure '06

July 24-28, 2006
Pollard Technology Conference Center
Oak Ridge, Tennessee, 37830

New: Lists of speakers are now available, see the program page.

Submitted abstracts can now be viewed and downloaded. Just click the "Master list of submitted abstracts" link on the Abstract page.

Note: Non-US citizens, especially citizens of "sensitive countries" need to allow ample time to obtain a US visa. Please contact the conference secretary if you need an official letter of invitation.

Nuclear Structure 2007

International Workshop on

NS07

Nuclear Structure:

New pictures in the Extended Isospace

Yukawa Institute for Theoretical Physics
Kyoto University, Kyoto, Japan
June 11 (Mon) -14 (Thu), 2007

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M. Takashina (Kyoto)

Deadlines:
Abstract submission: Feb 19, 2007
On-line registration: Apr 13, 2007

Oak Ridge, March 2007, 1st JUSTIPEN Workshop

Kyoto-Oak Ridge交流の経緯

1998 Nov. Nazarewicz 来訪
2001 Nov. YKIS01 京都
2002 Aug. ORNL meeting
2002 Nov. 会津シンポ
2002 Dec. 京都 meeting
2003 Aug. ORNL meeting
2003 Nov. 新潟シンポ
2003 Nov. 京都 meeting
2004 Sep. ORNL meeting
2005 May MF05 京都
2006 July NS06 ORNL
2007 Mar. 1st JUSTIPEN, ORNL
2007 June NS07 京都

学振・日米科学協力事業（共同研究）
Japan-US Cooperative Science Program on
Mean-field approach to collective excitations in unstable medium-mass and heavy nuclei

日本側 2003-2004
米国側 2002-2005

重い不安定核の構造に関する日米セミナー

不採択

**翌年から
いろいろな形で試みるも
3度つづけて不採択**

セミナーの日程

２０００年　１２月１１日（月）ー１４日（木）の４日間

参加者

日本 15 名　米国 15 名　合計 30 名

米国側参加者

Witold Nazarewicz, Alex Brown, Richard F. Casten, David Dean, Jonathan Engel, Henning Esbensen, Wick Haxton, Shalom Shlomo, Paul Semmes, Daniel Strottman, Michael Wiescher, 他　4 名

日本側参加者

松柳研一, 谷畑勇夫, 池田清美, 堀内　昶, 佐川弘幸, 加藤幾芳, 大塚孝治, 田島直樹, 松尾正之, 水鳥正二郎, 寺崎順, 他　4 名

計画の概要

現在、日本と米国でそれぞれ進められている放射性核ビーム施設が完成すれば、研究可能な不安定核の領域は軽い核から重い核にわたって飛躍的に拡大する。この状況に対応して、この新しい研究分野の物理の進展をはかるために、日米両国の理論家の協力を促進する。中性子（陽子）ドリップ線近傍の極限状態にある原子核の存在形態について、弱く束縛された核子系に対する量子多体理論の観点から突っ込んだ議論を行ない、これからの不安定核構造研究にとって基本的な理論的課題を定式化する。

NSF Award Abstract - #0124053

U.S.-Japan Cooperative Science: Mean-Field Approach to Collective Excitations in Unstable Medium-Mass and Heavy Nuclei

NSF Org INT
Latest Amendment Date December 14, 2001
Award Number 0124053
Award Instrument Standard Grant
Program Manager Myra McAuliffe
INT Office of Internatl Science &Engineering
SBE DIRECT FOR SOCIAL, BEHAV & ECONOMIC SCIE
Start Date January 1, 2002
Expires December 31, 2004 (Estimated)
Expected Total Amount $30000 (Estimated)
Investigator Witold Nazarewicz witek@utk.edu (Principal Investigator current)
Sponsor U of Tennessee Knoxville
404 Andy Holt Tower
Knoxville, TN 379960140 865/974-3466
NSF Program 5978 EAST ASIA AND PACIFIC PROGRAM
Field Application 0000099 Other Applications NEC
Program Reference Code 0000,5921,OTHR,

Abstract

0124053 Nazarewicz

This award supports a three-year collaborative research project between Professor Witold Nazarewicz at the University of Tennessee and Professor Kenichi Matsuyanagi of Kyoto University in Japan. The researchers will undertake a study of the mean-field approach to collective excitations in unstable medium-mass and heavy nuclei. The focus of the research is in those aspects of nuclear structure physics which are of highest priority in the community: 1) radioactive nuclear beam physics which will access nuclei at the limits of stability around the proton and neutron drip lines, and 2) gamma ray spectroscopy which accesses discrete nuclear states in rapidly rotating nuclei up to the fission limit. The intent is the further development of techniques that can treat the special properties of weakly bound nuclei, where the Fermi energy is close to zero. Hartree-Bogolyubov (HFB) programs that include unbound states are needed. Current programs that include the continuum states are usually restricted to spherical shapes. The proposal will continue the development of HFB programs that include non-spherical shapes as well as the continuum states. This is necessary for a more realistic description of nuclei around the neutron drip line. An interesting possibility of different shapes for neutrons and protons, including neutron halos, can then be investigated. The development of the program will permit investigation of double beta decay, which has fundamental interest not only to nuclear physics, but also particle physics and

The proposed collaboration concerns two subjects: i) mean field calculations for neutron rich nuclei and ii) high spin sta
of medium mass nuclei. Both represent the necessary theoretical complement to forefront experimental research .
i)Experimental facilities aiming at the study of very neutron rich nuclei are being developed all over the world and in the
US. The considerable efforts both in funds and manpower call for adequate support of related theoretical research , wh
will be deceicive for the evaluation of the experimental results. Two important topics are addressed: pair correlations
between nearly unbound neutrons and soft isovector oscillations. The proposed collaboration seems beneficial becaus
the complementaty expertise of the groups: The UT group is a leader in the development of the HFB approach for wea
bound nucleons, the Vanderbilt team is very experienced in computational methods on a grid and the Japanese partne
have an outstanding record in developing many body methods related to RPA. Clearly the collaboration has the necess
intellectual and computational resources to achieve their goals.
The collaboration seems well planned.
ii) Large detector arrays, like GAMMASHERE in the US, are studying the response of the nucleus to rapid rotation. A ne
detector generation is being developed. What was said in i) about the the necessesity of theoretical support applies to t
field as well. Both the UT group and the Japanese partners have developed mean field codes that are based on realist
interactions and low symmetry restrictions. It is
important to compare this method, which is the only possibel one for heavier nuclei, with the Shell Model in order to
establish limits and merits of the two alternative approaches. The proposed mass region is well suited.
The UT group (in close connection with ORNL) has the necessary resources for the Shell Model calculations.
It seems to me that the high spin activities are more bilateral.

Summary Statement

Well founded proposal, with clear objectives and benefits for all partners. Should be supported.

最近 20 年間の核構造分野の国際会議(国内開催を除く)

1985 Niels Bohr Centennial Conference on Nuclear Structure, Copenhagen, 20-24 May 1985: 浜本、有馬、松柳、

1987 International Conference on Nuclear Shapes, Crete, 29 June- 3 July 1887: 清水、佐川、松柳、

1990 Conference on ``Nuclear Structure in the Nineties", Oak Ridge, April 23-27, 1990 浜本、田島、谷畑、清水

1991 Workshop-Symposium on "Future Directions in Nuclear Physics with four pi Gamma Detection Systems of the New Generation", 4-16 March 1991, Strasbourg: 清水、大西、浜本、松柳、大塚、佐川

1992 International Conference on Nuclear Structure at High Angular Momentum, Ottawa, May 18-21, 1992: 松柳、清水、田辺、

1994 International Conference on "Physics from Large Gamma-Ray Detector Arrays", Berkeley, USA, August 2-6, 1994: 清水、松柳

1996 Conference on ``Nuclear Structure at the Limits", Argonne, 22-26 July 1996: 中務、清水、岸田、浜本、水鳥、松尾

1997 International Symposium on New Spectroscopy and Nuclear Structure 1997 dedicated to Aage Bohr and Ben Mottelson, The Niels Bohr Institute, Copenhagen, September 16-20, 1997: 松柳、中務、清水、松尾、佐川、谷畑

1998 ``Nuclear Structure '98" International Conference}, Gatlinburg, Tennessee, August 10-15, 1998: 大塚、佐川、松柳、松尾

2002 ``Frontiers of Nuclear Structure" International Conference, July 29 - August 2, 2002, Berkeley: 松尾、松柳、大塚、

2002 International Conference on ``Nuclear Structure with Large gamma-Arrays, Status and Perspectives", September 23-27, 2002, Legnaro-Padova, Italy: 大塚、中務、松崎

2003 The 10th Marie and Pierre Curie Nuclear Physics Workshop, September 24-28, 2003, Kazimierz Dolny, Poland, 松柳、在田、有友、

2004 The Fourth International Conference on Exotic Nuclei and Atomic Masses, September 12-16, 2004, Pine Mountain: 宇津野、延與、中村(隆)、山田、佐川、井手口、山上、岩崎、中務、酒井、桜井、本間

2005 International Conference on Finite Fermionic Systems, Nilsson Model 50 Years, June 14-18, 2005, Lund: 在田、本林、吉田（賢)、中村（隆)、明、清水

2006 `Nuclear Structure '06", Conference on Nuclear Structure at the Limits, Oak Ridge, July 24-28, 2006, 森本、松柳、大塚、本林、中務、松尾、山上、船木

Niels Bohr 生誕100年記念事業

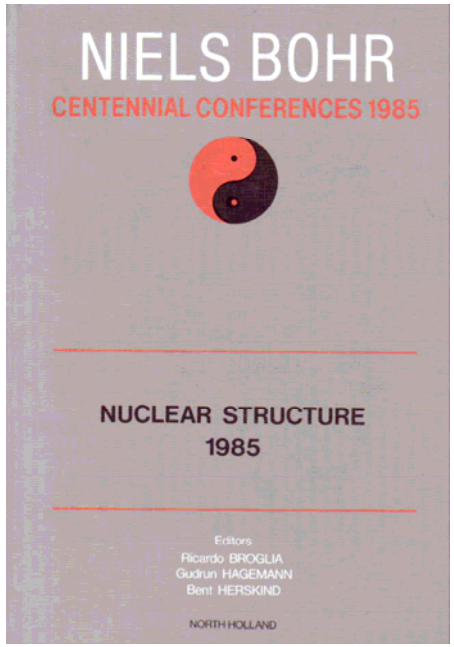
1985

ニールス・ボーア研究所

Niels Bohr Institutet

ニールス・ボーア生誕百年記念

国際交流推進事業会

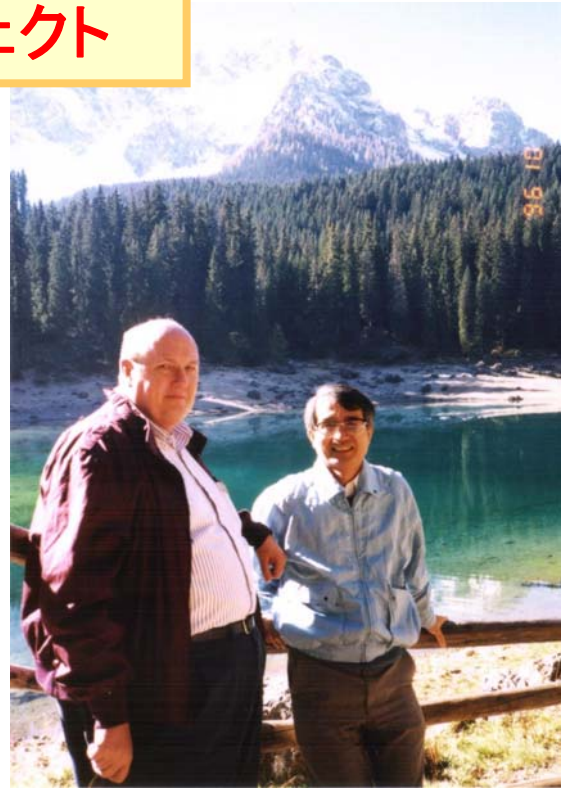


Aage Bohr　丸森壽夫


基礎物理学研究所
YUKAWA INSTITUTE FOR FUNDAMENTAL PHYSICS

1985-1992 INS-NBI国際共同研究プロジェクト

清水: 高スピンでの対相転移
松尾: 温かい核の減衰回転



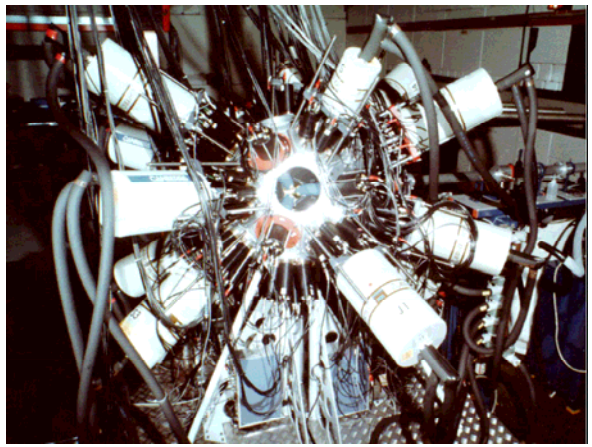
Jerry Garrett

Nord-ball project

国際共同研究

高分解能クリスタルボールによる
原子核の高スピン極限状態の研究

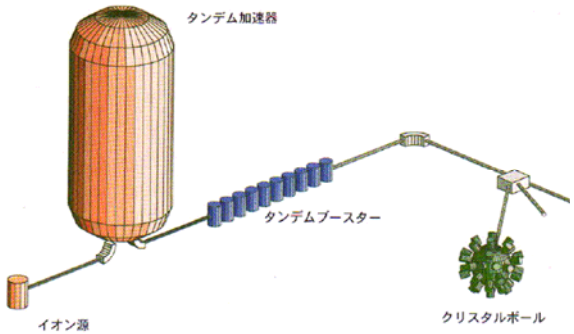
筑波大学・広島大学・九州大学

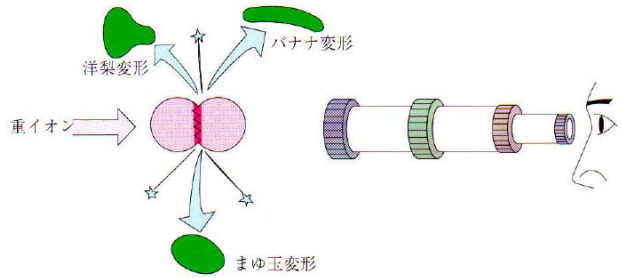


1993-1995 Japan-ball project (実現せず)

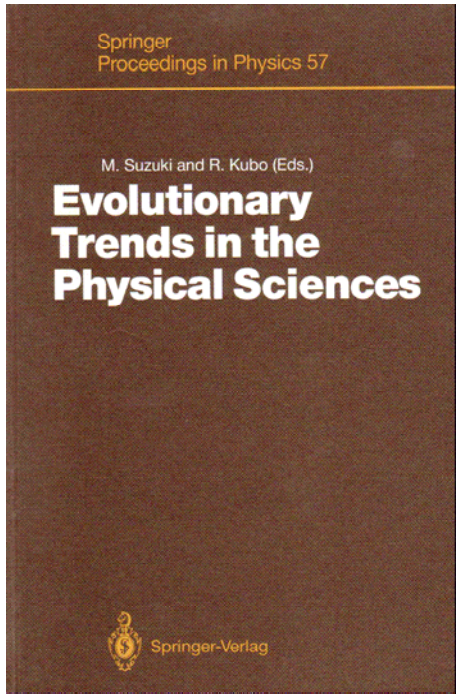
クリスタルボールによる
ガンマ線核分光

日本原子力研究所
原子炉工学部加速器管理室
先端基礎研究センター





仁科芳雄生誕100年記念シンポジウム, 東京, Dec. 1990



Ben R. Mottelson
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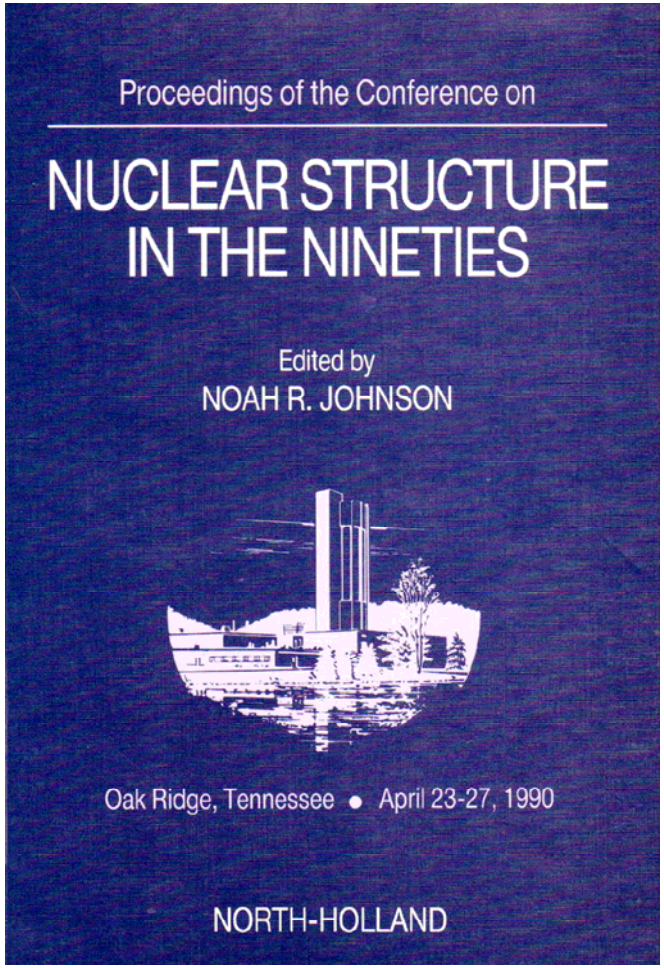
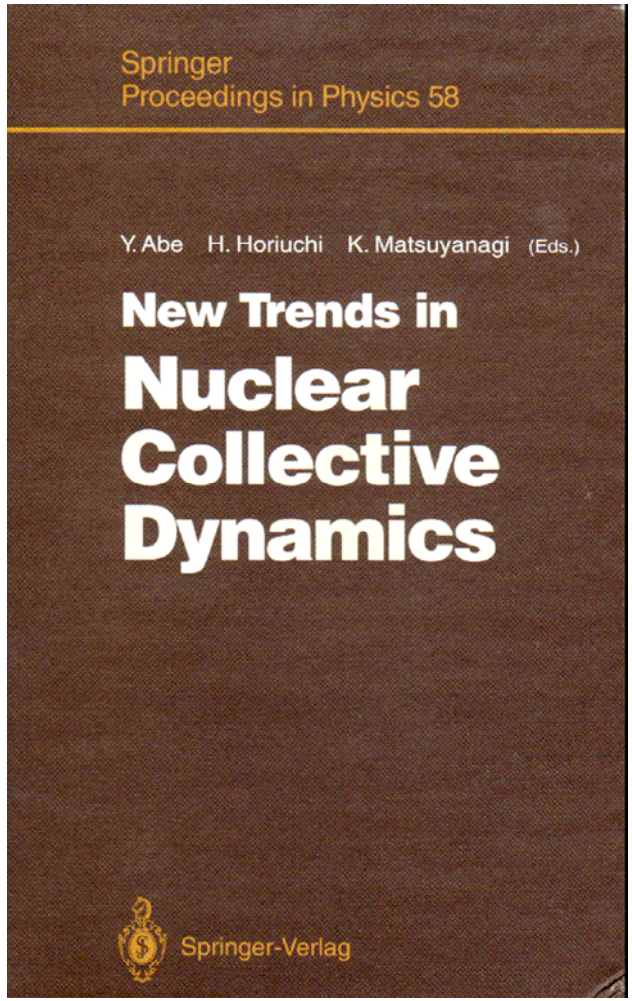
Niels Bohr and the Development of Concepts in Nuclear Physics

Ben R. Mottelson

Nuclear Structure 1990
Oak Ridge



1990　西宮湯川シンポ



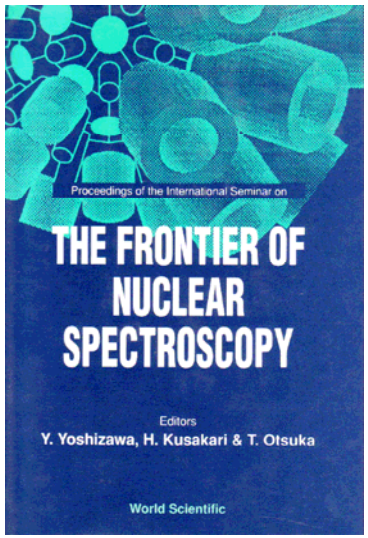
1992 高等研シンポ

Mottelsonから高等研への手紙　1990

核分光 International Seminar
on the Frontier of Nuclear Spectroscopy

October 23 to 24, 1992
Kyoto
Hosted by International Institute for Advanced Studies

Second Circular June 1992



NORDITA NORDISK INSTITUT FOR TEORETISK ATOMFYSIK
Danmark · Finland · Island · Norge · Sverige

Blegdamsvej 17
DK-2100 Copenhagen, Denmark
Telex: 15216 nbi dk
Fax: +45-31-38 91 57
Tel: +45-31-421616
Electronic mail: mottelson@nbivax.nbi.dk
Bitnet/EARN: mottelson at dknbi51

January 10, 1990

Professor Saburo Fukui
Chairman of Planning Commitee
International Institute for Advanced Study

Dear Professor Fukui,

I have been informed of the desire of Professor Y. Yoshizawa and his colleagues to organize a meeting at the International Institute for Advanced Study in Kyoto, in the fall of 1991 in order to discuss current issues connected with the study of rapidly rotating atomic nuclei. In my opinion this proposal is very well motivated and I would like with this letter to express my strongest support for the idea. I see two very valuable objectives in such a meeting. First it would be an occasion for bringing together the leading experts in this very exciting and rapidly developing field of research in order to assess the current state of development and through intensive exchange to clarify the basic issues involved. At the same time the meeting would provide a most valuable opportunity for the collaborators in the Nordball project to meet, take stock of their achievements and needs, and, perhaps most important of all, to define their future plans and relationships in the light of the large projects Gammasphere and Euroball. The large Japanese group is playing a decisive role in the Nordball project and a meeting in Japan would be a most appropriate and valued opportunity for all the members of the collaborations to meet and consider the status of their work.

I hope that you will agree with me in thinking that these arguments provide a very strong case for holding the suggested meeting in Kyoto.

Sincerely,

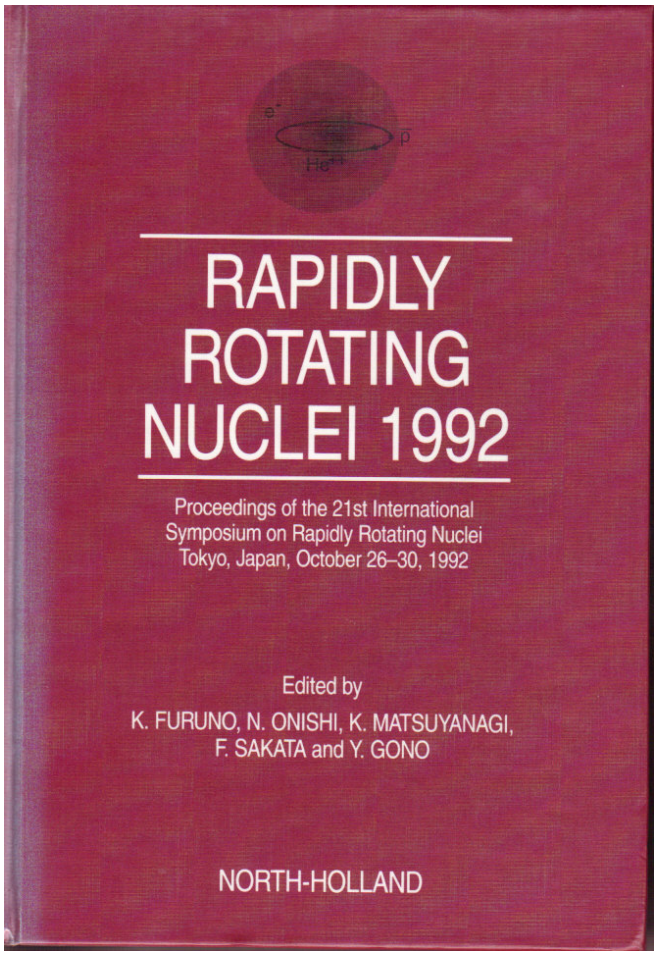
Ben Mottelson

Rapidly Rotating Nuclei 1992

- *21st INS INTERNATIONAL SYMPOSIUM* -

Tokyo, October 26-30, 1992

Institute for Nuclear Study, University of Tokyo, Tanashi, Tokyo 188, JAPAN



(President) T. Yamazaki (Director of INS)
(Symposium Co-Chairmen)
K. Furuno, N. Onishi, and F. Sakata.
(Executive Committee)
Y. Gono, H. Inoue, J. Kasagi, K. Matsuyanagi, S. Mitarai and M. Oshima.
(Programming Committee)
A. Ikeda, T. Komatsubara, T. Otsuka, Y.R. Shimizu and M. Sugawara.
(Advisory Committee)
A. Arima, H. Ejiri, H. Ikegami, M. Ishihara, Y. Yoshizawa, T. Kuroyanagi, N. Shikazono, M. Fujioka, T. Nomura and T. Marumori.

Nuclear Physics A557 (1993) 717c–728c
North-Holland, Amsterdam

NUCLEAR
PHYSICS A

Rapidly Rotating Nuclei 1992

B. R. Mottelson

NORDITA, DK-2100 Copenhagen Ø, Denmark

As professor Sakai reminded us in Kyoto, we are celebrating this year the thirty years anniversary of the first in-beam spectroscopy studies carried out by Morinaga and Gugelot. What boldness to put counters in such a harsh environment. What imagination to dream that you could detect a significant signal in the presence of a horrible complicated cascade of gamma-rays produced following a compound nucleus reaction. And what a brilliant discovery to see the sharp states of the ground state rotational bands extending up to angular momentum eight or ten units in many new bands throughout this whole region. And what a wonderful inspiration for all people who can appreciate the beauty of physics.

Nuclear Physics A557 (1993) 489c–514c
North-Holland, Amsterdam

NUCLEAR PHYSICS A

Diabaticity of Nuclear Motion: Problems and Perspectives

W. Nazarewicz[a]

Joint Institute for Heavy-Ion Research, P.O. Box 2008, Oak Ridge, Tennessee 37831, U.S.A.

Abstract

The assumption of adiabatic motion lies in foundations of many models of nuclear collective motion. To what extend can nuclear modes be treated adiabatically? Due to the richness and complexity of the nuclear many-body problem there is no unique answer to this question. The challenges of nuclear collective dynamics invite exciting interactions between several areas of physics such as nuclear structure, field theory, non-linear dynamics, transport theory, and quantum chaos.

Stimulating discussions with T. Kubo, K. Matsuyanagi, and F. Sakata, and useful comments from R.L. Robinson and M. Strayer are gratefully acknowledged. I would like to express my gratitude to Department of Physics, Kyoto University, for its warm hospitality during my stay there. The Joint Institute for Heavy Ion Research has as member


国際線出
International D
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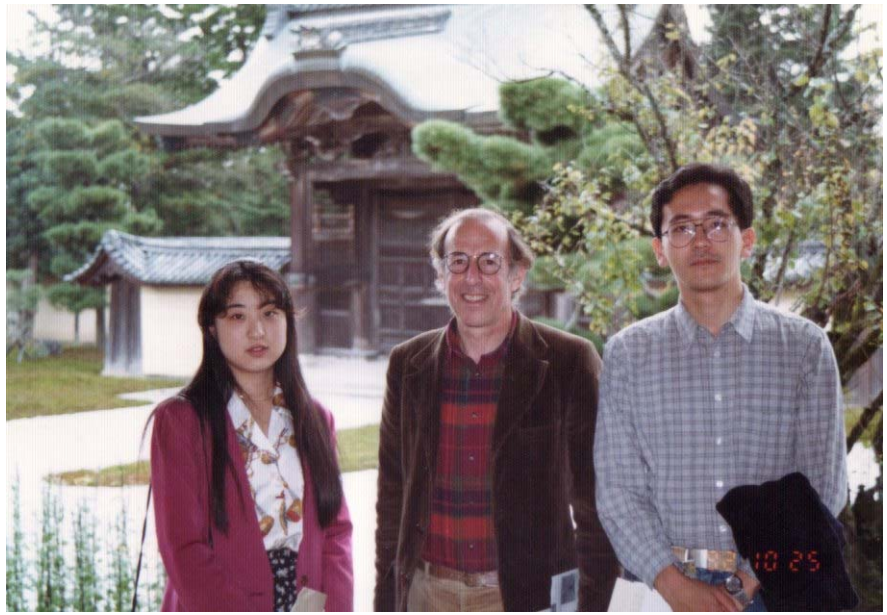
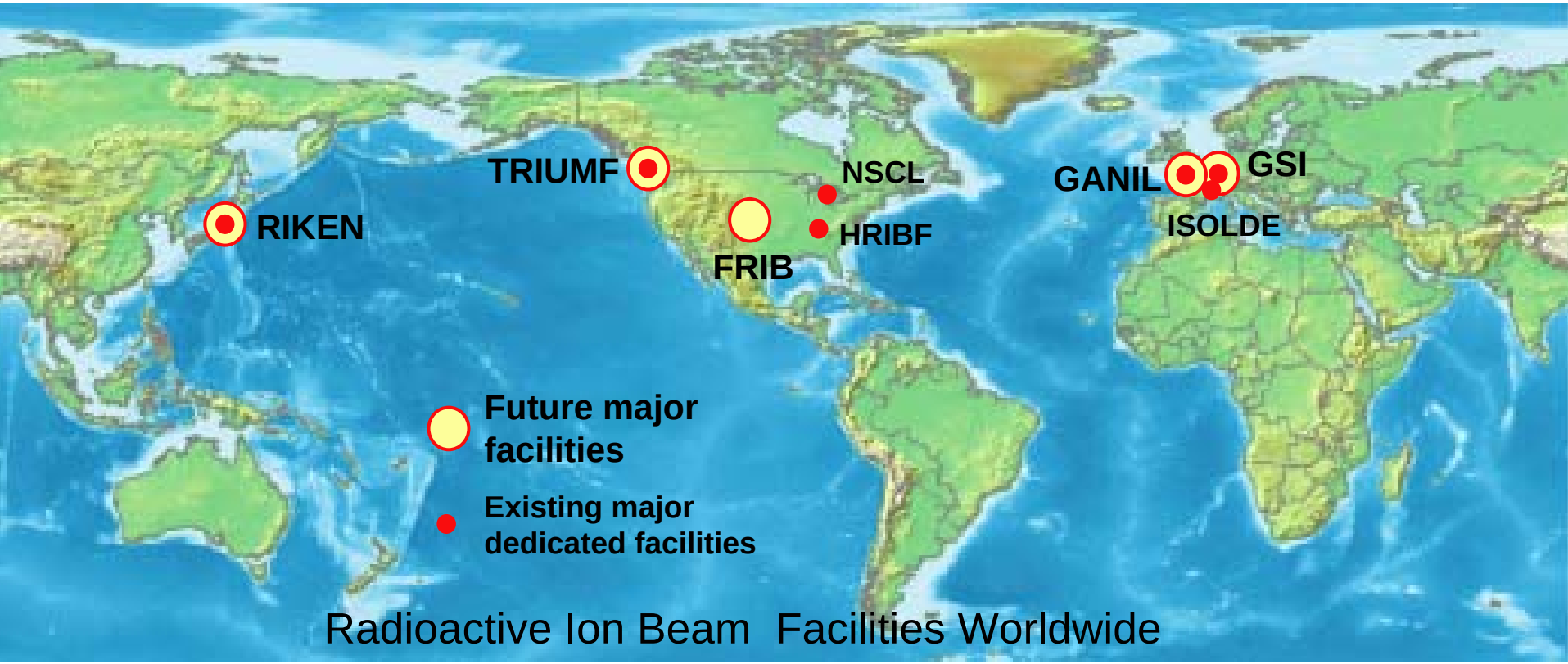
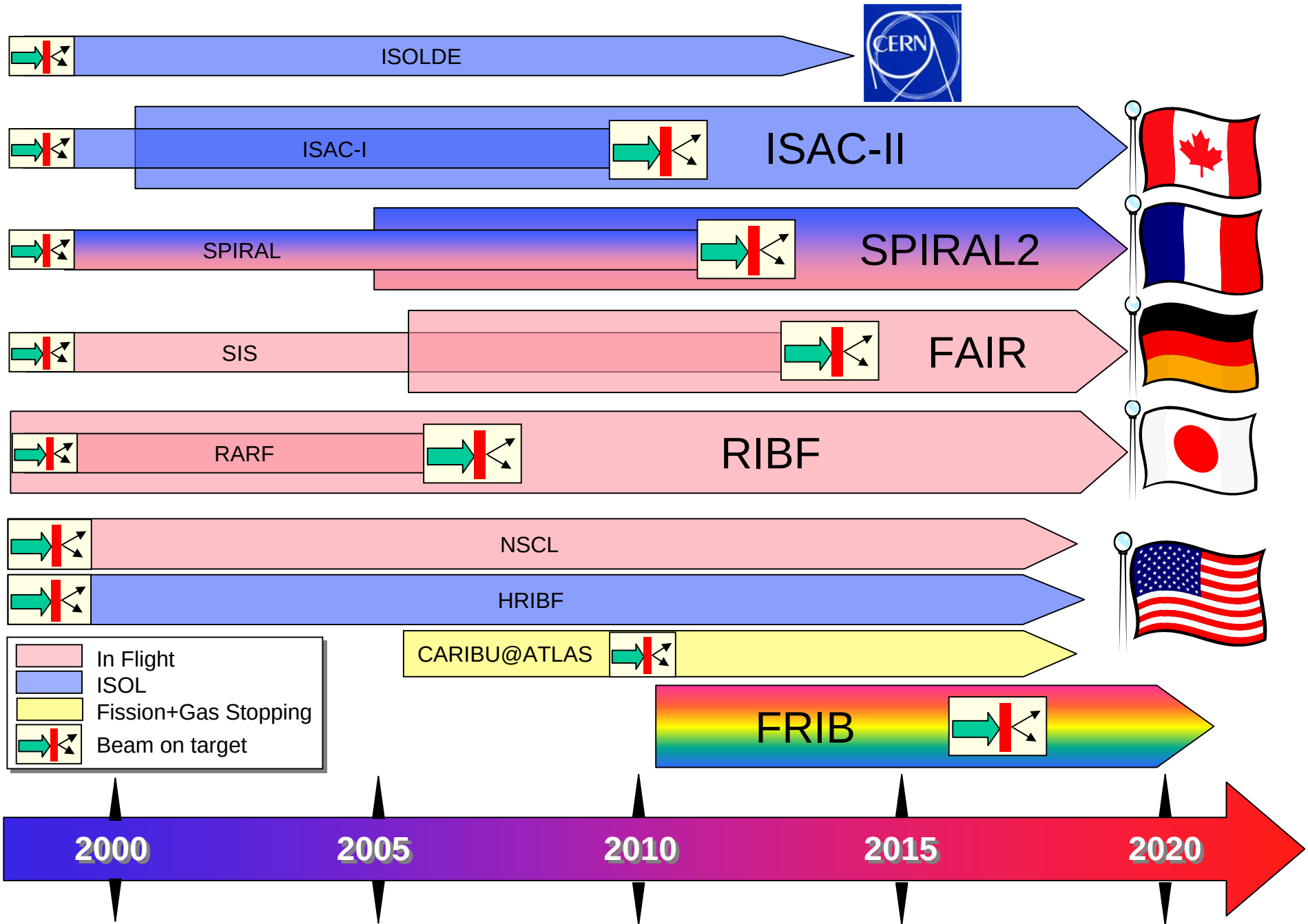
出発口
Departure
'92 11 7


10 25

Experiment


TRIUMF
NSCL
GANIL
GSI
RIKEN
HRIBF
ISOLDE
FRIB
Future major facilities
Existing major dedicated facilities
Radioactive Ion Beam Facilities Worldwide

Radioactive Ion Beam Facilities Timeline



Questions that Drive the Field

- How do protons and neutrons make stable nuclei and rare isotopes?
- What is the origin of simple patterns in complex nuclei?
- What is the equation of state of matter made of nucleons?
- What are the heaviest nuclei that can exist?

Physics of nuclei

- When and how did the elements from iron to uranium originate?
- How do stars explode?
- What is the nature of neutron star matter?

Nuclear astrophysics

- How can our knowledge of nuclei and our ability to produce them benefit the humankind?
  - Life Sciences, Material Sciences, Nuclear Energy, Security

Applications of nuclei

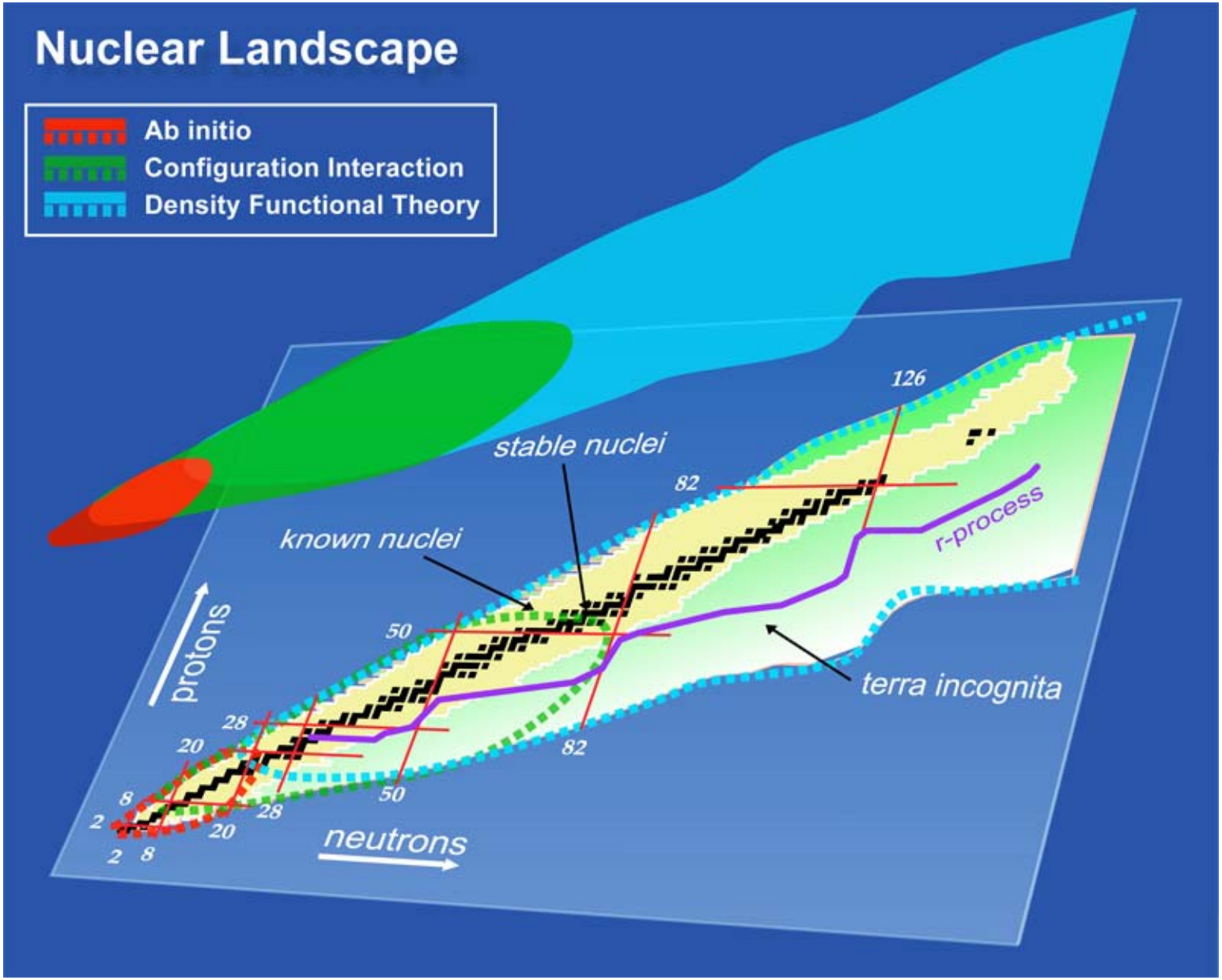
What is needed/essential?

- Young talent
- Focused effort
- Large collaborations

unedf.org

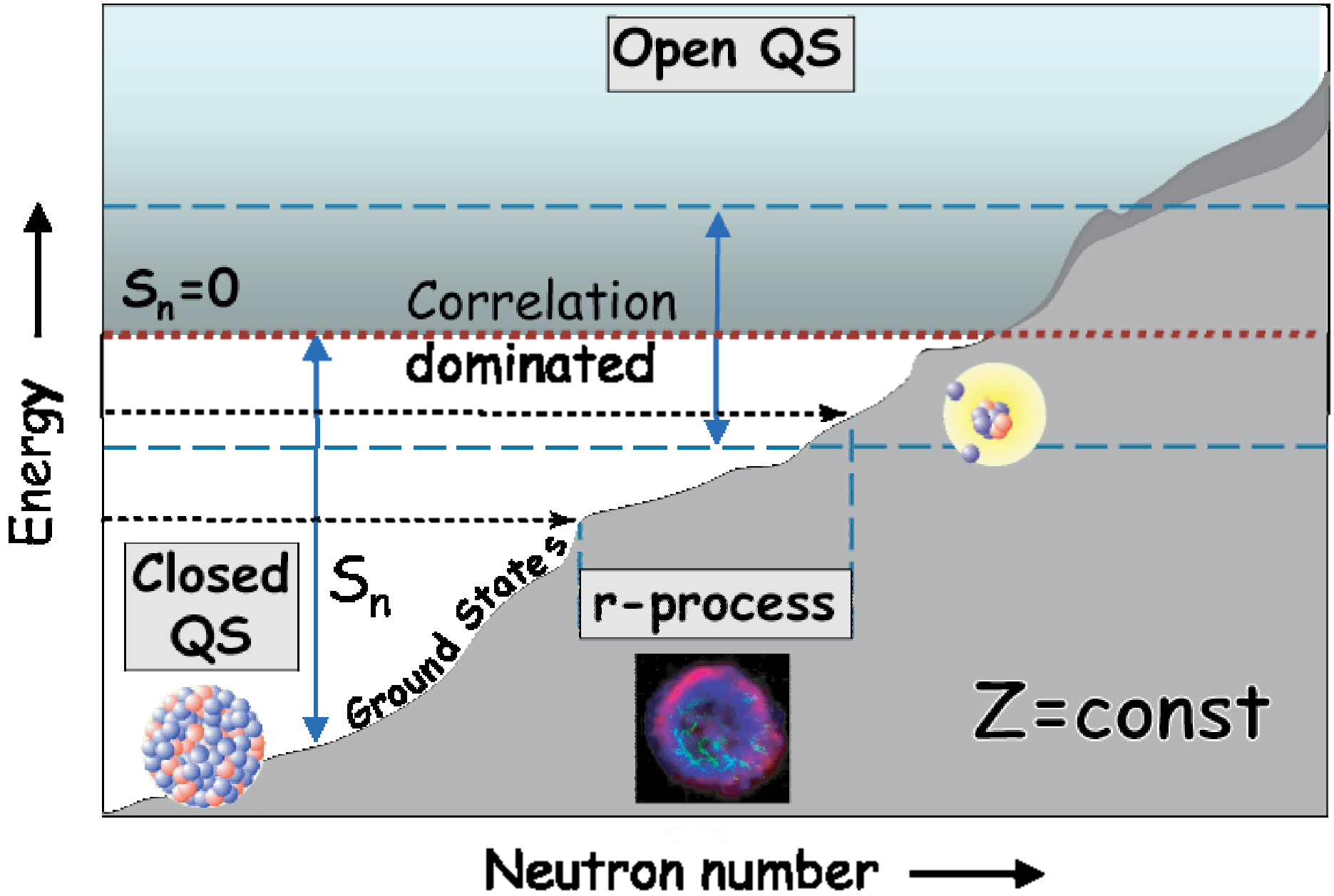
- Data from *terra incognita*

- High-performance computing
- Interaction with computer scientists



number of nuclei ~ number of processors!

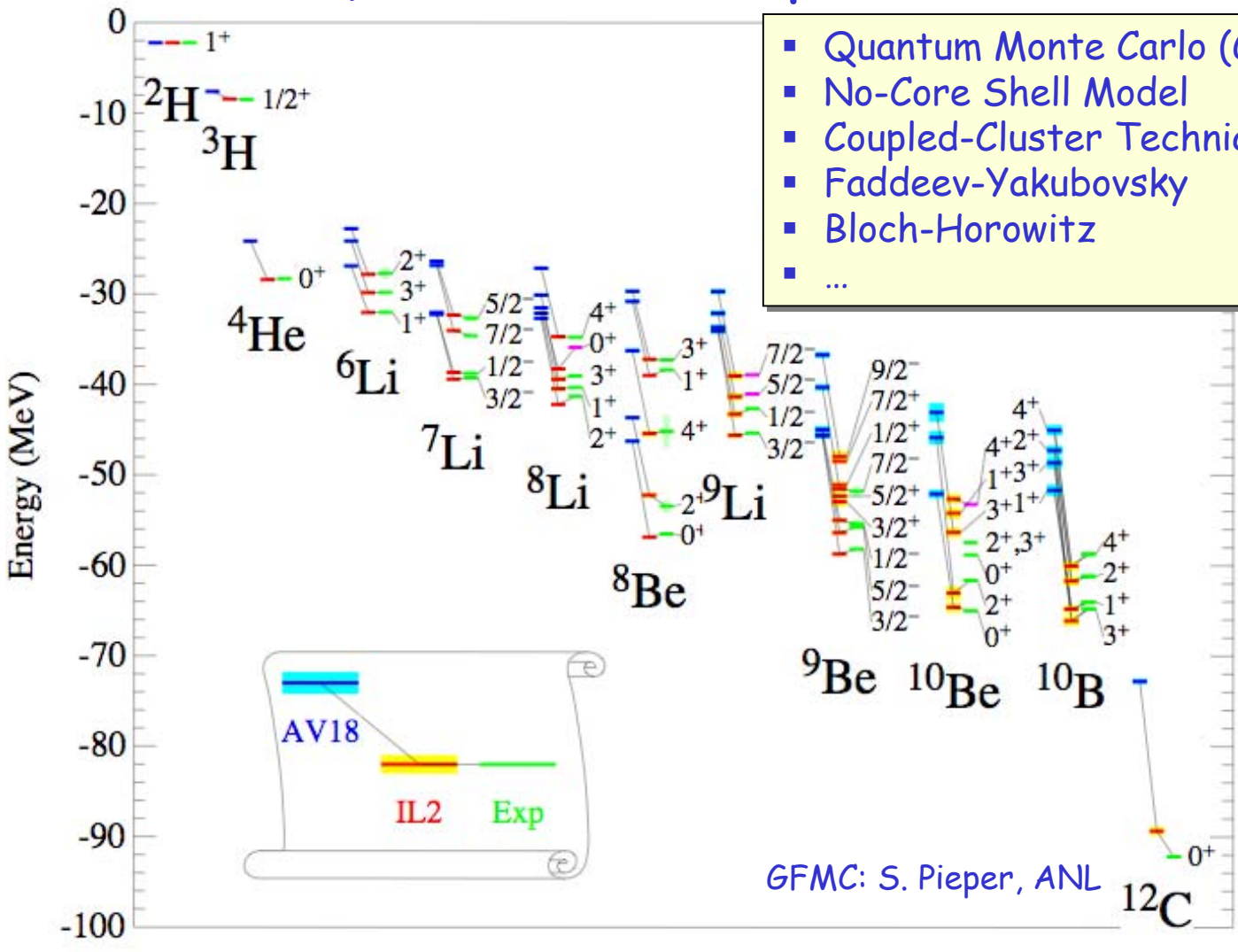
Prog. Part. Nucl. Phys. 59, 432 (2007)



Ab initio: GFMC, NCSM, CCM

(nuclei, neutron droplets, nuclear matter)

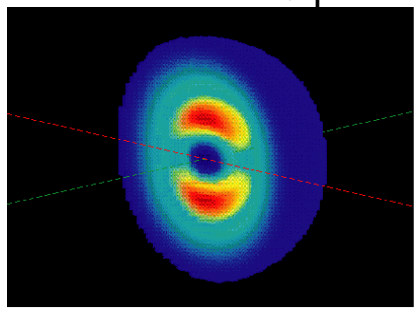
- Quantum Monte Carlo (GFMC) ^{12}C
- No-Core Shell Model ^{13}C
- Coupled-Cluster Techniques ^{40}Ca
- Faddeev-Yakubovsky
- Bloch-Horowitz
- …



Input:

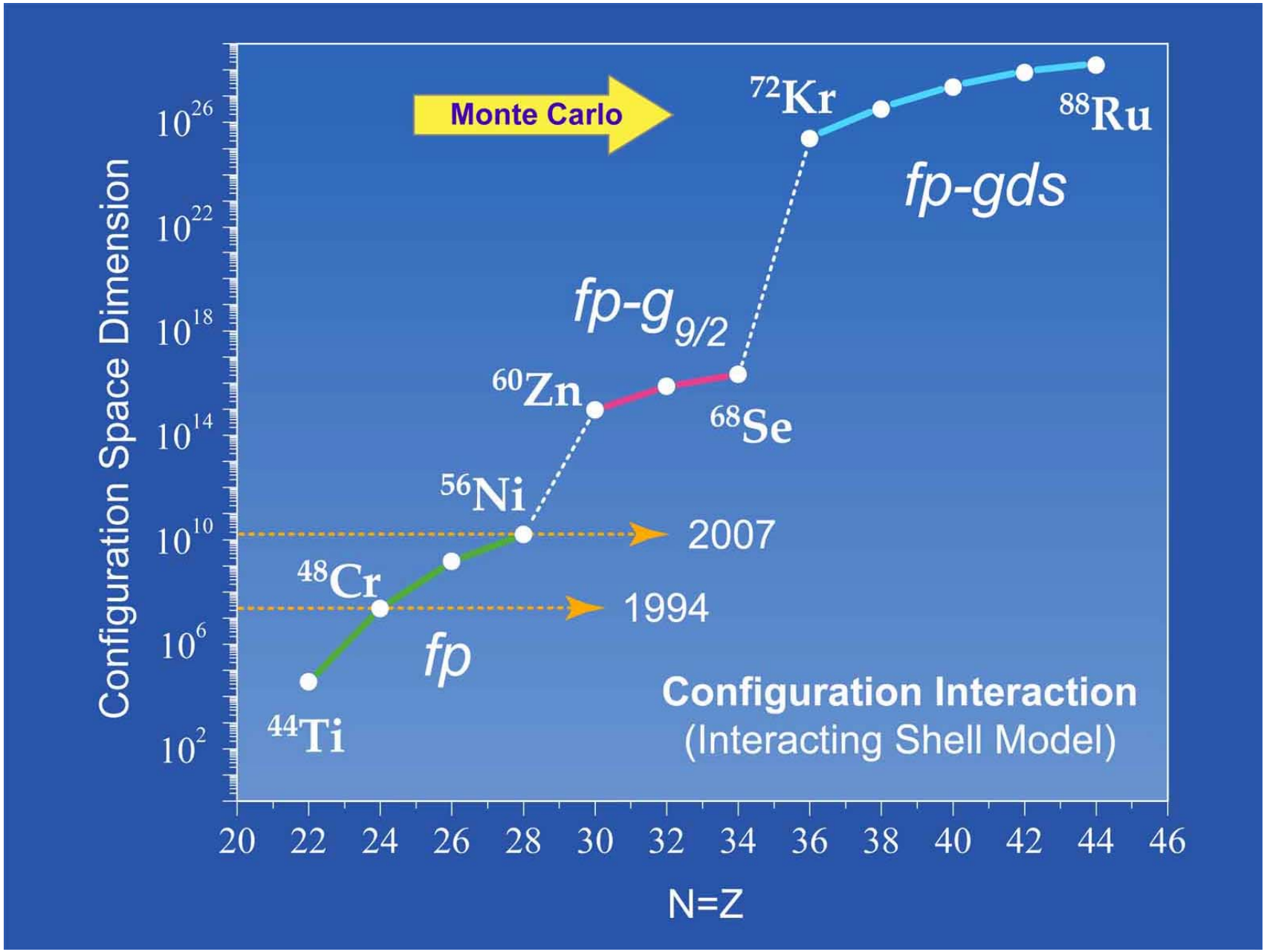
- Excellent forces based on the phase shift analysis
- EFT based nonlocal chiral NN and NNN potentials

deuteron's shape



1-2% calculations of A = 6 – 12 nuclear energies are possible
excited states with the same quantum numbers computed

The nucleon-based description works to <0.5 fm


Monte Carlo
^{72}Kr
^{88}Ru
fp-gds
fp-g$_{9/2}$
^{60}Zn
^{68}Se
^{56}Ni
2007
^{48}Cr
1994
fp
^{44}Ti
Configuration Interaction
(Interacting Shell Model)
Configuration Space Dimension
10^{26}
10^{22}
10^{18}
10^{14}
10^{10}
10^{6}
10^{2}
20 22 24 26 28 30 32 34 36 38 40 42 44 46
N=Z

Example: Large Scale Mass Table Calculations

Science scales with processors

Jaguar@ OAK RIDGE National Laboratory

M. Stoitsov, HFB+LN mass table, HFBTHO

Even-Even Nuclei

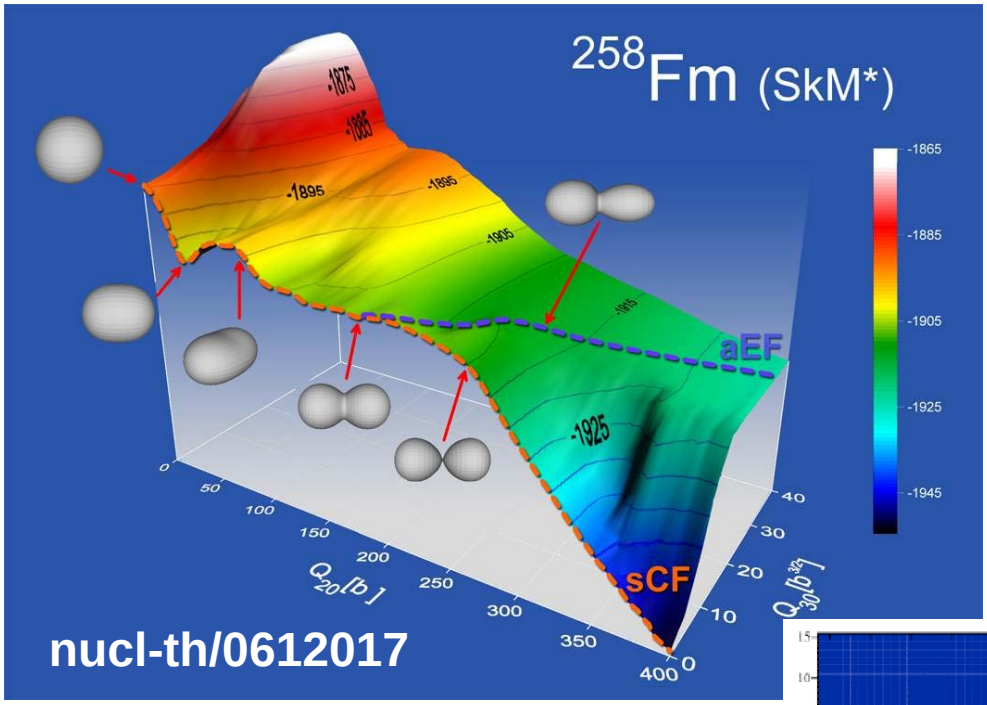
- The SkM* mass table contains 2525 even-even nuclei
- A single processor calculates each nucleus 3 times (prolate, oblate, spherical) and records all nuclear characteristics and candidates for blocked calculations in the neighbors
- Using 2,525 processors - about 4 CPU hours (1 CPU hour/configuration)

Odd and odd-odd Nuclei

- The even-even calculations define 250,754 configurations in odd-A and odd-odd nuclei assuming 0.5 MeV threshold for the blocking candidates
- Using 10,000 processors - about 24 CPU hours

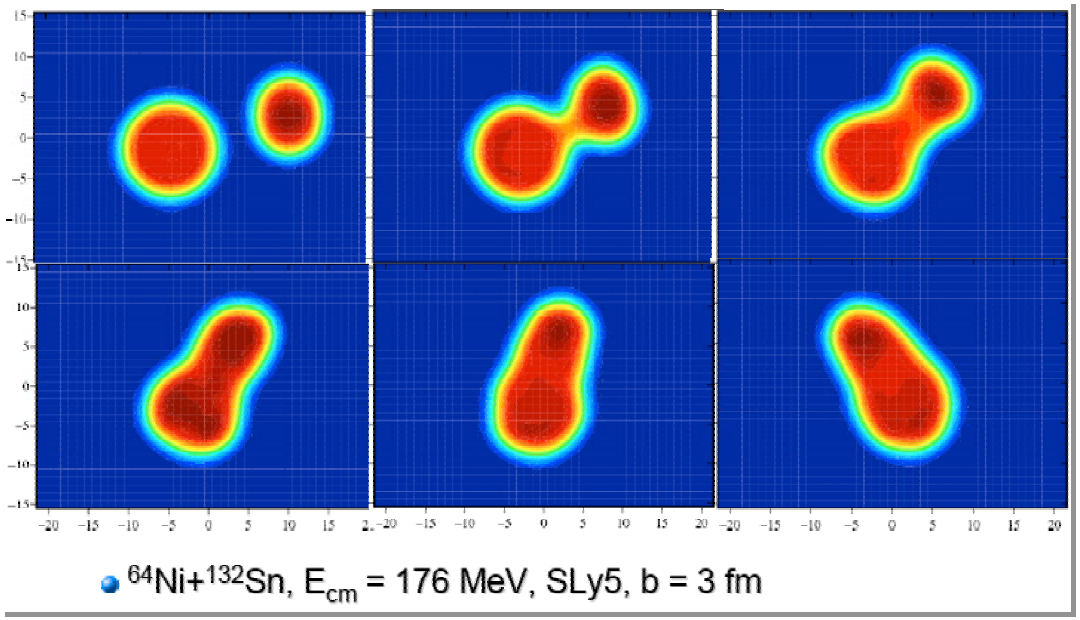
Bimodal fission in nuclear DFT

A. Staszczak, J. Dobaczewski, W. Nazarewicz, in preparation



S. Umar and V. Oberacker
Phys. Rev. C 76, 014614 (2007)

TDHF description
of heavy ion fusion



Connections to computational science

Jaguar Cray XT4 at ORNL
No. 2 on Top500

- 11,706 processor nodes
- Each compute/service node contains 2.6 GHz dual-core AMD Opteron processor and 4 GB/8 GB of memory
- Peak performance of over 119 Teraflops
- 250 Teraflops after Dec.'07 upgrade
- 600 TB of scratch disk space

1Teraflop=10^{12} flops
1peta=10^{15} flops (next 2-3 years)
1exa=10^{18} flops (next 10 years)

subfemto…

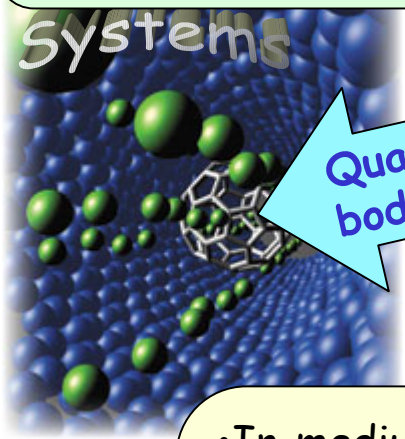
QCD

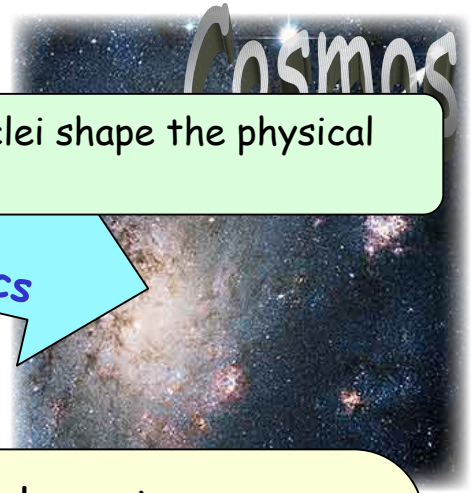
- Origin of NN interaction
- Many-nucleon forces
- Effective fields

- How does complexity emerge from simple constituents?
- How can complex systems display astonishing simplicities?

femto…

Giga…





Quantum many-body physics

Physics of Nuclei

Astrophysics

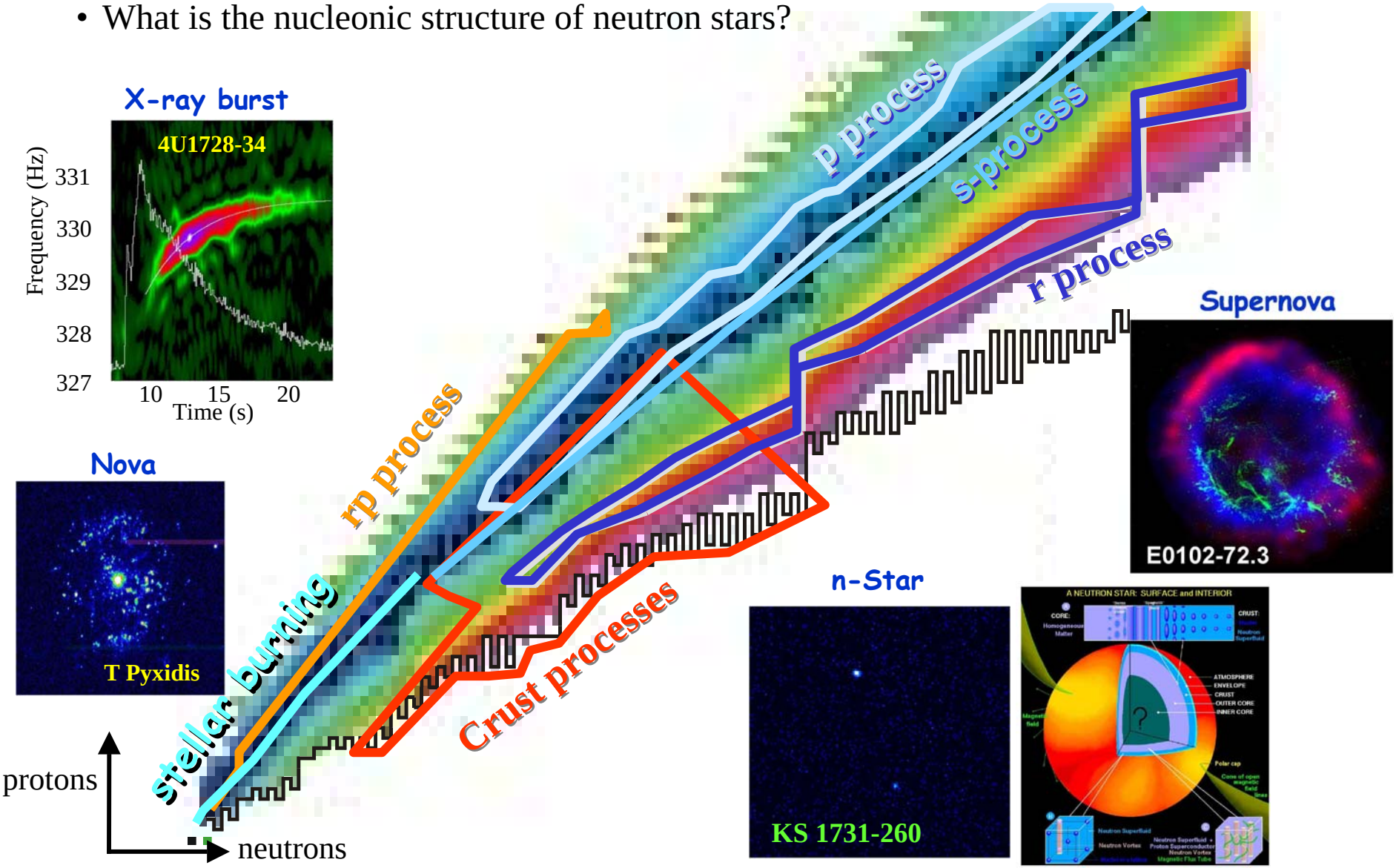
How do nuclei shape the physical universe?

- In-medium interactions
- Symmetry breaking
- Collective dynamics
- Phases and phase transitions
- Chaos and order
- Dynamical symmetries
- Structural evolution

- Origin of the elements
- Energy generation in stars
- Stellar evolution
- Cataclysmic stellar events
- Neutron-rich nucleonic matter
- Electroweak processes
- Nuclear matter equation of state

How does the physics of nuclei impact the physical universe?

- What is the origin of elements heavier than iron?
- How do stars burn and explode?
- What is the nucleonic structure of neutron stars?



Connections to complex many-body systems

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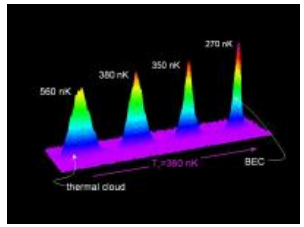
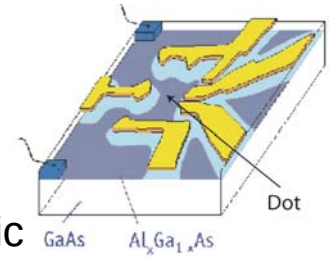
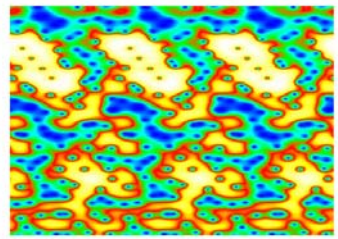
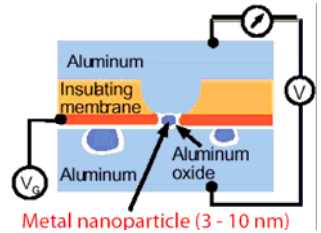
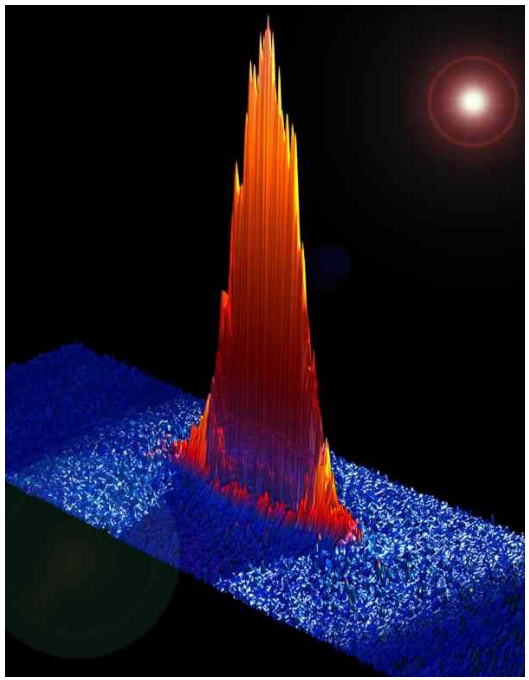


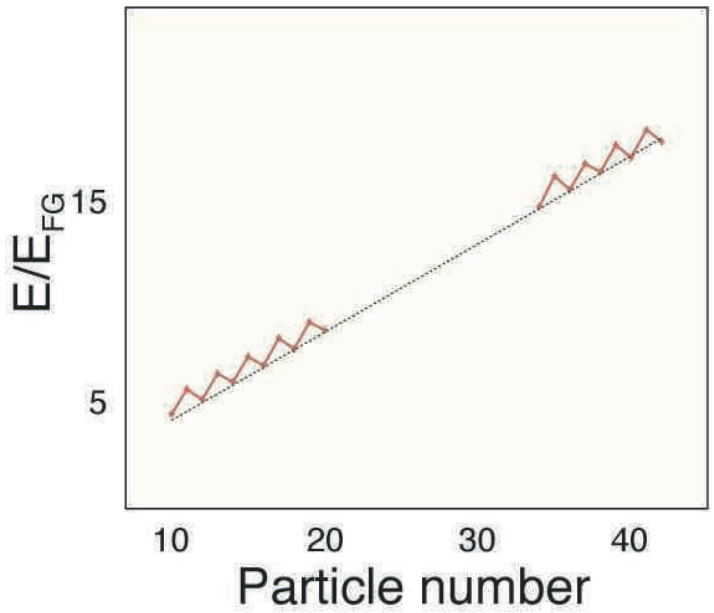


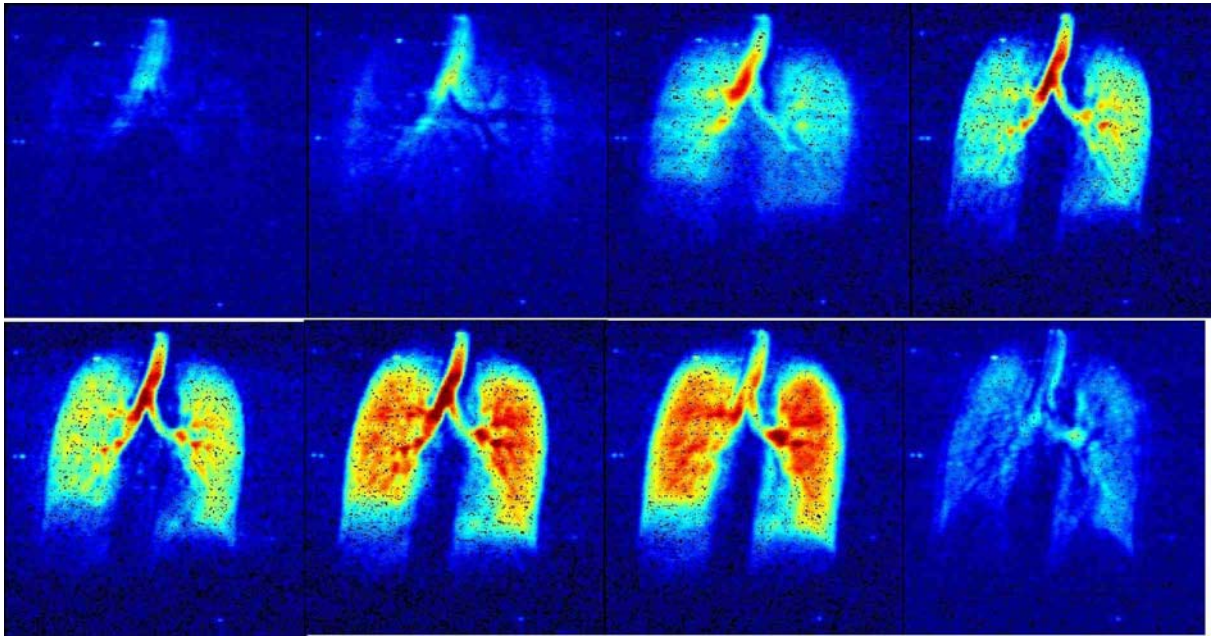
- Understanding the transition from microscopic to mesoscopic to macroscopic
- Quantum Chaos and the Random Matrix Theory
- Superconductivity
- Loosely bound and open systems
- Dynamical symmetries and Quantum Phase Transitions
- Coulomb frustration
- Fermionic sign problem











MRI of inhaled polarized ^{129}Xe by a human

Each frame is a snapshot of the absorption of the polarized gas in the lung tissue during a normal respiration cycle. The ^{129}Xe concentration is color coded with red indicating the highest concentration.

Atom Trap Trace Analysis: ^{81}Kr dating