

第5回国際ワークショップ

“Direct Reactions with Exotic Beams”  
(DREB2007)

開催報告書



九州大学大学院理学研究院

理化学研究所 仁科加速器研究センター

東京大学大学院理学系研究科附属 原子核科学研究センター

2007 年は湯川秀樹博士の生誕 100 年にあたる。この記念すべき年に、原子核物理学の最も権威ある国際会議 “International Nuclear Physics Conference 2007” が東京で開催された。この会議のプレ・シンポジウムとして、第 5 回国際ワークショップ “Direct Reactions with Exotic Beams (DREB2007)” を以下の要領で開催した。

開催日	2007 年 5 月 30 日(水) — 2007 年 6 月 2 日(土)
開催場所	理研仁科センター 2 階 大会議室
国際助言委員	Y. Blumenfeld (IPN-Orsay) W. Catford (Surrey), K. Kemper (Florida State Univ.) D.T. Khoa (Hanoi) W-P. Liu (CIAE) D. Morrissey (Michigan State Univ.) A. Mukhamedzhanov (Texas A&M) T. Nakamura (Titech) E. Pollacco (Saclay) P. Roussel Chomaz (GANIL) K. Rusek (Warsaw) Y. Sakuragi (Osaka City)
組織委員	八尋正信 (九州大学) (Chair) 本林透 (理研仁科センター) (vice chair) 下浦享 (東大 CNS) (vice chair) 青井考 (理研仁科センター) 緒方一介 (九州大学) (secretary) 松本琢磨 (理研仁科センター) (secretary)
URL	<a href="http://ribf.riken.go.jp/DREB2007/">http://ribf.riken.go.jp/DREB2007/</a>

本ワークショップは、米国のミシガン州立大学・フロリダ州立大学、フランスのサクレ一研究所(CEA/Saclay)・オルセー原子核研究所(IPN-Orsay)の研究者たちによって企画・立案された国際ワークショップの第 5 回目にあたる。このワークショップでは、不安定核が関与する核反応(直接反応)の研究を行っている専門家や若手研究者たちが一堂に集い、実験的・理論的研究の最新の成果が発表され、その内容について深く踏み込んだ議論が展開される。不安定核は、原子核物理学の新しい研究対象として注目されており、世界的に精力的な研究が行われている。研究者同士の議論に主眼を置くこのワークショップが、原子核物理学の国際交流に果たしてきた役割は大きいと考えられる。

これまでミシガン州立大学(第 1 回: 1999)、オルセー原子核研究所(第 2 回: 2001)、英国

サリー大学(第3回: 2003)、ミシガン州立大学(第4回: 2005)で開催されてきた本ワークショップを、今回初めて日本国内で開催することが出来た。参加者は92名(海外から43名)に達し、47の口頭発表と16のポスター発表がなされた。日本人の発表件数は口頭発表が26件、ポスターが4件であり、国内における原子核物理学研究のアクティビティの高さを示すことができたと考えられる。休憩時間中も参加者同士の活発な議論がなされ、ワークショップ本来の目的である研究者同士の交流という意味でも、大変意義深い会合であったと思われる。

開催にあたり援助・協力を賜った九州大学大学院理学研究院、理化学研究所仁科加速器研究センター、東京大学大学院理学系研究科附属原子核科学研究センターの関係各位に心から感謝の意を表したい。



本林氏(理研仁科センター)による講演の様子

# プログラム

5/30 (Wed.)

8:30--9:00	<b>Registration</b>
9:00--9:20	<b>Welcome Address:</b> (Yano, Yahiro, Simoura)
9:20--9:40	<b>Shrivastava:</b> Transfer reactions to probe structure of weakly bound nuclei ${}^6\text{He}$ and ${}^7\text{Li}$ around the Coulomb barrier
9:40--10:00	<b>Terashima:</b> Proton elastic scattering of ${}^{20}\text{O}$ at the 300 MeV/u and investigation of nucleon density distributions
10:00--10:20	<b>Furumoto:</b> New complex G-matrix interactions and application to proton-nucleus scattering
10:20--11:00	<b>Coffee Break</b>
11:00--11:20	<b>Lapoux:</b> Exploring densities and neutron excitation of near-dripline nuclei via direct reactions on protons
11:20--11:40	<b>Iida:</b> Black sphere approach to proton elastic scattering and reaction cross section
11:40--12:00	<b>Kohama:</b> Reaction cross sections of carbon isotopes incident on proton and on ${}^{12}\text{C}$ target
12:00--12:20	<b>Tanaka:</b> Measurement of reaction cross section for ${}^{22}\text{C}$
12:20--14:00	<b>Lunch</b>
14:00--14:20	<b>Takechi:</b> Reaction Cross Sections and Nucleon Density Distributions of Light Nuclei
14:20--14:40	<b>Sakaguchi:</b> Analyzing Power Measurement for Proton Elastic Scattering on ${}^6\text{He}$
14:40--15:00	<b>Sakuragi:</b> Analysis of polarized proton- ${}^6\text{He}$ elastic scattering based on an improved di-neutron model
15:00--15:20	<b>Tribble:</b> Radioactive beams for nuclear spectroscopy and nuclear astrophysics
15:20--16:00	<b>Coffee Break</b>

16:00--16:20	<b>Liu:</b> Indirect measurements for (n, $\gamma$ ) reaction rates in astrophysical r-process by using direct reaction induced by extremely neutron-rich beams
16:20--16:40	<b>Hashimoto:</b> Direct measurement of astrophysical $^8\text{Li}(d,t)$ reaction

## 5/31 (Thu.)

9:00--9:20	<b>Tostevin:</b> Momentum distributions from intermediate energy two-nucleon knockout reactions
9:20--9:40	<b>Bazin:</b> Mechanisms in knockout reactions
9:40--10:00	<b>Kondo:</b> Invariant mass spectroscopy of $^{13}\text{Be}$ and $^{14}\text{Be}$ via the proton-induced breakup reactions of $^{14}\text{Be}$
10:00--10:20	<b>Hoffman:</b> Unbound states of neutron-rich oxygen isotopes: Investigation into the N = 16 shell gap
10:20--11:20	<b>Poster with Coffee</b>
11:20--11:40	<b>Baba:</b> Isoscalar excitations in $^{14}\text{O}$
11:40--12:00	<b>Khan:</b> Measurement of the GMR and the GQR in unstable nuclei using the MAYA detector.
12:00--12:20	<b>Teranishi:</b> Recent resonance scattering experiments with low-energy RI beams at CNS
12:20--14:00	<b>Lunch</b>
14:00--15:40	<b>Facility Tour</b>
15:40--16:00	<b>Rogachev:</b> Spectroscopy of light exotic nuclei using resonance scattering in inverse kinematics.
16:00--16:20	<b>Ashwood:</b> Investigating the cluster structure of $^{10}\text{Be}$ and $^{16}\text{O}$ using gas target resonance reactions
16:20--16:40	<b>Takashina:</b> a inelastic scattering on $^{12}\text{C}/^{16}\text{O}$ exciting to a condensate state
16:40--17:00	<b>Saito:</b> $^4\text{He}+^8\text{He}$ cluster state in $^{12}\text{Be}$ via alpha-inelastic scattering

6/1 (Fri.)

9:00--9:20	<b>Khoa:</b> A consistent folding model study of ${}^6\text{Li}$ and ${}^6\text{He}$ elastic scattering
9:20--9:40	<b>Matsumoto:</b> The method of CDCC for four-body breakup reactions
9:40--10:00	<b>Rodriguez-Gallardo:</b> Four-body CDCC calculations applied to the scattering of Borromean nuclei
10:00--10:20	<b>Hussein:</b> Scaling and Interference in Breakup Reactions
10:20--11:00	<b>Coffee Break</b>
11:00--11:20	<b>Kikuchi:</b> Di-neutron correlations and Coulomb breakup reactions of ${}^6\text{He}$
11:20--11:40	<b>Egami:</b> A new procedure of analyzing four-body breakup reaction of the Borromean halo nucleus ${}^6\text{He}$
11:40--12:00	<b>Iseri:</b> Folding model analysis of elastic scattering between polarized proton and ${}^6\text{He}$
12:00--13:40	<b>Lunch</b>
13:40--14:00	<b>Motobayashi:</b> "DREB" studies at RIKEN RI Beam Factory
14:00--14:20	<b>Raabe:</b> A New Setup for Transfer Reactions at REX-ISOLDE
14:20--14:40	<b>Uesaka:</b> Future experiments with the SHARAQ spectrometer
14:40--15:00	<b>Mengoni:</b> TRACE: a highly-segmented Silicon detector for light charged particles emitted in direct nuclear reactions
15:00--15:20	<b>Beaume:</b> MUST2 : a new generation tool for DREB studies
15:20--16:00	<b>Coffee Break</b>
16:00--16:20	<b>Nakamura:</b> Coulomb and nuclear breakup of ${}^{11}\text{Li}$
16:20--16:40	<b>Capel:</b> Sensitivity of breakup calculations to projectile description.
18:00--	<b>Banquet</b>

6/2 (Sat.)

9:00--9:20	<b>Cizewski:</b> Direct reactions with exotic beams of neutron-rich nuclei near $^{132}\text{Sn}$
9:20--9:40	<b>Kanno:</b> Weakening of Z=28 shell closure in $^{74}\text{Ni}$
9:40--10:00	<b>Takeshita:</b> Large collectivity in $^{60,62}\text{Cr}$ studied by proton inelastic scattering
10:00--10:20	<b>Gelin:</b> New gamma ray spectroscopy of neutron rich nuclei around N=20
10:20--11:00	<b>Coffee Break</b>
11:00--11:20	<b>Ota:</b> High Resolution Gamma-ray Spectroscopy of Neutron-rich Nuclei around N=20 with Liquid Helium Target
11:20--11:40	<b>Ito:</b> Exotic molecular states in the $\alpha+^{6,8}\text{He}$ resonant scattering
11:40--12:00	<b>Suzuki:</b> Study of scattering amplitude in the complex scaling method
12:00--12:20	<b>Guo:</b> Boost-invariant mean field and the nuclear Landau-Zener effect
12:20--12:40	<b>Rolfs:</b> Nuclear fusion and nuclear decay in metals
12:40--13:00	<b>Closing</b>

# 参加統計

## 所属(国別)

日本	49名
フランス	10名
アメリカ	7名
デンマーク	4名
イギリス	3名
イタリア	3名
インド	3名
スペイン	3名
ベルギー	3名
ドイツ	2名
中国	1名
ベトナム	1名
ブラジル	1名
ポルトガル	1名
マレーシア	1名
計	92名 (うち海外から 43名)

## 国内からの参加者の所属

理研仁科センター	20名
東大 CNS	7名
九大	5名
北大	3名
大阪市立大	2名
法政大	2名
高知大	1名
千葉経済短大	1名
千葉大	1名
東工大	1名
東大	1名
日本原子力研究開発機構	1名



阪大	1名
阪大 RCNP	1名
その他	1名

## 身分

シニアスタッフ	50名
ポスドク	23名
学生	19名



休憩時には自由な雰囲気でも活発な議論が交わされた。

# 参加者のコメント

## Wilton Catford (Univ. of Surrey, UK)

The DREB2007 workshop, held at RIKEN, was very successful. The organisers were successful in attracting a good cross section of researchers active in the field of "Direct Reactions with Radioactive Beams". The representation from Japan was strong, making up about half of the conference, which was excellent because Japan has been very active and productive in this field in recent years. The timing to coincide with the first operation of BIGRIPS and the new coupled cyclotron facility at RIKEN was very appropriate. The tour of the facility was a welcome inclusion in the programme, and was appreciated by both experimenters and theorists.

An important feature of DREB has always been the presentation of the latest preliminary results and presentations by the full range of speakers from the very experienced to students still working on their PhD. This ethos was well maintained by the Japanese organisers. The reports from young Japanese researchers were excellent and a number of overseas institutes supported their students to attend DREB and to give talks. The idea of making all talks the same length, regardless of the seniority of the speaker, worked very well. Another important feature of the meeting is the mixture of theory and experiment, and this was also well balanced in the 2007 meeting.

On the organizational side, the delegates that I spoke with were all very happy. The accommodation was very economical, as requested by the international organisers, whilst being perfectly suitable. The web site contained all necessary information regarding the programme and arrival. The preparations for the meeting, including the selection of contributions for oral presentation, were very good. The attendance was typical of previous meetings. The hosts were very helpful and welcoming. The facilities and the presentations of the talks were all efficiently managed. In short, this was another successful meeting in this increasingly important series of Workshops. During the 2007 workshop, it was agreed that the next in the series will be held in Tallahassee, Florida, USA in 2009.

## Yorick Blumenfeld (IPN-Orsay, France)

As a member of the international advisory committee, I would like to thank you for having chaired the 2007 DREB (Direct Reactions with Exotic Beams) workshop in RIKEN, Japan from May 30 to June 2, 2007.

The scientific programme was of high quality showing the vitality of our subfield within the worldwide development of radioactive beam science. Once again we could assess the potential of direct reactions for obtaining spectroscopic information on both the collective and single particle properties of nuclei far from stability. The understanding of light halo nuclei such as  ${}^6\text{He}$  or  ${}^{11}\text{Li}$  has now reached great maturity, as attested by the numerous sophisticated theoretical approaches which were presented. The rapid development of experimental techniques, particularly for light particle detection, has opened the possibility to study heavier nuclei with increased precision, and new results on doubly magic Ni and Sn nuclei were among the highlights of the week. Particularly impressive for the participants from abroad was the visit of the new RIKEN facility which demonstrated the strong investment which will maintain Japan's leadership in the field of radioactive beams in the future years.

The practical organization perfectly maintained and enhanced the specificities of the DREB series. An excellent mix of junior and senior speakers underlined the maturity and vitality of the field in a casual atmosphere. Discussions were frank, open and in-depth. The excellent quality of the banquet and the reasonable price of the accommodations were unanimously praised by the participants. I thank you, your two vice chairs Pr. Motobayashi and Pr. Shimoura, and the local organizing committee for having organized a memorable 5<sup>th</sup> DREB workshop, and look forward to seeing you at DREB 2009 in Tallahassee, Florida.

## Patricia Roussel Chomaz (GANIL, France)

DREB2007 was the fifth of the serie, and the first one held in Japan. The Japanese contribution to these Conferences increased regularly over the time and it seemed important to the DREB International Advisory Board to acknowledge the investment of the Japanese community in our field of Direct Reactions with Exotic Beams, by having this fifth edition in Japan. DREB2007 shows that this was a good decision.

Indeed this meeting gave the opportunity to the international community working on Direct Reactions to discuss the results obtained in the last few years in this field, in the different facilities around the world and especially in Japan. The general quality of the presentations was excellent and the discussions were lively and of high interest to all participants. Many students presented their work in detailed oral contributions, with ample time for questions and comments, which is often not possible in Conferences with broader scope, where the student are limited to poster presentations, or « flash » oral presentations.

DREB2007 was also an excellent occasion to visit the new RIKEN facility, which was running the first experiment with the Uranium beam at 350 MeV/n. All participants of the Conference were extremely impressed by the possibilities offered by the new experimental halls. In particular, several possible collaborations between France and Japan for future experiment or detector development were investigated during the few days of DREB2007.

All this shows that DREB2007 was a fruitful and interesting meeting. As member of the International Advisory Board, I would like to express my thanks to the Local Organizing Committe for the relaxed and friendly atmosphere of the presentations and discussions, the smooth and efficient organization, and the overall high quality of DREB2007.

## David J. Morrissey (Michigan State University, USA)

I attended the most recent Workshop on Direct Reactions with Exotic Beams, DREB-2007, held at RIKEN as a member of the International Organizing Committee. The meeting successfully continued the tradition of bringing together the experts in the field of direct nuclear reactions from around the world in an interactive format. The organizers created an interesting program that allowed the people carrying out important work to present their most recent results. The workshop format allows young people to play an active part in the program. It was my impression that the talks were of high quality that engaged the audience, as there were many questions and discussions during the breaks. The topics covered the whole range of nuclear reactions being studied with exotic or unstable beams at the leading facilities around the world.

Our Japanese colleagues provided an excellent atmosphere for scientific discussions and interactions. They provided detailed travel information and assistance as necessary for all of the foreign visitors. The participants were able to enjoy many informal conversations at the dining facilities on the RIKEN campus and the banquet was especially nice and enjoyed by all. We look forward to the next workshop in Tallahassee Florida in two years time.

## 古本 猛憲 (大阪市立大学理学研究科 博士課程 2年)

今回行われた DREB2007 へ参加して、非常に有意義な時間を過ごせました。

これまで、世界で行われている研究報告などは論文などでしか見ることがありませんでしたが、まさに世界の最先端の研究をまぢかで見聞きすることができました。しかも、核反応を主にした研究会というのは初めてで、非常に勉強になりました。

現在私は陽子-核の反応解析を進めておりますが、もともとは原子核同士の反応解析を行うために進めているものであり、今回の国際会議では特に Khoa さんの不安定核を含んだ原子核間の反応解析に興味を持ちました。なぜならば、現在私も進めている **complex G-matrix** を用いた原子核間の反応解析を進めていて、すでにある程度の成果を収めていることがわかったからです。そこに使われている **complex G-matrix** 自体は違うものですが、ある程度うまくいくということが分かり、私が行っている研究をさらに進めていけるだろうという、そんな期待ができるとともにこれから進めていく研究が楽しみになりました。

これから RIKEN などですべて不安定核の実験がすすんでいき、これからの核反応の研究はさまざまな手法で不安定核へアプローチをかけ、その不安定核特有の反応プロセスや構造の特徴を解明することができるようになります。このように実験設備の充実化や計算機の発展が進んで、いざこれから本格的に解析が進んでいくというときに、このような核反応分野で活躍できる機会が与えられたことは非常にうれしく思います。



会場の様子