Seventh US-Japan Joint Science Policy Seminar

Appendix D: Plenary Session II: International Cooperation in Big Science

Abstracts of Remarks by:

Plenary Session II: International Cooperation in Big Science

From Bilateral to Multilateral: International and Interdisciplinary Character of Accelerator-Based Sciences

Toshimitsu Yamazaki

Abstract

Scientific research with the aid of large-scale accelerators has two distinct characteristics: international and interdisciplinary. Although accelerators were built originally as national or regional facilities, their uses have been extended to scientists across these original boundaries.

The following subjects will be discussed.

Disciplinary viewpoints

- Particle Physics
- Nuclear Physics
- Condensed Matter/Chemistry/Life Science

Global viewpoints

- Distribution of unique facilities over the world
- Regional aspect - North America, Europe and Asia-Pacific

International Committee for Future Accelerators (ICFA) principle

Coordination of multilateral collaborations

ICSU - IUPAP - ICFA
OECD Megascience Forum
Scientists
Research Laboratories
CERN and similar organizations - CERN Courier, WWW

Role of bilateral and regional collaborations from the global viewpoint

Plenary Session II: International Cooperation in Big Science

A Lesson from a Big Ship and the Ocean Drilling Program

Nicklas G. Pisias

Abstract

The Ocean Drilling Program is an international program of basic research supported by the US National Science Foundation (NSF) and several international partners: Japan; the United Kingdom; France; Germany; a consortium of Australia, Canada, Chinese Taipei and Korea; and the European Consortium for Ocean Drilling (Belgium, Denmark, Finland, Iceland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and Turkey). The ODP uses a commercial drilling vessel, the *JOIDES Resolution* to recover sediment and crustal cores, and remotely collected geochemical and geophysical records from the continental margins and deep ocean basins of the world. The ODP is the successor to the Deep Sea Drilling Project (DSDP), which began in 1968 and was funded solely by the U.S. National Science Foundation. In 1974 the DSDP entered an International Phase of Ocean Drilling, with organizations in five countries joining NSF. The International Phase of Ocean Drilling (IPOD) began with France, Germany, Japan, and the U.K. signing Memoranda of Understanding (MOU) with NSF. The USSR was a member from 1974-79. IPOD has been considered a model for cooperative international scientific programs. DSDP -IPOD officially ended in 1983.

The Ocean Drilling Program began in 1985 with increased international participation and a larger and better equipped drilling vessel. By the end of 1998, the Program will have drilled in all of the world's oceans, except the ice covered portions of the Arctic. A large representation of the international geosciences community has been involved:

- 1500 scientists from 40 nations participated.
- The samples and data distributed to 4000+ scientists,
- 5200 scientists contributed to the Proceedings, representing in total, 52 nations.

This highly successful international program provides many lessons for the development of new multilaterial research efforts.

Items of discussion:

What Makes Scientific Ocean Drilling Successful?

- Scientific Input from the International Scientific Community.
- Scientific Planning.
- Contractual Delivery of Science Services.

Scientific Input From International Scientific Community

- International conferences on scientific ocean drilling (COSOD-I, II) provide general scientific issues to be addressed.
- Unsolicited proposals from individual and independent cooperative research groups.
- Actual drilling is based on proposals written outside of the program planning and implementation structure.

Scientific Planning

- Provided by a structured panel structure made up of scientists from all participating nations.
- Chair of lead scientific committee is funded by the program. Chair is the scientific spokesperson of the program.

Scientific Planning Responsibilities

- Taking input provided by COSOD and other planning activities to formulate long term objectives and goals of the program.
- Evaluating proposals submitted to the planning structure in terms of long term objectives and scientific quality.
- Formulating plans for each expedition of the drill ship and developing annual program plans of field expeditions.
- Developing multi-year prospectuses for planing and implementation decisions.
- Setting policies with respect publications, and sample and data distribution

Scientific Planning Structure

Delivery of Science - How It All Works. Dollars and Yen: Memorandum of Understanding between partner nations and the U.S. National Science Foundation. Agencies are represented on the ODP Council. The National Science Foundation awards funds to a prime contractor responsible for delivery of the science formulated by the scientific planning structure. The prime contractor prepares a program plan, which includes all budget decisions that addresses the scientific priorities of the program. The prime contractor uses subcontract relationships to provide the necessary science activities to achieve ODP expedition specific objectives as well as overall priorities of the program.

Plenary Session II: International Cooperation in Big Science

International Cooperation in Global Environmental Science

Tsuneyuki Morita

Abstract

Introduction - Outline of Current Cooperation Initiatives

When one considers international cooperation in the context of global environmental science, the starting point must be the characteristics of global environmental issues themselves. These define the nature of the scientific approach, and thus in turn how this approach is implemented.

1. Global environmental science is a very broad field, incorporating many distinct scientific disciplines, often with diverse theoretical frameworks and analytical approaches.

2. It also touches, directly and indirectly, upon many social and economic issues; therefore global environmental issues can be characterized by involving the simultaneous evolution of research and policy making processes.

The importance of these two characteristics cannot be over-emphasized. The need to link wide scientific frontiers/interests to equally wide, and often distinctly differing, political interests and opinions, represents one of the most problematic characteristics of global environmental issues. And

3. the most serious environmental problems (local linking to global) are found in developing countries. Here the interface between scientific concerns (methodological and practical) and political concerns (economic and social) is characterized by being at its most problematic.

It is possible to identify three types of international cooperation networks, focusing on environmental problems:

1. those characterized by scientific linkages: such as in the World Climate Research Program (WCR), the International Biosphere/Geosphere Program (IGBP), and the International Human Dimensions Program (IHDP);
2. those characterized by policy science linkages: such as in the Intergovernmental Panel on Climate Change (IPCC), International Ozone Trends Panel (IOTP), and the Eco Asia Project: an Asian long term

initiative aiming to provide Environmental Ministers with scientific recommendations to facilitate policy formulation favoring sustainable development; and

3. those characterized by North-South linkages (networks which also often contain policy-science linkages). Some relevant examples here include: APN (Asia-Pacific Network for Global Change Research), IAI (Inter American Institute for Global Change Research), ENRICH (European Network for Research in Global Change).

Necessity of Integrated Assessment to Address Multidisciplinary Problems

Within the three structural classifications outlined, it is also necessary to consider what *kind* of research is most valid, both to address global environmental issues, and also to function best within multilateral organizations (containing diverse political and scientific interests).

There are many epistemological gaps, which need to be bridged between the science and policy fields, and also between different scientific disciplines:

1. policy makers are intelligent, but often lack the scientific training necessary to be able to interpret and implement detailed research results.

2. scientists have few incentives to link their research results to the policy making process, and to integrate their own results with those from other scientific fields.

Integrated Assessment (IA) has a vital role to play in bridging these gaps. It is a necessary tool which will greatly facilitate the optimal development of institutional and research linkages, projects and policy recommendations.

IA represents the "best available synthesis of current scientific, technical, economic, and sociopolitical knowledge" (IPCC 1995: 374). It differs from disciplinary research as IA aims specifically to inform knowledge and policy decision making using a breadth of knowledge sources from a variety of disciplines.

Integrated Assessment Modeling (IAM) Research

Integrated Assessment Modeling involves the use of a large-scale computer simulation model to assimilate many different factors and disciplinary inputs. As such it represents a core tool for Integrated Assessment approaches. The first integrated assessment of a global environmental issue was the Climatic Impacts Assessment Program (CIAP) in the United States. Formal Integrated Assessment Models were introduced in the late 1970s, and have progressively developed in scope and numbers since then. There has been a rapid increase of interest in the IAM approach in recent years, and there now exists more than twenty IA models for climate change alone. These models simulate a range of options and approaches from the global level to regional level changes.

My own work has involved development of the Asia-Pacific Integrated Model (AIM) as a common tool of the Asian region. AIM is an integrated assessment model focusing on Asia. The AIM project has been specifically developed using a *collaborative* approach with other Asian countries, involving an international collaboration program which has to date involved governments and researchers in China, India, Korea and Indonesia. Detailed links have also been established with American (National Pacific Northwest Laboratory) and European (International Institute of Applied Systems Analysis) research teams, and with the extensive network associated with the United Nations University.

In the context of IA modeling, one very important approach is that of transferring IA tools to developing countries, and supporting them in their efforts to develop their own IA tools and IA research teams. The AIM project has strongly supported this approach, with aid from the Japanese government, thus supporting the development of IA models and the training of models across Asia.

Results from the AIM project, involving its collaborative partners, have already been applied to actual policy making processes, such as the recent COP3 in Kyoto last December, as well as the Eco Asia project.

Several Points to be Considered to Enhance International Cooperation

Our research activities have allowed me to identify several key recommendations which I believe can help enhance international cooperation in the field of "big" science:

1. integrated assessment approaches have led to improvements in communication between policy makers and scientists.

2. the development of the Integrated Assessment Model has greatly improved the ability of, and incentives for, scientists to integrate their research activities.

3. the development of integrated assessment approaches has created a competitive situation among many science fields. For example economists and climatologists now often find themselves competing for the same funding budget, and this in turn has led to a greater understanding of their respective fields as different teams try and explain why their area of research - as opposed to a different analytical approach - represents the optimal strategy.

4. however IA activities have made it difficult for scientists to keep the optimal distance from political processes. This can create problems relating to the accuracy of research, and the objectivity exercised in the construction of

analytical frameworks. Sometimes the need for funding can overly influence the structure and objectivity of a research project.

5. this problem has influenced the representation of developing countries in IA modeling. Developing countries have not been satisfied by their representation in international IAM projects.

6. it is also worth noting that US-Japan cooperation has already contributed to regional collaboration in Asia. Links between AIM and the PNNL have helped establish a modeling structure which has then been disseminated, after consultative feedback, among several Asian countries.

Recommendations

I would like to conclude with a few key recommendations.

1. Integrated Assessment processes should be introduced to more international programs, and incorporated into multilateral structures, to support research activities.

2. It is both a practical political necessity, and a moral obligation, for developed countries to support research activities in developing countries.

3. US-Japan cooperation could be used to facilitate this support.

4. It is important to adjust existing structures, and introduce new frameworks, to keep academic independence for research teams. For example, a model structure can be designed by one research team, and then subcontracted out to individual users. These users can then set the assumptions to be utilized by the model (a process which inevitably involves some political considerations, for example relating to economic valuation criteria). This way the scientific rigor of the research can be maintained, whilst also allowing it to respond flexibly to diverse political requirements.

Plenary Session II: International Cooperation in Big Science

The Big Science Program of the Chinese Academy of Sciences and Some Suggestions and Proposals on Strengthening International Cooperation

Zhu Xuan

Abstract

Big science programs usually refer to large-scale scientific facilities. They also include distributed large scientific research programs.

The key significance of big science program is to explore the frontier science in mankind's cognition of nature, such as structure of matter, evolution of the universe, and essence of life. It is also to seek revolutionary knowledge innovation, to develop future industrial technologies, and to improve human beings living environment, in areas such as fusion energy, synchrotron radiation, gene research, ecological system and global change. In addition, it is to train new generations of leading researchers in science and technology, to raise the industrial technology level and to promote economic development.

In the march to the frontier of science, the facility scale and technological complexity of big science program are getting increasingly larger and more difficult. It is costing several billions of US dollars that no single country is able to afford it alone. In addition, big science programs essentially have the characteristics of long-term, fundamental research programs, their research subjects being well ahead of the present day research levels. Its experimental data and research results are open to the public. Therefore, international cooperation *has* become the consensus. Programs like the International Space Station, LHC, ITER, NLC and some other projects either in the planning or implementation stage are just some outstanding examples of international collaboration.

In a developing country as China is, science and technology are to serve the country's economic and social development; at the same time, it is essential to maintain a team of high-level scientists engaged in basic research and high technology innovation. In the recent 20 years, with the support of the government, the Chinese Academy of Sciences (CAS) completed the construction of several big science research facilities. Following the opening and reform policy, CAS has been actively involved in international cooperation in big science programs and has achieved good results. Here are some examples:

China's important role in international high energy physics field was made possible by the construction of Beijing Electron Positron Collider (BEPC) and the scientific fruit in the precision measurement of tau-lepton mass. Since 1979, the Chinese Academy of Sciences and the US Department of Energy (DOE) have held 18 annual meetings of the PRC-US Joint

Committee on Collaboration in High Energy Physics. Moreover, about 600 cooperative projects were carried out between CAS and DOE. Several national labs under DOE, such as ANL, BNL, FAIL, LBNL, SLAC and CESR of Cornell University, have made great contributions in the design and construction of BEPC. Scientists from both countries began to conduct a series of cooperative research works and to train graduate students after the commission of the BEPC. Meanwhile, China participated in some high energy physics projects in the United States, too, including producing components for the B factory of SLAC and Low Energy Ring of PEP-D, and joining in the top-quark experiment on at Fermi Lab.

The completion of Lan Zhou Heavy Ion Accelerator (HIA) provided China with the advanced facility to carry out frontier scientific research into the synthesis of new nuclides. In the design and construction of the HIA, we got much help from GANIL of France and some other laboratories in the world. The next step is to build a Heavy ion Research Facility in Lan Zhou Cooler Storage Ring (HIRFL-CSR). The Chinese government in principle has approved the project. In the past four years, we completed the conceptual design and preliminary technical design through the cooperation with GSI of Germany, ANL of the USA, RIKEN and Toledo University of Japan.

The National Center for Gene Research of CAS has constructed the first generation BAC-Contig map of the rice genome. We also benefited a lot from international cooperation, including the computer program with the largest capacity in the world to process and analysis contig data, which was designed by Sunger Center of Britain.

Because China is a developing country, CAS' funding for big science programs is still very limited, compared with me world's funding scale on big science. As a result, we have developed the following policies as our development strategy:

- **Choosing only limited subjects while laying stress on key ones.** These subjects should have important scientific significance or promising prospect of application. Meanwhile, their funding is within our affordable power and we have considerable basis in these fields. In short, some are to be done and some others are not.

- **Giving full play to the advantage of intelligence, developing our own distinguishing features, and emphasizing innovation.** Hence, we will be able to make our own contributions to the international development of big science programs.

- **Opening big science program facilities both to domestic and overseas scientists.** We will not only welcome distinguished senior scientists, but also greatly support outstanding, young scientists.

- **Strengthening international cooperation through various means.**

In order to face the challenge of science and technology development in the 21st century, the Chinese government has approved several new big science facilities to be built by CAS in the next five years. Still, it takes up only a few percentages in the world's frontier big science programs in terms of funding scale. Hence, they can be also called "small-scale" big science facilities. They include:

- LAMOST (Large Area and Multi Object Survey Telescope)
- HeFei Synchrotron Radiation Facility (Second Phase)
- HIRFL-CSR (Heavy Ion Research Facility in Lanzhou-Cooler Storage Ring
- Superconducting Tokamak (HT-7U)
- Ground Meridian Chain for Comprehensive Monitoring of Eastern Hemisphere Space Environment
- R&D for Shanghai Synchrotron Radiation Facility

There are some other programs yet to be reviewed and approved.

CAS will seek international cooperation in the implementation of these programs. In addition, we are going to join the cooperation of some international big science programs within our power. Here are our tentative ideas and suggestions:

1. **We will cooperate with others in some selected international big science programs, mainly in those fields where we have comparative advantage and that coincide with our own priorities.** We will focus on intelligence input with limited capital investment. For instance, we cooperated with CERN in the work of CMS of LHC We invested some capital on the research and construction work of some components and managed to complete our part of cooperative tasks with lower costs as compared with international price. This is a so-called in-kind contribution.

We also sent groups of young scientists to RIKEN of Japan in the design work of the RIB Factory. We contributed and also received experience from RIKEN, which is beneficial to our design and building of the CSR.

2. **We encourage other countries' investments to build big science facilities in China.** This is due to China's special geographical advantages, or because of CAS' innovative technical design and basic infrastructure in these fields.

For instance, the Kilometer Square Area Radio Synthesis Telescope (KARST) is one of the four next generation radio astronomical facilities under consideration in the world. CAS has detected more than 400 Karst depressions in Guizhou Province in Southern China, which are suitable for spherical reflector radio telescopes with apertures ranging from 300 to 500 meters in diameter. We put forward the specific ARECIBO plans and took part in the discussion in the Working Group on Large Telescope of the International Union of Radio Science (URSI) and in the Large-radio Telescope Working Group (LTWG) of the OECD Megascience Forum. We welcome international investment to build this large radio telescope in China.

The Space Solar Telescope (SST) under R&D by CAS is an optical telescope with an aperture of 1 meter in diameter, which is to be put in the sun synchronous orbit. Its main characteristic is its high-resolution observation of the sun's magnetic field, which will reach a resolution of only 0.13 arc second. It is 10 times higher than the world's present level of 1.5 to 2 arc seconds. Meanwhile, by using the newly invented 2-D real time spectrograph, we expect to procure breakthrough in research in solar physics. A sample telescope with 0.8 meter aperture has been built and is going to have balloon tests. CAS, together with Max Planck Institute of Aeronomy of Germany, has already completed its Phase A assessment study. We welcome other countries to join in the cooperation.

We also welcome international investments in the following projects:

- A site good for optical astronomy has been found in Yunnan Province in Southern China. It has been suggested that a telescope of a middle scale aperture (2 or 3 meters) be built in his site with international collaboration.

- The Yang Ba Jing Cosmic Ray Observation Station in Tibet. The Cosmic Ray Research Institute of Tokyo University has invested and engaged in the construction of Extensive Airshower Array. INFN of Italy will also loin in the program soon.
- .
- Shanghai Synchrotron Radiation Facility (SSRF). The Chinese government has approved its R&D phase.

- Advanced Facility for Tau-Charm Physics Research (the tau-charm factory is a possible scheme). It has attracted attention from the world's high-energy physics community. Several international seminars have held and we are expecting to begin its R&D soon.

3. **We suggest that international big science programs initiate a series of projects whose aim is to train outstanding young scientists.** These projects might include:

- Accepting young scientist groups from cooperation member countries to participate in design, R&D, construction, operation and further study.
- Giving courses to train young scientists.
- Establishing a science fund for young scientists.
- Establishing scholarships for graduate students and post-docs.

Through these measures, the international frontier big science program will become not only the scientific research center in specific fields, but also the science exchange center and the senior-researcher-training center for all countries.

4. Share both facilities and data with the public. According to international practice, our experimental data are published for the convenience of the world's science community's use. At the same time, we are taking full advantages of the international big science program data, too.

5. According to different situation of each big science program, varying ways of cooperation, either bilateral or multilateral, should be adopted. As to some largest big science programs, it is helpful to call in the promotion and coordination by such multilateral organizations as OECD, APEC and ICSU