付 録A　外部評価委員会報告書

2008 (平成 20) 年 7 月, 東京大学大学院理学系研究科天文学専攻及び同天文学教育研究センターに対する 2 回目の外部評価を受けた. ここに外部評価委員会報告書を載せる. 2002 (平成 14) 年 3 月受けた 1 回目の外部評価については TAO プロジェクトブック I を参照.

Report of the External Review Commitee
for the
Department of Astronomy and the Institute of Astronomy
School of Schience, University of Tokyo.
July 2008

1. Introduction

This is the report of the second External review Commitee (ERC) for the Department of Astronomy (DoA) and the Institute of Astronomy (IoA), School of Science, University of Tokyo. The previous ERC ment in December, 2001 and submitted its report in March 2002. The 2008 ERC members are

Professors:

Toshinori Maihara (Chair)	Kyoto University/NRI Inc
Leonardo Bronfman	University of Chile
Hajime Inoue	Director, ISAS/JAXA
Hyung Mok Lee	Seoul National University
Shouken Miyama	Director, NAOJ
Peter Strittmatter	Steward Observatory, U. Arizona

The ERC met at the IoA in Mitaka on July 3$^{\rm rd}$/ 4$^{\rm th}$ 2008. Its report is based on presentations and follow up discussions at the meeting, detailed descriptions of the various program elements and statistical data contained in a specially prepared compendium entitled “Booklet for the External Review”[1] , interviews with Masters

[1]This material was provided to the ERC well before the meeting

and Doctoral students and a Post doctoral fellow, visits to several laboratories at IoA and follow up discusstions with Professor Yuzuru Yoshii (IoA Director) and Takashi Onaka (DoA Head).

The agenda as adopted by the ERC for the meeting is provided as Attachment A and differs in a few details from the original draft.

2. Review and Findings

Based on the presentations at the meeting and the very extensive program summary provided in the "Booklet", the ERC was very impressed with the breadth and quality of the astronomy programs at the University of Tokyo. The DoA / IoA are clearly maintaining the long tradition of excellence in astronomical research and teaching developed at the University of Tokyo since the founding of the DoA/Tokyo Astronomical Observatory in 1877/88 respectively.

2.1 Organizational Considerations. Following brief welcoming remarks by Professor T. Onaka and Professor Maihara (chair) and self-introductions by the participants, Vice-President/Professor S. Okamura provided a brief overview of the transition, initiated in 2004, of the University of Tokyo to a new organizational form as a National University Corporation. (This University transition followed another affecting the Tokyo Astronomy program, namely the abolition in 1988 of the Tokyo Astronomical Observatory and its reconstitution as the National Astronomical Observatory of Japan (NAOJ) — an Inter-University Research Institute.) Professor Okamura summarized the goals of the Corporation Law in terms of increased autonomy, flexibility and accountability for universities throughout Japan. He also spoke of the requirement for mid-term planning and evaluation, the steadily planned decrease in running budget and the growing need to finance research programs through competitive funding. It appears to the ERC that the situation with regard to DoA / IoA is still evolving amid some remaining uncertainty associated with the reform requirements. Despite these changes — and perhaps in some cases in response to them — DoA / IoA are continuing to develop programs designed to keep them in the forefront of international astronomical research. The ERC is, however, concerned about the planned budget cuts since this is occurring at precisely the time that astronomical research activity and hence competition is growing internationally.

2.2 Education Program. Professor Onaka gave a review of the educational program at the DoA and IoA. He also describe synergies with other departments / institutes within the University of Tokyo (the Research Center for the Early Universe, the Graduate School of Arts and Science and the Institute for the Physics and Mathematics of the Universe). In addition, he noted participation in the program by the cooperative staff at NAOJ and the Institute of Space and Astronautical Science (ISAS-JAXA) which together have provided a significant augmentation to personnel resources.

Student Population. The ERC received enrolment statistics for Undergraduate, Masters and Doctoral students since 2000. The ERC noted that student numbers have remained relatively stable over the last eight years as have the graduation success rate and the number of degrees awarded per year. The quality of the program continues to be maintained at a high level. The data do, however, show an unfortunate and continuing lack of female and international students and an overwhelming tendency of the students to remain at the University of Tokyo after graduation at the Bachelors or Masters level. Overall there appears to be little inclination for students to go overseas and correspondingly little interest on the part of overseas students in attending the University of Tokyo (data presented showed even fewer foreign students than females students).

Undergraduate Program Size. In regard to the undergraduate program, the DoA has succeeded in achieving a modest increase in the number of undergraduates by making special but temporary arrangements with the Department of Earth and Planetary Science thereby achieving an enrolment increase from the official 5 to the current 9-10 students per year. In consideration of the current staffing situation, the ERC recommends that the official number should be at least doubled.

At present there appears to be no astronomy component of undergraduate education in the "liberal arts" program for non-science students. The ERC suggests that such a program be considered as it might provide a valuable addition to the curriculum for non-science majors. It would also mesh with the University of Tokyo ' s stated principle that "*At the undergraduate level the University of Tokyo will adopt a flexible system integrating diverse and specialized education on a wide-ranging liberal arts foundation*"

Student Financial Support. The DoA / IoA expressed concerns about the level of financial support available to students, noting that with the exception of Ph.D. students with JSPS awards, the available support fell well below living costs let alone the cost of tuition. The ERC received data showing the relatively high tuition costs and low financial support in Japan as compared to the rest of the world — a state of affairs that does not augur well for the future and which certainly mitigates against foreign students attending Japanese universities.

Overall, however, the ERC concluded that the DoA / IoA programs at all educational levels continue to maintain their traditional high quality. Indeed the ERC believes that the DoA / IoA continues to play a leading role in inspiring and educating the next generation Japanese astronomers.

2.3 Research The ERC heard presentations from faculty members at DoA and at IoA on most of their areas of research activity. It also received a report on the programs and developments at the Kiso Observatory. Because of time constraints it was not possible to listen to presentations on all fields of active research at DoA / IoA / Kiso although this was to some extent mitigated by the extensive reports provided in the "Booklet". Overall the ERC was very positively impressed with the research being carried out within DoA / IoA / Kiso. The faculty members at DoA / IoA have selected their specific areas of research well, are clearly engaged in topics at the forefront of the field, and are contributing at a level having a strong impact at the international community. They are also making excellent use of Japan ' s Inter-University Research Institutes. The following report focuses on those areas on which presentations were made to the ERC - beginning with those from the DoA.

Some Research Activities at the Department of Astronomy

R1. Galaxies, Clusters of Galaxies and Observational Cosmology. The group led by Professors S. Okamura and K. Shimasaku has made numerous seminal contributions to the study of high red-shift galaxies. Using the Subaru telescope and other instruments they have determined the luminosity function, star formation rates and clustering properties of galaxies in the red-shift range $3 < z < 6$ and have discovered the so far highest known red-shift object at z = 6.96. They have documented the so-called "down-sizing" effect in which the more massive galaxies complete their star formation first. They have also carried out studies of more local galaxies and

their environs and, together with colleagues at IoA, are participants in the Sloan Digital Sky Survey. Their plans for future work involve exploration of galaxies at still higher red-shifts using a variety of instruments both ground-based and in space.

R2. Theory of Stellar Evolution, Supernovae, Gamma-ray Bursts and the Origin of the Elements. This research group is led by Professor K. Nomoto (recently transferred to the Institute for the Physics and Mathematics of the Universe) and has led to deep insights into the physics of supernovae (especially Type Ia which are the basis for current understandings of (dark energy) and hypernovae, the probable origin of some Gamma-ray Bursts (GRBs). They have been pioneers in the use of multi-dimensional hydrodynamic simulations to study these and other dynamic phenomena and are following up with observational work to test their conclusions. The group has also done important work on initially extremely metal poor (population III) stars, the evolution of which is key to understanding of the process of "metal" enrichment in the early universe. Some of the group ' s results were presented at the ERC meeting by Professor H. Umeda. Plans for the future involve studying the effects of rotation and magnetism in a number of these astrophysically very important phenomena.

R3. Infrared Astronomy and Laboratory Study. This effort, led by Professor T. Onaka, is focused on infrared observations from both space and ground-based telescopes to study the properties of interstellar matter in our Galaxy and in others close by. The group collaborates extensively with others both within Japan (IoA, ISAS, NAOJ, Ibaraki University.) and overseas (Korea, Europe and USA) and is involved in constructing hardware as well as in observation and analysis. Onaka was PI of IRTS, the first Japanese infrared space telescope, for which the Tokyo group developed the cryogenically cooled telescope and the mid-IR spectrometer. The instrument yielded important results on the mid-IR emission bands. More recently, the group has been heavily engaged in the AKARI project (formerly ASTRO-F). This ISAS/JAXA mission, which involves many international collaborators, is built around a cryogenically cooled SiC 0.68m Telescope developed by the U. Tokyo/ISAS group and was launched in 2006. It has successfully carried out an all sky survey at wavelengths between 9 and 160 microns and pointed observations with two focal plane instruments (one, the IRC, developed by the U. Tokyo group) until the liquid Helium boil off in August 2007. Akari is now operating only near infrared

instrument with the mechanical cooler. Professors Onaka and I. Sakon provided a sampling of AKARI results at the ERC meeting. These included a 9 micron all sky map, evidence of several new circumstellar disks, imaging of the Large Magellanic Cloud, new results on water/carbon dioxide ice in YSOs in the LMC and new data on dust formation around SN2006jc. The group has ambitious plans for future involvement in the SPICA project, a 3.5m cooled space telescope to be launched in 2017.

Some Research Activities at the Institute of Astronomy

R4. Progress from the last external review. Professor Yoshii provided the ERC with an overview of progress made at IoA since the 2002 ERC report. He first gave a short history of the IoA since its establishment in 1988, following the formation of the NAOJ from the Tokyo Astronomical Observatory. The mission of the IoA is: (1) observational research and education in astronomy; and (2) development of astronomical instruments. The research activities at IoA are organized into three basic areas (see below for reports) namely (a) Galactic and Extragalactic Astronomy; (b) Stellar Astrophysics; and (c) Radio Astronomy. In addition, the Kiso Observatory operates under IoA management. There is considerable collaboration with other groups especially the DoA and NAOJ. Particularly noteworthy accomplishments related to the MAGNUM (on Haleakala, Hawaii) and ASTE (on Pampa la Bola, Chile) projects

Professor Yoshii provided a list of instrumentation developments undertaken for the four areas into which IoA is organized. Each of the research teams has overseas collaborations, especially the Galactic and Radio groups. The ERC was impressed with the obviously strong working level cooperation among the various groups at Mitaka and with DoA and ISAS.

Professor Yoshii briefed the ERC on staffing changes at IoA since its establishment in 1988. In the meantime there has been a substantial renewal of staff at IoA while maintaining approximately constant numbers. A similar analysis at Kiso shows a 50

Finally the ERC reviewed data on the non-personnel funding of IoA, showing a rather modest but relatively stable level of basic funds. These are augmented by generally larger but more strongly variable grant funds and occasional modest fund-

ing from other institutes. The TAO project began to have a significant impact in 2007. Donor funding showed a peak associated with the MAGNUM telescope project and is anticipated to recommence at a significant rate with TAO

R5. Galactic and Extragalactic Astronomy. The impressive body of recent work by this group was presented by Professor Doi and is focused on quasars and supernovae. The IoA program is thus highly complementary with that of the DoA Extragalactic Astronomy group and permits an excellent coverage of extragalactic research for students at the University of Tokyo. We comment only on a few highlights here.

The MAGNUM telescope has been used by Professors Yoshii, Minezaki and colleagues to establish a correlation between the optical luminosity and the time interval between changes in primary optical and secondary infrared emission which arises from the distance at which the AGN dust torus can form. This in turn has implications for the cosmic distance scale. The remotely operated MAGNUM telescope has also produced important data on high red-shift GRB afterglows and multi-color spectral broadband supernova light curves.[2]
A second program (Professors Doi and Motohara) is part of the Supernova Cosmology Project and has used the Subaru and other telescopes to identify supernovae and to study their light curves. The same data set yields multiple faint variable objects, principally AGNs, which can be studied with the new 15 channel spectrophotometric CCD imager.
Professor Kawara and colleagues are studying the relative abundance Fe/Mg as a function of red-shift (cosmic time). They find that the Fe II remains strong even at high z contrary to initial expectations based on supernova lifetimes. Kobayashi and colleagues maintain an active program of QSO absorption line studies focusing on the NIR region at wavelengths 1.0-1.35 microns. A new higher resolution echelle spectrometer (WINERED) operating in this wavelength range is under construction for this purpose.
Finally the group has active collaborations with members of DoA in both galaxy evolution and supernova spectroscopy.

[2]During the presentation, the ERC learned that the MAGNUM telescope would have to be moved from its Haleakala site next year when its lease expires. Apparently the University of Hawaii host wishes to use the site for another purpose. Ioa is considering moving MAGNUM to Chajnantor, Chile.

R6. Radio Astronomy. Professor Kohno reported on the work which he and Professor Handa are carrying out, focusing on research in progress with ASTE and preparations for ALMA. The 10m ASTE has started its science operations in 2004 and can be operated remotely at its 4869m Atacama site. It has been conducting a large scale CO (J=3-2) imaging survey of nearby galaxies in order to compare its results with CO (J=1-0) data with the NRO 45m, placing constraints on mechanisms of star formation. The group has also collaborated with the University of Massachusetts to implement the AzTEC 144 pixel bolometer camera (at 230GHz). It has used this instrument to carry out a deep search for sub-millimeter galaxies (SMGs) and has achieved remarkable success with over 300-400 detections. By comparing with AKARI data, the group was able to conclude that most of the galaxies were at z ¿ 2. ASTE publications are now appearing at an accelerating pace. On the ALMA front the group has been demonstrating ALMA 230 GHz receivers using a test 60cm telescope. It is also involved in developing state-of-the-art THz receivers based on NbTiN junctions. Given the small size of the group, the ERC was very impressed with its accomplishments and its ambitious plans for the future. While the 2002 ERC goals of increasing effective use of ASTE and becoming more involved in ALMA have been realized, augmenting the group size has not.

R7. Stellar Astrophysics. Professor Kobayashi reported progress on behalf of his colleagues Professors Nakada, Tanabe, Tanaka and Miyata (IoA). The group is working on several projects using a range of telescopes and observing wavelengths. Nakada and Tanabe are studying NIR variables in the Magellanic Clouds and in globular clusters using the IRSF 1.4m (Nagoya) telescope in South Africa. They have discovered a new Mira sequence and a new Period-Ks relation for Type II Cepheids through RV Tau stars. Tanaka and colleagues are using the 1.5m IR simulator telescope (now at Hiroshima University) to study mass loss phenomena in stars using the NIR echelle spectrometer (NICE). The Miyata group is using Subaru/COMICS to study fossil dust emission in the environs of planetary nebulae, suggesting that SiC grains survive for longer than predicted (also true of CO molecules). Kobayashi and colleagues are studying star formation in the extreme outer regions of our Galaxy and have detected embedded clusters at distances exceeding 18kpc and in regions of sub-critical density.

R8. Kiso Observatory. The Kiso Observatory was established in 1974 and provides a useful, relatively dark and reasonably close venue for research, experimentation, education and outreach. It now has a 3 person local staff under Professor Kobayashi ' s direction and is operated out of IoA with assistance from Professors Kobayashi, Doi and Miyata. The base operating budget is $0.3M/year and it has a 1.05m Schmidt telescope with a 2K x 2K CCD. The facility is used for research in a "common-use" mode attracting some 20-30 research programs per year from around the country, resulting in 5-10 papers per year. The site is increasingly active in public education and outreach with programs for university and high-school students, making KISO one of the the most active astronomical outreach sites in Japan. The IoA/Kiso management proposes to continue mixed operations, retaining the "common-use" style for research, upgrading the CCD to 8K x 8K format (16 times the area) and enhancing the education and outreach programs. The ERC supports this plan

R9. Summation. The ERC recognized that the presentations covered only a sample of the broad research programs but these were sufficient to demonstrate that the staff at DoA and IoA are engaged in forefront topics at the international level. There is no doubt that the DoA / IoA are having a strong impact on the international astronomical community.

3.0 The Tokyo Atacama Telescope (TAO) — A major new initiative.

3.1 Overview. At its December 2001 meeting, the ERC learned initial plans for a University of Tokyo 6.5m infra-red optimized telescope at Cerro Chajnantor, a 5600m peak near the ALMA site in Chile. The Tokyo Atacama Observatory (TAO) telescope would, because of its location, provide unique capabilities at mid-infrared wavelengths and would provide enhanced performance over the entire IR range to beyond 30 microns. This ambitious concept was encouraged in the 2002 ERC report to move the project ahead by carrying out further studies and investigations; these included refinement of scientific goals, more detailed documentation of site conditions, furtherconsideration of telescope and instrument designs, development of institutional collaborations, and assessment of financial resources and appropriate man-power.

At the July 3rd/ 4th meeting, the 2008 ERC received a comprehensive status report on the TAO/Chajnantor program from Professor Doi. Additional information was

then provided in a follow up meeting on the second day afternoon by Professor Yoshii. From these reports it was clear to the ERC that the 6.5m telescope at the TAO site is viewed as the anchor telescope for the University of Tokyo in Chile. Moreover, it would be accompanied by other telescopes, including the 1m mini-TAO telescope now almost ready for installation and, possibly, a relocated MAGNUM telescope. It is also possible that other institutions/projects might locate at the Cerro Chajnantor site, for example the CCAT project (25m sub-millimeter telescope) of Cornell University and Caltech. There have also been encouraging developments in identifying private sources of funding for the TAO. With this evolution it appears that the University of Tokyo may be poised to develop its observatory in a manner modeled after Caltech ' s Palomar Observatory or, perhaps still more appropriately, Carnegie ' s Las Campanas Observatory. Given the benefits these institutions have derived from their investments, this is indeed an exciting prospect. Although the situations are different from those around U.S. universities, the ERC supports this new approach to project planning and implementation in Japan.

3.2 Progress Report. A brief summary of the progress made in regard to TAO and Cerro Chajnantor is provided below, as derived from Professor Doi ' s presentation.

Access. This has been improved enormously with the construction of a road, completed in May 2006, from the ALMA plain to the summit. With vehicular access now possible to the summit, it has become possible to install both weather and seeing monitoring equipment and a solar power generator. Together these mark a huge step forward. The road has also facilitated the access of other potential users, for example the CCAT project. (Note that agreements with other potential users of the site are the purview of the Republic of Chile, taking into account, of course, the interest of TAO.)

Site Characterization. While satellite studies of Cerro Chajnantor were started in 1993 and measurements from the Chajnantor Plateau have been in progress since 2001, in situ measurements have been accomplished only since 2006, when weather and cloud monitoring equipment and a DIMM seeing monitor could be installed at the summit. These instruments have provided confirmation of the excellent qualities of he site in regard to clear skies, low water vapor and good seeing (not statistically different from other Chilean sites as expected once the atmospheric

effects are dominated by high altitude turbulence). Wind speeds are typically 10 m/s (36 kph) but winds above 20 m/s are very rare. Some additional care may be needed in telescope and enclosure design for operations in typical conditions. The expected transparency provides strong encouragement for observations extending beyond 30 microns under the best conditions and with superb transparency below 25 microns even in median conditions. Indeed it appears that the Paschen alpha line at its rest wavelength of 1.87 microns will be observable from the site.

Mini-TAO (1m pilot telescope). The IoA has wisely decided to install a 1m pilot telescope at the site in order both to gain experience in working and operating at the site and to demonstrate the excellent site characteristics for IR observations. To that end, Mini-TAO telescope has been constructed by the Nishimura Co., Kyoto, Japan with funding through a JSPS grant. It is approaching completion at the plant and will hopefully be installed at the site in late 2008 or early 2009. In the meantime, two instruments are approaching completion namely: (a) the ANIR (Atacama Near-InfraRed) camera with a Hawaii2 and filters for Y, J, H, K, Paschen alpha (on and off) and Paschen beta; and (b) MAX38 a MIR camera for the wavelength range 10-38 microns, based on a 128x128 Si:Sb array and giving a 3.2 arcmin x 3.2 arcmin field of view. Both instruments are being tested at the "Kanata" 1.5m telescope of the Hiroshima Observatory and will be sent to Chile in early 2009.

The TAO 6.5m Telescope. As currently conceived the TAO is based on the Magellan telescope design with a 6.5m f/1.25 honeycomb primary mirror and an undersized adaptive secondary system providing a final f/15 focus. The TAO telescope would have three foci - two Nasmyth foci assigned respectively to a facility NIR instrument and an optical/visitor instrument and one Cassegrain focus for the facility MIR instrument. The telescope can thus be optimized for thermal infrared use beyond 2 microns and retain flexibility in operation.

Basic design information for the telescope and enclosure are being provided by the Magellan project but detailed design will be undertaken by the construction company selected for the task. Discussions have taken place with the Arizona Mirror Lab about providing the primary mirror and can proceed assuming that private funds become available as expected. Arizona will also assist, if needed, with the mirror support system and the adaptive secondary based on its experience at the MMT and LBT.

Site and Operations Arrangements in Chile. The IoA has performed very well in his relationship with the Chilean authorities regarding both the operations of University of Tokyo in Chile and the arrangements for the use of the site at Cerro Chajnantor.

For its operations in Chile, the University of Tokyo has signed an agreement of collaboration with the Universidad de Chile, which resulted in an official decree of the Ministry of Foreign Affairs, published in the Diario Oficial de la Repblica de Chile on 3 April 2007, allowing operation of the University of Tokyo in Chile subject to special benefits and prerogatives.

Regarding the use of the site, IoA-UT has asked in due time for all needed authorizations from CONICYT (Consejo Nacional de Ciencia y Tecnologa, Repblica de Chile), present holder of the land concession. IoA-UT has presented to CONICYT all the requested information in a timely manner, as well as reports of the activities both for the road construction and for the installation of mini-TAO.

The presence of IoA is also well perceived by the local communities in San Pedro de Atacama. The IoA representatives and scientists have made a good impression by inviting the local authorities to visit the site, as well as sharing important events, like the ceremony for the opening the road. It has become clear that UT has already purchased the land for the operation center of TAO/min-TAO, in the nearby town of San Pedro de Atacama, and that the construction of the center building is planned in the near future.

Instrumentation. The science priorities for an IR optimized telescope were enumerated at the 2001 ERC meeting and have, of course, evolved somewhat in the meantime. A new scientific focus for the MIR is the evolution of dust disks and pre-planetary systems, a focus re-enforced by the AKARI results noted above and results from Spitzer and Subaru. The IoA is therefore planning to construct, in collaboration with ISAS, a MIR high resolution camera and spectrograph to cover the wavelength range from 8-38 microns using Si:As and Si:Sb detector arrays and arranged to exploit 1 arcsec resolution at 38 microns. For the near infrared, IoA is planning to construct, in collaboration with NAOJ, a wide field multi-object spectrograph for the 0.9-2.5 micron band to exploit the superb transmission of the atmosphere at these wavelengths and the high spatial resolution provided by the adaptive secondary system. Among the scientific drivers is the study of galaxies

at medium red-shift (z= 1-3) to probe the evolution of "ordinary" galaxies. The ERC considers the instrumental plan well conceived and commends the decision to implement only a small number of facility instruments. This approach is both cost-effective and practical given the likely difficulty of operations at the high elevation site.

TAO and the Japanese Astronomy Community. In 2002, the ERC recommended a stronger interaction with the Japanese astronomical community than appeared to be the case at the time. The 2008 ERC is pleased to note the generally positive approach to TAO of members of the DoA and other Tokyo-based personnel with whom it met during its visit to Mitaka. It also noted the involvement of Hiroshima Observatory, ISAS and NAOJ in the instrument development for both mini-TAO and the latter two organizations in TAO instruments. The plan to make 40% of the TAO observing time available to other research institutions is a very important positive development and is strongly endorsed by the ERC.

The TAO Project — Organization and Style. This project represents a significant departure from normal international practice for constructing and operating large telescopes and is more closely akin to the university-style telescope developments in the U.S.A. Recent examples of the latter are the Hobby-Eberle Telescope, the MMT and, perhaps most relevant, the Magellan project. The latter resulted in two 6.5m telescopes at Las Campanas, Chile, funded through non-government sources from five participating institutions and constructed through a relatively small but extremely competent Carnegie-based project office staff that was free to make decisions without elaborate formal consultation. The Magellan project was completed under budget — albeit not on the initial schedule. Like Magellan, the TAO is a major undertaking that will require its own project office, presumably at Mitaka, but, given its presumed largely private funding, can and should proceed in a similar manner if it is to achieve its goals. The TAO project, both in construction and operation, will be different from the normal Professor-based research group, with which it can co-exist at the University of Tokyo much as it does at the Carnegie Observatory, Steward Observatory, Palomar etc. The presence of such a university-scale project at the University of Tokyo, will also have a profound effect long term on graduate students who will be able to participate in major observatory developments during their studies.

4.0 Summary of Findings and Recommendations

4.1 General. The ERC was very positively impressed with the overall DoA / IoA program in both education and research and with the collegial atmosphere in which it is being conducted. The ERC is also pleased to see the substantial progress in regard to the TAO project, which will give the University of Tokyo program a truly unique and internationally significant major long term focus. The University of Tokyo program exists in a global setting in which international interest and involvement in astronomy and astrophysics is growing rapidly. The ERC therefore urges that support for the DoA / IoA program be continued and strengthened. In the current global context, a program that is currently at the forefront will quickly be left behind unless it receives continued investment. In this sense, the ERC supports further efforts for additional funding from the Government (the Monkasho) to construct innovative TAO instruments which are crucial in gaining success of the project.

4.2 Education

On the basis of the materials provided and presentations made, the ERC:

- Believes that the DoA and IoA have been playing a leading role in inspiring and educating the next generation of Japanese astronomers. The quality of the academic program is high on the international scale.
- Encourages the university to increase the number of the undergraduate astronomy students from the current formal number of 5 per year to at least 10 per year in consideration of staff ' s capability and growing demand from potential students.
- Supports the efforts of DoA / IoA to improve the instruction of graduate students in instrumentation.
- Suggests that consideration be given to the introduction of a general astronomy course for non-science students within the liberal arts curriculum.
- Considers that the financial support for graduate students, especially in the Masters course, is not sufficient and needs to be augmented. Correction of this problem might generate more interest on the part of foreign students in doing graduate studies in Japan. (The ERC understands that current Japanese government policy has resulted in the least favorable ratio of tuition fees to financial support world-wide — at least from the student perspective.)

- Finds the English language capability of the graduate students to be inadequate given that English has become the international language of scientific communication in astronomy and astrophysics. Since the international astronomical research literature is overwhelmingly published in English, the ERC suggests that steps to be taken to improve this situation for the benefit of the students, perhaps by conducting journal clubs or similar meetings in English.

4.3 Research

After reviewing the research program, the ERC:

- Concludes that DoA / IoA faculty members have generally chosen excellent research fields in which to work and are contributing at a level that is having a strong impact internationally.
- Is impressed with the mutual collaboration among members of the DoA, IoA, NAOJ and ISAS (also with RCEU, IPMU etc) despite the geographical and institutional fragmentation that exists among them.
- Encourages continued development of further synergies with Physics, Chemistry and Biology, and suggests that consideration should be given to developing fields of astrochemistry and astrobiology.
- Believes that the program of instrumental development is of high quality and that the resultant instrumentation is generally being exploited in a scientifically productive way.
- Is impressed with the achievements made at ASTE within the last 3-4 years despite the relatively small staff working in this area. It notes especially results with the bolometer array obtained in collaboration with UMass and the much increased involvement with ALMA, working with NAOJ. (This success more than satisfies the recommendations of the 2002 ERC report and calls for more support for this area.)
- Supports the plan to continue scientific work at Kiso Observatory, especially if the new larger format CCD can be implemented soon. It also strongly supports the expansion of the public education and outreach program at Kiso and suggests that ways be investigated to raise more funds for the purpose — including contributions from scientifically oriented corporations and payments by visiting members of the public.

4.4 Future Plans — The Tokyo Atacama Observatory (TAO).

The ERC heard extensive presentations on the TAO project and:

- Recommends the TAO project (and in particular its 6.5m infrared optimized telescope) as a valuable scientific project providing a unique capability to the Japanese and world-wide astronomical community.
- Considers the site and telescope to be uniquely suited for the stated scientific goals.
- Realizes that site development has been proceeding successfully as have the relations with the host country, Chile, and that they intend to operate the TAO as far as possible remotely in the way in which this has been accomplished at MAGNUM and ASTE.
- Considers the step-by-step development approach, beginning with mini-TAO and associated instruments and potentially incorporating a relocated MAGNUM telescope to be appropriate.
- Is impressed to learn that TAO is being organized with an innovative strategy in regard to financing from the construction phase to initial operation. The TAO team recognizes that success will depend on assembling a lean, highly competent and dedicated core group to steer the project to fruition.
- Still has some concern about the heavy burden represented by the TAO 6.5m project even for the very active DoA / IoA team. In this regard, the ERC recommends that the team should consider reinforcing its capabilities, especially in the areas of project management and telescope engineering.
- Recommends that the TAO 6.5m team make use of appropriate external consultants and arrange regular progress reviews by outside experts.
- Notes that the TAO project has achieved enhanced status by providing more detailed goals and specifications of the TAO 6.5m and its instrumentation and by involving the Japanese astronomical community; both of these steps were recommended by the 2002 ERC report.
- Suggests continued efforts be made to broaden cooperation with and involvement of other organizations and institutes on an inter-university basis, especially in the areas of scientific collaboration and instrument development.
- Acknowledges the synergies of TAO with ASTE and ALMA in the southern hemisphere and the complementarity of TAO with Subaru in providing large telescope coverage of both hemispheres.
- Encourages efforts to collaborate with other universities from Japan at the University of Tokyo research facilities in the TAO/Chajnantor site.

4.5 Administrative/Financial Matters

Although it acknowledges that it could not, in the short time available, fully understand the role of MEXT, the implications of the Corporation Law or the administrative structure of the University of Tokyo, the ERC:

- Is concerned about the continuing budget cuts and the consequent reduction of staff numbers. This seems inappropriate at a time when basic science including astronomy and astrophysics is expanding internationally. It is especially difficult for an already relatively small (but very productive) group such as DoA / IoA. The Committee requests the School of Science to take some positive measures in regard to this matter.
- Is satisfied with the successful efforts made by DoA / IoA in securing financial support through competitive external funding sources. (This is a case when reduction of staff leads directly to loss of research income).

5. Acknowledgements

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図 5: miniTAO 望遠鏡完成を記念してチリ郵政局より発行された記念切手, 小型シート, 封筒.