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Committee on the Peaceful Uses of Outer Space

Report on the Eighth United Nations/European Space Agency Workshop on Basic Space Science: Scientific Exploration from Space, hosted by the Institute of Astronomy and Space Sciences at Al al-Bayt University on behalf of the Government of Jordan

(Mafraq, Jordan, 13-17 March 1999)

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I. Introduction

A. Background and objectives

1. In its resolution 37/90 of 10 December 1982, the General Assembly decided, upon the recommendation of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82),[1] that the United Nations Programme on Space Applications should promote greater cooperation in space science and technology between industrialized and developing countries as well as among developing countries.

2. At its forty-first session, in 1998, the Committee on the Peaceful Uses of Outer Space took note of the programme of workshops, training courses and seminars proposed for 1999,[2] as outlined by the Expert on Space Applications (see A/AC.105/693 and Corr.1, sect. I). Subsequently, the General Assembly, in its resolution 53/45 of 3 December 1998, endorsed the United Nations Programme on Space Applications for 1999.

3. Pursuant to General Assembly resolution 53/45 and in accordance with the recommendation of UNISPACE 82, the Eighth United Nations/European Space Agency (ESA) Workshop on Basic Space Science: Scientific Exploration from Space was organized by the United Nations, ESA and the Government of Jordan at the Institute of Astronomy and Space Sciences at Al al-Bayt University, in Mafraq, Jordan, from 13 to 17 March 1999. The workshop was co-organized by the Austrian Space Agency, the Centre national d'études spatiales of France, the German Space Agency, the International Astronomical Union, the National Aeronautics and Space Administration (NASA) of the United States of America and the Planetary Society. The Institute of Astronomy and Space Sciences at Al al-Bayt University acted as host of the workshop on behalf of the Government of Jordan. The workshop continued the series of United Nations/ESA workshops on basic space science, organized for the benefit of developing countries in India in 1991 and Sri Lanka in 1996 for Asia and the Pacific (see A/AC.105/489 and A/AC.105/640); in Colombia and Costa Rica in 1992 and Honduras in 1997 for Latin America and the Caribbean (see A/AC.105/530 and A/AC.105/682); in Nigeria in 1993 for Africa (see A/AC.105/560/Add.1); in Egypt in 1994 for western Asia (see A/AC.105/580); and in Germany in 1996 for Europe (see A/AC.105/657).

4. The main objective of the workshop was to provide a forum to highlight recent scientific results obtained using major space-based observatories in studies of the stars and the far reaches of the universe. Such satellite missions constitute an impressive means of studying all aspects of basic space science from space as a complement to studies being done from the ground. The question of the large volumes of data generated by such missions was discussed in relation to changing research needs within the scientific community, as was how access to the important databases maintained by major space agencies could be facilitated. The importance of data research and education based on space missions was discussed, together with the relevance of such missions to the needs of developing countries wishing to participate actively in the voyage of discovery through the universe. Future access to space by means, for example, of a world space observatory was seen as crucial. Anticipated long-term developments will necessitate early planning and an examination of the capabilities associated with the running of such an observatory.

5. The present report was prepared for the Committee on the Peaceful Uses of Outer Space at its forty-third session and the Scientific and Technical Subcommittee at its thirty-seventh session. The proceedings of the workshop will be made available later.

B. Programme

6. At the opening of the workshop, introductory statements were made by representatives of Al al-Bayt University, ESA and the United Nations. The workshop was divided into scientific sessions and working group sessions, each focusing on a specific issue. Presentations by invited speakers describing the status of their findings in research and education were followed by brief discussions. Sixty papers were presented by invited speakers from both developing and industrialized countries.

7. The workshop sessions focused on (a) the Sun, the 1999 solar eclipse and exploration of the solar system; (b) astronomical satellite missions and the related databases; (c) small astronomical telescopes in education and research and networking of optical and radio telescopes; and (d) astrophysics and cosmology. Poster sessions and working group sessions provided an opportunity to focus on urgent problems and projects in basic space science. The 120th anniversary of the birth of Albert Einstein on 14 March 1999 was commemorated by a special lecture delivered by an eminent scholar from Yarmouk University in Irbid, Jordan, on the reception given to Einstein's work in the Arab world.

C. Attendance

8. Researchers and educators from developing and industrialized countries in all economic regions, but in particular from western Asia, were invited by the United Nations and ESA to participate in the workshop. Participants held positions at universities, research institutions, observatories, national space agencies and international organizations and in private industry, and were involved in all the aspects of basic space science covered by the workshop. Participants were selected on the basis of their scientific background and their experience with programmes and projects in which basic space science played a leading role.

9. Funds allocated by the United Nations, ESA and Al al-Bayt University were used to cover travel and other costs of participants from developing countries. Some 95 specialists and students of basic space science attended the workshop.

10. The following 35 Member States were represented at the workshop: Algeria, Armenia, Australia, Austria, Denmark, Egypt, France, Germany, Guatemala, Hungary, India, Iran (Islamic Republic of), Iraq, Italy, Japan, Jordan, Kuwait, Lebanon, Luxembourg, Mauritius, Mexico, Morocco, Nigeria, Palestine, Panama, Philippines, Poland, Romania, Russian Federation, Spain, Syrian Arab Republic, United Kingdom of Great Britain and Northern Ireland, United States of America, Uruguay and Zambia.

II. Observations and recommendations

11. Participants at the workshop noted with satisfaction:

(a) The progress made in all regions in education in basic space science and the heightened level of awareness of its importance, especially as promoted by the series of United Nations/ESA workshops at the national and regional levels. The workshops had acted as an important stimulus to activities aimed at achieving the long-term goals of sustainable development, as highlighted in the reports of the previous workshops (see para. 3 above and bibliography);

(b) The efforts that had been made to make fully operational the 40-cm telescope at Al al-Bayt University in Mafraq and the 31-m Baquaa radio telescope at the University of Jordan in Amman, which will serve both for educational purposes and in scientific research. Those efforts constituted an important step in a broad-based educational process in basic space science and represented a significant element in multidisciplinary training to enable scientists from developing countries to participate in basic space science projects at both regional and international levels;

(c) The role of the regional centres for space science and technology education in addressing the problem of employment opportunities in basic space science in the developing countries at the regional level. It was noted with concern, however, that generally their work had received limited attention at the national level. It was noted that the creation of employment possibilities in basic space science was a precondition to ensuring balanced development and avoiding the loss of investment in high-level training when those who had benefited from it were obliged to find work in other fields. The absence of national opportunities in basic space science could introduce a destabilizing element in an otherwise well- balanced programme of sustainable development;

(d) The progress made towards full participation by developing countries in pioneering science projects and the continued efforts as regards graduate education exemplified by activities such as the Network of Oriental Robotic Telescopes (see A/AC.105/682, paras. 53-57) and the regional project for Mediterranean astronomy (MAN 2000), as well as the development of a radio telescope as part of a larger international interferometry network. In that context, it was also noted that the world space observatory (see A/AC.105/682, paras. 22-34) represented a unique possibility for equal participation, at levels appropriate to the capacity of each country, in advanced basic space science, for example, space astrophysics, with such participation starting at the earliest stages of a project and including the process of discovery related to the scientific and cultural application of human curiosity to fundamental questions related to man's place in the universe. The feasibility of the establishment of a world space observatory would be explored further at the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III, A/CONF.184/3 and Corr.1, para. 186).

III. Summary of presentations

A. Basic space science and society

12. Answering questions about the universe challenges astronomers, fascinates a broad national audience and

inspires young people to pursue careers in engineering, mathematics and science. Basic space science research assists nations, directly and indirectly, in achieving societal goals. For example, studies of the Sun, the planets and the stars have led to experimental techniques for the investigation of the Earth's environment and to a broader perspective from which to consider terrestrial environmental concerns such as ozone depletion and the greenhouse effect.

B. The place of planet Earth in the universe

13. Basic space science addresses questions about the origin and evolution of the planets, the stars and the universe. Over the course of the twentieth century it has become evident that the climates and weather patterns of the planets of the solar system are driven by many of the same physical processes that determine the Earth's environment; that stars form out of clouds of gas and eventually die either in quiet solitude or in spectacular explosions; that most of the common chemical elements are created in explosions of stars; that stars group together in isolated galaxies; that galaxies and clusters of them stretch in sheets and filaments as far as the largest telescopes can see; and that the universe itself came into existence in a violent explosion some 15 billion years ago. Most amazingly, it has become clear that the laws of nature that humans have discovered on Earth apply without modification to the furthest reaches of the observable universe.

C. International cooperation

14. The international basic space science community has long shown leadership in initiating international collaboration and cooperation. Forums have been established on a regular basis in which the basic space science community has publicized its scientific achievements and the international character of astronomical study. The most recent such initiative was the International Space Year (1992), with its elements Mission to Planet Earth and Mission to the Universe. The scientific side of the latter was represented by an international array of space satellite missions operating during 1992. Many other new satellites have been launched during the 1990s.

15. Research in basic space science is an international enterprise. Recent examples of successful international collaboration include the International Ultraviolet Explorer, the Hubble space telescope and the International Space Station. International cooperation in building major facilities is most effective when the project draws on the complementary capabilities of different nations, or when the project would be too expensive for individual nations to afford or if the international cooperative initiative itself represents a major challenge for human beings to achieve a particular goal.

16. The implementation of the recommendations of the workshops organized since 1991 by the United Nations, through the Office for Outer Space Affairs of the Secretariat, and ESA has strengthened scientific infrastructure in developing countries. One of the proposals made by workshop participants has been to set up a world space observatory, a small satellite mission focusing on the ultraviolet segment of the electromagnetic spectrum, with international participation, including that of developing countries.

D. Basic space science as a national asset

17. Basic space science makes humanistic, educational and technical contributions to society. The most fundamental contribution of basic space science is that it provides modern answers to questions about humanity's place in the universe. Quantitative answers can now be found to questions about which ancient philosophers could only speculate. In addition to satisfying curiosity about the universe, basic space science nourishes a scientific outlook in society at large. Society invests in basic space science research and receives an important dividend in the form of education, both formally through instruction in schools, colleges and universities, and more informally through television programmes, popular books and magazines and planetarium presentations. Basic space science introduces young people to quantitative reasoning and also contributes to areas of more immediate practicality, including industry, medicine and the understanding of the Earth's environment.

IV. World space observatory: using science to stimulate sustainable development—an appraisal

18. One conclusion of the United Nations/ESA workshops on basic space science has been a realization of the importance of the incorporation of basic space science into sustainable development plans. The rationale behind this may be summarized as follows. The world space observatory

has been proposed as an important and effective means of establishing some of the necessary structures, not only for the benefit of the scientific community, but also for nations wishing to use space applications in the interest of accelerated and sustainable development. In the following section the nature of a generic world space observatory is described and a possible implementation strategy proposed.

A. Introduction

19. The post-industrial times, approaching the beginning of the next millennium, are going to bring with them one of the most important challenges ever presented to the world at large. Although globalization is driving the current economic and sociological evolution of the industrialized world, regional cultural identity still represents an extraordinarily strong force in the world. Events of the last decade have shown dramatically the strength of such human forces, which defy quantitative analysis and the absence of proper consideration of them has been one of the main problems associated with the implementation of sustainable development programmes in the second half of the twentieth century. It is now widely recognized that the implementation of sustainable development schemes will have to be based on original and innovative approaches to the development process, where sharing must be an integral part of the support given by the industrialized world.

20. History has shown that development in a socially peaceful environment is extremely difficult to achieve and that revolutionary changes, driven by intellectually advanced (and at times extreme) ideas, can become dominant. It must therefore be concluded that sustainable, culturally appropriate and sociologically stable development can only be brought about when the educational processes required for development lead to professional outlets for those whose motivation for learning and development has a broader meaning than arrival at an often locally defined socio-economic status.

21. As a consequence of the current development strategies in many developing countries, significant investment in education is not bearing the desired fruits. The reason for this is closely associated with the fact that participation in advanced science can only function efficiently in the industrialized world. Consequently, investment in education often results only in the creation of a consumer market, without the creation of the professionally well-formed, culturally and intellectually identifiable and academically oriented cadre of scientists that is necessary for sustainable development. In hindsight, it is very clear that the success of the industrial revolution was based on a fruitful interplay between the academic community and the commercial sector of the population.

22. It is remarkable that, without the relatively small fraction of the population driven by the pursuit of intellectual progress, such a synergetic process cannot be sustained in the context of its original socio-cultural climate. For the required accelerated and sustainable development essential for all future projections of the world economy during the next century to have any chance of success, quantum leaps in development in various areas are essential. Many of the areas in which such advances can be feasible and practicable are associated with space activities. In particular, space activities will allow basic space scientists to share access to and use of advanced scientific discovery without economically crippling national investment and, at the same time, will support education and encourage the development of infrastructure, which is beneficial to the whole population. Space activities can also supply mechanisms to retain the most highly trained people within the developing countries through the creation of satisfactory career paths. In this way national participation in the most advanced scientific activities can be assured and nationals of developing countries can become an active and integral part of the important group of internationally recognized and competitive associations of researchers in many fields.

23. Over the centuries, astronomy has played a major cultural role as the predecessor of all scientific and philosophical development in basic space science. This is because it uses scientific method to approach a most fundamental question, basic to many religious as well as non-religious philosophical concepts: What is the place of the people of planet Earth in the universe?

24. During the United Nations/ESA workshops on basic space science, the concept of a world space observatory has been recognized as an important tool to bring about the desired quantum leaps in development identified above.

25. The world space observatory embodies a twofold goal:

(a) To create opportunities for participation at the frontiers of science, on a sustainable basis and at the national level, by all countries in the world without the need for excessive investment. In so doing, the observatory will make an important contribution to the development of an academically mature and competitive cadre in many developing countries within 5 to 10 years after inception of the project by offering equal opportunities to astronomers all over the world;

(b) To support worldwide collaboration and to ensure that the study of the mysteries of the universe from space can be maintained in a sustainable way by scientists from all countries. This will then not only maintain the curiosity-driven spirit of discovery that is an integral part of sustainable development, but also make a reality in the scientific world of the visionary principle that space is the province of all mankind.

B. The world space observatory: from concept to reality

26. The world space observatory would consist of a satellite observatory in a context that extends beyond the normal planning of the major space agencies. The new approach incorporated into the planning and launching of the world space observatory could result in significant cost savings as well as facilitate to a considerable decree the participation in the space sciences of currently non-“space-faring” nations. It would thus contribute to vigorous space science activity in the future.

27. The model selected will constitute a missing element in the range of tools available at present to the astrophysical community for the exploration of the universe, extending from the near solar environment to the far distant phases of evolution, when the basic building blocks of human life were being created. Even though the world space observatory has, in the first instance, been defined in the context of the ultraviolet domain, the extension of the concept to other areas that require operations based in space would be an obvious bonus that could have a major impact on the way in which research in basic space science is conducted worldwide.

28. The scientific needs in the ultraviolet domain have been clearly expressed by the international astrophysics community, as, for example, in the discussion at the ESA/NASA conference held in Seville, Spain, in November 1997.[3] A working group was established with the following mandate:

(a) To define a conceptual baseline from which to determine the issues and scientific areas in which such an observatory could have a major impact;

(b) To evaluate and define the possible applications of innovative organizational and other configurations in a world space observatory;

(c) To prepare for the presentation of the goals of the world space observatory to UNISPACE III (see A/CONF.184/3, para. 186) as a major activity in the context of the space sciences with the active participation of developing countries.

(a) Scientific objectives

29. The scientific objectives of the activities of the observatory in the ultraviolet domain can be summarized as follows:

(a) To observe ultraviolet absorption lines in the intergalactic medium, from which to determine the evolution in chemical element abundances;

(b) To trace the history of star formation in the closer reaches of the universe (at red shifts of less than 4), which covers some 80 per cent of the age of the universe and is essential for an understanding of the early phases of the evolution of matter;

(c) To identify possible candidates for primitive solar systems amongst the stars, by attempting to discover dust disks around stars of all types;

(d) To produce a time chart of magnetospheric interactions between the solar wind and planetary magnetospheres, as well as to investigate the associated mechanisms for deposition energy in the upper atmospheres of the planets, leading to a better understanding of atmospheric and magnetospheric phenomena on Earth;

(e) To provide a quick reaction facility for the study of important targets of global interest, such as near-Earth objects and comets, which may change trajectory as a result of sudden temporary outgassing.

(b) Mission concept

30. The driving principles behind the design of the ultraviolet element are:

(a) Operation of a 1-2 metre-class telescope in Earth orbit with a spectroscopic and imaging capacity specific to the ultraviolet domain (91.2-360 nanometres (nm));

(b) High throughput and optimized operational and orbital efficiency;

(c) Optimum benefit to be derived from the fact that ultraviolet cosmic background radiation is at a minimum around 200 nm;

(d) Minimal operational costs without affecting the scientific excellence of mission products;

(e) Direct access to basic space science for the international astrophysics and planetary science community;

(f) Limitation of the technological developments needed for a prime science mission;

(g) In-orbit integration of the major components of the mission.

31. To reach the scientific goals and objectives of the mission, the project should be structured in an integrated manner, that is, contributions to project development would be integrated internationally on the basis of an evaluation of the capability of individual participants. This would mean integration of all activities on an international level—science, operations, data collection and maintenance and training—and would allow the international community as a whole to benefit directly from the innovative operational model used in the world space observatory.

(c) Operational principles

32. In accordance with the objectives described above, the following mission operations profile is proposed:

(a) Application of innovative engineering and management methods in order to combine the various contributions of all nations participating as appropriate to their capability;

(b) Establishment of national scientific operations centres in all countries;

(c) Spacecraft operations to be carried out by an integrated network of mission operations centres in the main nations contributing to implementation of the mission in accordance with final orbit requirements;

(d) Location of the organizational structure where maximum scientific, educational and public participation can be assured.

33. This will require:

(a) Establishment of a number of scientific operations centres in all countries expressing the wish to host them, independent of their direct contribution to the implementation of the project;

(b) Centralization of a small number of mission operations centres to perform the minimal functions required to operate the mission;

(c) Integration of the work of all the centres involved. Because of the worldwide distribution of the scientific operations centres, special attention will need to be paid to the coordination of their activities and to links with other satellite missions and terrestrial facilities;

(d) Open access to data collected. To guarantee optimal use of the scientific data obtained by the mission, all data will be in the public domain. The scientific operations centres will publish their data after processing and quality control.

34. The concept of a world space observatory is based on:

(a) Efficient observatory-like access to space;

(b) Allowing scientists from developing countries to participate in cutting-edge astrophysics in their own cultural environment;

(c) Maintaining the random nature of space astrophysics and catering to the needs of ultraviolet astronomy beyond the specialized capabilities of existing and currently planned missions.

35. At the present stage, the world space observatory is concerned as a free-flying satellite with in-orbit assembly that would operate within the framework of the International Space Station. This could open the way for many other possibilities that would otherwise be impossible to implement because of the excessive requirements of monolithic launches.

Notes

[1] See *Report of the Second United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 9-21 August 1982* (A/CONF.101/10 and Corr.1 and 2), para. 430.

[2] *Official Records of the General Assembly, Fifty-third Session, Supplement No. 20* (A/53/20), paras. 48-67.

[3] European Space Agency, Ultraviolet astrophysics beyond the IUE final archive: proceedings of the conference, held at Sevilla, Spain, 11-14 November 1997, W. Wamsteker and R. Gonzalez Riestra, *eds*. (SP-413), pp. 849-855.

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