Teaching of Astronomy in Asian-Pacific Region

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Syuzo ISOBE

Chairman of Teaching of Astronomy
in the Asian-Pacific Region

Preface

Publication of this Bulletin was started in February, 1990, after the Asian-Pacific regional meeting of the International Astronomical Union held in Beijing in October, 1987. Originally we thought two volumes of the Bulletin would be published every year, but because of shortage of papers present to this editor we now reach Volume No. 17 after 11 years. This bulletin has a name of Teaching of Astronomy in Asian-Pacific region, but since this bulletin is practically only one regular journal for astronomy education, contributions from all over the world are welcome. This editor would like to continue this publication and wait for many presentations of astronomy education paper.

January 31, 2001

Syuzo ISOBE
National Astronomical Observatory of Japan
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Conceptual Approach To Astronomy And Space Science Education On The Undergraduate Level

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ABSTRACT

An approach is developed in which major dynamical and physical concepts of astronomy and space science are used to build up a scheme (prototype model) for their education on the undergraduate level. It has been shown a way to teach different theories, their applications and observational facts in which those concepts are built in or used, within the suggested educational scheme.

The computational techniques which are needed in astronomy and space science are discussed at which steps through the suggested educational scheme might be introduced.

1. Introduction:

Education of any specialization through its concepts and not through subjects is, relatively, a new trend in developed world. This approach possesses several advantages in comparison with the standard educational subjects approach. These advantages can be summarized briefly as follows:

1.Creating an integrated specialist who knows how several concepts do work in different subjects.

2.Increasing the capabilities of lecturers in understanding and teaching parts from several subjects using concepts which are well know to them in one subject.

3.Saving time for more educational material to be taught for students. These advantages can be tested and verified by using any suitable "lecture feedback project" (cf. Hodgson and Mc Connell (1980)).

In this paper a conceptual approach (prototype model) for astronomy and space science education is developed. In sections 2, 3 the major dynamical and physical concepts of astronomy and space science are exposed in a way to build up a scheme for education of gravitational dynamics and physics and their applications in understanding different natural or artificial systems in the universe. In section 4 a prototype model for educational scheme via concepts is proposed for six semesters.

2. Major Dynamical And Physical Concepts Of Astronomy:

The suggested conceptual approach is based on considering the major building blocks of astronomy to be its major dynamical and physical concepts, for the purpose of building several educational structures (modules) on the undergraduate level to have graduates with certain specifications. Those modules are constructed according to fulfil several jobs description in astronomy.

One of the important facts which should be realized by astronomy students is; the observational studies are not sufficient to understand the time evolution of fundamental processes occurring in or to different cosmic structures. But the observational studies are necessary for the confrontation between different theories; which are constructed to help in understanding the dynamical and physical properties of different celestial systems; and observations. Therefore, there should be an independent, integrated and unified way which is different from the observational studies, but consistent with them. This is one of several major concepts of astronomy which are going to be exposed in the following subsections.

2.1 Concept Of Degrees Of Freedom Of A System:

Astronomy students should realize that degrees of freedom of any system are nothing more than its dynamical and physical properties (variables). Those properties should be represented by mathematical quantities like scalars, vectors, tensors of second order, spinors or specific elements of certain geometrical or algebraic structures. They should learn how to use those degrees of freedom to define measurable quantities which characterizes the dynamical and physical status of the considered system. Also, it is important to learn students how one can determine the independent dynamical and physical degrees freedom for different systems (e.g. examples from Newtonian mechanics, planetary theory, satellite theory, stellar structure and atmosphere theories, galactic dynamics, cosmology). (cf. Kaufmann (1994)).

2.2 Concept Of Constructing A Dynamical And (Or) Physical Theory For A System Using Its Degrees Of Freedom:

After the students learn how one can determine the independent degrees of freedom for any system, they should learn how to construct a dynamical and (or) physical theory for a system using its degrees of freedom. The students should know that all existing successful dynamical and physical theories are constructed using the least action principle (Hamilton's principle). The least action principle is the principle which all dynamical and physical systems do follow.

The students should be familiar with the fact that this procedure will lead to differential equations for the dynamical and physical degrees of freedom of the system under consideration. The solution of these equations will lead to know exactly the dynamical and physical status of any system at any value of the considerd evolution parameter. In this context, students should learn different analytical and numerical techniques of solving ordinary and partial differential equations.

The students should know the equivalent way of constructing a theory using the Hamiltanion formalism passing by the Hamilton-Jacobi approach.

They should realize and learn how one can distinguish between linear theories which deal with linear phenomena (e.g.Newtonian mechanics, hydrodynamics, electrodynamics ,...) and non-linear theories which deal with non-linear phenomena (e.g. general theory of relativity). A very good example of such type of phenomena is the phenomenon of planets advance of perihelia. This phenomenon is of pure non-linear origine which is well understood using a non-linear theory of gravity which is the general relativity .

Also, students should realize the fact that using the perturbation techniques for the purpose of allowing linear theories the adoption of effects of pure non-linear origine is not generally acceptable due to fact that this approach is not capable to explain all non-linear effects on certain systems (e.g. the phenomena of gravitational red shift, spin retrograd motion of planets and the planets advance of prehelia, can not be obtained from perturbed Newtonian mechanics).

2.3 Concept Of Isolated And Interacting Systems:

Astronomy students should realize, while studying different theories for different celestial systems, whether the system under consideration is considered to be an isolated or interacting with other systems or is embeded in other system or is dominating other systems. Several examples should be taught to the students from universe, clusters of galaxies, galaxies, clusters of stars, stars, star-planets system and planet-satellites system; which can be considered as individual systems or interacting binaries, triplet ...etc. The students should learn how to add new degrees of freedom to describe different interactions and influences. Here, they should feel measurable, negligible effects and accuracy of theoretical predictions in confrontation with observations. At this point, students should learn numerical techniques and data analysis methods.

In this context, some interesting cases should be investigated by students and lecturers when two interacting systems are described satisfactorily by two different theories. For instance, the motion of photons and neutrinos in gravitational field at certain celestial objects.

2.4 Concept Of Formation, Evolution And Stability Of Systems:

Students should learn the physical and dynamical conditions leading to formation of celestial systems like universe, galaxies, stars, planets... etc. They should study using the second concept; the evolution of a system via the evolution of its dynamical and physical properties . In this context, students should learn how to calculate the life time of certain system. Also, they should study whether it is possible; always; to trace back the properties of any system to be aware of their primordial values.

They should realize that a theory describing a system in a certain phase may not be suitable for its description in another phase. for instance , systems started as classical systems, i.e. well understood using classical physics, and then converted to be a quantum system, i.e. well understood using quantum physics; like a star when it is becoming a neutron star. Also, systems started as quantum systems and then converted to classical systems, like the universe.

2.5 Concept Of Conservations And Invariancies Of Different Properties Of Systems Through Their Evolution:

Students should learn the way to know and construct conservative and invariant properties of a system. For instance, systems's energy budget and momentum.

2.6 Concept Of Initial And Boundary Value Problems:

Students should learn how to use the observational data as initial values for physical and dynamical variables which are involved in different theories (differential equations) describing different systems in the universe. Besides that, they should learn the mathematical techniques of boundary value problems and their application in stellar, galactic and cosmic issues.

2.7 Concept of Symmetrical Properties Of A system:

Students should learn the impact of the deviation form ideal symmetric properties of certain system on structures formation inside it. For instance, the universe as a non-homogeneous and anisotropic system containing all other cosmic systems. Also, the impact of the environment, in which a galaxy was formed, on determining different morphological types of galaxies.

At the end of this section, it is worth to point out that astronomy students should be familiar with the way of how the previous concepts are elaborated in different theories which are used and applied in astronomy to understand the dynamics and physics of different cosmic structures and phenomena. Therefore, by the end of the undergraduate level, students should be familiar with the different astronomical applications of the following theories:

1. Newtonian mechanics, 2. Hydrodynamics, 3. Thermodynamics,

4. Electrodynamics, 5. Magneto hydrodynamics, 6. Plasma physics,

7. Quantum mechanics and 8. General relativity.

3. Major Dynamical, Physical And Technological Concepts Of Space Science:

Space science is a good example as a science in which many and different concepts of different sciences are integrated and used to build up an educational scheme for it. The major building blocks of space science are exposed in the following subsections.

3.1 Concept of an Object Orbiting Around A source of Gravity:

Space science students should learn how one can choose an orbit for an object; having certain geometrical shape (e.g. sphere, cylinder, … etc. to move arround the earth to fulfil certain objectives. They should realize that all major concepts of astronomy should be used to do such job taking into consideration:

1.The earth's oblatness at the equator, **2.** The earth's atmosphere drag force, **3.** The earth's magnetic field and 4.The direct and indirect solar radiation pressure. They should realize that the satellite is not an isolated system and has six degrees of freedom (its position and velocity in space).

3.2 Concept Of The Needed Energy To Put A Satellite On Its Chosen Orbit:

In this context, students should learn how to calculate the amount of the needed fuel for the carrier of the satellite besides the needed stages; via a multistage carrier; and the initial trajectories to reach its chosen orbit.

3.3 Concept Of Optimization;

Students should learn how to use the optimization techniques to determine the best latitude, time and initial angle for launching and the best angles for maneuvering within the satellite's trip to its chosen orbit.

3.4 Concepts Of Designing The Satellite's Geometrical Shape And Choosing The Used Materials:

Students should study physical and chemical properties of different materials, e.g. rigidity, elasticity, conductivity, ability of bearing high and low temperature and the ability of resisting against all existing different hazards in space. In this context, students should study space physics in a way to know the different hazards that can meet the satellite. Therefore, they should study vibrational mechanics and aerodynamics. Moreover, they should study material science and failure analysis for different materials for the purpose of choosing some of them to have the best performance, either for the satellite's structure or for the payload of different instruments.

3.5 Concept Of Stability And Life Time:

students should study factors affecting the satellite's life time and the order of magnitude of each factor relative to others. Theory of stability of differential equations and catastrophe theory are useful to be taught, in this context.

3.6 Concept Of Guidance And Automatic Control:

Here, it comes the role of communication science, electronics, software programming and hardware engineering to transmit orders, data and information from the satellite to ground stations and vice versa. Students should learn how to find the difference between the elements of the actual orbit; via tracking stations; and the calculated one. Then, they should learn how to build in (design) a software in the satellite and the ground stations, to be used to modify the orientation and the position of the satellite to the desired values.

3.7 Concept Of Transmission Of Data And Information:

Students should learn finite mathematics and its applications in digital technology of transmitting data and information from the satellite to ground stations and vice verse (up and down links).

By the end of this section, it is important to point out the possibility of designing different educational modules, using some of the major concepts from astronomy and others from space science or only some of space science, according to different jobs description in space and ground segments.

Here, it is worth to point out that by the end of the undergraduate studies, space science students should be familiar with the relevant applications of the following theories: 1. Newtonian mechanics,

2. Aerodynamics, 3. Electromagnetic theory of radiation, 4. Propulsion and energy transformations (thermodynamics), 5. Optimization, 6. Automatic control, 7. Stability and 8. Special and general relativity.

4. Prototype Model For Educational Scheme Via Concepts:

The following suggested prototype scheme is constructed for students would like to study astronomy and/or space science as a major or major – minor for six semesters. Those students should study the needed mathematics, physics and a bit of chemistry at first and second semesters.

4.1 The Case Of Astronomy:

Major Concept	Lectures (Hours)	Theoretical Exercise (Hours)	Observationl Training (Hours)	Equivalent Credits
Degrees of freedom	10	6	4	15
Constructing a theory	16	12	-	22
Isolated and interacting systems	6	3	3	9
Formation, evoluation, stability	12	8	-	16
Conservations, Invariancies	6	2	2	8
Initial, boundary value problems	6	4	8	12
Symmetric properties	3	2	2	5
Sum	59	37	19	87

4.2 The Case Of Space Science :

Major Concept	Lectures (Hours)	Theoretical Exercise (Hours)	Experimental Training (Hours)	Equivalent Credits
Orbiting	12	8	-	16
Needed energy	4	4	-	6
Optimization	6	4	-	8
Shape and materials	10	-	12	16
Stability, life time	6	6	-	9
Guidance, control	8	4	8	14
Transmission of data, analysis	10	-	10	15
Sum	56	26	30	84

References:

1. Hodgson V. and Mc Connell D., 1980, Institute of Educational Techology, University of Surry, Great Britain.
2. Kaufmann W.J., 1994, Universe, Freeman and Company, New York, U.S.A.

THE IMPORTANCE AND NEEDS OF ASTRONOMY AND SPACE SCIENCES IN ARAB COUNTRIES

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ABSTRACT: The Basic Space Sciences (BS^2) and Astronomy and space sciences (A^2S^2) are an important fields of research, study, knowledge and culture. They have been the cradle of both eastern and western sciences.

We all know, from education and psychology, about the effective teaching and learning of (BS^2). Unfortunately, a small percentage of this knowledge is actually used in teaching at schools, universities level and any other academic institutions in the Arab countries. The challenge is to provide effective professional development for (BS^2) educators and researchers at all levels, from elementary school to university.

(A^2S^2) is the most appealing subject to young students and very important tool to convey scientific knowledge? Once students have understood the importance of science, they might be more easily pursued to continue their education in science and technology. The aim of this paper is to show the importance of the formal and informal (A^2S^2) research, and education, giving an example of a possible curriculum, projects, and comments of the experiences have been carried out in few Arab countries.

We feel the need of a new communication channel among Arab people based on our common scientific ground. (A^2S^2) is, in this respect, the best choice that it is possible to identify in the vast cultural heritage of the Arab basin, the final purpose is scientific and economical ?
Building a modern and good observatories in the region jointly by Arab astronomers and space scientists is essential and, will be an excellent step toward developing astronomy and astrophysics.

Introduction and Historical Background:

Astronomy has influenced the Arab history and culture, through its practical applications, and its philosophical and religious implications. This is reflected in calendars

{Particularly the lunar calendar (the Hijra Months)}, mythology, and a variety of art forms. We know that astronomy was well advanced in Mesopotamia and Egypt, over the past 4000 years, have established in many aspects, in the birth and the growth of science and technology, in continuous interplay with religions, substantially influencing history. Every one knows the great achievements of the Arab and Muslim scientists in the field of astronomy, there fingerprints are still apparent in the Arabic names of the celestial bodies that are even now used in astronomical observations throughout the world.

i- During the period between the 11^{th} and 15^{th} centuries, the Arab astronomy was in a great positions and had very important achievements, marvelous and a great influence to other sciences. For examples: -

-The achievements of Arab astronomers and their discoveries in the field of planetary theories, which refer to the various constructions of geometric models that represented the modern of the celestial spheres and planets, it was very important episode of the history of sciences that has been studied (Saliba, 1994) .

- In the area of computational mathematical astronomy, which called in that time alzyaj (sing.zij) (Kennedy 1956)

- In the area (sacred) astronomy, which covers problems related mostly to religious matters and is usually treated in the miqat (Time keeping) literature and engaged the most active astronomers of the that time (Ahmad 1995).

- In the topic of astronomical instruments. This field shows the most brilliant developments in Islamic instruments making during those centuries (King 1987 and 1988).

- In the institutions of astronomy, namely the most impressive observatories, which were developed during this period into veritable professional centers (Aydin 1960).

- Many famous and great astronomers have appeared during that time, such as AL-Kindy, Al-Battani, Ben Qurra, Ebn al - shater.... And many others, their names and contributions are fluorescent up to now (Said 1983)

ii- Because of the importance and the fast development of (A^2S^2) in the world, we have to convince that, (A^2S^2) should be established (in small or large scale) in each Arab countries and, to be included in the science curriculum of the schools and universities, as a track of increasing public knowledge, understanding, and appreciation of (A^2S^2), as well as for educating scientists, engineers, teachers, researchers, and other science and technology personnel. There are many reasons {scientific, technological, educational and cultural } why (A^2S^2) is useful, important and should be included in the school and university curriculum (Percy 1999) ,in the same time there are challenges to effective teaching and learning. (BS^2) or any other subject can be taught, but there is no assurance that it will be learned (Baxter 1989, Nussbaum and Novak 1982, Sadler 1998,and Percy 1999). High school and undergraduate students, per-service teachers (Woodruff et al. 1999), and the general public (Schneps and sadler 1988) have deeply-rooted misconceptions about (BS^2) topics: day and night, seasons, moon phases, celestial coordinate systems, eclipses, gravity, light, celestial motion and crescent visibility. Ahlgern (1996) and Sneider (1995) suggest strategies for teaching more effectively.

It is also important to relate the curriculum to local Arabic language, culture, historical background and other needs. This is true on all parts of the Arab countries, and helps to meet another important challenge: reaching the undeserved-women, minorities, and the economically disadvantaged. In many countries, the education system favors rote memorization of lecture or textbook material. While this "Classical" approach to teaching has some merit, it does not prepare students to develop new solutions, to new problems.

The problem is how to maintain the sense of awe and excitement which (A^2S^2) can provide. The standard astronomy topics in the school curriculum are: day and night, seasons, moon phases, eclipses, tides, comets and planets. Students frequently ask about the peculiar celestial objects and sudden events (i.e. Comets, Eclipses, Supernova, Black holes ...etc) and some times on the origin and fate of the universe, the origin of life.... etc.

The Importance of (A^2S^2):

(A^2S^2) is not a type of scientific and technological luxury in which mankind indulges or is being stimulated by mere curiosity and insistent desire to wards understanding the unknown of the universe and unveiling its secrets. In fact, these sciences have their direct applications, nowadays, in the various scientific and technological fields, including global techniques for ground-base astronomical and space observations, wireless communications, remote sensing of natural Earth resources using artificial satellites, the study of the environment and Earth bio-environment, as well as strategic and military applications and certain technologies that have recently been introduced and utilized on a wide scale. At the same time (A^2S^2) applications are now common in other human aspects such as medicine, agriculture, industry, computers, image processing, energy...etc. The followings are reasons for the importance of teaching (A^2S^2 or BS^2):-

1- Modern space and astronomical observing techniques take advantage of the use of the most frontier technologies. Exceptional technological developments have been encouraged by the needs of (BS^2) or (A^2S^2) research; many space ventures are based on and are aimed at astronomy. As a consequence of the critical reliability and sensitivity required to approach advanced problems, the cost of modern astronomy is difficult for single countries. Successful applications of the advancement related to (A^2S^2) have found applications into many important sectors of civil life :

   a- In general: optics, fiber- optics, electronics, laser technology, research with each or all the wavelength of electromagnetic spectrum, image analysis, telecommunications (Satellites), new technologies for space research, remote sensing and geographic information system for meteorology, atmospheric physics, physical oceanography, geoscience including the study of environment on land and in the seas, and the search for new natural resources use many of the techniques and types of instruments developed for (BS^2) or (A^2S^2).

   b- In particular: (A^2S^2) has practical applications to navigation, time-keeping, calendars, climate, for the Islamic sharea (i.e., fixing the beginning of the Hijra months (Lunar Months)), calculating the Islamic praying times (which depends on the sun set and sun rise), finding the Qibla direction for the use of praying from any place on earth) and other external influences on our environment.

2- (A^2S^2) based on advanced physics, mathematics, sciences and technology and has a great influence on the personal mind and thinking toward the modern science and technology, this will lead to harnesses curiosity, imagination and sense of shared exploration and discovery.

3- (A^2S^2) attracts young people to science and technology and will keep the Arab countries on track with scientific innovations and technological know-how in these countries.

4- (A^2S^2) deals with Earth in time and space and with our cosmic roots: the origin of the sun, earth, the elements in the human bodies and the life itself.

5- (A^2S^2) reveals a universe that is vast, varied and beautiful. Unlike most sciences astronomy can be enjoyed as a hobby.

6- (A^2S^2) an interdisciplinary subject, it will add to tertiary education in the physical sciences such as chemistry, geology, and physics. (McNally 1999) defined two key areas where (A^2S^2) can introduce highly significant area within the teaching of the physical sciences:

i- The interaction of matter and radiation.
ii- The nature of information in signals.

(A^2S^2) forces education in physical sciences away from the introspection of science for its own sake and towards science as a practical and useful tool.

Besides the importance of teaching (A^2S^2) in schools and universities there are many problems with teaching such as:

a-Teachers not necessarily have a good background in (BS^2) teaching . They have studied astronomy in very simple manner with small quantities of information's or they have not studied (A^2S^2) at all.

b-Women usually do not get enough formal training, in consequence they cannot help their children with their scientific assignments. They do not have experience with observations, because them is not allowed to go observatory in the night time (There are many restrictions).

Three- Some teachers are afraid to say, " I do not know " and forget that science is build on what we ignore. Some time they answer the student questions in wrong way, or they give wrong informations.

Four- Teachers believe that, they need expensive materials such as, advanced (BS^2) laboratories, telescopes, planetarium, communication systems, satellite stations …etc in order to teach (A^2S^2).

Five- Students have misconceptions about the topics of (A^2S^2) and teachers, usually not been trained to discover them.

We feel (A^2S^2) can be a mind broadening experience, it can convey scientific knowledge in a way that can be attractive to basic school level students and to the undergraduate & postgraduate students.

It is very important to encourage astronomers, space physicists, researchers and teachers to do research and / or teach (A^2S^2) only if they feel comfortable with the subject, otherwise those who teach might confuse the students leading to an inadequate outcome. It is very important to give women a chance to receive formal education, to go for observatories and stay for couple of nights in observatory.

Summary for (BS^2 /A^2S^2) activities in few Arab countries as an example

We will summarize the (BS^2) or (A^2S^2) activities in few Arab countries, such as: Egypt, Iraq and Jordan's who have these activities in different categories and levels, other countries they have less activities and some of them do not have at all.

1- Egypt: (A^2S^2) in Egypt is distributed in the following organizations.

- Research and postgraduate studies are carrying out in the National Research Institute of Astronomy and Geophysics (In Hellwan city). In the Kottamia observatory operates 2M optical telescope with UBVIR photometer, spectrograph and CCD camera. The observatory was build in the 1963.This telescope is the largest optical/infrared telescope in North Africa and the Middle East.The Carl Zeiss company was recently contracted to modernize the optical system of this telescope (Deebes & Heileman 1999).
  The Institute has a plan of building a radio telescope at Abu Simbel in the South of Egypt as part of the European VLBI Network (EVN) to cover the gap between the radio telescope in the Western Europe and the radio telescope at Hartebeesthoek in South Africa, (Shaltout 1999).

- Teaching & training of (A^2S^2) are given in few universities particularly in Cairo University, which has a good astronomy department including undergraduate and postgraduate studies contributes in different fields of (A^2S^2), besides there is one or two astrophysical courses in physics department.

- In the schools, there is a general course in astronomy mainly in the most secondary schools of Egypt.

2- Iraq: The Iraq astronomers and space scientists are started with very good and healthy direction for establishing and developing (A^2S^2) in 1980. They build an Iraqi computerized observatory in the Northern part of Iraq " The Iraqi National Astronomical Observatory" which contained:-

- LOT" Large Optical Telescope " of 3.5M reflector with IR & UBVIR photometers and different types of spectrographs like Echelle, Code, and Nasmyth .

- SOT " Small optical telescope" of 1.5M reflector with different type of spectrographs and photometers with many auxiliaries for both SOT & LOT telescopes.

- MRT " 30M mm Radio telescope" with receiver system plus its Auxiliaries. (The observatory build by Joint Venture of three German Companies SEIZZ, MAN and KRUPP, the cost was 150×10^6 U.S $ (1980 price). The observatory built on the top of High Mountain of 2200 meter above sea level with very good observational site less than 0,01 arcsec seeing conditions (Al-Naimiy 1986). But unfortunately this observatory has been damaged during the two wars (1980 and 1991). Any way, nowadays (A^2S^2) is distributed in Iraq on the following organizations:-

- Space Research Center: Connected to the Scientific Research Council in Baghdad. The main research programs are: Remote sensing, wave propagation, communications, and astronomy.

- There are courses of astronomy and astrophysics in physics departments, in the most of the Iraqi universities, while in university of Baghdad (college of science), there is good astronomy department, established in 1998, for undergraduate and postgraduate studies in (A^2S^2), in the same time it has as small observatory " Al-Battani Observatory" contains two telescopes: 40cm reflector and 20cm refractor, they purchased from the Japanese Goto company. The observatory is located in Tarmia city, about 50km from Baghdad.

- In secondary schools, there are small general topics about astronomy, included in physics courses, (day & night, moon-earth system, solar system, stars) distributed in different school level.

- Regarding the popularization of astronomy there are few small astronomical clubs & planetariums in youth ministry besides, from time to time there is TV programs about special subject in (A^2S^2).

3- Jordan : Research, teaching and popularization of (A^2S^2) is very good nowadays in Jordan if we compare it with most of the Arabs countries. It is distributed as follows:

3-1 Universities: There is an astronomy and astrophysical courses given for undergraduate student in physics departments in more than 5 universities, but the main (A^2S^2) activities are concentrated in the Al al-Bayt University.(http://alalbayt.aabu.edu.jo) This university managed to establish in 1994, the Institute of Astronomy and Space Science (IASS), which contains:-

One- M.Sc research projects and curricula in the following directions:

- Astronomy and Astrophysics.
- Space Sciences.
- Remote Sensing (Science and Technology).
- Environment and Water Resources.

b-: Maragha Astronomical Observatory (MAO):-which contains a 40cm Meade Schmidt-Cassegrain optical telescope ,and CCD camera (Pictor 1616).

c-: Scientific Activities in A^2S^2 Fields :-Beside a few national meetings, IASS managed to organize two international meeting: -

c-1 The First International Conference was held at the IASS of the Al al-Bayt University in Mafraq, Jordan 4-6 May 1998. The conference attended by more than 50 astronomers and space scientists from 18 countries: Algeria, Australia, Belgium, England, France, Germany (UN), Iran, Iraq, Jordan, Kuwait, Mexico, Palestine, Sudan, Tunisia, Turkey, and USA.

(http://www.seas.columbia.edu/~ah297/un-esa/ws1998-jordan-astronomy.html)

The program of this Conference included presentations on

i- The Earth environment.
ii- The solar system.
iii - The Sun.,
iv- Star formation and binary stars,
v. Cosmology,
vi- Missions to the universe. The proceeding for the conference, have been published by AL al-Bayt University press (Al-Naimiy & Kandalyan 2000).

C-2- IASS Hosted the 8^{th} UN/ESA workshop: Scientific Exploration from Space, which organized by UN, ESA and the Government of Jordan at Al al-Bayt University, in Mafraq, Jordan, from 13-17 March 1999. More than 120 astronomer's, scientists and students of basic space sciences from 35 countries attend the workshop. (http://www.seas.columbia.edu/~ah297/un-esa/activities-html#1999)

The proceeding for the workshop will be published as a volume of Astrophysics & Space Science Journal.

3-2 Arab Union for Astronomy and Space Sciences (AUASS) (http://www.jas.org.jo/union.html): This union established in 1998 as an outcome of the second Arab Conference on (A^2S^2), held in Amman Jordan during 29^{th} August- 1^{st} of September 1998. The participants were more than 100 astronomers & scientist from 14 Arab countries, in addition to observers from France, Italy and USA, were present. The participants decided to establish the union and its head quarter to be in Amman. The aim of the union is to develop (A^2S^2) in the Arab countries through conferences, meeting, publication, joint research projects…etc with the cooperation of the International (A^2S^2) institutions.

3-3 Jordanian Astronomical Society (JAS), (http://www.jas.jo/index.html) : It is an organization that popularizes amateur and some times professional (A^2S^2). Founded in Amman September 1987 and its headquarters at Haya Cultural (http://www.arabist.com/jo/hayacenter/index.html) since then, JAS promoting

(A^2S^2) not only throughout Jordan but also to the rest of Arab world, it has more than 250 members. JAS popularization of (A^2S^2) as an aid for education and developments in universities, schools, public (Educational Television, Radio programs & Hot line), planetarium, public lectures...etc. It has good observing program in Al-Azraq camp for astronomical events: comets, meteor showers, lunar & solar eclipses...etc.

Four- ICOP Project: Aims to gather a largest possible number of lunar observers worldwide. This for the predicting the visibility of the young crescent moon which takes the most important applications of astronomy in Islamic world (to be used for fixing the beginning of the Islamic Holly Lunar months) (http://www.jas.org.jo/icop.html). ICOP supervised by a committee from AUASS, IASS & JAS called "Crescents' Observation and Mawaqeet committee. Their members are from different part of the world in general , and from Islamic countries in particular(http://www.jas.org.jo/come.html)

Five- Teaching of (A^2S^2) in Jordanian schools: Most of the general astronomy courses given in different level of secondary schools. The courses contain general information's about: Earth – Moon system, day & night, seasons, solar system, stars, clusters, the Milky way, galaxies & finally the universe.

3-4 An important decision have been made by UN, that the Hashemite Kingdom of Jordan has been selected to host a (Regional Center for (BS^2) and Technology Education in Western Asia), this will be an excellent move toward developing (A^2S^2) in the Arab countries.

Suggestions for developing (A^2S^2) in Arab World

As we know that there is much less of (A^2S^2) in other Arabic countries than above, and there are non-in many others Therefore we have to convince these countries about the importance of (A^2S^2) and they should do like what Jordan doing at least, they have to be a member in AUASS. For all Arab countries, it is necessary to take into account the following suggestions:

I- (A^2S^2) Popularization's: The popularization's should include some of the following:

- It is necessary for Arab countries to have books in (A^2S^2) at all levels written in Arabic language. The examples must deal with the local culture and present role models. This should be made by establishing a translation program for (A^2S^2) from English or other languages into Arabic.

- Magazines on education are extremely important because they provide access to up dated (A^2S^2) information, particularly those are detected teachers. It is necessary to have magazines on popular science for all age levels, including children (Magazines like Sky & Telescope, Astronomy, Mercury..etc), it is necessary to be edited in Arabic language.
- Planetariums: It is very important for each Arab country to have a planetarium with suitable size, or even a portable one.

- Public lectures and workshops: These two activities are extremely popular and useful because they promote several pedagogical qualities.

- Other activities: such as: Newspaper articles, Educational TV, Radio programs and Hot line, Museums, software's and computers, summer schools & meetings ...etc, all are very important for popularization of (A^2S^2) (Fierro 1999).

II- (A^2S^2) Curriculum: There should be very good (A^2S^2) curriculum in the Arab countries, to be prepared for different levels according to ages {School, Academic Institute and University level}. This was stated by (Percy 1999, Percy & Matti 1999). We suggest a committee, its members are, astronomers and space scientists from different Arab countries with the cooperation of International astronomers and space scientists. The duty of this committee is to write the curriculum, and suggest practical recommendations for the development of (A^2S^2).

III-Cooperation: Enhancing (A^2S^2) in Arab countries requires cooperation among many Arab universities & organizations in particular, and with International institutions in general. Because we all know that, establishing good (A^2S^2) in any region can not be done without strong cooperation between parties. In Arab countries everything for (A^2S^2) development is available (such as budget, personal ...etc) the only think in missing is the cooperation and scientific supports from International organization & scientist.

IV-Building a modern and good observatories in the region jointly by Arab astronomers and scientists is essential and, will be an excellent step toward developing astronomy and astrophysics, particularly when the observatory contain a modern size optical telescope with its auxiliaries, beside a millimeter radio telescope to be part of any International VLBI system. Keeping in mind there is very good sites in different part of Arab countries, particularly in those places were observations can be made to both, Southern & Northern parts of sky. It might be very useful if the observatory comes through AUASS scheme (Al-Naimiy & Konsul, 2000). It is very useful to Arab astronomers to have a look and get an idea about Querci proposal for NORT Project (Querci 1998a, b, c, 1999a,b) or projects like MAN 2000 a proposal for regional project for Mediterranean astronomy. (Ferrini 1999).

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Astronomy and Space Sciences In Jordan

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Presented at the 9th UN/ESA workshop on Basic Space Science, Toulouse, France, 27th-30th June 2000.

Abstract: The aim of this paper is to summarize the activities and research projects of Astronomy and Space Sciences in the following Jordanian organizations and Institutions:

1- Jordanian Astronomical Society (JAS):

- Popularization of astronomy and space sciences as an aid for education and developments, Universities, Schools, public (Educational Television, Radio programs and Hot line), planetarium, public lectures...etc.
- Observing programs in Al-Azraq camp for astronomical events such as, Comets, Meteor showers, lunar and solar eclipses...etc.

2- Universities { Mainly Al al-Bayt University }:-

A- Institute of Astronomy and Space Sciences (IASS), M.Sc Research projects and curricula in: Astronomy and Astrophysics, Space Sciences, Remote Sensing (Science and Technology), Environment and Water Resources.

B- Maragha Astronomical Observatory (MAO): - 40cm Meade optical telescope with CCD Camera.

3- Arab Union for Astronomy and Space sciences (AUASS): - Its activities, conferences, meetings, and publications.... etc.

4- ICOP Activities: Islamic Crescent Observational Program: Supervised by a Higher Committee from AUASS and JAS.

The paper summarizes also other activities in some Jordanian organizations and finally the future expectation, for AASS in Jordan.

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1- Introduction:

Most of us know that astronomy and space sciences (AASS) are an important field of research, knowledge and culture. They have been the parents of both eastern and western sciences. Today we might convince our self that astronomy is Human's attempt to study and understand celestial phenomena, part of his never-ending urge to discover order of nature. The science of astronomy was well advanced in Mesopotamia, Egypt, Greece, India and China. Over the past 4000 years have established in many aspects the roots of our culture, and have been the stimuli and the bases for the birth and the growth of science and technology, in a continuous interplay with religions substantially influencing history.

In all Muslim countries astronomy has been used as a Basic science and applied successfully for the Islamic Mawaqeets (i.e. determinations of the Islamic praying times, and for fixing the beginning of the Hijra months in general and Ramadan, Shawal & the Al-Hija in particular and to calculate the Qibla direction). That's way astronomy and space sciences established in different Arab countries, especially in Jordan, were started in a good manner.

The Hashemite Kingdom of Jordan, are situated in the northwest corner of the Arabian Peninsula, with a population of around 5 million people and about 57×10^4 km^2 in area. Jordan features highly diverse topography, from the desert areas in the east and southeast, to the hilly areas in the north and south, down to the Jordan Rift Valley, which includes the Dead Sea (The lowest point on the Earth's surface, averaging 400m below sea level). Amman, the Capital of Jordan, which lies in Jordan's mountainous north-central region, enjoys moderate, Mediterranean - like climate, making it ideal for astronomical observations.

The first official major step of astronomy in Jordan was started in September 1987, with the foundation of the Jordanian Astronomical Society (JAS) in Amman. Later on, the Institute for AASS in Al al-Bayt University (IAASS) was found in September 1994. While in September 1998 the Arab Union for Astronomy & Space Sciences (AUASS) was also established. Nowadays, there is a plan by UN to establish in Jordan, a Regional Center for Basic Space Sciences & Educational Technology in Western Asia (Al-Naimiy, 2000).

The aim of this paper is to shed a light on the development of AASS in Jordan in last 15-year and it's future outlook.

2- Jordanian Astronomical Society (JAS):

JAS is the only organization in Jordan that popularizes amateur astronomy, formerly known as the Jordanian Amateur Astronomers Society. JAS was found in Amman in September 1987, it is located in Haya Cultural Center. This society has been promoting astronomy & space sciences not only throughout Jordan but also to the rest of the Arab world. Currently JAS have about 300 members, 100 of who are active in club programs. (http://www.jas.org.jo) (Odeh, 2000).

Objectives:

- Assembling amateur astronomers in Jordan and in the Arab World, in order to develop their astronomical hobby through the exchange of astronomical data, information, articles, and observational expertise, as the provision of all what an amateur astronomer may need (e.g. astronomical equipment, periodicals, books, references, Internet, planetarium ...etc) if possible.
- Popularization of Astronomy, that is, spreading astronomical culture and awareness among all classes of the Community, and ascertaining the importance of astronomy and allied sciences in every-day life, and their inter-relationship with all fields of knowledge Basic Sciences and Technology.
- Transferring astronomy in Jordan and the Arab World from amateurism to professionalism, and from individual initiatives to institutional frames.
- Contributing in astronomy education in primary and high -schools, and sometimes in universities (at the undergraduate level).

Ways And Means of Fulfilling JAS's Objectives:

- Weekly lectures (astronomical or scientific) at Haya Cultural Center.
- Publications, such as "Pleiades", and "Al-Debran" the Monthly Internal Publication of JAS.
- Publishing astronomical articles, essays and astronomers in local newspapers and mass media.
- Provision of astronomical periodicals (Such as "Astronomy", "Sky & Telescope", "Astronomy Now", "Popular Astronomy", "The Planetary Report"...), as well as astronomical books, videotapes, posters, astro-software...etc.

- Weekly and monthly observation of the sky and of the major celestial events, using the naked eyes and astronomical equipment (such as binoculars and telescopes).
- Organizing "Astronomical Camps" in the Jordanian deserts, which are usually devoted to certain astronomical events, such as meteor showers, comets...etc. (http://www.jas.org.jo/camp.html)
- Cooperation with other institutions (Jordanian, Arab or International), possessing similar interests, for example JAS is a members of the International Meteor Organization (IMO), the International Occultation Timing Association (IOTA), the American Meteor Society (AMS). And the Royal Astronomical Society of Canada (RASC). (http://www.jas.org/out.html).
- Delivering lectures and seminars, and organizing " Star Nights", at various universities, schools, clubs, societies, youth camps..etc.
- Founding " Astronomy Clubs" at various schools and universities- which are continuously supervised by the Society (http://www.jas.org.jo/clubs.html).
- Organizing " Astrofests", activities dedicated only to schools, which may include an opening ceremony, astronomical lectures, an astronomical exposition, and a star night.
- Organizing " Scientific Astronomical Days", in cooperation with universities and / or institutions (such as the professional unions).
- Organizing conferences about astronomy and space sciences, usually in cooperation with universities or other agencies. (http://www.jas.org.jo/confe.html). JAS paid special attention for organizing the 1st (1992), 2nd (1995), 3rd (1998) and the 4th Arab Conferences in AASS. These are organized in cooperation with other universities, particularly Al al-Bayt University. The out come of 3rd conference was the establishment of AUASS. Now AUASS, JAS and IAASS are preparing for organizing the 4th ACASS at Al al-Bayt University, during the period 28th-30th August 2000.
- Organizing special training courses on various topics in astronomy, both for students or teachers-some of which are held in cooperation with the ministry of Education.

Other JAS activities

Since its inception, JAS has paid special attention to the visual observation of meteors, comets, planets and the crescent for fixing the beginning Hijra months. More than 40 astronomical camping were organized by the society so far. More than 20 have been dedicated to observer meteor showers.

In May 1997, the President of the International Meteor organization (IMO), Jurgen Rendtel, and two other members visited the JAS during the Eta Aquarids shower. The IMO delegation gave valuable lectures about observing techniques, including how to monitor meteors with an FM radio receiver and Yagi antenna, which can detect smaller meteors than visual observation could, (http://www.jas.org.jo/radio.html). The most important activities for meteor shower was the one of November 1999, JAS organized the 1999 Leonied conference in cooperation with (IAASS) during the period of (12^{th} –21^{st}) November 1999. More the 40 distinguish astronomers attend the conference, among them, Professor Jack Backly, David Fisher. The first 2-day was given more than 15 papers at Al al-Bayt University on the Meteor Showers. Then the participants moved to Al-Azraq camp, which locate at a desert 60km east of Amman, they observed more the 4000 Meteor.

3- **Institute of Astronomy and Space Sciences (IAASS) at Al al-Bayt University (AABU):**

a- The establishment of IAASS (http://www.aabu.edu.jo/space/mainl.htm) at AABU (http://www.aabu.edu.jo), in 1994, came as a concrete step towards linking the University with developed countries worldwide and keeping it on track with scientific innovations and technological know-how in these countries. IAASS represents the nucleus for basic space science foundation in the Arab world. It is hoped that it will continue to develop with a view to fulfilling the needs and aspirations of the University community, the local community, and the region as a whole.

b- **Objectives:**

- Preparing and Qualifying national human resources to work in the two fields of astronomy and space sciences and to deal with their technological developments. The objective is to render services to the Arab and Islamic societies, in general, and to the Jordanian society, in particular.

- Carrying out researches, astronomical studies and observations, in various wavelengths, on the different celestial objects.

- Conducting research and studies on the atmosphere and its layers and that may contribute towards improving the efficiency of wireless networks and natural earth resources using space photographs and images.

- Studying the ionosphere and magnetosphere and preparing the mathematical models that can describe the motion of space plasma in those regions.

- Sustaining the quality of graduate studies at Institute with a view to supplying the local and Arab societies with human resources capable of assuming a number of specialized professional responsibilities in the future.

Iii-Ways and Means of Fulfilling the Institute's Objectives:

- Establishing scientific and technological links with foundations and centers in the Arab and Islamic word to secure maximum utilization and exchange of results, studies, and research executed at the Institute.

- Organizing conferences, seminars, scientific meetings, workshops, and local training courses in cooperation with Arab, Islamic and international universities and scientific establishments, and forming a specialized team that would help in promoting basic understanding of space sciences and to increasing participation in analogous activities inside and outside Jordan.

- Strengthening cultural and scientific ties with counterpart universities and establishments on issues of common interest. These may include signing scientific agreements, exchanging experiences and experts to follow-up on scientific and technological developments, exchanging updated information and offering consultations and scientific experience in relevant specialties to universities and scientific foundations.

- Collecting information, data sources, and various documents that are necessary for the follow - up on relevant technological developments in areas of specialization.

- Securing the availability of specialists and assistants in the fields of astronomy and space sciences and up dating their knowledge and experience on constant basis.

- Installing and acquiring needed laboratories and workshops to boost research activities at the Institute.

- Attracting available human resources in order to assure the creation of a selection of scientists, researchers, staff members and technicians capable of working with astronomy and space sciences and their related technologies.

- Deepening the formulae and relations between the setup of theoretical, and applied and basic research projects conducted by Al al-Bayt University and other universities, on the one hand, and the requirements of applied research conducted by Research and Development (R&D) Departments in the public sector, on the other, for the sake of translating research projects and adapting them for the service of this region.

iv-Department of IAASS :

- Department of Astronomy.
- Department of Space Sciences.
- Department of Environment and Water Resources (Strategic Environment and Water Resources Research Unit).
- Information & Computer Unit.

◆ **Department of Astronomy:**

This Department consists of:

- The Department with its teaching, technical, and administrative
- Astronomical staff Observatory.
- The Unit of Reviving the Astronomical Heritage of Arabs and Muslims.

The Department is entrusted with task of teaching astronomy for graduate students and carrying out theoretical and observational research and studies on different celestial objects and clusters using different wavelengths in different observational and analytic facilities available in the observatory. It is anticipated that the Institute will cooperate with international observatories and organizations in these domains. In addition, the Institute carries out practical studies on designing observational devices and accessories, analytic and computer control and its future developments, and applications used in fixing the beginning of lunar months and prayers time.

- **Department of Space Sciences:**

This Department consists of:

- Space Physics.
- Remote Sensing.
- Space Communications.

The Department is in charge of teaching at the graduate level and carries out research on the atmosphere. Its fields of interest include the ionic layers in relevance to wave propagation inside the atmosphere, which aims at utilizing commercial links and radio frequencies.

In addition to using available space technologies for studying the earth surface and its environment, the institute is interested in studying space physics, like, for instance, cosmic rays, airglow, geomagnetism, ionosphere physics, upper atmosphere, and geophysics. The Institute is also interested in studying the earth natural resources with their applications to Jordan, and in building the basic infrastructure of image analysis and its applications in different fields.

- **Strategic Environment & Water Resources Research Unit:**

This unit (http://www.aabu.edu.jo/water/home.htm) in charge of teaching at the graduate and post graduate level & executing environmental research and survey for it protection non-conventional research projects for the development resources.

- **Information and Computer Unit:**

This unit bears the task of building a computer network with monitors connected to other Units and Departments at the Institute for the analysis of scientific data and space images. The Unit will also store information concerning astronomical and space research projects, while keeping open communication lines with international institutions. This process is vital for getting acquainted with international research and studies in areas of specialization.

v-Curriculum:

The study plan at the Institute is divided as follows:

- Nine credit hours for compulsory courses.
- Nine credit hours for the thesis.

In addition, the Institute offers six credit hours as university requirements and three credit hours as remedial requirements. The total number of credit hours needed for fulfilling the requirements of the M.Sc degree is 33.

The contents of compulsory and elective courses in the various fields of astronomy and space sciences are in line with those offered by similar departments in international universities. The compulsory courses concentrate on the fundamentals of astronomy and space sciences, mathematical physics and astronomical and space techniques. Elective courses for astronomy students, on the other hand, concentrate on astrophysics, radio astronomy, cosmology, celestial mechanics, stellar structure and galactic and extrgalactic structure, while elective courses for the space sciences students include space physics, remote sensing and technologies, plasma physics, electromagnetic theory, computational techniques, and radio astronomy.

To be eligible for admission to the M. Sc. Program offered by the Institute, candidates should be holders of the B.Sc. degree in one of the following fields: astronomy-physics-mathematics-space engineering-electric engineering or communication and control system engineering.

vi-Academic Facilities (Equipment & Observatory):-

The Institute's laboratories, equipment, and academic facilities include the following:

- The Computational Laboratory: This consists of a network equipped with terminals that provide the academic departments and units at the Institute with data significant to research in space and astronomy and to studies relevant to the concerns of the Institute.

- Remote Sensing Laboratory: This is formed of a number of devices particularly linked with computer scanning and remote sensing relevant to space images and their analysis (it has various related packages, software such as, Remote Sensing ERDAS Software and DRISI Geographic Information System Software).

Vii-Astronomical Observatory (Muragha Observatory):

One- The Meade 16" LX200 Telescope:

The Meade Schmidt-Cassegrain Optical System: In the Schmidt-Cassegrain design of the Meade 16" model, light enters from the right, passes through a thin lens with 2-sided aspheric correction ("correcting plate"), proceeds to a spherical primary mirror, and then to a convex aspheric secondary mirror. The convex secondary mirror multiplies the effective focal length of the primary mirror and results in a focus at the focal plane, with light passing through a central perforation in the primary mirror.

The 16" mode includes an oversize 16.3759" (about 41.59 cm) primary mirror, yielding a fully illuminated field-of-view significantly wider than is possible with standard-size primary mirrors. It is this phenomenon which results in Meade 16" Schmidt-Cassegrains having off-axis field illumination 10% greater, aperture-for-aperture, than other Schmidt-Cassegrains utilizing standard-size primary mirrors.

Main Specifications and Features: 16" LX200.

Optical Design		Schmidt-Cassegrain
Clear Aperture		406.4 mm (16")
Primary Mirror Diameter		415.9 mm (16.375")
Focal Length		4064 mm
Resolving Power (arc sec.)		0.28
Limited Photographic Magnitude		18.0
Image Scale (arc sec/mm)		50.75
Maximum Practical Visual Power		800
Telescope Mounting		One-piece fork, double-tine
Materials:	Tube body	Aluminum
	Mirrors	Pyrex glass, Grade-A
	Correcting Plate	BK7 optical glass
Telescope Dimensions, swung down		18"x26"x51"

b- CCD Camera (Pictor 1616):

The observatory possesses, besides the telescope, a Couple Charge Devices (CCD), which can be used for photographic, photoelectric and spectral observations of celestial objects. The main specifications are:

CCD size	1536x1024
Pixel size	9 microns
Raw image size	3 MB
Dark current (20 deg. C)	< 1 e^-/5 seconds
Quantum efficiency	< 30% at 520-700 nm.
Readout noise	< 15 e^- rms.
Charge transfer efficiency	99.999%
Well depth	85 000 e^- per pixel
Dynamic range	65 536 brightness levels
Readout time	10 microns per pixel

Host PC programs: Image transfer and display, contrast control, smoothing, sharpening filters, image alignment.

On board programs: automatic exposure level, dark current exposure and flat-field sequence, pixel binning and accepts color filter system.

c-The computer

The telescope and CCD are controlled by Pentium II 440 BX computer, which can be used for data acquisition too. The astronomy software is: The sky levels IV and epoch 2000 image processing with interface cable.

d-Main proposes of the observatory

- Training of AABU students, as well as students from Other Universities of Jordan.
- Research projects and observations for M.Sc. and future Ph.D. students.
- Research projects and observations for the Institute staffs.
- Unit of the network of the small astronomical telescopes of the World.
- Training of school students and developing of astronomical education in Jordan.

Five- The observatory will be used for observing different celestial objects, mainly variable stars (Eclipsing Variables) and some astronomical events besides the crescent observations.

- Any Arab and International astronomer as an aid for scientific cooperation can use the observatory (Al-Naimiy & Kandalyan 2000a).

e- The observatory site

The observatory is located at the campus of AABU, near the building of the Institute of Astronomy and Space Sciences.
Longitude: 36° 14' 19"
Latitude: 32° 20' 30"
The site seeing at the observatory is 2-3 arcsec. The number of clear nights is around 200 days.

f-The name of the observatory (Maragha)

Comes from the name of an old observatory, which was installed by the Muslim astronomer Nasir Al-Dean Al-Tousi in 627 H/1264 A.H. in the city of the Maragha (The capital of the old Azerbaijan). The old observatory contained most of the books, which has been brought from Iraq, Syria and Al-Jezera during Baghdad collapse in 656 H/ 1258 A.H. Many Islamic astronomers used the observatory in that time.

Viii-Aspirations:

The Institute aspires to realize the following projects and attain the following goals and objectives in the future:

I-Institute Departments

In the next five-year plan, the Institute looks forward to establishing the following divisions and departments:

One- Astronomy Department and Al al-Bayt Observatory.
Two- Space Physics Department.
Three- Remote Sensing and Environment Department.
Four- Communication and Meteorological Department.

It is anticipated that the following laboratories, workshops and telescopes will support these departments:

- Mechanical and Electronic Workshop.
- Remote Sensing Laboratory.
- Communication Laboratory.
- Meteorological laboratory.
- Computer Laboratory.
- Optical and Radio Telescopes (Establishing a 1.5m optical telescope and 20m RT in a selected site in Jordan, which gives Jordan a good opportunity for fruitful cooperation with other astronomical institutions from different countries).

II- International Cooperation

The present and future plans of the Institute are oriented towards opening wide channels with the international world. This may be fulfilled by means of reaching scientific agreements, personal contacts and participating in conferences and related scientific activities. The Institute also aspires to enhance its cooperation with related scientific international organizations such as the International Astronomical Union (IAU), International Geophysical Union (IGU), ...etc. Accordingly IAASS had very good scientific relation with UN, ESA through the series of UN/ESA workshops on Basic Space Sciences.

C- Teaching , Scientific Research, and Technical Staff

Given the fact that research techniques and technologies in space sciences are developing at high pace, the Institute has plans to achieve the following:

- Selecting distinguished scientists of a high standard that are constantly on track with developments in the field of AASS at the international level.
- Utilizing, fully, all available training avenues such as scholarships, sabbatical leaves, and training courses that may contribute to securing a sufficient number of staff in all needed levels and specialization's.
- Offering intensive training programs for technicians who work on ready-made projects, on contract basis. The programs should include design and scientific activities for different technological aspects included in these projects. This is needed in order to increase the abilities of these technicians and to help them keep up with technological developments, and to satisfy research and teaching requirements.

IV- Plans for the coming five years:

The Institute's plans for the coming five years include the following :

One- Employing some 20 researchers and teaching staff holders of Ph.D. degree in the fields of space physics, astrophysics, astronomy, cosmic ray physics, atmospheric physics, electronic engineering, communication engineering, space image analysis, remote sensing and computer science.

Two- Recruiting about 30 staff assistants such as engineers and physicists holders of the B.Sc. or M.Sc. degree, in addition to a number of technicians to organize and operate the observatory, organize workshops, and run intensive and integrated training programs in collaboration with international institutes and organizations.

V- Selection of projects:

In order to maintain the quality of teaching and research, the Institute plans to move in two directions:

One- Ready – made Projects

This includes signing contracts with international agencies for designing, manufacturing and establishing large and developed scientific research facilities that can serve two goals:

- Providing staff members with recent technologies needed for conducting excellent research programs in accordance with up-to-the-minute advancement worldwide.
- Proving to the international community the academic seriousness of AABU in pursuing scientific research and seeking knowledge, besides encouraging international organizations, committees and pronounced scientists cooperate with the Institute.

Two- Local Projects

Initiating the design of certain projects and executing them completely or partially by staff members of the Institute. Given the limited experience and facilities available at the Institute, projects at the very beginning will be modest. However, they will, hopefully, develop and expand in the future, as the Institute will, gradually, is able to depend on its own.

VI- Future Scientific Projects

One- Establishing new Mathematical Models in such studies as space physics, ionosphere layers magnetosphere and upper atmospheric layers.

Two- Establishing a catalogue for the observed x-ray stars. This includes physical and geometrical properties of these stars and their positions in the sky using new mathematical methods and computer programs that can rise to an international standard.

Three- Establishing an astronomical map for the Hashemite Kingdome of Jordan including correction of al-Qebla direction for the Kingdom mosques, tables of prayer times and calculations of the beginning of the lunar months for the next hundred years, especially the religious months (i.e. Ramadan, Shawwal and Thu al-Hujja).

Four- Studying the earth natural resources from different aspects by using space image analysis for the Arab and Islamic world, and distributing the results to the concerned countries according to their interest.

Five- Building a large Astronomical Observatory (AO), (Optical and Radio) with a diameter for the optical mirror not less than 1.5 meters, and a diameter for the radio dish of (20-30) meter.

Six- Keeping the Institute posted on international scientific projects and taking part in some of them, especially those relating to studies of stars with a complete spectrum. This can be easily accomplished now that the Institute has obtained a small optical telescope (40cm). In addition, the Institute is now looking forward to bolstering its cooperation in this field with Arab countries.

Seven- Further plans will be made to offer on academic program leading to Ph.D. degree in AASS.

Eight- IAASS aims to expanding its activities at the local and regional levels. This can be attained by means of interacting with the public Jordanian and regional Universities and investing in the corresponding experimental capabilities that are already available at those Universities.

VX- IAASS Activities:

1- Teaching activities of IAASS during the period, September 1994 up to September 2000.

- During the above period IAASS, maneged to give M.Sc in AASS for No.'s of students with B.Sc. background, as follows: -

M.Sc Students	No. of Students
Attended M.Sc Program	**50**
Graduated	**16**
Continuing there program in different levels	**22**
Continuing there Ph.D. Program	**4**

- The trends of the above students are: Astronomy & Astrophysics (Mainly variable Stars), Remote Sensing & GIS, Environment, Space Communications and Space physics.

2- Conferences and meetings:

Among the most distinct activities of the Institute in the last three years was holding number workshops (Space communications, Remote Sensing, (Science and Technology), Astrophysics and Space Physics). Besides there was many astronomical observation nights using the Maragha Observatory, one of them was devoted to observing Hell-Bop comet, the other night was devoted for planets observations Beside observing few variable stars. The above events were attended by a large number of distinct professor's physicists, engineers and other members from Jordanian Universities and Scientific centers. The Institute organizes a continues seminars which were attended by interested staff members and graduate students.

The most important activities are:

- The First International Conference was held at the IAASS of the AABU in Mafraq, Jordan 4-6 May 1998. The conference attended by more than 50 astronomers and space scientists from 18 countries: Algeria, Australia, Belgium, England, France, Germany (UN), Iran, Iraq, Jordan, Kuwait, Mexico, Palestine, Sudan, Tunisia, Turkey, and USA.(http://www.seas.columbia.edu/~ah297/un-esa/ws1998-jordan-astronomy.html). The program of this Conference included presentations on: The Earth environment, The solar system, The Sun, Star formation and binary stars, Cosmology and Missions to the universe. The proceeding for the conference, have been published by AL al-Bayt University press (Al-Naimiy & Kandalyan 2000a).
- IAASS Hosted the 8th UN/ESA workshop: Scientific Exploration from Space, which organized by UN, ESA and the Government of Jordan at Al al-Bayt University, in Mafraq, Jordan, from 13-17 March 1999. More than 120 astronomer's, scientists and students of basic space sciences from 35 countries attend the workshop.(http://www.seas.columbia.edu/~ah297/un-esa/activities-html#1999)The proceeding for the workshop will be published as a volume of Astrophysics & Space Science Journal.

4- Arab Union for Astronomy and Space Sciences (AUASS) (http://www.jas.org.jo/union.html) or (http://www.auass.org/srd): This union established in August 1998 as an outcome of the second Arab Conference on (AASS), held in Amman Jordan during 29th August- 1st of September 1998. The conference organized at the time by JAS and IAASS. Amony the participants, there were more than 100 astronomers & scientist from 14 Arab countries, in addition to observers from France, Italy and USA. The participants decided to establish the Union and its head - quarter to be in Amman. The aim of the union is to develop (AASS) in the Arab countries through conferences, meeting, publication, joint research projects...etc with the cooperation of the International (AASS) institutions.

Objectives:

- Introducing astronomy & space science in the Arab countries as scientific disciplines on their own, in order to play their role in the progress and the development of Arab societies scientifically and technically.
- Encouraging the exchange of scientific data, information, and expertise, in the various fundamental and applied fields of astronomy & space science, among the concerned institutions and individuals.
- Improving the scientific and technical competence of specialists in astronomy and space science, working in Arab countries.
- Unifying the scientific and technical terms of astronomy & space science that are in use in the Arabic language.
- Unveiling and ascertaining the contribution of the Arab Islamic civilization in the realm of astronomy and related sciences, as well as the roles of various other past civilizations in the region.

Ways & Means of fulfilling the objectives:

- Promoting astronomy education as a pivotal means to fulfill the long-term objectives.
- Organizing conferences, seminars, and workshops, in astronomy and space sciences.
- Encouraging the popularization of astronomy & space sciences, through the writing, translation, and publication of articles and books for the general public, through public lectures and any other useful means.
- Forming various databases containing information about professional institutions and societies dealing with astronomy & space science in Arab countries, about Arab specialists in these fields and also about astronomical societies, clubs and planetariums in the Arab World.
- Adopting some long-term (large-scale) astronomical projects that involve the participation of as many Arab specialists, institutions, and countries, as possible.
- Developing cooperation at the international level, with the aim of realizing AUASS's objectives.

Some of the AUASS activities:

AUASS established few scientific committees for a achieving some of its goals such as:

- The Crescents observation and Mawaqeet Committee of the AUASS, to follow up the problems of the young crescent moon visibility prediction (for the use of fixing the beginning of the Islamic Holly Lunar months). (http://www.jas.org.jo/icop.html). Creating a refereed Journal in the name of Arab Journal for Astronomy and Space Sciences (AJAASS). To be issued twice a year starting from September 2000.
- The scientific research division (SRD). The SDR/AUASS aims at helping the AUASS in achieving its general goals & objectives, particularly those connected to scientific research in the various fields of AASS. This can be achieved principally through: The creation of various working groups within the SRD /AUASS; and by enhancing the scientific collaboration between the SRD's member, via the exchange of astronomical data and information; and also by finding research projects of
- common interest, that might be finally adopted by the AUASS's Higher Council and thus supported by the AUASS's member states. Although the SRD/AUASS is primarily concerned with research in AASS at the basic and applied levels, it should be noted, in this era of multidisciplinary research, that the interests of the SRD/AUASS cannot (and should not) be limited to basic science. In other words, the emergence of working groups in somehow social fields, such as the history of AASS, or even AASS in culture and education, might seem inevitable at one stage or the other. Actually, any working group created within the SRD/AUASS would reflect the research interests of its members, as long those interests confirm with the AUASS's goals and internal regulations.

5- Islamic Crescents Observation Project (ICOP):

It is a global project, organized by the AUASS and JAS. Aims to gather a largest possible number of lunar observers worldwide. This for the predicting the visibility of the young crescent moon which takes the most important applications of astronomy in Islamic world (to be used for fixing the beginning of the Islamic Holly Lunar months) (http://www.jas.org.jo/icop.html). ICOP supervised by committee from AUASS, IAASS & JAS. Their members are from different part of the Islamic countries (http://www.jas.org.jo/comc.html).

Objectives:

- To develop the crescent's observation criteria, based on the data and information obtained by the persons participating in this
- Project, so that we will have a better judgment of the visibility of young crescents.
- To inform people around the world of the first day of some important lunar (Islamic) months, particularly the Holy month of Ramadan, and Shawwal, which is of particular interest for those who do not live in Islamic countries.

6- Teaching of (AASS) in Jordanian Schools and Universities:

Most of the general astronomy courses given in different secondary schools. The courses contain general information's about: Earth-Moon system, day & night, seasons, solar system, stars, clusters, the Milky way, galaxies & finally the universe. Besides there is an astronomy and astrophysical courses in physics departments of most of Jordanian Universities, usually at the undergadnate level.

7- Future expectations:

- An important decision have been made by UN, that the Hashemite Kingdom of Jordan was chosen to host a (Regional Center for Basic Space Sciences and Technology Education in Western Asia), this will be an excellent move toward developing (AASS) in the Arab countries.
- The Jordanian astronomical organizations have strong feeling to move toward building a large astronomical observatory (Optical & Radio) with a diameter for the optical mirror not less than 1.5m and a diameter for the Radio dish not less than 20m to be used by local and international astronomy and scientists.
- Since astronomical and space science research projects are too expensive to be carried out, and as it is rather difficult for a single country to support big research projects on its own, group of countries usually work out for the establishment of a common space agency, an example of which is the European Space Agency (ESA). Therefore, we hope that the Arab and Islamic countries can join hands, in the future, to establish an Arab Space Agency (ASA).

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Modern CCD epoch of moving celestial objects observations : algorytms and software for their processing in interactive mode

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CCD observations of the Small Solar System bodies are extremely progressing. Every month professional astronomers together with more and more extending amateurs in the World obtain several hundred thousand asteroid positions and send them to the Intrnational Minor Planet Center. The fact is that when one observes a celestial object his CCD matrix registrates as "by product" all moving celestial objects fixed during CCD exposition. Usually, a test of such observations and an identification of observed moving objects are not produced by observers themselvs.

Now it is necessary to provide the astronomers, especially amateurs, by the package for express solution of the control and identification problems immediatly the observations were done. It is obvious that it would be better for the MPC to receive observations of asteroids with their identification.

The algorytms and softwares were elaborated in Pulkovo observatory to solve the following problems:

* a test of any positional observations of celestial bodies, artificial and natural, by means of analysis of an orbital or approximational (O-C) residuals as for coordinates as for their first and second derivatives,
* a calculations of Apparent Motion Parameters (namely topocentric angular velocity and acceleration, positional angle and curvature of celestial body trajectory) by means of the spherical coordinate approximation,
* a preliminary orbit determination of a celestial body observed on a super short arc of its topocentric trajectory; we use the classical Laplace's Method and the new Apparent Motion Parameters Method created at Pulkovo observatory for the calculation of the circular and elliptic orbital elements,
* an identification of observed celestial body with the use of known orbital catalogues or with the help of own orbit determinations,
* an own ephemeris service for known and unknown celestial objects from the artificial Earth Satellites up to the Kuiper Belt asteroids.

The algorytms, softwars and examples will be presented. Our large experience of their applications is succesful. The main results were published in Russian.

The author hopes that these algorytms may be useful for near Earth space control and also for a search of the moving celestial objects with the help of the analysis of old and new CCD frames obtained by any telescope at amateur or professional astronomical observatories.

New Pulkovo EPOS Software for amateur and professional astronomers

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EPOS is a powerful software package for calculating the ephemerides of the major planets, minor planets and comets and for executing related tasks. EPOS will be of great service for you:

1. To store in its integrated database the orbital elements and other characteristics of all minor planets and comets as well as to browse and to update the data. It is possible to use up to 99 catalogues of objects (for example the catalogues of Numbered Minor Planets, Unnumbered Minor Planets, Periodic Comets, NEOs, Transneptunian Objects, etc.) and to use the most recent data from the well known world catalogues.

2. To calculate ephemerides of various types for various members of the Solar system. It is possible to obtain spherical or rectangular coordinates (geometric positions) of any specified object referred to the center of the Sun, the Moon or a major planet. For the Earth the geocentric or topocentric astrometric coordinates are also available, as well as the apparent coordinates with their first and second derivatives. The coordinates can be referred to the planes of equator, ecliptic or horizon. It is also possible to get a set of heliocentric osculating elements. The ephemerides can be calculated with various accuracy and be represented in many forms (including the original Pulkovo Apparent Motion Parameters, namely: an angular topocentric and geocentric velocity and acceleration of object, positional angle of velocity direction and a curvature of its trajectory). One can obtain the coordinates of an asteroid or comet either from simple Keplerian motion or by numerically integrating the perturbed motion, taking into account the perturbations by any or all of the major planets, the Moon and some minor bodies. Various numerical ephemerides can be used in this task.

3. To compare the observed objects' positions and velocities with the calculated ones in automatic regime and to obtain the accuracy estimations of made observations.

4. To store, to browse and to update the coordinates of more than 800 observatories for which topocentric positions of objects can be computed.

5. To visualize the tracks of several celestial objects in a selected sky area and to show the motion of all of them against the star background. Several new star catalogues (Hipparcos, Tycho, USNO, etc.) distributed on the compact disks can be used.

6. To get a list of spherical coordinates and their first derivatives for the objects which would be observable within a chosen sky area at a specified moment. So the problem of identifying objects (and therefore discovering new ones) is facilitated in particular with the help of an additional analysis of the first derivative.

7. To model visually a dynamical picture of the perturbed motion of several selected objects, the Sun and the major planets simultaneously. The point from which the picture is to be viewed can be specified arbitrarily, and the scale and speed of action and the presence of the orbits, axes and planes are also adjustable. A user can save a picture to the PCX-file on the hard disk.

EPOS runs on the IBM PC compatibles as MS-DOS application, the version for Windows is now created. It has an English interface and bilingual user's guide.

These new facilities can help an observer in planning various observations, in controlling their accuracy before publishing, in identification of observed celestial bodies and detection of new objects.

New conception of the moving celestial object observations

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ABSTRACT

The epoch of supremacy of CCD technique allows us to elaborate a new approach to the problem of observations of any celestial body moving on the background of stars. Using the computerized star catalogues one can calculate several astrometric positions for any moving celestial object, the first and sometimes the second derivatives of its spherical coordinates by means of statistical treatment in a real time during CCD observations. The classic Laplace method for initial orbit determination may be successfully used now. These derivatives and also so called the Apparent Motion Parameters, namely topocentric angular velocity and acceleration, positional angle of motion and curvature of object's trajectory are the important additional values for an identification of the observed object. The algorithms and software were developed in Pulkovo observatory for the fast analysis of any CCD frame where the moving celestial objects were detected.

Keywords: CCD observations, Orbit determination, Identification, Asteroid discoveries.

INTRODUCTION

Before the beginning of Photographic era in Minor Planets investigations about 300 asteroids were discovered in the World with a visual searching during the XIX century. At the last decade of the XX century we see a triumphal coming of the epoch of CCD observations. By means of photographic technique a number of well known asteroids became more than 5000 for one hundred years period of observations. Now after ten years the total amount of Numbered Minor planets is 13000 and for Unnumbered ones this value is about 60000. A number of discovered asteroids, more and more faint, will only rise as in the Main and Kuiper Belts, as in near-Earth Space also. So in this fields we shall have a huge information stream in near future.

But the mankind ought to constantly remember about Space Debris problem - problem created by our civilization. Its solution also requires worldwide observations. As it is known, the first photographic frame of artificial body contained an image of a rocket of the First Artificial Earth Satellite and was made by T.Mc.Magon in Houbart, Australia, 6/7 Oct. 1957. There was a long AES trail without any breaks on the background of stars. It was published in "Nature", 1957, vol. 180, No 4591.

At the Pulkovo Astronomical observatory the second frame with the same rocket image was obtained on 10 Oct. 1957 by Dr. T.Kiseleva with Short Focus Astrograph, but the trail was broken by means of opening and closing of telescope shutter connected with UT marks. The fast processing of this data were immediately made. Spherical coordinates of these rocket strokes were calculated with usual astrometric reduction, Topocentric velocities of coordinate variations were also determined and some photometric characteristics were obtained. The results were published in Russian "Astronomical Circular", 1957, No

186. Later on, Pulkovo astronomers in different fields of Astrometry and Celestial Mechanics successfully used the new information from short arc of positional observations of moving objects.

We give an Example of preliminary orbit determination by the Laplace method with the use of current ordinary amateur CCD observations for the asteroid named 1999 CV3. All explanations as to content of Tables are given in Comments. Our results were obtained with the help of EPOS software [1]. Final conclusions are presented after Tables.

AN EXAMPLE OF PRELIMINARY ORBIT DETERMINATION BY THE LAPLACE METHOD

Table 1. CCD topocentric observations of 1999 CV3 made the observatory 714

Num	UT*1*		*RA*	*DEC*	Mag	MPC	code
			h m s	o / //			
32192	C1999 02	12.26116	10 11 57.26	+17 06 23.2	13.5 V	a3876	714
		12.26546	57.12	46.1	13.4 V		
		12.27409	56.84	07 31.8	13.4 V		
32192	C1999 02	13.32635	10 11 31.17	+18 42 26.0	13.1 V		714
		13.32972	31.05	44.5	13.1 V		
		13.33259	30.95	43 00.5	13.2 V		
32192	C1999 02	14.20843	10 11 09.24	+20 05 22.9	12.9 V		714
		14.21199	09.12	43.5	12.9 V		
		14.21432	09.04	57.0	12.9 V		

Comment. CCD observations presented in the Table 1 were carried out at the interval of three close nights by an amateur observatory in USA (MPC code is 714) which has 0.30 m mirror, 3 m focus length and an usual CCD matrix. The observed object is moving fast enough. It was discovered by automatic American tracking system (MPC code 704) on February 10, 1999.

Table 2. Test of the CCD observations

Num	code	DT	RA	O-C	DEC	O-C	mgn	z
			h m s	"	o ' "	"		o
32192	714	1999 02 12.26191	10 11 56.337	0.32	+ 17 06 33.78	-0.04	13.5	32
		12.26621	56.240	0.32	06 56.57	0.05	13.4	30
		12.27484	56.050	0.37	07 42.07	-0.04	13.4	28
Mean of last 3 obs.		*12.26766*		*0.34 ± .02*		*-0.01 ± .03*		
Mean error of single observation				*0.03*		*0.05*		
			s	"	o ' "	"		
dRA, dDEC and (O-C)s			*- 22.19*	*4.24*	*+ 1 28 00.9*	*-0.94*		
Relative errors of velocities (%)				*1.3*		*0.0*		
32192	714	1999 02 13.32710	10 11 30.991	0.15	+ 18 42 34.93	-0.46	13.1	16
		13.33047	30.911	0.22	53.41	-0.64	13.1	16
		13.33334	30.846	0.32	43 09.40	-0.55	13.2	15
Mean of last 3 obs.		*13.33031*		*0.23 ± .05*		*-0.55 ± .05*		
Mean error of single observation				*0.08*		*0.09*		
dRA, dDEC and (O-C)s			*- 23.27*	*28.72*	*+ 1 32 03.0*	*-16.03*		
Relative errors of velocities (%)				*7.6*		*0.3*		
32192	714	1999 02 14.20918	10 11 07.806	0.20	+ 20 05 34.19	-0.30	12.9	43
		14.21274	07.717	0.32	05 54.64	-0.34	12.9	42
		14.21507	07.657	0.38	06 08.04	-0.34	12.9	42
Mean of last 3 obs.		*14.21233*		*0.30 ± .05*		*-0.33 ± .01*		
Mean error of single observation				*0.09*		*0.02*		
dRA, dDEC and (O-C)s			*- 25.36*	31.76	*+ 1 35 45.8*	-6.73		
Relative errors of velocities (%)				*7.7*		*0.1*		
				"	"	"	"	
TOTAL mean value of 9 observations				***0.288 ± .026***		***-0.295 ± .080***		
Mean error of single observation				***0.078***		***0.240***		

Comment. By the middle of the summer 1999 there were more than 500 positional observations of this Earth approaching asteroid obtained by various professional and amateur observatories around the World. No one of them photographed it, all observations were carried out with CCD technique. Besides, at the International Minor Planet Center the "old" positional observations of this asteroid made in 1998 and even in 1992 were found after calculation of its improved orbit.

This object has got a preliminary name 1999 CV3 and was put to MPC with reliably determined orbital elements. With this orbit as a basis, we can check up the accuracy of any observations of the 1999 CV3 taking into considerations the residuals "O-C" between its Observed and Calculated positions. These data are presented in the Table 2.

Mean "O-C" and *its error* are calculated for each night position. It allows to estimate formal accuracy of one obtained astrometric position by *Mean error of single observation.* Here these values are quite good within each night and for several successive nights as well - an amateur worked as professional astronomer. Besides the estimation of observational accuracy by analyzing positions, it is possible to analyze the angular velocities , i.e. the first derivatives *dRA, dDEC and their "O-C"* values. These values are presented here as a result of linear approximation of coordinate sets. By this mode an accuracy of obtained CCD observations is given in *Relative errors of velocities (in percents).* Obviously these values are also good for amateur observations.

All results are obtained with the help of the EPOS software package [1] created in Pulkovo observatory.

Table 3. Parameters of motion as a result of polynomial approximations

(Epoch 1999 02 13.33031)

Parameters of motion		Polynomial 2/2 approximations of the Table 1 positions	EPOS (exact values)
		h m s	h m s
//	*RA*	10 11 30.913	10 11 30.900
mu = 5550.15		± 0.003	
EPOS 5550.55	*dRA*	- 25.165	- 25.184
dmu/dt = 244.47		± 0.002	
EPOS 243.99	*d(dRA)*	- 2.564	- 2.577
o		± 0.004	
psi = 356.31		o ' "	o ' "
EPOS 356.30	*DEC*	18 42 52.60	18 42 53.14
C = 1.004516		± 0.03	
EPOS 1.004637	*dDEC*	1 32 18.62	1 32 19.01
		± 0.03	
	d(dDEC)	4 02.84	4 02.35
		± 0.04	
Geocentric distance		0.276248	0.267619
Radial velocity (per day)		-0.006322	-0.006115

Comment. Here the result of processing the data from the Table 1 is presented. Polynomial approximation (the second degree polynomials) and calculation of polynomial coefficients by means of the Least Square Solution with further differentiation of taken polynoms allows to get all the necessary values - the positions *RA, DEC,* their first and second derivatives *dRA, dDEC, d(dRA), d(dDEC)* - for an application of the Laplace method of preliminary orbit determination of asteroid. These values are very close to the real ones, which were improved on the basis of more than 500 positional CCD observations. We used this improved orbit to compare our results with the standard precise data. At the right part of the Table the Pulkovo Apparent Motion Parameters are presented, namely geocentric angular velocity *mu* in arcsec per day, geocentric angular acceleration *dmu,* positional angle *psi* of motion direction and a curvature *C* of object's geocentric trajectory. One can see the high accuracy of derivatives and parameters obtained from observations and their good coincidence with the ephemeris values given by EPOS. Of course, distances are not observational parameters, they are presented as a result of orbital calculations.

Table 4. Osculating elements: ecliptic and equinox J2000.0

Epoch 1999 02 13.33031 DT

	M	*w*	*N*	*i*	*e*	*a*
	o	o	o	o		
LAPLACE	314.3220	95.4856	141.5268	23.6856	0.40962	1.49786
err.	0.6488	0.2090	0.0224	0.2532	0.00466	0.01202
EPOS	312.1293	96.1646	141.4526	22.8575	0.393897	1.459521

Comment. Table 4 contains osculating elements of 1999 CV3 orbit which were calculated by Laplace method and by the EPOS software package using the data presented in Table 3. These elements are close enough. It should be remarked that in the EPOS line orbital elements are supported by more than 500 positional observations during a period of six months and the first Laplace line - by only 9 observations carried out during three close nights. The line "err." shows formal estimation of accuracy of Laplacian orbit elements. This estimation is obtained by numerous calculations of these elements with variations of the first and second derivatives in a range of their formal errors. Thus Laplacian system of elements obtained by us differs somewhat from the real one. It is caused by difference of the first and especially the second derivatives from their precise meanings assigned by the standard orbit.

Table 5. Approximation, Orbital and Standard representations of observations

Dates 1999 Feb.	*RA*	appr.	orb.	EPOS	*DEC*	appr.	orb.	EPOS
	h m s	"	"	"	o / "	"	"	"
12.26191	10 11 56.33	-0.08	-0.72	0.32	17 06 33.7	-0.04	0.16	-0.04
12.26621	56.24	0.01	-0.62	0.32	56.5	0.06	0.26	0.05
12.27484	56.05	0.07	-0.55	0.37	07 42.0	-0.02	0.18	-0.04
13.32710	10 11 30.99	-0.06	-0.06	0.15	18 42 34.9	0.07	0.07	-0.46
13.33047	30.91	0.01	0.01	0.22	53.4	-0.09	-0.09	-0.64
13.33334	30.84	0.05	0.05	0.32	43 09.4	0.01	0.01	-0.55
14.20918	10 11 07.80	-0.10	-0.32	0.20	20 05 34.1	-0.01	0.05	-0.30
14.21274	07.71	0.02	-0.21	0.32	54.6	0.01	0.08	-0.34
14.21507	07.65	0.08	-0.15	0.38	06 08.0	0.00	0.07	-0.34

Geocentric coordinates and their "O-C"

Comment. Here the values "O-C" are presented. They were obtained by polynomial approximation of sets *RA(t), DEC(t)* from Table 1 and also by presenting our Laplacian orbit and standard orbit with the use of the EPOS software package. A small systematic shift of the used observations from the standard orbit is quite natural (see EPOS column). It is a characteristics of considered observations compared to all 500 observations used for standard orbit. As for approximation of "O-C" they are mainly random values and absolutely coincide with Laplacian ones only at the mean moment of observations.

Table 6. Prediction of the 1999 CV3 positions in April with the use of the Laplacian preliminary orbit

1999 APRIL	*RA, dRA, d(dRA)*	*DEC, dDEC, d(dDEC)*		
Laplacian .orbit from the Table 4 gives:			Real CCD observations made by observatory with MPC code 750	
d	h m s	o ' "		
29.22814	22 35 21.599	+61 21 16.91	22 35 48.322	+61 28 16.08
			+/-0.020	+/-0.19
	56.083	- 40 26.16	59.935	-40 54.12
			+/-2.146	+/-20.15
	4.248	9.79	Values *dRA* & *dDEC* are not determined due to lack of observed positions (1 night, 3 observations only).	
EPOS gives:				
29.22814	22 35 48.335	+61 28 16.07		
	57.656	- 40 41.83		
	4.308	9.46		

Comment. Here one can see the quality of calculated Laplacian preliminary orbit after two and half months from its determination. Differences in positions are about + 27 seconds for *RA* and about +7 arcminutes for *DEC*.

The first and second derivatives calculated with the Laplacian and standard orbits coincide better. This may be used for identification of observed object when an initial orbit is not enough accurate. In comparison with *dRA* value calculated by processing of April observations we can see a residual approximately +3 seconds. It may be explained by possible errors in determination of angular velocity from CCD observations of the amateur observatory 750 at the indicated date.

CONCLUSIONS

Our conception of the moving celestial object observations are based on Pulkovo investigations [2-5] and may be formulated as following.

1. Positional celestial bodies CCD observations obtained with the use a short topocentric arc have an additional information about a real motion of these objects, namely the first and second derivatives of their coordinates or the parameters of apparent motion (see Tables 1 - 3). This information may be derived from statistical treatment of object coordinate sets.
2. It is necessary to get several (more than 2) CCD positions per night for each observed object for testing an accuracy of calculated object's coordinates (see Table 2).
3. Set of positions of Main Belt asteroid observed during three successive nights are sufficient to apply the classic Laplace orbit determination method and calculate a preliminary orbit close to real one (see Table 4, 6).
4. Fast orbit determination in interactive mode allow to identify any celestial object with known asteroids or comets or to continue its observations in near future, up to month (see Table 6).

As to CCD observations of the Artificial Earth Satellites and Space Debris objects our results remain in force, only the time intervals are changed from several seconds to several hours as a function of an angular topocentric object's velocity.

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Struve 889: An Optic Double Star

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May 2000

ABSTRACS: An astrometric study was made (RA and DEC measurements in addition to proper motions measurements) and spectrometric study (stellar spectral type) of STF 889. In March 2000 a CCD image was taken using a V filter from which astrometry study an update for the θ *and* ρ *parameters was possible.. By this study it was possible to calculate the ephemerids. This proved the optic nature of STF 889.*

1. Introduction.

Tofol Tobal, a member of Garraf Astronomical Observatory (Spain), sent me a double star list from his observing program. STF889 was included in this list and a note from a well-known amateur in Spain, J.L.Comellas, appear in his work **"Catálogo de Estrellas Dobles Visuales"**: *"PA has increased* more it be *than expected. If retrospective data are true, necessarily orbital type"*. The objetive of this work is mainly the study of the nature of STF 889. For the take of an CCD image a S/C 11" telescope with a ST7 CCD was used.

STF 889 is located at 3 degree Northeast of μ Gem. In Ilustration 1 is the STF 889 chart with a photometry sequence where Tycho-1/Tycho-2 stars are used. This chart will be usefull for photometry studies.

2. Proper motion Study

For proper motion study the astrometry of Astrographic Catalogue for 1896 was used like first epoch; for second epoch, astrometry of HIPPARCOS satelite in adittion to the astrometry made in this work in 2000,192 were used. The time interval covered is 104 years.

3. Spectral Type Study

For the spectral type study the B-V index color and spectral type relationship were used. For this work several spectrocopically catalogs were used like *"13th General Catalogue of MK Spectral Classification"* (Buscombe 1998) for selecting a set of stars with the same B-V index color as that the star in study and consulting their spectral types.

4. Interstellar extinction study

For stars located near the galatic plane and at a distance of several hundred light-years it is important to allow for interstellar dust. In this study two methods were used for the calculating the effects of reddending, **E(B-V),** and stellar magnitude absorption, **Av**. Av is calculated like R * E(B-V). In this paper, R = 3.0.

4.1.1. E(B-V) vs Distance diagram.

For calculating a deep space object's distance, like planetary nebulae and open clusters, professionals use a diagram that shows the relationship between E(B-V) and the stellar distance. In this work several diagrams pertaining to this relationship were taken from professional works. The calculation of E(B-V) and Av was made assuming STF 889 is at a distance of about 1000 light-years. The results are:

$E(B\text{-}V) = 0.08 \pm 0.05$ and $Av = 0.24 \pm 0.15$

4.1.2. Herk's Formulae

The reddending can also be calculated if the distance and galactic latitude (b) is known. This relationship is expressed by Herk's formulae obtained at 1.965:

E(B-V) = (0.0463 cosec b) * (1 –exp(-0.01 * d * sin b)) (1)

Where **b** is the galactic latitude , and **d** is the stellar distance (in parsecs).

The results using this formulae are : E(B-V) = 0.13 and Av = 0.38

As we know, the interstellar dust density is not the same for different sky regions. These methods do not take into account this variable density. Nevertheless their accuracy is sufficient for this study (about 0.03 magnitudes in E(B-V) and 0.07 magnitudes in Av).

Table I. Unreddending photometry

Component	(B – V)o	Vo
A	+1,33	+7,16
B	+1,22	+9,73

In this study both have been averaged to yield these results:

E(B-V) = 0.11 and Av = 0.31

In **Table I** are shown the (B-V)o and Vo values for the A and B components (assuming this stars are at a distance of about 800 light-years). The B-V and V values used for the calculating of (B-V)o and Vo came from Tycho-2 catalog.

5. "A" component

The A component is **SAO 78231**, a red star with +7,47V magnitude.
The H-R diagram ~~it~~ can show us two things about this star:

- This star could be a M1V-M2V main sequence star with an absolute magnitude (Mv) of +10,5±0,5. STF 889 A would then be located at a distance of 8 light-years. This is very improbable.
- It seems more probable that STF 889 A is a normal red giant with a spectral type, inferred from the unreddening (B-V), K2-K4 III. This result agrees well with another reference like SAO, PPM and HD catalogs which list K2 spectral type. If it were thus, this star would be in a long-period variable stars region of the HR Diagram.

Table IIa. STF 889 "A" Proper Motion

Reference	μ(α) [“/yr]	μ(δ) [“/yr]
Fco. Rica	+0"020±0"003	-0"043±0"001
Tycho-2	+0"024±0"001	-0"043±0"001

A proper motion study of the primary is shown in **Table IIa** together with the results from others reference.

6. "B" component

B component is **GSC 1882 1687** with +10.11V magntiude. The Tycho-2 catalog lists a B-V index color of +1.33. I haven't found spectral data in the literature and CDS catalogs. Its B-V index color matches to K7/M0[1] spectral type if this star were at main sequence region; or K0/K2[2] spectral type if it were a normal giant. The V and B-V data are from Tycho-2 catalog.

Table IIb. STF889 "B" Proper Motion

Reference	μ(α) [“/yr]	μ(δ) [“/yr]
Fco. Rica	-0"005±0"002	-0"007±0"001
Tycho-2	+0"011±0"004	-0"005±0"004

An ephemerid study by proper

[1] Francisco Rica found 25 main secuence stars with the same B-V index color getting spectral type between K4 and M1. About 80% of spectral type of these stars are between K7 and M0.

[2] Francisco Rica found 23 normal giant stars with the same B-V index color, all stars wih G8 and K5 spectral type; About 83% of spectral type of these stars are between K0 and K2. At this case the B-V index color was corrected by reddending, which result was (B-V)o = +1.22.

motion interpolation has showed that B component proper motion measured by Francisco Rica is more accurate than Tycho-2 proper motion. The mean O-C using B component Tycho proper motion is about 5 times larger in θ and about 3-4 times larger in ρ than those using B component proper motion measured by Francisco Rica.

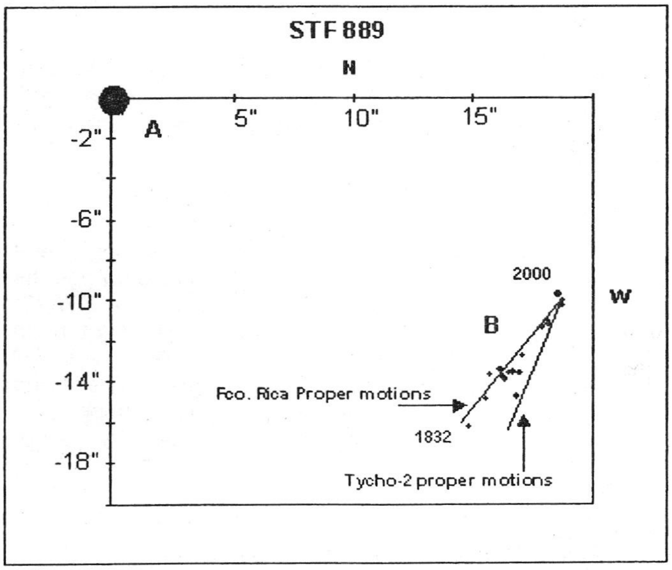
7. Measurements

This double star was discovered in 1.830 by F.G.W. Struve in PA= 221.5 and D=22"1. Since then STF889 has been measured 15 times. The last one in 1.992 (PA=242.0 and D=21"32).

Table III. STF 889 Measurements

Époch	θ	ρ	V_A	V_B	Author/Reference	Method
1830.750	221.5	22.05	7.20	9.50	Struve, F.G.W.	Refractor, micrometer
1865.420	225.6	21.56	7.00	9.20	Dembowski, E.	Refractor, micrometer
1887.190	228.2	22.41			Celoria, G.	Refractor, micrometer
1891.960	230.6	21.81			Cosserat, E.	Refractor, micrometer
1891.960	229.9	21.05			Rossard, F.	Refractor, micrometer
1893.120	228.4	20.88	7.20	10.20	Glasenapp, S.	Refractor, micrometer
1895.200	229.2	21.53			Struve, H.	Refractor, micrometer
1896.058	**229.8**	**21.30**			**AC2000 Catalog**	
1905.070	229.9	21.42			Burnham, S.W.	Reflector, micrometer
1915.090	230.6	21.54			Franks, W.S.	Refractor, micrometer
1921.780	232.9	21.39			Guillaume, J.	Refractor, micrometer
1957.900	237.4	21.26	7.70	9.90	Bos, W.H. van den	Refractor, micrometer
1964.140	238.1	21.37			Haupt, H.	Photographic, with astrograph
1987.970	238.6	21.22			Sturdy, K. (Webb Soc., Double)	Reflector, micrometer
1989.070	242.3	21.00			Girard, P.M. (Webb Soc., Double)	Meridian circle
1991.250	**241.3**	**21.40**	**7.47**	**9.78**	**HIPPARCOS/TYCHO**	
1992.400	242.0	21.32			Girard, P.M. (Webb Soc., Double)	Meridian circle
2000.192	**242.1**	**21.30**			**Francisco Rica**	**S/C 12" + CCD ST 7+ V**

The author of this work took a CCD image in 11 March 2000 (2000.192). The astrometric study results was θ = 242.1° and ρ = 21.3". For the calculating of θ and ρ values first the difference between ecuatorial coordinates of A and B component was calculated. The diffference was expresed in rectangular coordinate **(x,y)** that was tranformed to polar coordinate (θ, ρ).



Ilustration 1. B component trayectory fitted to a line.

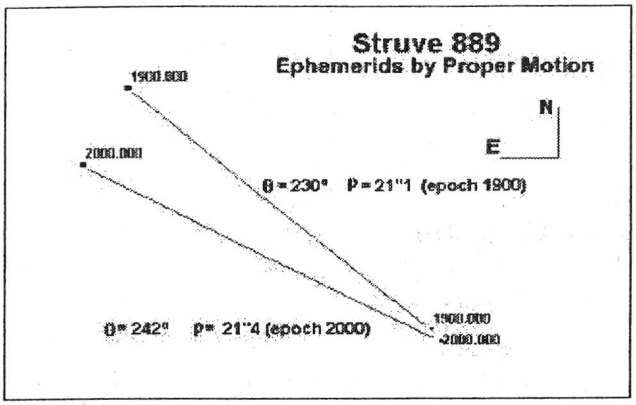
In **Table III** is shown all official measurements listed in the WDS catalog in addition to the measurements in this work (in negrite). The columns show the measurements epoch, θ and ρ, the magnitudes of two components, the measurer-reference and the method used in measurements. All these measurements have been plotted (see Ilustration 1). A linear fit is plotted too.

In **Table IV** is shown the measure of J.L.Comellas made

Table IV. STF889 data from "Catalogo de Estrellas Dobles Visuales" by J.L.Comellas

PA	D	MgA	MgB	SpA	SpB	Type
249	21"	7.5	9.9	K0	A0	¿physic?

J.L.Comellas note: *"PA have increase more it be expected. If retrospective data are true, necessarily orbital type"*



Ilustration 2. A and B component trayectory using proper motion.

in 1.980.
It will be seen that the θ value does not match the Table III measurements.

8. Ephemerids

Two methods have been used for calculating the ephemerids. Both methods consider STF889 like an optical pair:

- By the proper motion of A and B components. An accurate RA and DEC measurement for reference to the RA and DEC interpolation to any epoch (see Ilustration 2).
- By the linear fit of all measurements.

In 2.010 the ephemerids are $\theta = 244^{o}$ y $\rho = 21"3$.

The linear fit of the measurements showed in Table III (previous position angle correction for get precession-free variation of the position angle) matched with a relative motion of the B component of 0.044"/year in the direction of 328°. By the calculating of the proper motions difference between A and B components we would must to obtain the same relative motion.

When Tycho-2 proper motions are used, the relative motion is 0.040"/years in the direcction of 341°. When proper motions obtained in this work is used the relative motion is 0.045"/year in the direction of 326°. Therefore the proper motions of this work matches to the θ and ρ measurements much better than Tycho-2 proper motions.

In Ilustration 1 shows the θ and ρ measurements (the points) in addition to two lines that show the relative motion by Tycho-2 proper motions and this work proper motions.

The rectangular coordinate can be calculate using the followed expression:

$$X = 16.48" + 0.023" * (t - 1900)$$
$$Y = -13.65" + 0.037" * (t - 1900)$$

where **"t"** is the epoch of the calculation.

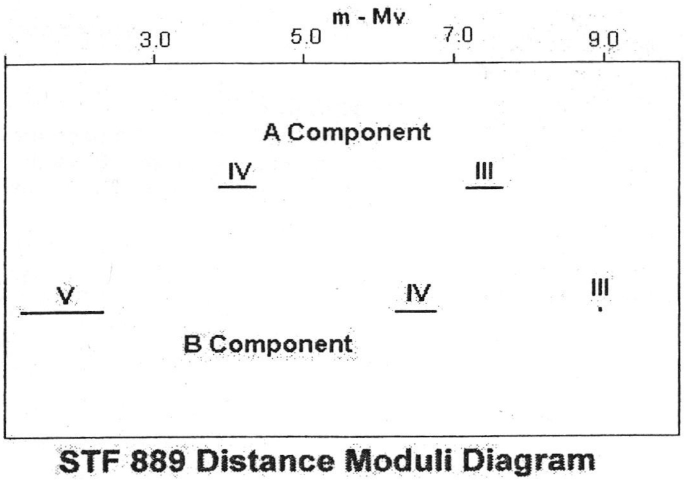
9. Nature of STF 889

In **Ilustration 3** we can see a diagram that shows the A and B distance moduli for different luminosity classes. The absolute magnitude used in this diagram were obtained by several H-R diagrams. For calculating distance moduli the reddening of the components was taken into account.

If the primary component was a normal red giant and the secondary a sub-giant, there could exist a slight posibility a physical association.

If a physical association exists, STF 889 would have be at about 800 light-years. The expected semi-axes would be about 7,400 A.U. The A and B masses would be about 3.4 and 1.7 solar masses, respectivaly, and the system could have a period of about 288,000 years. However the B relative movment is about 80 times higher than the expected value if a physical association exists.

To confirm the optical nature of STF 889 the hyperbolic criteria were calculated (using the calculated masses for A and B) and the proyected value of V^2r. The proyected V^2r value is,



Ilustration 3

at least, 1,530 times higher that the hyperbolic criteria value. **Therefore STF 889 is a clear optical pair.**

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Impact Threat from the Source of Edgeworth-Kuiper Belt.

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The main asteroid and trans-Neptunian (Edgeworth-Kuiper) belts are considered to be the main sources of near-Earth objects (NEOs). These belts supply different material to a near-Earth space. Bodies coming from the Edgeworth-Kuiper belt (EKB) are more icy. The first object of the EKB was found in 1992, and now orbits of about two hundreds trans-Neptunian objects (TNOs) with diameters d~100-400 km are known. It is supposed that in the 30-50 AU region the inferred number of such objects is about 10^5 and the total mass of the present-day belt is of order $0.1m_{\oplus}$, where $m_{\oplus}$ is the mass of the Earth. The number of bodies with diameter $d\geq1$ km for $30\leq a\leq50$ AU is predicted to be about 10^{10} (Jewitt *et al.* 1996) or 10^{11} (Jewitt 1999). The object 1996 TL_{66} (a=85 AU, e=0.6, and i=24°) with $d\approx500$ km is the first object found in eccentric orbit with a>50 AU. Luu *et al.* (1997) considered that there are about 10^4 such objects between 40 and 200 AU with a total mass of 0.5 $m_{\oplus}$. Some new TNOs (1999 CF_{119}, 1999 CY_{118}, 1999 CV_{118}, and 1999 DG_8) moving in highly eccentrical orbits were found in 1999. Fernandez (1980) first supposed that short-period comets came from the trans-Neptunian belt.

The estimates of the number of TNOs migrating to the Earth can be made on the basis of simple formulas and results of numerical integration (Ipatov 1999a). The number of TNOs, which reached the Jupiter's orbit during the considered time span T, equals to $N_J=P_N p_{JN} N$, where N is the number of objects in the belt, P_N is the portion of TNOs migrating to the Neptune's orbit and leaving the belt during this time T, and p_{JN} is the portion of Neptune-crossing objects leaving the belt, which reach the Jupiter's orbit during their lifetimes. The number of TNOs, which are now Jupiter-crossers, equals to $N_{Jn}=N_J\Delta t_J/T$, where Δt_J is the average time, during which the object crosses the Jupiter's orbit.

Duncan *et al.* (1995) obtained that the portion P_N of TNOs that left the EKB during T=4 Gyr under the influence of the giant planets is about 0.1-0.2. As mutual gravitational influence of TNOs also takes place (Ipatov 1999b,c), we take this portion equal to 0.2. Ipatov (1999a-c) noted that gravitational influence of TNOs could play an important role in unpopulating of a region ($36\leq a\leq39$ AU) with small values of e and i, which is dynamically stable under the gravitational influence of planets. The portion of Neptune-crossing objects, which reach the Jupiter's orbit during their lifetimes, was obtained by Duncan *et al.* (1995) to be equal to 0.34. For T=4 Gyr, p_{JN}=0.34, Δt_J=0.2 Myr, and $N=10^{10}$ ($d\geq1$ km), we have $N_J=6.8\cdot10^8$ and $N_{JN}=3.4\cdot10^4$.

Ipatov and Hahn (1999) investigated the evolution of orbits of Jupiter-crossing objects close to the orbit of the object P/1996 R2 ($a\approx3.79$ AU, $e\approx0.31$, $i\approx2.6°$) and obtained $p_{JE}\approx0.2$ and $\Delta t_E\approx5000$ yr, i.e., $\Delta t_E/\Delta t_J\approx1/40$, where p_{JE} is the portion of Jupiter-crossing objects that reached the orbit of the Earth during their lifetimes, Δt_E is the mean time during which a Jupiter-crossing object crosses the orbit of the Earth. The value of p_{JE} was smaller by a factor of several for the use of the RMVS integrator worked out by Levison and Duncan (1994) than that for a usual one integrator. Levison and Duncan (1994) found that 0.5% of short-period comets cross the orbit of the Earth during $\Delta t_E=10^3$-10^5 yr. Probably the actual portion of such comets is larger, because these authors used the RMVS integrator.

Ipatov (1999a) made some appraisals of migration of TNOs to the Earth. The number of former TNOs, which reached the orbit of the Earth during the considered time span T, equals to $N_E=Np_{JE}=P_N p_{JN} p_{JE} N$. About $N_{Jn} p_{JE}\Delta t_E/\Delta t_J$ of former TNOs cross the Earth's orbit now. The ratio of the number N_{NE} of Earth-crossing objects (ECOs), which came from the EKB, to the total number N_{ECO} of ECOs at the considered time moment equals to $P_{NE}=N_{NE}/N_{ECO}=P_N p_{JN} p_{JE}\Delta t_E N/(N_{ECO}T)$, where $N_{NE}=N_E\Delta t_E/T$. The number of collisions of such former TNOs with the Earth during time T equals to $N_{col}=N_E\Delta t_E/T_E$, where T_E is a characteristic time elapsed up to a collision of such ECO with the Earth. Note that the mean value of T_E for Jupiter-crossing ECOs is greater by a factor of several than that for other ECOs, so the portion of former TNOs, which collide the Earth, is smaller than the their portion among ECOs. Jupiter-crossing ECOs usually move more far from the Earth than other ECOs, so a smaller part of them was observed. Sometimes they move in 5:2, 7:3, 3:2 and other resonances with Jupiter (Ipatov and Hahn 1999).

For $N=10^{10}$ ($d\geq1$ km), N_{ECO}=750, T=4 Gyr, p_{JE}=0.2, and $\Delta t_E\approx5000$ yr, we have $P_{NE}\approx0.2$, $N_E\approx1.4\cdot10^8$, $N_{NE}\approx170$. For the above values at T_E=200 Myr, we obtain $N_{col}\approx3500$, i.e. 1-km former TNO collides the Earth on average ones in 1 Myr. The above estimates are very approximate, but they show that the number of TNOs hitting the Earth is not small. For larger values of Δt_E, the values of P_{NE} and N_{col} are greater. Let us denote the portion of Jupiter-crossers that acquire Earth-crossing orbits with aphelion distance $Q\leq4.5$ AU as k_E and their mean lifetime in such orbits as Δt_E^*. Then the number of such objects is $N_{NE}^*=N_E k_E\Delta t_E^*/T$. At Δt_E^*=1 Myr and

$d \geq 1$ km, we have $N_{NE}^{*}=3.5 \cdot 10^4 k_E$ yr. Results of the investigations of orbital evolution of Jupiter-crossing objects obtained by Ipatov (1995) with the use of the sphere's method (two problems of two-bodies) showed that several percents of such objects got orbits with $Q \leq 4.5$ AU. At $k_E=0.01$, $N_{NE}^{*}=350 \approx 2N_{NE}$. Therefore, the number of former Jupiter-crossers that move inside the orbit of Jupiter can be of the same order (or even more) than the number of objects that cross both the orbits of Jupiter and Earth. The above values of N_{NE} and N_{col} were obtained for $N=10^{10}$ (for $N=10^{11}$ they will be greater by an order of magnitude). So they can be considered as lower limits for former TNOs. The estimates presented above were obtained for the bodies, which migrated from distances 30-50 AU from the Sun. Bodies with a >50 AU moving in highly eccentric orbits also can migrate to the Earth.

Objects that move from the main asteroid belt got in the resonant regions, from which they were delivered to near-Earth space, via collisions with other asteroids (for small asteroids also via the Yarkovsky effect) and usually doesn't exceed 10 km in diameter. TNOs can leave the EKB without collisions. This may be the reason of that the largest craters are mainly of a comet origin.

As it is more easy to destruct icy bodies than stone or metal bodies (for example, on their way to the Earth bodies can break up at close encounters with planets and at collisions with small bodies), the portion of TNOs among ECOs for bodies with $d \leq 100$ m (for example, for Tunguska-type bodies) may be greater than that for 1-km bodies, but small icy bodies disappear in the atmosphere and cannot reach the surface of the Earth.

Acknowledgements

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