Book Review

Science in western and eastern civilization in Carolingian times

edited by Paul Leo Butzer and Dietrich Lohrmann, Birkhauser Verlag AG, Klosterberg 23, CH-4010 Basel, Switzerland, 1993, pp. 609, sFr. 88.

Many branches of science have had their origins in enterprises that, according to today s canons, would be considered utterly unscientific. Chemistry is the classic case of a scientific discipline that originated in nonscience, viz. alchemy. It is interesting and instructive to investigate these and similar genetic links between modern science and earlier human attempts at dealing with the facts and phenomena of objects and the universe.

The symposium on Science in Western and Eastern Civilization in Carolingian Times held at Aachen University of Technology from 25th to 28th September, 1991, was an expression of this interest. The book under review is the publication of the proceedings of the Aachen symposium.

Two additional contributions are included in this volume: Joachim Wiesenbach s study of the astronomical treatise Horologium nocturnum by Pacificus of Verona (d. 844), and the complete Latin text and German translation of the oldest preserved collection of mathematical problems in Latin, viz. Propositions ad acuendos iuvenes ascribed to Alcuin of York (c.735-804). The beautifully produced volume has reproductions of 30 folios from ancient manuscripts preseved in various libraries in Europe.

Twelve of the articles are in German, eleven in English and one in French. All the articles are preceded by a summary in English and almost all have a concluding bibliography. The articles cover a wide range of topics categorised into four sections, viz. Centres of Tradition and Transmission in Western Europe , Astronomy , Computistics and Mathematics and Applied Sciences .

The cover design draws the reader s attention to a remarkable aspect of this fascinating period, i.e. the artistic beauty of the illustrations that accompanied scientific texts of the time. The cover is a reproduction of a colour plate which figures in Anne Tihon s article on 8th century Byzantine texts copied at Constantinople University. As Tihon discusses Ptolemy s tables, we can feast our eyes on a famous sun diagram which depicts the sun as a charioteer. The chariot is drawn by four white horses and is located at the centre of three-coloured circles with figures. These three circles represent the hours of the day, the months of the year and the twelve zodiacal signs. The coloured circles are separated by two white circles in which are inscribed the day and the hour of the sun s entry into each zodiacal sign.

Anton von Euw s article on illuminated codices shows that the fusion of artistic beauty and scientific exposition in artistic manuscripts reached its peak in the age of Charlemagne and his successors before the time of Charles the Bald. Though meant to be used for biblical or liturgical purposes, these astronomical codices deal with descriptions of the constellations of celestial bodies. These descriptions are supplemented with splendid images. Other scientific manuscripts too received

simple forms of ornamentation lines in red ink, or squares and cirlces to highlight tabular and chronological information. Anton von Euw points out the Greek origin of these BOOK REVIEWS 372 Tholasi Prints Mar Apr. Issue Received on No. Pgs. 9 1st proof Date: 17/10/02 SP (Book Review. p65) geometrical figures, which were at the same time formulas of the universe and its composition out of the four elements, viz. earth, water, fire and air. This view is directly linked to Greek cosmogony as imparted to the Carolingians by Roman antiquity. The author shows how far the Carolingians used ancient spiritual accounts of the world and the repertoire of artistic forms, and gives the example of codex 83II from the Dombibliotheek of Cologne. Astronomical and computistic diagrams, representation of the earth, and a catalogue of the constellations, given in Codex 83II, can be regarded as among the most important Carolingian achievements in the field of science, next to the Aachen Encyclopedia of 809.

The Computus of 809, also known as the Seven Book Computus, a result of an astronomical computistical conference held at Aachen in 809, is the subject of articles by Arno Borst, Bruce Eastwood and Wesley M. Stevens. Besides, Stevens, in article on Walahfrad Strabo s computusmanuscripts and Paul L. Butzers in an article on Mathematics in West and East, discuss the significance of this event.

A quote from Stephen C. MaCluskey s article on Latin astronomies, during the 5th-9th centuries is reproduced below:

"The Carolingian renewal of learning contained no agenda for astronomical research. The impetus behind the Carolingian reforms was primarily religious and a pre-eminent concern was to insure uniform adherence to authoritative standards. Charlemagne speaks in the Admonitio Generalis of the importance of rituals being conducted properly. These concerns called forth two distinct aspects of his reform that concerned the development of astronomy. First, in the schools he established, clerics were taught computus. Secondly, and perhaps less obviously, complete and authentic texts were carefully collected, copied, and distributed.

The most significant of these texts are the astronomical and computistical anthologies that emerged around the year 809. These anthologies reinforced the study of astronomy by adding to the traditional computistical texts reflecting the Carolingian interest in astronomy .

The star catalogues , as they are commonly called, are a far cry from what modern astronomers and ancients such as Ptolemy meant by that term; they do not give the position of the stars by any mathematical system of coordinates. Rather they are qualitative descriptions of the constellations, noting the number of stars in each part of the constelllation and the general location of the brighter stars. Their goal was not astronomical observation but artistic and mythological edification; it seems revealing that they are studied today more by art historians than by historians of science (p. 153).

Joachim Wiesenbach s article on Pacificus of Verona as the inventor of a star clock is also notable for the aesthetic brilliance of the illustrations. Wiesenbach

was inspired by the question whether Gerbert von Aurillac had known about the astrolabe and had taken this instrument to the Latin west. Gerbert s Oralogium has been explained as a sundial, a water clock, even as an astrolabe or a nocturlabe. On the other hand, it has been possible to trace a pre-astrolabic instrument the horologium nocturnum to Pacificius of Verona on the basis of Pacificus epitaph, his poem Spera coeliquater and a series of drawings in a 10th century manuscript. The present volume contains four of these drawings. In his description of folio 76r from Vat. Lat. 644, Biblioteca Apostolica Vaticana, Wiesenbach raises an intriguing point: From the head of the peculiarly dressed observer the sighting tube leads directly to the center of the disc subdivided BOOK REVIEWS 373 Tholasi Prints Mar Apr. Issue Received on No. Pgs. 9 1st proof Date: 17/10/02 SP (Book Review. p65) by three circles. (p. 242) (translation is reviewer s). Could the unusual clothes be an indication of the nonwestern origin of this astronomer? A scrutiny of more folios might be rewarding in this regard.

In a short article, in English, W. Schlosser and B. Hoffmann compare Ptolemy s description of the Milky Way with the information provided by modern surface photometric techniques. Their discussion of contrast thresholds and atmospheric effects shows that the range of latitudes of observation employed by Ptolemy coincides with Egypt as the geographical location of an observer. The article by Paul Kunitzsch on Arabic astronomy surveys the pre-scientific popular astronomy of the Arabs, and the Arabic-Islamic scientific astronomy in the eighth through the tenth centuries. Kunitzsch ends his article by referring the reader to David King s survey, The exact sciences in medieval Islam: Some remarks on the present state of research . Middle East Studies Association Bulletin, 1980, 14, pp.10-26).

No single collection of papers can claim to have revealed everything about the mythical, mystical origins of what we now take to be the exact sciences. Yet the organizers of the Aachen Seminar deserve congratulations for trying to reach out to a wider audience through the publication of this stimulating book on the history of science.

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Book Review

Thermal physics and statistical mechanics

by S. K. Roy, New Age International Publishers, 4835/24, Ansari Road, Daryaganj, New Delhi 110 002, 2001, pp. xiv + 418, Rs 200.

Serious students of science realize that their understanding of a subject is tested by their ability to solve analytical and numerical problems in that subject. In some patterns of teaching, the student is made to work through a few hundreds of questions, thereby acquiring skills in applying the basic principles from different directions to analyze and answer varied questions. By this training the students get a capability to tackle any new issue. In engineering and applied subjects, this mode of teaching is considered to be the best way of preparing the students to face real-life challenges. Even in basic science subjects this approach has much to recommend, specially because of the tendency in many universities to frame essay-type questions requiring the students to reproduce from memory what they have been taught. The present book is a part of a series of volumes to teach physics through the problem-solving channel. This is a philosophy in pedagogy to improve the qualitative and quantitative understanding of the subject. However, one must state that a group of traditional teachers deride the problem-solving method as a short cut to passing the competitive examinations. While there is some truth in this statement especially in the present Indian context, the method has its own intrinsic value. In addition, the subject gets richer by having inputs from differing points of view.

The present book is aimed at developing a healthy understanding of the topics by graduate students in physical and engineering sciences, though a good fraction of the book will be understood only by the M. Sc.-level students of physics of most Indian universities. It starts with a chapter on temperature and thermal expansion followed by two chapters on the kinetic theory of gases. The fourth chapter is on the equation of state while the fifth is on transport phenomena and BOOK REVIEWS 374 Tholasi Prints Mar Apr. Issue Received on No. Pgs. 9 1st proof Date: 17/10/02 SP (Book Review. p65) Brownian motion. The sixth chapter is on heat transport by conduction and convection. Thermodynamics makes its appearance as the seventh chapter, with the eighth chapter devoted to thermodynamic relations. Radiation phenomena are discussed in the next chapter. Classical statistical physics and the elements of quantum statistics are discussed in the next two chapters. The 12th chapter, the last one, is on the applications of statistical mechanics to thermodynamic problems. The range of applications of thermal physics is very vast and only a selected list can be accommodated in a book of modest size. The author has chosen the topics to suit the conditions common to most Indian universities. However, only the M. Sc.-level students of Indian universities can appreciate many of these topics.

Each chapter has a short introduction covering basic definitions and principles, theoretical results and formulae. Then a number of fully worked-out examples are given, deriving some important results in a question-answer format of analysis. These cover numerical as well as analytical results. A number of questions are then given, with solutions, for the students to have a self-test of their understanding of the subjects. Supplementary problems are then given with short

answers at the end of the book to provide an opportunity for the students to test their knowledge and skills. More than 350 worked examples with complete step-by-step solutions as well as around 100 practical problems with answers are given in the book. The problems include analytical derivations, approximate numerical estimates and illustrative applications. They also cover a range of elementary to advanced topics. On the whole the author must be congratulated for the excellent job done in the selection of the problems. These coupled with the summary of the basic theory, principles, equations and formulae will enable the serious student to acquire a mastery of the subject.

While appreciating the good efforts of the author, one must also point out some weaknesses. A large part of the subject is based on experimental research and the analysis of painstaking observations. This aspect of the linkage with experiments is often missed out in such books dealing with problems and solutions. A list of good books, which describe these experimental aspects of the subject, should be given to prepare the background knowledge of the students. Then the present text would perform an admirable job of being an excellent guide for the tutorial work. Perhaps some remarks could have been added on the empirical origins of the subject of thermodynamics and the beginning of kinetic theory of gases to give a molecular interpretation to the phenomena in gases. The genesis of statistical mechanics to complete the links between the bulk macroscopic properties and the microscopic atomic phenomena would then be appreciated. Some teachers like the students to tackle the problems independently and finally compare their work with the menu given by the instructor. This would require the solutions to be given separately, say at the end, rather than be attached to the problem itself.

The book is wholeheartedly recommended as an excellent supplementary material to students and teachers. The average student will get a grinding in solving the problems and thus will get prepared to reach higher levels of performance. The good student will use the book to jump further and excel in competitive situations. The teacher will benefit by getting better insights into the quantitative aspects of the subject. They will also have a bank of 450 problems, which can be expanded several folds by variation of the themes and parameters. Printing and proofreading appear to be well done. The book is reasonably priced for the Indian and the third world market conditions. The editor of the series is to be congratulated for bringing out the series of texts with the problem-solving approach. We wish the book good success not only in the Indian market but also internationally.

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Book Review

Atomic and molecular spectroscopy

by M. C. Gupta, New Age International Publishers, 4835/ 24, Ansari Road, Darya Ganj, New Delhi 110 002, 2001, pp xii + 466, Rs 220.

This is a textbook aimed at the B.Sc. (Hons) and M.Sc. students of chemistry of the Indian universities. Starting from the basic principles of quantum theory and wave mechanics the structure of atoms and molecules are discussed first before moving to cover the conventional atomic and molecular spectroscopy. Finally, the book deals with resonance techniques in applied spectroscopic investigations. Being a comprehensive book with problems and solutions, it is likely to have a good appeal for the students as well as the teachers.

In a historical perspective, the studies of the spectra of atoms and molecules lead to developments in the understanding of the structure of atoms and molecules and then to the underlying principles of quantum mechanics. The first part of the book, dealing with the principles of quantum mechanics, consists of five chapters. The first gives an account of the evolution of the quantum aspects of blackbody radiation and the wave aspects of matter. The Schrodinger wave equation and its simple consequences are treated in the second chapter. The structure of the hydrogen atom and the extension to the structure of many electron atoms are summarized in the third chapter. The fourth chapter deals with electronic configuration of molecules and ideas of different types of chemical bonding. The fifth chapter shows how electric and magnetic properties of molecules can give information and insight into the structure of the molecules.

The stage is now set to discuss the spectra of molecules, which is taken up in the second part of the book. Chapter 6 deals with the general features of emission and absorption of electromagnetic radiation by atoms and molecules. The simple case of the rotational spectra of molecules is taken up in the seventh chapter giving ideas of the frequencies of the spectra and their relative intensities of the lines. The vibrational and vibrational rotational spectra of molecules are taken up in the eighth chapter. There is a large amount of work in this area and hence the chapter discusses the topic in some detail, giving the characteristic absorption bands of various organic molecules. Raman spectroscopy is considered next, showing the link with the IR spectra and the studies of molecules in solutions. The tenth chapter deals with UV and visible spectroscopy of the electronic spectra of molecules. The interpretation of molecular spectra involves the symmetry considerations and so some group theoretic ideas are briefly introduced in the next chapter, followed by Chapter 12 containing several examples of the applications of group theory to interpret the observed spectra.

The third part of the book is connected with resonance spectroscopy, which can be taken as the major advance in the field extensively developed since the 1950s. The elementary ideas of atomic and nuclear magnetic moments are given in Chapter 13. This is followed by a discussion of nuclear magnetic resonance spectroscopy. Examples are given to illustrate the information about molecular structure as well as local environment of the molecules in the condensed solid or liquid phases. Nuclear quadrupole resonance spectroscopy is discussed in Chapter 15. Electron spin resonance spectroscopy of magnetic ions and its uses are described with some applications in Chapter 16. The next chapter deals with Mossbauer spectroscopy using the recoil-less emission and absorption of the gamma rays from the Fe57 nucleus.

The concluding part of the book consists of five appendices giving some useful numerical constants and relations, some mathematical aspects of partial differential equations and the approximate solutions of quantum mechanical problems. There is a glossary of symbols used in the book, a bibliography of about 30 books for supplementary reading and a combined author- subject index.

Overall the book accomplishes the main goal of introducing the subject to the students of chemistry, simplifying the topics of quantum mechanical applications held otherwise to be fearsome. The incorporation of several worked-out problems and numerous figures has made the book easily readable. Some universities may need a little more of some topic and a little less of another, but the author, having taught at several universities, has struck a reasonable balance. The book is well produced without any noticeable mistakes or slips. It is also reasonably priced.

If at all one gap is noticed, it is in relation to the description of the experimental techniques. The objective of the book is not to make research experimenters. Nevertheless the students should appreciate the range and the limitations of the various techniques, the study of spectra in the gas phase and in the condensed phases or the reason for the popularity of Fourier Transform methods of recording the spectra. The description of the experimental procedures in various chapters is quite inadequate. This gap should be corrected at a future date.

On the whole, the book is a good effort at producing a nice textbook and is warmly recommended to the students and the teachers.

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Book Review

The origins and technology of the advanced extravehicular space suit

by Garry L. Harris, AAS History Series, Vol. 24, Series editor, D. C. Elder, Published for the American Astronautical Society by Univelt, Inc., P. O. Box 28130, San Diego, California 93198, USA, 2001, pp. 542, $ 85.

A pressure suit is pivotal to carry out any manned space activity outside the protective environment of a space vehicle or habitat, in order to protect humans from the harsh conditions of space, like pressure, temperature, radiation, micrometeorites, and also to provide comfortable workability in space-empty or filled with nocuous gases. A space suit thus is not only protective clothing, but also a life-saving system. Although the fundamental considerations in any suit enclosure are mobility and safety, the requirements differ depending upon the mission. The suit requirements to work on the surface of the Moon or Mars cannot be the same as those for the extra-vehicular activity (EVA) of the space shuttle.

As the name suggests, the book is a comprehensive account of the space suits. It covers not just a history of their gradual evolution but gives a detailed description of the technology, incorporating design, materials and engineering of the suit and the life-support system. Original contributions of the designers and companies involved, NASA s own contribution in designing various types-soft, hybrid and hard-of suits, role of contractors and politics of their selection, etc., are some of the issues discussed.

It is really fascinating that the genesis of space suit began not with the space age but with the period of electronic vacuum tube. In order to solve the numerous technical problems associated with the vacuum tube, a scientist working at the Litton Industries, USA, the builder of the vacuum tube in the 1950s, suggested to create a man-size tube enclosed in a room-size vacuum chamber, where a person gets in and looks into the tube while it was in operation. To get into the chamber one needed special clothing to withstand vacuum, and that led to the idea of a pressure suit!

Indeed, the first pressure suit was designed at Litton around 1954. It was a crude design but one point became obvious the suit need not be made entirely out of fabric. Since then Litton went on improvising and produced a series of excellent suits of all types-soft, hybrid and hard- suitable for EVA. Its hard suits, RX-5 and RX-5A, provided greater suit comfort than its Apollo suit counterpart, and could be donned in just 60 seconds in zero gravity. However, none of them was ever used in a space mission and ended up as museum pieces. In fact, Litton was one of the prime space suit contractors of NASA in the initial development stages of the space suit. Its last advanced extra-vehicular suit (AES), equipped with a life-support backpack, was baselined for Apollo-17. The funding for the lunar flights, and the AES program, however, was terminated in the 1970s, and Litton Industries parted company with the space suits.

A space suit looks deceptively simple in its outer appearance but beneath it rests a machine that is among the most complex technologies employed in space efforts. The construction cost of a new advanced EVA suit runs from $ 300 to 700 million.

In its simplest form, a space suit is designed to contain its occupant in a pressurized enclosure and provide him with an Earth-like environment. Pressure is contained by a flexible rubber bladder, which is surrounded by layers of fabrics to keep its shape. The so-called intravehicular activity (IVA) suits (worn inside the space vehicles) used in the Mercury and Gemini missions were essentially aviation pressure suits. Their prime function is to provide pressurization only in an emergency, should the cabin pressure fail.

The EVA suits, in contrast, have to suit the harsh conditions of the outer space all the time, and hence have to cater for cooling the suit occupant, controlling carbon dioxide build-up in the suit, etc. These are essentially composed of three subsystems: the pressure suit assembly including helmet and gloves; the life-support system; and the various extraneous elements that are added depending on the outer conditions, like sun shields, helmet covers, thermal-micrometeoroid cover garments, etc. Most suits like the shuttle EMU (extra-vehicular mobility unit) are pressurized to 4.3 psi, slightly above 3.08 psi, the partial oxygen pressure in sea-level atmosphere. It comes as a surprise to most people that all pressure/space suits leak internal gases. Leakage usually occurs at mobility joint, suit closures, rotary wrist seals, zippers, etc.

The design of a convolute mobility joint was a major task. Fabric or rubber molded convoluted mobility joints were used in Apollo lunar suits. Many types of mobility joints were designed subsequently. A toroidal joint, which had excellent joint mobility was designed by Elkins for the post-Apollo application program. Interestingly, hard and hybrid suits did not come about due to a need in the space program. However, they have some distinct advantages like impermeability to leakage, allowing higher internal suit pressure, long life and greater reliability. These suits use mainly aluminum and composites for torso. The mobility elements, such as the arm, legs and gloves are often composed of synthetic fibers, elastomers and fluorocarbons.

Hamilton Standard and AiResearch were selected by NASA to be prime contractors for the post-Apollo suits and life-support systems, respectively. NASA s Ames Center also began investigating this field. The possibility of fabricating a light-weight IVA suit for shuttle that could be worn during launch or landing or be rapidly donned in case of cabin pressure loss while in orbit was also explored. However, no dedicated IVA was adopted for space shuttle until after the Challenger disaster. The IVA suit flown on the first few shuttle flights was ejection escape suit manufactured by David Clark Co. Today s space shuttle EMU is designed to meet the projected minimum criteria based on the fact that its primary function was limited to jettisoning and retraction of payloads and to serve as a back-up for the closure of the payload bay doors. The first shuttle suit prototype was actually built by Crew Systems Division in Houston. It had rigid aluminum upper torso and Apollo helmet. Hamilton Standard won the suit contract and supplied 43 suits and 13 life-support systems at a cost of $107 million (1981). The pressure suit itself weighs 85 lbs including the liquid cooling

garment. With primary life-saving system (PLSS) and accessories the shuttle EMU weighs 258-295 lbs depending upon configuration. The book gives a detailed account of the major components of the shuttle EMU.

Unlike the US suits, the Russian EVA suits were all built by the same company i.e. Zvezda Enterprises. The combination of limited funding, a single supplier, and a pragmatic design philosophy led to effective, practical and functional (without frills) suits. The so-called Krechet (falcon) semi-rigid suit, designed for manned moon program, had the rear entry and closure, which is considered a brilliant innovation of the Soviets. It is donned easily by a cosmonaut without the help of other crewman. Only two Krechets are known to exist one at Zvezda and the other with Ross Perrot, the American billionaire. The EVA suit (Orlan-D) was a modified lunar suit for Salyut space station. Operating at 5.8 psi, it weighed 150 lbs; it used 82 ft umbilical that made it dependent on the stations power supply. The next modification, Orlan-DMA was used for the Mir space station.

The US began developing a new suit for Freedom Space Station (FSS). Although the goals of the station were not clearly defined, a dedicated suit was to be used for a total of 1000 to 4000 man-hours a year for the first ten years. Hence, any suit needed to be orbital based rather than the ground based (like the shuttle suit). Hamilton Standard/ILC Dover built ZPS Mark-III, which was a rear entry closure suit. NASA felt that ground-based donning and doffing of the suit was easier. Another hard suit (AX-5) was designed at the Ames Research Center by Vykukal, which had no fabric components. It had excellent mobility, but the program was suspended after the demise of FSS.

The EVA suit design for the FSS renamed as International Space Station (ISS) after the Russians decided to join the program, builds on the joint experience of the USA and Russian partner. Since the basic aims of the station are not yet clear, designing a new suit has therefore no specifics, except the job which the FSS did. A common design suit is yet to evolve.

NASA intends to human exploration of Mars within the next 25 years. Such an effort will require a very different space suit. The long duration of mission and divergent climatic conditions on Mars makes the Mars surface suit a unique challenge. Besides, the suit must also be alterable so that it can be used in free space on trans-Mars and trans-Earth flights. The suit must also be puncture resistant, light, rugged, dust resistant, stowable, comfortable for long periods, and must have a Mars-suited portable life-support system. NASA lists many other criteria to guide the contractor in designing the suit. Although a wealth of EVA technology exists with NASA, the evolution of a suitable space suit for Mars exploration is indeed a challenge, which is rightly emphasized in this book.

The author also outlines the intricate procedure followed by NASA in contracting a space suit. NASA doesn t select a space suit; it selects a contractor. It involves a whole range of considerations such as cost, integration of the PLSS and suit, who were the contractor s key personnel, design and test philosophy of the contractor, certification method, prior experience, who the subcontractors were, scheduling and delivery, and how compatible the suit system is with the spacecraft. In addition, blatant national political factors more than likely affected contractor selection; how much money was NASA already spending in the respective states

of the suit competitors, who were the states representatives and did NASA owe the representative any political favors?

This volume is Bible of the space suits, covered in over 500 pages in fine print. It addresses almost all issues relating to the EVA suit in one volume. It is perhaps the only source book of space suits. It is a rare occasion that an entire volume of the AAS History Series is devoted to a single topic, which indeed is an honor to the author. In Indian context, may be the ISRO has no plans to design a space suit, since there are no plans of any manned space mission as of today, but eventually it will have. This book will serve as a reference in design specification and technical details of the various types of EVA suits and their suitability for a particular mission.

Bound in blue hard cover as usual, the book has a illustration of the Litton RX-5A hard suit being demonstrated on a simulated lunar surface.

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Book Review

Guidance and control 1999

edited by Robert D. Culp and Douglas J. Wiemer. Published for the American Astronautical Society by Univelt, Inc., P. O. Box 28130, San Diego, California 93198, USA, 1999, pp. 528, $ 120.

The papers in this volume constitutd the proceedings of the 21st Annual AAS Rocky Mountain Guidance and Control Conference held on February 3-7, 1999, at Breckenridge, Colorado. This is an annual event that has attained almost ritualistic proportions and, for the world s astronautical science community, it is a must-attend event. Cosequently, the papers presented in the conference are of high quality and of great current interest.

The papers in this volume are classified under several major topics. The section on Celestial flak has several papers on the detection, orbit determination, and deflection or fracture of large rocks and comets that pose a serious threat to the planet Earth. Despite its somewhat science fictionesque premise, it is indeed not an idle threat that the human population can afford to ignore. The first two papers in this section focus on NASA s effort on detection, classification, tracking and impact probability of near-Earth objects (NEO), a very small percentage of which has been detected till date. The paper by Lambert et al. compares the performance of radars against optical telescopes and concludes that radars, although of greater use for low-Earth objects (LEO), are of marginal use for NEO detection. The paper by Chodas et al. carries the work a little further and estimates the probability of Earth impact based on close approach uncertainties. The next group of three papers address the problem of deflecting these objects. The paper by Meek investigates the possibility of using conventional propulsion system to deflect an asteroid and a comet to non-impacting orbits. The paper by Abu-Saymeh and Kluver discusses the use of trajectory optimization methods to deflect a small asteroid with low-thrust high-impulse electric propulsion systems using ion thrusters or stationary plasma thrusters. The third paper in this group by Canavan discusses the deflectability of different types of NEOs. The last paper in this section entitled Rock a bye baby by Sonnabend is delightfully entertaining (a phrase seldom used when one talks about a technical paper!). How do you save planet Earth from a huge asteroid hurtling towards it at a tremendous speed? Simple, says Sonnabend-while generously attributing the original idea to Edward Teller and Louis Alvarez-just push a smaller asteroid directly in front of the big bad guy! Even though the problem is posed in a lighter vein, the analysis and simulation results are quite enlightening.

The section on Advances in guidance and control has a paper by Potteck that demonstrates the use of a pattern recognition algorithm in combination with a star sensor to impart increased autonomy to a satellite. The paper by Deutschmann et al. presents a MATLAB-based extended Kalman filter navigation system for low-Earth orbit satellites. The contribution by Pasetti and Giulicchi presents experimental results on three multipath error correction algorithms that essentially compensate for the error caused by the GPS signal being diffracted or reflected from surfaces in close proximity to the antenna. The paper by Soyka and Dasenbrock addresses the problem of navigation state vector propagation for

the interim control module in the International Space Station. This is expected to facilitate the accurate pointing of antennas. Nguyen et al., in their paper, discuss the results of a prototype reusable spacecraft X-40A that functions as a reusable satellite bus as well as a reusable upper stage. The results are mainly on the design of the guidance and controls in terms of its hardware, algorithms and software. The next paper by Thayer et al. addresses the problem of vibration isolation in space interferometers using Stewart platforms, applying modern control techniques rather than the usual classical control techniques. Finally, the paper by Scott et al. discusses a systematic approach taken to define, implement and test the failure detection and correction design features used in the LANDSAT-7 earth remote sensing satellite.

The section on Autonomous rendezvous and docking has a group of papers on this interesting topic. The paper by Junkins et al. proposes a vision-based proximity navigation for spacecraft using position sensing diode photodetectors. The paper by Mokuno et al. discusses the successful testing of autonomous rendezvous docking on the Japanese Engineering Test Satellite. The next paper by D Souza et al. presents results on the evaluation of a relative GPS system for the same Japanese satellite. The paper by Cislaghi et al. discusses the preliminary studies conducted for the rendezvous pre-development programme to be used in the automatic transfer vehicle developed by the European Space Agency. The last paper in this section is by Howard et al. and presents the video guidance sensor developed by NASA for automated rendezvous and docking operations in space stations.

The next section on Systems modeling and simulation has several papers that address important issues in modeling and simulation. The first two papers are concerned with the applicability of MATLAB (Dellinger et al.) and MATRIXx (Ward et al.) toolkits for some specific space-related applications. The paper by Holmes et al. describes the Landsat 7 simulation and testing environments for its attitude control and determination subsystem. The paper by Slivinsky et al. presents an excellent overview of the three consecutive missile technology demonstration missions and their flight results, mainly with respect to the performance of the GPS-based guidance system. The paper by Barnes describes a technique to use a new detector focal plane technology to extend the accuracy and operating range of the existing Earth/Sun reference sensors systems. The last paper in this section is by Barry and Olson and describes the display system to be used in the space-based radar constellation, being designed by Boeing for the US Air Force, meant for tracking both ground and airborne moving targets.

The section entitled Recent experiences in guidance and control presents a few papers on the experiences gained during the operation of various space systems. They collectively describe the experiences gained during the inorbit operation of the Indostar-1 geosynchronous satellite belonging to the class of small and relatively cheap satellites (Arluk et al.), the Geosat follow-on satellite which is mainly used for ocean survey data collection (Frazier et al.), the Tropical Rainfall Measuring Mission Satellite s attitude control system which is a joint study between NASA and the Japanese NASDA (Robertson et al.), the NASA s TRACE spacecraft which has a primarily scientific objective of studying magnetic fields on the solar surface (Zimbelman and Watzin), and finally the Antarctic mapping mission using a synthetic aperture radar on the RADARSAT

satellite (Crocker et al.).

By and large, this collection of papers is fairly representative of the current research and development effort in the area of guidance and control of spacecraft systems. As is normal with this series of conference proceedings, the papers are of high practical utility as they describe analysis, design and experiences with actual systems.

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