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Astronomy Education and Instructional Aids[1]

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LIST OF SUPPLIERS

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Preface

It is a pleasure to present as an IAU Commission 46 Newsletter "Astronomy Education and Instructional Aids," which has been reproduced from Chapter 12 in Springer-Verlag's upcoming *Astronomy Compendium*, a three-volume set of 28 chapters covering a wide range of astronomical subjects from history and education to observational and analytical techniques. This set was, for the most part, translated directly into English from its German counterpart, *Handbuch für Sternfreunde*, which appeared in a fourth edition in 1989. The original chapter on astronomy education (authored by A. Kunert) focused primarily on the education system in Germany, and was, therefore, largely rewritten and expanded so as to address the English-speaking audiences in the U.K., Canada, and the U.S. It has subsequently, with the inclusion of some supplemental material in the appendices, been preprinted as this Newsletter.

§1 provides a very brief overview of the entire document. §2 outlines the steps to be taken on the path to a career in astronomy, and also includes a commentary on the pseudoscience of astrology. §3 summarizes the various facilities (planetariums, observatories, etc.) and services (lectures, workshops, etc.) which are available to educators primarily in Great Britain, Canada, and North America, and also includes a subsection on special services for the visually handicapped. §4 discusses the vast array of educational resources which are currently available in astronomy, including mechanical models and exhibit items (planetaria, telescopes, sundials, etc.), audio-visual media (audiocassette tapes, videodiscs, etc.), broadcasting and communications (radio and television programs, telephone news services, computer bulletin boards, etc.), computers and software, printed materials, games, and musical compositions. Finally, the **Appendix** provides detailed resource lists which have been assembled from the appendices of the *Astronomy Compendium*.

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Several notes of thanks are due, first to Prof. W. Beigelböck and his secretary Ms. S. Landgraf of Springer-Verlag, Heidelberg, for their invaluable guidance in the completion of this project. I also wish to thank Profs. R. Robbins, Aa. Sandqvist, and L. Houziaux of IAU Commission 46 for their correspondence while the book chapter was being modified and updated to serve as this Newsletter. Finally, I gratefully acknowledge the unwavering assistance of departmental secretaries Ann Seltzer and Christine Carrafa who helped put together many preliminary versions of this document.

Harry J. Augensen
Chester, Pennsylvania, USA
September 1991

1 Introduction

The field of astronomy serves not only to perform research on matters of astronomical and astrophysical relevance, but also to administer an invaluable didactic function: that of guiding and contributing to the scientific education of the general public as well as of future astronomers, physicists, and other scientists. In this regard, instructors affiliated with public and private educational institutions and also amateur astronomers can participate in educating interested persons in this most fascinating of subjects. Astronomy is—particularly at the introductory level—arguably the most approachable of all the sciences.

This chapter[2] will also survey the broad spectrum of astronomy education in the United Kingdom, Canada, and the United States, with the intent of providing the reader with information regarding:

1) how students who will become future astronomers are trained within the formal educational systems in the U.K., Canada, and the U.S. Several possible career paths will also be mentioned.
2) facilities, such as planetaria and observatories, and services, such as lectures, which are available to school groups and the general public throughout most of the English-speaking countries in the northern hemisphere.
3) some currently available (1991) sources of instructional materials such as slides, videodiscs, films/videocassette tapes, and computer software, as well as books and other printed materials for all age groups. Also listed are some of the distributers of mechanical instruments and exhibit items such as globes, planetaria, telescopes, and clocks.

2 Formal Astronomy Education[3]

The subject of education in astronomy is a complex one, especially when one considers the fact that most professional astronomers do not begin formal training in the subject until they enter graduate school. Indeed, a number of persons who call themselves astronomers received their first university degrees (e.g., B.A., B.Sc.) in physics, mathematics, engineering, computer science, chemistry, or some other technical field. On the other hand, very few students enrolled in an undergraduate course in introductory astronomy are destined to pursue the

[2] This chapter has been extensively rewritten from the original German version, authored by A. Kunert, in order that it be applicable to the principal English-speaking countries in Great Britain and North America. Those readers who live in the southern hemisphere, particularly in Australia and New Zealand, will undoubtedly extract some useful information too.

[3] Much of the information in this section is extracted from the career pamphlets/brochures *Becoming a Professional Astronomer* [1], which is available from the Association for Astronomy Education or from the London Planetarium, *Astronomer* [2], which is available from the Guidance Centre of the University of Toronto, and *Understanding the Universe: A Career in Astronomy* [3], put out by the American Astronomical Society.

subject beyond that point. The explanation of this paradox lies in the nature of astronomical research: it is chiefly *quantitative*, and moreover many of the principles and techniques used to obtain planetary and stellar distances, sizes, temperatures, masses, luminosities, and other relevant quantities are founded in physics or mathematics.

The popular notion that an astronomer is a man who spends every night peering through a telescope at the Moon or looking for "new" stars is far more fantasy than fact. In reality, the percentage of time actually spent at the telescope is relatively small. Moreover, very few modern research astronomers perform purely visual observations; instead they attach a plate camera, spectrograph, photometer, micrometer, or other device at or near the eyepiece position of the telescope, and record their results photographically or electronically. [4] Some astronomers observe with radio telescopes, which can be operated during the daytime, and still others observe from a ground-based control room with satellite telescopes such as the *Hubble Space Telescope* and the *International Ultraviolet Explorer* (*IUE*). Furthermore, most of their time is spent in *reducing* and *analyzing* the data that they accumulate during a few nights of observing at the telescope. Thus, on a typical day an astronomer is likely to be found sitting at a computer terminal, or browsing through journals in the library, or writing up the results of research into a publishable paper, or—for astronomers who are affiliated with a college or university—teaching and advising students. Finally, astronomy (as well as physics, mathematics, and the other sciences) is for women as well as for men, and today the opportunities for women to enter the field are greater than ever before.

It is only at the introductory level that astronomy can be successfully presented in a descriptive fashion (as would be a course in art, for example) and thus is suitable for students who wish to know something of the stars and planets but without getting into an extensive mathematical treatment. A science-bound student taking such a course will have received only the "frosting" on a large, multi-layered cake. If, on the other hand, the student has formed a solid undergraduate background in physics or mathematics, then he/she has also in effect been prepared for advanced work in astronomy or astrophysics.

The preparation and demands for a career in astronomy vary somewhat, especially at the secondary school (pre-college) and college levels, depending upon the particular country or province where one receives his/her schooling. Nevertheless, there are so many similarities that a general presentation of the requirements at the pre-college, undergraduate, and graduate (sometimes called postgraduate) levels, as well as possible avenues in postdoctoral research and teaching can here be attempted. In fact, the further along the ladder one rises en route to becoming a professional astronomer, the less evident are these seeming dissimilarities. Fortunately for science, there is no fundamental difference in the manner in which research is performed and published by professional astronomers working on opposite sides of the Atlantic Ocean.

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[4] In contrast to the other devices mentioned, micrometer data are usually recorded with pencil and paper.

Not all courses in astronomy are designed for those who intend to pursue astronomy as a career; some (primarily at North American institutions) are intended for persons whose future occupations will most likely not be in science, and yet whose curiosity for the subject has been whetted by newpaper or television reports of exciting astronomical events and discoveries (e.g., the passage of Halley's comet in 1986, the appearance of Supernova 1987A in the Large Magellanic Cloud, the recent Voyager spacecraft encounter with Neptune). The needs of this latter group must be met just as successfully as those of future astronomers, as much of the funding to support astronomy programs, including the recent space missions, comes from government agencies (such as the Science and Engineering Research Council (SERC) in the U.K. and the National Science Foundation (NSF) in the U.S.); hence, the fate of any program is ultimately dependent upon taxpayers from all walks of life. Unless society has been adequately informed of developments in the field and convinced of the need for funding for research, support for that research will most likely not be continued.

2.1 The Education of Professional Astronomers: An Overview

The subsections which follow are designed to provide the reader with a very general idea as to what goes into the education of a professional astronomer, with the emphasis on the education systems in the United Kingdom, Canada, and the United States. As the terminology used to describe pre-university and university school systems in the U.K. differs somewhat from that used in Canada and the U.S., the former will be treated separately from the latter two in this subsection. As the level of education progresses to the advanced undergraduate and graduate levels, the apparent dissimilarities in education systems become insignificant. It is not unheard of for an American student, for instance, to obtain his or her undergraduate degree in the United States and the doctorate in England, and vice versa.

Irrespective of which country the student is educated in or what the structural details of the particular educational system are, the underlying theme during the entire preparation from pre-college level to the Ph.D. (Doctor of Philosophy) degree in astronomy is a firm background in physics and mathematics. The theoretical and experimental tools acquired in the process of learning these two subjects are essential for advanced work in astronomy. Needless to say, persons with aspirations to become astronomers but without the necessary strengths in these two areas will find university studies very rough going, if not impossible.

The student who wishes to become a professional astronomer is strongly encouraged to pursue advanced studies leading to the Ph.D. While it it is not absolutely necessary to "go all the way" in order to become a professional astronomer, it must be noted that the vast majority of the available jobs in astronomy in North America and Europe do require the Ph.D. just to be considered for the post (see §2.6). Nevertheless, persons with an undergraduate major in astronomy or physics are needed in support positions at national

observatories, national laboratories, federal agencies, and sometimes in large astronomy departments at universities. An undergraduate degree in astronomy is considered an excellent preparation for secondary school science teachers, laboratory technicians, and computer programmers, and it can be the basis for higher degrees in fields other than astronomy (e.g., medicine or law). In addition, there are a small number of professional positions in planetariums, science museums, and a few in science journalism and science writing, many of which do not require an advanced degree.[5]

Students who intend to pursue graduate studies should be prepared to pass one and often two written and oral examinations during their graduate years before obtaining the Ph.D. At some point the student will be expected to prepare and deliver a paper at an astronomical society meeting, or publish the results of his/her thesis work in an astronomy journal. In either case, the work will be subject to critical scrutiny by seasoned professionals from other institutions, and the student will be required to answer any queries about one or more aspects of his/her research

Once the Ph.D. is obtained, the road to learning has not ended. After securing a position as a teacher, researcher, government employee, or some other post, the education of an astronomer continues at an advanced level. Many astronomers keep a hand in research, continuing to publish papers on ongoing research, giving invited colloquia at colleges and universities, and attending meetings of various local, national, or international astronomical societies. Some take time to write textbooks, monographs, and popular books for the edification of future generations of beginning and advanced students. Those individuals who successfully reach this stage have gone beyond merely learning about the body of knowledge which encompasses modern astronomy; they are actively contributing to it.

2.2 Pre-College/University Preparation

2.2.1 Pre-University Preparation in the United Kingdom. [6] Any young person who sincerely desires to become a professional astronomer should realize that usually six or seven (or more) years at the university level are mandatory. To ensure a strong preparation for this formidable undertaking, careful preparation is virtually a must, beginning with judicious selections of courses at the GCSE- and A-levels.

General Certificate of Secondary Education (GCSE). The decision as to which GCSE-level courses to take will depend upon one's own interests—art, music, history, and even needlework are all quite acceptable. Of course, one should not hesitate to enroll in a GCSE-level astronomy course if it is offered, but even if it is not, physics, mathematics, and chemistry are strongly recommended at

[5] It is worth noting that the recent supernova SN 1987A was discovered by a technician with a B.Sc. degree only.

[6] The source for much of this information is the pamphlet *Becoming a Professional Astronomer* by Couper [1], which is available from the Association for Astronomy Education or from the London Planetarium.

this early stage. Mastering one or more languages is also a good investment of time, as professional astronomers are as a rule well-traveled. Finally, a mastery of the *English* language is indispensible, as professional astronomers regularly write and publish papers in order to communicate the results of their work to colleagues and the public. A grade of C or better should be achieved in all GCSE subjects, as these will ultimately form the basis of further study at the A-level and/or be credited toward entrance to a university.

A-levels. To ensure the best possible chance of getting into a university, the student will need to take three A-level subjects: 1) mathematics (essential), 2) physics (also essential) and 3) a choice of another branch of mathematics (applied or statistics), or chemistry, biology, geography, or other science course. Note that N.U.J.M.B.'s Physics A-level includes an astrophysics option. Two appropriate AS-level subjects may be offered in place of the third A-level.

2.2.2 Pre-University Preparation in Canada and the U.S. The student of secondary school age can begin preparing for a career in astronomy by taking as many courses in science, mathematics, and English as possible, the last being necessary to ensure the development of good writing skills, which are indispensible in any field of science. The science courses usually include one year each of biology, chemistry, and physics. Mathematics courses should be taken during each of the four years, and should include analytical geometry, trigonometry, and, if offered, calculus. It should be noted that the recommendations at this level are basically sound ones for a student who intends to pursue advanced work in *any* of the sciences or in engineering.

It is also desirable to attain a mastery of at least one foreign language, such as French, German, Russian, or Spanish, but even more important is familiarity with computer programming using a language such as BASIC, PASCAL, C, or FORTRAN. Computer skills are now virtually mandatory at all levels, but this is especially true if one intends to pursue advanced work in science and engineering.

During the junior year, the student should begin to consider various colleges and universities for undergraduate training. Early in the senior year, he/she should arrange to take the Scholastic Aptitude Test (SAT) and select and apply to colleges.

2.3 Astronomy at the College/University Level

2.3.1 University-Level Training in the United Kingdom: First Degree.[7] University entrance requirements vary widely, and applicants are usually provisionally offered places subject to their "A-level" results being satisfactory. As a first step in deciding which course and which university to apply for, the *U.C.C.A. Handbook* (P.O. Box 28, Cheltenham, Gloucester) should be consulted. A degree in astronomy, physics, mathematics, or a combination of these will enable the student to choose from among a wide variety of research topics ranging from radio astronomy to planetary geology. A degree in one of the other sciences may

[7] *Note added in proof:* See also the article by Dworetsky [32].

place a constraint on the future choice of graduate studies; a degree in electrical engineering, for example, would normally restrict the graduate to research in astronomical instrumentation.

A great deal of care and planning should precede one's choosing a university. Some of the following questions should be considered when in making the final decision: (1) Is the college or university located in the city or in the country? (2) Is the school close to home or quite distant? (3) What are the course offerings in astronomy at the school? (4) What are the research interests of the astronomy or physics department in the school? (5) Do they have an observatory on or near campus?

During the years spent at college or a university, the student will probably find numerous astronomical activities to become involved in "after hours." The long vacation between school years provides other opportunities, and some student spend the vacation between their second and third years working at an observatory in order to become familiar with the manner in which astronomers conduct research. In fact, the Royal Greenwich Observatory at Herstmonceux and the Royal Observatory at Edinburgh run special eight-week-long "vacation courses" to cater to this need, but competition for these places is keen.

As the student is nearing the end of his/her studies toward the first degree, he/she should keep in mind that the prerequisite for acceptance into a doctoral degree program is a first degree of the highest possible grade—first or upper second class honors. If the first degree grade is not up to standard, on the other hand, it is still possible to go on. Students with upper and lower second-class honors may usually proceed straight to a one-year M.Sc. course after their first degree. After the M.Sc. has been obtained through examination or thesis, he/she may then apply for a Ph.D. place, though at the price of losing one year of SERC studentship support.

2.3.2 University-Level Training in Canada and the United States. In Canada and the U.S., "introductory" astronomy generally manifests itself at the university level in two tiers:

1) a one-semester survey course in astronomy, with or without an associated laboratory and/or telescope viewing sessions, designed for students who are not science-oriented; breadth rather than depth is the goal here.
2) a one- or two-semester course in general astronomy (usually with laboratory) aimed at those students with good mathematical skills and/or who are majoring in one of the sciences or engineering. This is a more rigorous introduction to astronomy than 1), and frequently numerical problems will be assigned as homework. Much of the same material is covered as in 1), but with a more quantitative, in-depth approach.

Few four-year colleges offer advanced astronomy courses beyond this, although some do have a course on advanced topics which undergraduates can enroll in, and occasionally a course on the history of astronomy is available. There do exist a small number of colleges and universities in North America which offer very fine undergraduate programs in astronomy, but the paucity of

such institutions will mean that many astronomy-bound students must obtain their initial training in physics or some other area (see below).

Perhaps the best general advice that can be given to the college student who aspires to be an astronomer is to focus on the curriculum in physics and/or mathematics. The careers of physicists and astronomers are much more alike than they are different, and usually a solid undergraduate preparation in physics, even without the inclusion of a course in general astronomy (although admittedly taking such a course at this stage would certainly do no harm and might save some time later on) lays a reasonably solid foundation for first graduate work and ultimately a career in astronomy or astrophysics. According to the *1986-87 Graduate Student Survey* [4] which was conducted by the American Institute of Physics (AIP), approximately one-half of the students enrolled in graduate school in astronomy had been physics majors as undergraduates and one-fifth had majored in a related field such as mathematics or engineering. Only 28% of the sample had majored in astronomy.

As noted in *Enrollments and Degrees* [5], a survey taken by the AIP, "students interested in astronomy benefit from a greater number of options than their physics counterparts, because they can begin to concentrate on their major either at the undergraduate or graduate level and they have a choice of two types of departments, the separate astronomy departments or the combined physics and astronomy departments."

Though requirements will naturally vary from school to school, the following generic curriculum for a student majoring in physics will give the reader an idea as to what is usually required at this level. During the first year (and often into the second year) of undergraduate studies, the student will be taking introductory calculus along with the following sequence of general physics courses:[8]

- General Physics I. Introductory mechanics, structures, fluid motions, and wave motion. (with laboratory)
- General Physics II. Heat and Thermodynamics. Electricity and Magnetism, Circuits. (with laboratory)
- General Physics III. Radiation, Optics (with laboratory)

These are generally followed by more intensive work in many of the areas covered in these courses, but also with new, advanced material not previously dealt with. These include:

- Modern Physics (Atomic and Nuclear Physics, Relativity)
- Solid State Physics
- Classical Mechanics
- Thermodynamics and Statistical Mechanics
- Electricity and Magnetism
- Optics and Wave Motion
- Quantum Mechanics

It is assumed that the student will be taking concurrent advanced coursework in mathematics, the most essential being differential and integral cal-

[8] The term "general" here connotes an introductory course for students who are oriented towards science or engineering.

culus, differential equations, complex variables, numerical methods, complex variables, statistical analysis, and linear algebra, although others may also be included. In addition, at least one year of chemistry is advisable.

The student will also need to enroll in a minimum of one semester of a computer science class in which at least one specific computer language, such as FORTRAN, is taught and writing programs to solve problems is stressed. It is not necessary that all of the inner workings of the computer be comprehended, but rather that the essential programming skills needed to solve problems in physics and mathematics be mastered.

The student would also be well-advised to get some career-related job experience during the summer months, especially if research is not an implicit part of the undergraduate program. Government institutions (such as NASA), many universities (e.g., Harvard), and some observatories (e.g., Kitt Peak National Observatory, the Maria Mitchell Observatory) offer summer jobs in astronomy for students.

By the end of the first three of the (usually) four years of mandatory undergraduate training, the student will likely have a clearer idea of whether he or she wants to pursue astronomy in earnest as a career. If the answer is negative, then the student should not feel that the education he/she has received during their college days has been for naught. On the contrary, the many skills in mathematics, computer science, physics, and astronomy that he/she has learned will be invaluable in any one of a number of non-astronomy professions. These would include in particular computer programming and teaching science at the secondary school level (much in demand in the U.S. at this time). There may also exist openings in astronomy for such posts as observing assistant at an observatory or lecturer at a planetarium.

If, on the other hand, the answer to the astronomy career question is affirmative, then preparation should now begin for the next step in the education chain: graduate school. The school chosen for graduate studies may be the same one where the undergraduate degree was attained, but usually it is not. Most graduate schools in Canada and the U.S. require at least as B average or better grade point average in college and an undergraduate major in physics or astronomy. Most schools also require, or at least strongly recommend, that students take the Graduate Record Examination (GRE) administered at a local school at regular intervals during the fall, winter, and spring. The GRE tests, which are created under the aegis of the Educational Testing System in Princeton, NJ, consist of a General Test measuring verbal, quantitative, and analytical abilities, and an Advanced Test in one of Physics, Mathematics, Engineering, Computer Science, and other areas. The student should check carefully whether any or all of these are required by the particular university. The results are usually sent directly to the graduate school of the student's choice prior to the deadline for receipt of applications. The student should be aware of the fact that many schools base financial aid on the results of the GRE Advanced Test. In addition, students from non-English speaking countries are required to take the Test of English as a Foreign Language (TOEFL).

For more information on GRE or TOEFL exams, write: ETS, Box 899, Princeton, NJ 08541, USA.

2.4 Astronomy at the Graduate Level

The in-depth training of an astronomer for his or her profession is often said to begin in graduate school. There he or she will, over a time interval of approximately two years, be required to take a sequence of core courses, each containing one or more elements of the foundation for advanced observational and/or theoretical research. In addition, there are more specialized courses and seminars aimed at a particular aspect of the subject.

Outstanding students who wish to achieve a doctorate should not be discouraged by the perceived financial burden to be incurred in this endeavor. In the U.K., SERC and other foundations will normally fund much or all of graduate education of those who have achieved first or upper second class honors for their first degree. In Canada and the U.S., individual universities provide financial aid in the form of teaching assistantships, research assistantships, and full fellowships in order to attract qualified students into their doctoral programs. These awards often provide for all or part of the tuition, plus a stipend for living expenses.

Course offerings at the graduate level will, of course, vary somewhat from institution to institution. The following might constitute a typical sequence of courses, a substantial subset of which would be taken over a roughly two-year period.

- Astronomical Observing Methods I. Photometry
- Astronomical Observing Methods II. Spectroscopy
- Astrophysics I. Stellar Atmospheres
- Astrophysics II. Stellar Interiors and Evolution
- Interstellar Medium and Galactic Structure
- Galaxies and Cosmology
- Seminar: Special Topics in Astronomy/Astrophysics
- Independent Study/Research

It should be noted that some universities offer only the terminal master's degree in astronomy or physics, while others offer both masters and Ph.D. degrees. This can be checked by referring to the *1990–91 Graduate Programs in Physics, Astronomy, and Related Fields* [6] (or the most recent edition), which lists in some detail the graduate programs of universities on the North American continent, to the *Directory of Graduate Programs Vol. C* [7], or to *Understanding the Universe: A Career in Astronomy* [3], a brochure available from the American Astronomical Society. Students in the U.K. should consult *Postgraduate Opportunities in Astronomy and Geophysics* [8], published by the Royal Astronomical Society (Burlington House, Piccadilly, London W1V 0NL), or the aforementioned brochure *Becoming A Professional Astronomer* [1].

Following the completion of graduate coursework, the student usually selects a research project which has promise of developing into a Ph.D. dissertation. The dissertation is carried out under the guidance of one or more faculty

members in his/her department, the thesis *adviser(s)*. The project selected will depend on the student's propensity toward a specific aspect of observational and/or theoretical astronomy, and also upon the diversity of astronomical research done at that institution. Therefore, if a student applying to graduate schools has a strong preference for a particular research area, then he/she should be certain that the graduate program has at least one faculty member involved in that research.

Most of the major categories of astronomy research are listed below. These groupings are not necessarily mutually exclusive, and in some cases the overlap is considerable.

- **SOLAR SYSTEM**
  Planetary Atmospheres
  Planetary Interiors, Magnetic Fields
  Solar-Terrestrial Interactions, Aurorae
  Meteorites and Tektites
  Comets and Asteroids
  Solar Atmosphere and Composition
  Solar Flares, Prominences, Corona, and Solar Wind
  Solar Interior, Neutrinos
- **STARS AND INTERSTELLAR MATTER**
  Positional Astronomy, Stellar Parallaxes and Motions
  Stellar Spectra/Atmospheres
  Stellar Interiors and Evolution
  Low Luminosity Stars, Degenerate Stars
  Binary Stars
  Star Clusters and Associations
  Interstellar Matter, Dust
  Molecular Clouds and Star Formation
  Young Stars, T Tauri Stars
  HII Regions
  Intrinsic Variable Stars
  Novae and Supernovae
  Planetary Nebulae
  Supernova Remants, Pulsars, Black Holes
  Cosmic Rays, X-ray Sources
- **THE MILKY WAY GALAXY**
  Kinematics and Dynamics of Stars in the Galaxy
  Spiral Arm Structure and Motions
  Galactic Halos
  Stellar Populations
  The Galactic Center
- **GALAXIES**
  Normal Galaxies
  Active Galaxies, Quasars
  Clusters and Superclusters of Galaxies
- **COSMOLOGY**
  Cosmology, Early Universe
  Missing Mass
  Relativistic Astrophysics
- **ASTRONOMICAL INSTRUMENTS AND TECHNIQUES**
  Telescope Design and Tracking
  New Technology Telescopes
  Optical Interferometry
  Spectroscopic, Photometric, and Photographic Techniques
  Charge-Coupled Devices (CCDs)

- **HISTORY OF ASTRONOMY**
  Archaeoastronomy
  Old Astronomical Records and Techniques
  Noted Astronomers of the Past

The distribution of astronomers engaged in research in these various subfields is by no means uniform. According to the *1986-87 Graduate Student Survey* of the AIP [4], cosmology/extragalactic objects is currently the biggest attractor of graduate students—one-quarter of the graduate student population. The second and third largest enrollments are in stellar atmospheres and interstellar matter, respectively.

Once the dissertation research has been embarked upon, the adviser will carefully monitor the student's progress, having frequent meetings to discuss the latest results. The student should be prepared to spend three or more years on the dissertation, especially if the project is one which involves numerous observations. According to [4], the median number of total years spent in graduate studies (this includes both coursework and dissertation) in the U.S. was 5.4 years for 1986-87 graduates. One-third of those students took six years to complete their studies and one-quarter took seven. While these figures may seem daunting, it must be noted that students in the humanities and social sciences take even longer to complete graduate studies.

The numbers quoted above can in large part be attributed to the originality and thoroughness demanded of the dissertation research, and also to the amount of time needed to accumulate and reduce the requisite data. Not everyone is suited for the rigors of of graduate school, and the conferring of a Ph.D. degree upon someone means that that individual has demonstrated fitness to be a doctoral astronomer.

It should be borne in mind, however, that although the road to the Ph.D. can be a long one, the research in which the student is involved is often quite exciting, and will sometimes involve visiting major observatories, such as Kitt Peak National Observatory in Arizona or the Canada-France-Hawaii Observatory in Hawaii, for the purpose of gathering observational data or using computer reduction facilities. It means travel to conferences and meetings in different parts of the country or of the world to present the results, whether preliminary or final, of the dissertation and to meet and engage in stimulating discussions with professional astronomers from other institutions. It can mean the excitement of being the first to discover some bit of astronomical knowledge which no one had known before. Thus, the progression toward the doctoral degree should be regarded as a genuine adventure, not a prison term!

2.5 Postdoctoral Positions

Although theoretically it is possible for an astronomer with a freshly minted Ph.D. to obtain a permanent position, this option is not usually available. Instead, many astronomers accept temporary (1–3 year) "postdoc" positions involving research (usually in the same area of astronomy in which the Ph.D. work was done) and occasionally some teaching as well. In fact, according to the

AIP Employment Survey 1987 [9], some three-quarters of new astronomers in the U.S. traditionally accept postdoctoral positions. Many employers, especially the larger research universities and laboratories, stipulate a prerequisite of one or more years of "postdoc" experience before consideration for a permanent teaching or research post.

2.6 Vocational Opportunities

After the receipt of the Ph.D., there are several possible routes to go, such as college/university teaching, civil service (government), business/industry, and public service. Some of these possibilities are discussed below.

2.6.1 Colleges and Universities. Many astronomers will acquire at least some experience in teaching during their years of graduate training, and most will ultimately secure teaching posts at the college/university level. That is not to say that the astronomer hired to teach is absolved of research duties. On the contrary, an astronomer who teaches at a university, particularly one with a Ph.D. program, will often be engaged in a vigorous research program. In this case, his or her students can benefit from the direct experience of a teacher who is also a research astronomer. Job advertisements from 4-year colleges sometimes state the importance of the ability of the candidate to involve undergraduates in his/her research.

Once a "permanent" college/university post has been obtained, usually at the assistant professor level, the candidate will most likely be required to attain *tenure* within three to eight years after having signed a contract. During that period of time, the astronomer faculty member must demonstrate excellence usually in one or more of the areas of teaching, research, and service to the college or university. The years during which tenure is strived for can be challenging, as the astronomer must juggle the duties in these three areas, not to mention family responsibilities. Once achieved, however, the astronomer's position is considered "secure" essentially for life.

2.6.2 National Observatories and Government. A number of professional astronomers (about one-third in the U.S., for example) are employed by the federal government directly or by federally supported national observatories and laboratories. A Ph.D. is nearly always a prerequisite for such posts, and a form of tenure is granted after a certain period. A few of the more prominent institutions are listed below:

NATIONAL OBSERVATORIES
- La Palma Observatory (U.K.)
- Royal Greenwich Observatory (U.K.)
- Dominion Astrophysical Observatory and Dominion Astrophysical Radio Observatory (Canada)
- Canada-France-Hawaii Observatory (Canada)
- James Clerke Maxwell (mm-wave) Telescope (Canada/U.K./Netherlands)
- Cerro Tololo Inter-American Observatory (U.S./Chile)
- Kitt Peak National Observatory (U.S.)
- National Radio Astronomy Observatory (U.S.)
- Space Telescope Science Institute (U.S.)

GOVERNMENT AGENCIES
- Science and Engineering Research Council (U.K.)
- Herzberg Institute of Astrophysics of the National Research Council (Canada)
- National Aeronautics and Space Administration (U.S.)
- Naval Research Laboratory (U.S.)
- U.S. Naval Observatory (U.S.)

2.6.3 Business and Private Industry. A small number of astronomers (fewer than ten percent in the U.S., for example) are employed in business or private industry, but there are indications that this percentage has increased. Some industries, especially in the aerospace field, hire astronomers to do astronomical research which can increase the competitiveness of the the company, and a number of consulting firms supply astronomical talent to the government for specific tasks. Still other companies, while not engaged in astronomical research, hire astronomers in order to benefit from their acquired talents in instrumentation, remote sensing, spectral observations, and computer applications to unusual problems. Industrial employment also offers a wide variety of non-technical career paths. A Ph.D. is normally not required for such positions.

2.6.4 Public Service. A very small number of astronomers choose to work in planetariums, science museums, or in other public service positions where they provide an invaluable interface between the technical world of professional astronomy and the society in general. Such jobs require not only a knowledge of astronomy, but also the ability to interact well with the general public.

There are also some jobs available teaching physics, earth sciences, or mathematics in the secondary schools and community colleges. While a doctorate is usually not a prerequisite, such positions generally require teaching certificates or practical experience, and the salary levels and job security in these positions are generally lower than those in government and university employment. In the U.S. especially there is an urgent need for qualified persons to fill these posts.

A few jobs in science writing and science journalism are also available, and these almost never require an advanced degree (although it certainly would do no harm). Job security is not as a rule very high, but the satisfaction gained by translating research discoveries into exciting and cogent material for the public can be an important asset in this position.

2.7 Interdisciplinary Approaches to Astronomy

While astronomy may be considered most akin with physics and mathematics, ties with other, often seemingly unrelated disciplines have also been demonstrated. In a two-part article appearing in *Mercury* magazine and reprinted in the information packet *Interdisciplinary Approaches to Astronomy* (see §4.5.3), Fraknoi [10] has compiled a bibliography to various crossovers between astronomy and the following other subjects: literature, music, art, anthropology, archeology, energy (solar power), history (supernovae), law, meteorology, molecular biology, philately, philosophy, psychology, (including UFOs), and society (light pollution). Those teaching introductory astronomy will find this

reference list especially valuable as students are often fascinated to learn that astronomy has real-world ties.

2.8 Comments on Astrology

No survey of astronomy education would be complete without at least a mention of the "science" of astrology. The term astrology means literally "science of the stars," and was in ages past used interchangeably with astronomy. Today, however, there is a major distinction. According to *Webster's Dictionary*, astronomy is that science which treats the nature, distribution, magnitudes, motions, distances, periods of revolution, eclipses, etc. of the heavenly bodies. Astrology, on the other hand, is defined as a pseudo-science which claims to foretell the future by studying the supposed influence of the relative positions of the Moon, Sun, and stars on human affairs. While most modern scientists are well aware of this distinction, the terms astronomy and astrology are frequently still equated in the eyes of the general populace. This is perhaps not surprising given the fact that many astrologers use astronomical terminology and charts of planetary positions and motions, thus leading the uninformed public to believe that astrology is merely applied astronomy (Kruglak and O'Bryan [11]). On more than one occasion has a professional astronomer been misintroduced to an audience as a noted "astrologer" from the — Observatory, or quoted in a newspaper or radio interview as an "astrology" professor at — University.

Rigorous statistical tests have been applied time and again to astrological forecasts, but the conclusion has always been the same: there is simply no empirical support for them (Kelly [12] and Pasachoff [13]). Yet horoscope columns are fixtures in many newspapers, and some astrologers even appear on local television to provide the daily horoscopes for astrology devotees. According to a 1975 Gallup poll of a sample of the U.S. population[9], 22% of those surveyed of ages 18 and older said they believed in astrology, and 23% of those polled said they read astrology columns regularly. The percentages were even higher for a subsample in the age range 18–24: 38% and 26%. These and other daily experiences point up a distinct fact: that the predictions of astrologers are still taken seriously by a non-negligible fraction of the populace. Consequently, many professional astronomers, particularly those who teach introductory level courses or have contact with the public, are continually faced with the task of refuting the tenets of astrology.

There are numerous papers and books which deal critically with the subject of astrology and the scientific arguments against it; the reader is directed to the listing of books and articles assembled by Robbins and Fraknoi on p. 29 in [14] or to the information packets *Astronomy Versus Astrology* and *Debunking Pseudoscience* listed in §4.5.3. To these can be added two recent articles by Fraknoi: "Your Astrology Defense Kit," in *Sky & Telescope*, August 1989,

[9] Quoted from Table 2 in the article by Kruglak and O'Bryan [11], who compared these percentages with ones taken from a sample of students attending Western Michigan University.

p. 146, and "Scientific Responses to Pseudoscience Related to Astronomy," in *Mercury*, September/October 1990, p. 145.

3 Facilities and Services Available to Schools and the General Public

The best general references for this section are the *International Directory of Professional Astronomical Institutions* (A. Heck, 1989) and the *International Directory of Astronomical Associations and Societies* (A. Heck and J. Manfroid, 1988). They are published by Centre de Donnees de Strasbourg, Observatoire Astronomique, II, Rue de l'Universite, F-67000 Strasbourg, France.

For North American Astronomers, the American Association for the Advancement of Science has recently published the *AAAS Science Education Directory 1989*, which is designed to be a resource to those involved in science, mathematics, or technology education. The Directory contains addresses and telephone numbers of principal executives, directors, administrators, and policy-makers who are leaders in associations, scientific academies, museums, educational resource centers, educational laboratories, and state and federal agencies. A copy of the Directory may be obtained free of charge by writing to Barbara Walthall, AAAS, Office of Science and Technology Education, 1333 H Street, NW, Room 1139, Washington DC 20005, USA.

Educational Affairs Division: Programs and Services, PED-102, is a special NASA publication which gives overviews of all the educational programs and services provided by the agency's Educational Affairs Division. Included are listings of resources showing how to receive additional information. It can be obtained from Educational Affairs Division, Code XEP, NASA, Washington, DC 20546.

Other references will be found in the individual subsections.

3.1 Planetariums, Museums, and Exhibits

A visit to a public planetarium can be a marvelous experience for children and adults alike, especially if it is a large one with extensive facilities and adjoined by a museum and/or observatory. A sophisticated planetarium projector can simulate all the wonders of the night sky, including sunrise, sunset, twilight, the nightly motion of the stars, the seasonal motions of the Sun and planets, and the presence of the Milky Way (see also §4.1.2). Receptive visitors will often find that their awareness of the real night sky has thereafter been heightened. It should be noted that many of the larger planetariums are connected with observatories which provide public viewing sessions.

A listing of the major planetariums and museums in Great Britain and North America is provided §A.1 in the attached Appendix. Most of the larger

planetariums offer a full range of services and facilities, including exhibits, tours, lectures, classes, public telescope observing sessions, planetarium shows, special children's programs, and bookstore/giftshop. Detailed information regarding hours, fees, and services can be obtained by contacting the planetarium or museum directly. Readers can also obtain more information on individual planetariums from the *Directory of the International Planetarium Society* [15], from which some of the items in the aforementioned list in the Appendix have been extracted, or by writing the International Planetarium Society, c/o Dr. Terrence P. Murtagh, The Planetarium, College Hill, Armagh, Northern Ireland BT61 9DB.

Those readers living in the U.K. will find a great deal of information on planetariums, observatories, and other interesting places to visit in the most recent edition of *Handbook for Astronomical Societies* [16], which is available from Ken Marcus, 5 Cedar Gardens, Brighton, East Sussex BN1 6YD, England. This is a 104-page guide to amateur resources in the U.K., and also lists clubs, societies, periodicals, equipment, suppliers, speakers, and sources of astronomical software. The cost is currently £3.50.

Readers in North America should consult *The Observer's Handbook 1991* [17], published by the Royal Astronomical Society of Canada and which contains essentially all of the major Canadian planetaria, or Kirby-Smith's *U.S. Observatories: A Directory and Travel Guide* [18], which lists many small college museums and planetaria in the United States. General listings are also provided by the *1989 Directory of Observatories, Planetariums, and Museums* [19] in the May 1989 issue of *Astronomy* magazine, and by the *Astronomy Resource Guide* [20] in the September 1991 issue of *Sky & Telescope* magazine.

3.2 Observatories and Research Laboratories

While a visit to a planetarium can be rewarding, a trip to a major observatory where astronomical research is carried out can be even more so, particularly if viewing sessions are permitted. The sight of the Moon, a planet, or a star cluster through even a modest instrument can be quite inspirational especially for a young person.

There are multitudes of observatories in Great Britain and North America; many offer evening viewing hours for the interested public and school groups. The names and addresses of the more prominent ones can be found in §A.2 in the Appendix. These institutions should be contacted directly in writing or by telephone for information and current hours. As with planetaria and museums, readers can also obtain some basic information (e.g., visiting hours) from the *Handbook of Astronomical Societies* [16] (U.K.), from the *The Observer's Handbook 1991* [17] (Canada), and from *U.S. Observatories: A Directory and Travel Guide* [18] (U.S.), as well as [19] and [20] (Canada and U.S.).

3.3 Lectures

The following lectures are available in the U.S. and Canada:

— *Harlow Shapley Visiting Lectureships in Astronomy* (Canada and the U.S.). The American Astronomical Society (AAS) sponsors the Visiting Professors Program, in which professional astronomers make two-day visits to colleges and universities which do not offer a degree in astronomy. During the visit, the astronomer will give usually two (or more) lectures, from public talks to graduate-level seminars. The lectures are designed to strengthen and stimulate interest in astronomy and related sciences, and to enhance the understanding of this discipline by the general public. All costs incurred by the visiting astronomer (food, transportation, lodging) are borne by the AAS, and, in return, the participating institution is asked to make a contribution of $250 in support of the program. For a brochure with application and a list of participating astronomers, contact: Dr. Mary Kay Hemenway, AAS Education Office, University of Texas, Department of Astronomy, Austin, TX 78712-1083; Tel: 512-471-3000.

— *Morrison Public Lectures*. The Astronomical Society of the Pacific sponsors public lectures by noted astronomers, explaining new discoveries and ideas in astronomy. Some of the lectures are offered in conjunction with amateur astronomy groups and colleges, others are presented at larger astronomical conferences. The host club or institution pays for the speaker's travel expenses, the ASP pays the honorarium. Also, the ASP each year presents the Bart Bok Memorial Lecture, which is nontechnical, free, and open to the public. For more information, contact: Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112, USA; Tel: 415-337-1100.

— *R.A.S.C. Lectures* (Canada). The Royal Astronomical of Canada sponsors the vast majority of astronomy lectures in Canada. Queries should be addressed to: R.A.S.C., 136 DuPont St., Toronto, Ontario M5R 1V2.

— *Sigma Xi Lectures* (Canada and the U.S.). Sigma Xi, The Scientific Research Society, has chapters at most major universities and colleges in North America. Each year it designates an official group of scientists (often including an astronomer or astrophysicist) who are available for speaking engagements. For more information, contact: Sigma Xi, The Scientific Research Society, 345 Whitney Ave., New Haven, CT 06511-2316, USA; Tel: 203-624-9883 or 1-800-243-6534.

— *Society of Physics Students (SPS) Speakers* (Canada and the U.S.). The SPS is an organization designed explicitly for students. There are local chapters of SPS at most major universities and colleges in North America. Each academic year they publish *Speakers, Tours, and Films: A Program Resource for SPS Chapters* [21]. Copies may be obtained from: National Office, Society of Physics Students, American Institute of Physics, Second Floor, 2000 Florida Ave., N.W., Washington, DC 20009.

The following institutions in the U.K. have identified themselves to the Association for Astronomy Education (AAE) as being willing to provide speakers for schools. Usually the school is expected to reimburse the the visiting speaker for travel and other expenses.

- Hatfield Polytechnic Observatory
- University of London Observatory
- Lancashire Polytechnic, Preston
- Mills Observatory, Dundee
- Glasgow University Observatory

More information can be obtained from the *Handbook of Astronomical Societies* [16], or by contacting the AAE Secretary, 34. Aeland Crescent, Denmark Hill, London SE5 8EQ.

3.4 Workshops and Other Programs

The following workshops and activities are a few of the more notable ones in astronomy:

— *Astronomer for a Day Program* (Canada and the U.S.). This program is sponsored by the AAS and is designed to bring high school science teachers into contact with professional astronomers. For more information, contact Dr. Mary Kay Hemenway, Education Officer of the AAS, at the address given in the previous section.

— *ASP-Sponsored Workshops on Teaching Astronomy* (Canada and the U.S.). The ASP organizes workshops on teaching astronomy throughout North America. Approximately 100-200 teachers attend each workshop and take back information, resources, and teaching activities to their home districts. For more information, contact the ASP at the address given previously.

— *Astronomy Day.* Astronomy Day has been celebrated in North America in many ways, including display techniques, activities, and recruiting by various astronomical societies. These are described in *The Astronomy Day Coordinator's Handbook*, published by the Astronomical League. To obtain a copy, contact: Gary Tomlinson, Astronomy Day Handbook, Chaffee Planetarium, 54 Jefferson SE, Grand Rapids, MI 49503.

— *GEMS.* GEMS (Great Explorations in Math and Science) provides activities from preschool to high school, not only in astronomy but also in Earth science and many other fields. Contact: GEMS, Lawrence Hall of Science, University of California, Berkeley, CA 94720.

— *STAR.* Project STAR (Science Teaching through its Astronomical Roots) is oriented toward grades 10 through 12. It will produce the first high school astronomy textbook. Both STAR and GEMS use simple, inexpensive materials and focus on fundamental concepts. Contact: Philip Sadler, Center for Astrophysics, 60 Garden St., Cambridge, MA 02138.

3.5 Where to Find Information on Astronomy as a Career

Young people who wish to find out more about pursuing astronomy as a career should write for one of the available pamphlets or brochures (all of which have been referred to earlier) which pertains to his or her locale.

— *In the United Kingdom.* The Old Greenwich Observatory produces a leaflet called *Becoming A Professional Astronomer* which may be obtained by writing to: Dr. R. Lopes, Old Greenwich Observatory, National Maritime Museum, London SE22. In addition, a little booklet called *Astronomy* and booklets on opportunities for astronomical research in the U.K. are published by: Royal Astronomical Society, Burlington House, London W1V 0NL. Finally, the British Astronomical Association (same address as the RAS) publishes various leaflets which can be obtained by reference to the BAA.

— *In Canada.* Write for the pamphlet *Astronomer* at the following address: Guidance Centre, Faculty of Education, 252 Bloor St. W., 2nd Floor, University of Toronto, Toronto, Ontario M5S 1V5.

— *In the United States.* Write for the brochure *Understanding the Universe: A Career in Astronomy* from: AAS Education Office, University of Texas, Department of Astronomy, Austin, TX 78712-1083.

For young women in particular, there is the booklet *Space for Women*, which is published by the Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138.

For general reading, *The Astronomers* by Donald Goldsmith (St. Martin's Press, 1991) and the career-oriented article "How We Became Astronomers" by

Graham-Smith and Lovell in their book *Pathways to the Universe* (Cambridge University Press, 1988) should be especially inspirational to young persons. Also highly recommendable are the autobiographies of successful modern astronomers: *In Quest of Telescopes* by Martin Cohen (Cambridge University Press), *On the Glassy Sea, An Astronomer's Journey* by Tom Gehrels (American Institute of Physics, 1988), and *Astronomer by Chance* by Bernard Lovell (Basic Books, 1990). A recently published biography, *Clyde Tombaugh: Discoverer of Planet Pluto* by David H. Levy (University of Arizona Press, 1991), and an older but still quite serviceable book, *How to Become an Astronomer* by Freeman Miller (Sky Publishing Co., 1969), can also be recommended.

3.6 Films on Astronomy as a Career[10]

The following are just a few of the several available films and/or videotapes dealing with astronomy (as well as science in general) as a career:

- *The Astronomers* (1991, Six 60 min tapes) — A major PBS production funded by the W.M. Keck Foundation, and broadcast as a six-part PBS series. The companion book of the same name (by Donald Goldsmith) is mentioned in §3.5. Each episode deals with a current area of astronomical research, and highlights the lives of some of the astronomers involved in that research. Available from KCET Public Broadcasting Service, PBS Home Video, Beverly Hills, CA.
- *The Sun and Beyond* — Highlights the work of husband-and-wife team Aden and Marjorie Meinel. Available in both videotape and 16-mm formats from EDUCATIONAL MATERIALS AND EQUIPMENT CO., Old Mill Plain Road, Danbury, CT 06811, USA; Tel: 800-848-2050, in Connecticut 203-798-2050.
- *The Observatories* (27 min) — Astronomers from some of the major observatories in North and South America describe the functions of optical and radio telescopes, the discoveries being made, and the prospects for newly developed computerized equipment. Produced by the National Science Foundation. Available from MEDIA DESIGN ASSOCIATES, INC., Dept. P, P.O. Box 3189, Boulder, CO 80307-3189, USA; Tel: 800-228-8854 or 303-443-2800.
- *Science—Woman's Work* (27 min) — Discusses why young women are turned off by mathematics and science, and explores the lives of women who are already established in their scientific careers. Produced by the National Science Foundation. Also available from MEDIA DESIGN ASSOCIATES, INC.
- *A Private Universe: Misconceptions That Block Learning* (1989, 18 min) — Deals with the subject of scientific illiteracy among American children. The film was produced by Matthew H. Schneps of Project STAR (Science Teaching through its Astronomical Roots), a curriculum-development program at the Harvard-Smithsonian Center for Astrophysics. The tape may be purchased or rented from PYRAMID FILM & VIDEO, Box 1048, Santa Monica, CA 90406. See p. 586 of the June 1989 issue of *Sky & Telescope* for a somewhat more detailed description of this film.
- *Space Women* (1984, 57 min) — Astronaut Sally Ride discusses the physical and mental rigors of being an astronaut, and the responsibility of role models. Available from AMBROSE VIDEO PUBLISHING, INC., 381 Park Avenue South, Suite 1601, New York, NY 10016; Tel: 800-526-4663. In New York: 212-696-4545.

[10] A more complete discussion of the available books, films, and videotapes on astronomy will be dealt with in §4.

3.7 Astronomical Societies and Clubs

Persons who want to benefit from contact with other observers to share their mutual enthusiasm for astronomy should consider becoming a member of a local astronomy club. Residents of Canada and the U.S. should consult the *1989 Directory of Astronomy Clubs* [22] published in the May 1989 issue of *Astronomy* magazine or the *Astronomy Resource Guide* published in the September 1991 issue of *Sky & Telescope*. In the U.K., there is a complete listing of the major astronomical societies in the *Handbook for Astronomical Societies* [16]. Information on societies can also be obtained by writing to: Astronomy Section, Old Royal Observatory, National Maritime Museum, London SE10 9NF, England.

In addition to local clubs, there are also national and international organizations, some of which have local chapters, to which an amateur or professional astronomer can belong. While some of these have been mentioned in the various chapters of this book, a more complete listing with the addresses is provided in §A.3. A somewhat more extensive listing is provided by Robbins and Fraknoi in *The Universe at Your Fingertips* [14]. It should be noted that nearly all of the "national" societies welcome members from other countries.

3.8 Inns and Travel Tours

The following companies arrange travel tours to view eclipses and other astronomical events:

- EAST AFRICA TRAVEL CONSULTANTS, INC., 574 Parliament St., Toronto, Ontario M4X IP8, Canada; Tel: 416-967-0067. Solar eclipse tours.
- EXPLORERS TRAVEL CLUB LTD., 5 Queen Anne's Court, Windsor, SL4 1DG, England; Tel: 0753 842184.
- HANSSEN TOURS, 3705 NASA Rd. 1, Seabrook, TX 77586, USA; Tel: 713-326-7643.
- SCIENTIFIC EXPEDITIONS, 1832 Quail Lake Dr., Venice, FL 34293; Tel: 800-344-6867. Organizer of specialized astronomical tours in association with *Sky & Telescope* magazine.
- WORLD OF OZ LTD., 20 E. 49th St., Suite 500, New York, NY 10017; Tel: 800-248-0234. Arranges tours to astronomical events, especially solar eclipses, in association with *Sky & Telescope*.

The following inn is quite possibly unique: it caters to astronomers:

- STAR HILL INN, located near Santa Fe, New Mexico at an altitude of 7200 feet. Astronomers can bring their own telescope or rent the Inn's 24-inch Cassegrain. (A wide-angle photograph of the summer Milky Way taken from this site appears on page 328 in the September 1989 issue of *Sky & Telescope*.) For free information, contact: Star Hill Inn, Sapello, NM 87745, USA; Tel: 505-425-5605.

3.9 Astronomy Books for the Visually Handicapped

Those who are visually impaired can learn about the wonders of the sky from Braille-printed astronomy books. For example:

- *Touch the Stars*, by Noreen Grice, a 44-page astronomy textbook which includes 11 tactile illustrations. Text pages are printed in Braille and large print.
- *Tactile Illustrations*, a set of 20 astronomy pictures with Braille captions.

Both of these books can be ordered from MUSEUM OF SCIENCE, Public Outreach Department, Science Park, Boston, MA 02114-1099; Tel: 800-729-3300.

Numerous works on astronomy are now available on audiocassette tapes; see also §4.2.1. The best sources are the following:

- *RECORDING FOR THE BLIND* — A non-profit organization with studios in 16 states in the U.S. It maintains a central library of audiocassette tapes of approximately 80,000 books, with 4,000 new books being recorded each year for the use of 20,000 borrowers. The total collection on astronomy numbers around 150 entries. The cassettes are loaned free of charge to students, and include in addition to the written text complete descriptions of all illustrations and associated tables and appendices. For more information contact: RECORDING FOR THE BLIND, INC., 20 Roszel Road, Princeton, NJ 08540, USA.
- *ASP* — offerings discussed in §4.2.1.

4 Educational Resources in Astronomy

The 1980s were extremely fruitful years for the development of resources in astronomy, especially in the realm of videocassette tapes and computer software. The balance of this chapter is devoted to the plethora of educational materials which are available as of this writing (1991). The lists of distributors of these various products are meant to represent a generous, but not exhaustive, cross section. Completeness is not the objective and indeed is an impossibility within the scope of this chapter, as the number of distributors for slides, for instance, must total several hundred in North America alone.

Except where noted, the author does not endorse any particular product or company, but merely gives a liberal sampling of the ones that have appeared in advertisements during the recent months. Note that there is a great deal of overlap in the sense that a particular product is often carried by several different companies. Prices for various items are not as a rule given here, as these will doubtlessly change during the lifetime of this document. Any purchases of products listed here or in the distributors' catalogues should be made without haste and using common sense. The reader should telephone or write the particular company for a catalogue and/or current price information.

Readers in the U.K. can obtain more information on resources from the aforementioned *Handbook for Astronomical Societies* [16], or by contacting the

ASSOCIATION FOR ASTRONOMY EDUCATION, the LONDON PLANETARIUM, or the LONDON SCHOOLS ADVISORY CENTRE (addresses given earlier) for resource lists. Those in North America should consult the following:

- *The Air and Space Catalogue* by J. Makower (ed.), Vintage Books, 1989 — Extensive listings cover resources, products, planetariums, clubs, places to visit, and other useful information.
- *Directory of Science Education Suppliers* which lists equipment, other firms, educational services, media producers, and publishers. It is available from the National Science Teachers Association (NSTA), 1742 Connecticut Ave. NW, Washington, DC 20009.
- *Equipment Directory 1989* [23], an advertising supplement to the October 1989 issue of *Astronomy* magazine. It contains a sizable number of sources for a wide variety of observational and educational items.
- *Astronomy Resource Guide* [20], a supplement to the September 1991 issue of *Sky & Telescope* magazine. It lists planetariums, observatories, museums, clubs, computer bulletin boards, and equipment manufacturers.
- *The Universe at Your Fingertips: An Educator's Desktop Reference of Astronomy Education Materials in English* [14] — A very comprehensive document (up to 1985) assembled under the auspices of the International Astronomical Union's Commission 46 (Education) by R. Robert Robbins and Andrew Fraknoi. It available from the ASP. A 1988 update is available from the IAU and is published in the Teachers' Guide to the introductory astronomy textbooks by J. Pasachoff.
- *Universe in the Classroom* by A. Fraknoi (W.H. Freeman & Sons) — A highly recommended teachers' guide.
- *The Universe at Your Desk* — A resource guide for the beginning teacher of high school astronomy, and developed by Project STAR, Center for Astrophysics, 60 Garden St., Cambridge, MA 02138.

4.1 Mechanical Models and Exhibit Items

There are seemingly innumerable kinds of astronomy items that can be used productively in the classroom or simply as display pieces. The most common ones will be discussed in the following subsections; a general list of companies which distribute these materials can be found in §A.4.

4.1.1 Globes. The globe or sphere is generally used to represent the terrestial and celestial spheres with true-to-scale angles and areas. There are Earth globes, lunar globes, Mars globes, celestial globes, and so on. The classic Earth globe can be modified by additional equipment and spheres so as to explain the origin of the seasons and demonstrate the subsolar point on the Earth's surface, zones of twilight, and other phenomena.

The celestial globes are designed so that the constellations can be shown in one of two ways: 1) as they are seen in the sky, so that the globe has the function of a star map, or 2) in the reverse sense, where the viewer must imagine he is observing the sky from the center of the sphere in order to "see" the patterns of constellations correctly. Some globes are transparent (or at least translucent) and can be illuminated from the inside. There are also "blackboard" globes with or without gradation on which chalk can be used.

Some of the best sources of globes are FARQUHAR GLOBES, CAROLINA BIOLOGICAL SUPPLY CO., CENCO, EDMUND SCIENTIFIC,

FISCHER SCIENTIFIC, HUBBARD SCIENTIFIC, MMI CORPORATION, SCHOOLMASTERS SCIENCE, and WARDS NATURAL SCIENCE ESTABLISHMENT, INC. (addresses given in §A.4).

4.1.2 Telluria and Planetaria. A *tellurian* is an apparatus designed to demonstrate how the Earth's position and movement (diurnal rotation, annual revolution, etc.) causes day and night, the phenomenon of the seasons, lunar phases, and eclipses. A *planetarium* is a device designed to show the motions of a variety of celestial objects, but especially planets, the Sun, and the Moon. Typical museum planetaria are miniature models of our solar system which display the motions of celestial bodies by accurately calculated machinery; these devices are often referred to in the English language as *orreries*. In Germany, for instance, a planetarium is generally understood to be a *projection* planetarium, where the celestial globe is in fact projected (via multitudes of tiny, individual light beams) onto the dome of the presentation room so that the "stars" appear in a more or less natural-looking fashion.

Projection planetaria are offered nowadays in a great variety of dimensions and also different facilities; for example the largest instruments number V and VI of the Carl Zeiss Oberkochen in West Germany. Small- and medium-sized planetaria are also available with many of the facilities of the larger domes. Some suppliers are listed later in this subsection.

A totally new development is the DIGISTAR Planetarium from the EVANS & SUTHERLAND COMPUTER CORPORATION in Salt Lake City, Utah. It employs a powerful computer (VAX 11/730) which steers via a graphic processor an ultrabright cathode-ray tube of 18×18 centimeter area. The images from an 8000×8000 pixel surface are projected onto a dome with a superwide angle objective at videospeed (25 images per second). The images of stars, particularly those at the horizon, appear fainter and less sharp than in the traditional planetarium projectors. Although DIGISTAR's representation of the celestial view is less than perfect, it offers many new possibilities. For instance, the proper motions of stars in past and future can be shown in different time lapses, and even travel by spacecraft through certain constellations, where the distances of the stars have been stored in the computer, can be simulated. Currently the only European facility of this type is The Hague in the Netherlands, but in North America there are several.

For use in schools, colleges, and public observatories, there is available a type intermediate between projection planetarium and orrery: a transparent star globe containing a tellurian. With this device, the following facilities can be represented: day and night, seasons, representations of lunar revolution, phases, and eclipses, the tides, universal time, sidereal time, solar time and the motion of the lunar nodes. The relation between equator and ecliptic, seasonal nighttime view, dependence of circumpolar stars on geographic latitude, position of satellite orbit, phases of Venus, the platonic year, and precession of the Vernal Equinox can also be shown.

The Baader Planetarium in West Germany, for instance, contains such a device. This instrument has an easily exchangable projection screen or dome

in two different sizes, and can also be used for smaller projection planetaria. One instrument in particular corresponding to the old orreries is the *Helios Planetarium*, which contains a plexiglass dome with a northern and southern hemisphere, and inside a representation of the planetary system (but not to scale). This instrument can be used as a tellurian.

The following is a list of the names and addresses of companies which distribute orreries and planetaria.

Projection Planetaria

- EVANS & SUTHERLAND COMPUTER CORPORATION, Salt Lake City, UT, USA.
- GOTO OPTICAL MFG. CO., 4-16 Yazakicho, Fuchu-Shi, Tokyo 183, Japan; Tel: 0423 (62) 5311.
- MINOLTA CAMERA CO., Osaka Kokusai Bldg. 30-2, Chome, Azuchi, Osaka 541, Japan.
- MMI CORPORATION, 2950 Wyman Parkway, P.O. Box 19907, Baltimore, MD 21211, USA; Tel: 301-366-1222.
- SCHOOLMASTERS SCIENCE, 745 State Circle Box 1941, Ann Arbor, MI 48106, USA; Tel: 800-521-2832.
- SEILER INSTRUMENTS & MANUFACTURING CO., INC., 170 East Kirkham Ave., St. Louis, MO 63119-1791, USA; Tel: 314-968-2282 or 1-800-444-7952.
- SPITZ SPACE SYSTEMS, Chadds Ford, PA, USA.
- STARLAB PLANETARIUM SYSTEMS, 59 Waldenstreet, Cambridge, MA 02140; Tel: 800-537-8703.
- VIEWLEX AUDIO-VISUAL, Broadway Ave., Holbrook, NY, USA.

Other Planetaria

Most of the companies which supply globes and telluria also supply model planetaria. See the list in §4.1.1 and also the following possible source:

- COCHRANES OF OXFORD LTD., Fairspear House, Leafield, Oxford OX8 5NY, England: Tel: 099-387641. Helios planetaria.
- LEARNING TECHNOLOGIES INC., Starlab Planetarium Systems, 59 Walden Street, Cambridge, MA 02140, USA; Tel: 800-537-8703, in Massachusetts 617-547-7724. Telex: 5106008300 LRNG TEC.
- ORBIC SYSTEMS, INC., 109 Eltingville Blvd., Staten Island, NY 10312, USA; Tel: 718-356-2328.

Accessories

- Alan Castelman, c/o CARL ZEISS INC., 1 Zeiss Dr., Thornwood, NY 10594.
- SKY-SCAN, P.O. Box 3832, Rochester, NY 14610, USA.
- TALENT, INC., 1010 Marietta Way, Sparks, Nevada 89431, USA.

Planetarium Shows

- MARYLAND SCIENCE CENTER, Allan C. Davis Planetarium, 601 Light St., Baltimore, MD 21230; Tel: 301-685-2370 x440.

Literature on Planetaria

- Fernbank Science Center: Physical Science Teacher's Guide, *The Planetarium*.
- Various authors—NASA: *The Planetarium* (An Elementary School Teaching Resource, 1966).
- Berendzen, Richard (editor and conference chairman): International Conference on Education in and History of Modern Astronomy Part II. *Annals of the New York Academy of Sciences*, Vol. 198 (August 1974).
- Jettner, Frank C., and Soroka, John J.: The Planetarium in Modern Science Education. p. 178 in Berendzen ref.
- Branley, F.M.: Education in Major Planetariums. p. 192 in Berendzen ref.

Journals and Magazines

- *The Planetarian*, put out by the International Planetarium Society. Contact: Griffith Observatory, 2800 E. Observatory Rd., Los Angeles, CA 90027, USA, Telephone 213-664-1181.

- *Planetarium Sourcebook*, a new resource guide published by the Great Lakes Planetarium Association. It lists companies and organizations offering products and services of interest to the planetarium community. Cost is $5 ($7 outside the U.S.). Write: Gary E. Sampson, Wauwatosa West High School Planetarium, 11400 W. Center St., Wauwatosa, WI 53222, USA.
- *Publication of the Planetarium Association of Canada*, (Manitoba Museum of Man and Nature, 147 James Ave., Winnipeg 2, Manitoba), in Vol. 4, 1972.
- *Planetarium News*, Carl Zeiss, Oberkochen/Würt.

4.1.3 Telescopes and Accessories. The consumer is well-served for telescopes and observing equipment these days. During the latter half of the 20th century, the number of companies which market telescopes and accessories increased dramatically (as did prices for these items), and there is currently fierce competition to satisfy the demands of amateur and professional astronomers. Unfortunately, the cost of even a good 3-inch reflecting telescope[11] with equatorial mount and clock drive, for example, may dissuade all but the most hard-core astronomy buffs from making the purchase.

As with audio-visual equipment, the number of companies which sell telescopes, binoculars, and all the standard accessories such as eyepieces, filters, finderscopes, etc. is overwhelming. Some are well-known national and international suppliers which advertise in the popular astronomy magazines, but anyone seeking to purchase a telescope would be well advised to check local suppliers also. Two very useful guides are the *Astronomy Resource Guide* [20], a special insert within the September 1991 issue of *Sky & Telescope*, and the 1989 Guide to Telescopes [24], a special section in the October 1989 issue of *Astronomy* magazine. In the latter can also be found the *Equipment Directory 1989* [23], which lists major North American distributers of telescopes and accessories as well as the requisite tools and supplies for telescope making. Readers in the U.K. can find some distributers in the indespensible *Handbook for Astronomical Societies* [16]. These lists will not be reproduced here, but the names of companies which market certain specialty items or perform repairs etc. are given in §A.6.

4.1.4 Astronomical Clocks. Astronomy is, of course, *the* science of reference for timekeeping. Below are given a few of the more distinctive astronomical clocks which are currently on the market.

- *Geochron clock*. This device is an electronic map which shows the time of day and amount of sunlight anywhere in the world. The geochron reveals how the distribution of sunlight over the Earth's surface is affected by the changing seasons. Source: AMERICAN WEATHER ENTERPRISES, P.O. Box 1383, Media, PA 19063, USA; Tel: 215-565-1232.
- *Lunatime clock*. A lunar clock which shows the position of the moon at all times, while following the circadian day of $24^h 50^m$.
- *Solar/Lunar clock*. Mechanism shows exactly the positions of both Sun and Moon in relation to the Earth. Gives phases of the Moon, lunar time, conventional time, and times of sunrise and sunset for each day.
- *Startimer*. Reads celestial time and illustrates the rotation of the Earth in relation to the stars.

[11] 3 inches is usually considered the mininum aperture with which useful observations can be made of planets and stars with this type of scope.

The latter three items are available from most of the sources in the general list in §A.4.

Astronomical timepieces are also manufactured by:

- ASTROTECH, 39 Periwinkle Lane, Dunstable, Beds. LU6 3NP, England; Tel: 0582 605464.
- GEMINI, 8930 Blue Smoke Dr., Gaithersburg, MD 20879, USA; Tel: 301-921-0157.
- WILLMAN-BELL INC., P.O. Box 35025, Richmond, VA 23235, USA; Tel: 804320-7016.

4.1.5 Sundials. Sundials provide a traditional and ornate way of telling the time. They come in many sizes, and are usually permanently mounted, although this need not be the case. For a full discussion of sundials and instructions on how to build one, see Chap. 10 (Modern Sundials)[12].

A few sources of sundials include:

- AMERICAN WEATHER ENTERPRISES, P.O. Box 1383, Media, PA 19063, USA; Tel: 215-565-1232.
- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215, USA; Tel: 919-584-0381.
- WIND AND WEATHER, The Albion Street Water Tower, P.O. Box 2320, Mendocino, CA 95460.

4.1.6 Early Scientific Instruments. The following offer antique scientific instruments (and/or reproductions of such) and early associated books. They should be contacted for information and a catalogue:

- GREYBIRD PUBLISHERS, 11824 Taneytown Pike, Taneytown, MD 21787. Publisher of bimonthly advertising journal of antique scientific instruments.
- HISTORICAL TECHNOLOGY, INC., 6B Mugford Street, Marblehead, MA 01945.
- PAUL MACALISTER & ASSOC., 280 Arden Shore Rd., Lake Bluff, IL 60040, USA.
- G.B. MANASEK INC., P.O. Box 961, Hanover, NH 03755, USA; Tel: 603-643-2227.
- RENAISSANCE INSTRUMENT CO., 635 6th St., Myrtle Point, OR 97458, USA; Tel: 503-572-2595.
- ST. JAMES HOUSE CO., 3010 W. Montrose Ave., Chicago, IL 60618; Tel: 312-267-0400.
- TESSERACT, Box 151, Hastings-on-Hudson, New York, NY 10706, USA; Tel: 914-478-2594.

4.1.7 Meteorites and Tektites. Meteorites are available in limited quantities to astronomers, schools, and collectors. The following are possible sources:

- ASTROSYSTEMS, 1536 Meeker Dr., P.O. Box 1183, Longmont, CO 80501; Tel: 303-678-5339.
- BETHANY TRADING COMPANY, P.O. Box 3726-S, New Haven, CT 06525, USA; Tel: 203-393-3395. Catalogue $2 (U.S.).
- FIREBALL ELECTRONICS, 246 E. 52nd St., Odessa, TX 79762, USA; Tel: 915-366-4802.
- ROBERT A. HAAG - METEORITES, 2990 E. Michigan St., Box 27527, Tucson, AZ 85726, USA. Catalogue available.
- R.A. LANGHEINRICH, 326 Manor Ave., Cranford, NJ 07016, USA.

[12] In Vol. 1 of *Astronomy Compendium*, Springer-Verlag 1991 (forthcoming)

- MINEROLOGICAL RESEARCH, 15840 E. Alta Vista Way, San Jose, CA 95127, USA; Tel: 408-923-6800.
- JAMES M. WILLIAMS, 4017 W. 10 St., Odessa, TX 79763, USA; Tel: 915-381-0249.

4.1.8 Optics/Spectroscopy Demonstrations. The many properties of light can often be demonstrated in the classroom using a wide variety of "blackboard optics" equipment which has been available over the past several years. These devices make it especially easy to demonstrate the principles of refraction and reflection. Most of the companies in the general list of sources in §A.4 supply them.

A spectroscope can be a very simple device for dispersing the radiation from a light source into its constituent colors. Several instructive experiments can be done with a spectroscope, including making observations of various gas discharge tubes, incandescent lamps, and the Sun. It is usually helpful also to have on hand a large spectrum analysis chart for identifying the various elements in the spectrum. Again, suppliers can be found from amongst the companies in the general list provided in §A.4.

4.1.9 Maps, Posters, Starcharts, and Postcards. Various wall posters, charts, and maps are abundant, and the following list gives just a few of the numerous suppliers. Most of the companies in the general list in §A.4 also supply miscellaneous charts, maps, and posters.

United Kingdom

- ARMAGH PLANETARIUM. Offers a wide selection of all of these materials.
- BROADHURST CLARKSON & FULLER LTD., Telescope House, 63 Farrington Road, London EC1M 3JB. Tel: 01-4052156.
- DAILY TELEGRAPH, 135 Fleet Street, London EC4 or bookshops. Offers *Sky at Night* map.
- GEORGE PHILIP, 59 Grosvenor Street, London W1X 9DA; Tel: 01-493 5841. bookshops.
- LONDON PLANETARIUM, Marlebone Road, London NW1 5LR; Tel: 01-486-1121.
- MACMILLAN EDUCATIONAL, Houndmills, Baskingstoke, Hants.
- PICTORAL CHARTS EDUCATIONAL TRUST, 27 Kirchen road, London W.13.
- THE ROYAL ASTRONOMICAL SOCIETY, Burlington House, London, W1V 0NL. Limited quantities of posters.
- SPACECHARTS, Newton Tony, Salisbury, Wilts.

Canada and the United States

- ASP, 390 Ashton Avenue, San Francisco, CA 94112, Tel: (415) 337-1100. Posters of the Moon, Space Shuttle, Earth at Night, Solar System, Galaxies, An Explorer's Guide to Mars, and Astro-Posters set.
- ASTRONOMY Magazine, Order Dept., 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612, USA; Tel: 414-796-8776. Posters of Space Shuttle by NASA, Uranus from Voyager, Map of the Universe, Solar System Exploration.
- BLACK FOREST OBSERVATORY, 12815 Porcupine Lane, Colorado Springs, CO 80908; Tel: 719-495-3828. Has star charts and many unique products in astronomy.
- DOVER PUBLICATIONS, INC., 31 East 2nd Street, Mineola, NY 11501. Puts out a series of postcards on space exploration from the archives of NASA.
- HADDON'S POSTERS, Box 9514, Station A, Halifax NS, B3K 5S3, Canada. Solar System poster showing all nine planets.

- HANSEN PLANETARIUM, 15 South State Street, Salt Lake City, UT 84111, USA; Tel: 800-321-2369. Has wide variety of outstanding charts, posters, and postcards; see their catalogue.
- MAGRATH PHOTOGRAPHY, 2202 Willett, #45, Laramie, WY 82070. Sky photography and calendars.
- NIGHTSKY ENTERPRISES, Box 278, Pomona, NJ 08240, USA; Tel: 800-NITESKY. Offers giant $7' \times 7'$ mural of the night sky.
- SCHOOLMASTERS SCIENCE, 745 State Circle Box 1941, Ann Arbor, MI 48106, USA; Tel: 800-521-2832.

4.1.10 Calendars. Astronomical calendars abound these days. Below are a few of them which were available for 1990 (and presumably will also be on the market in succeeding years), along with the companies which distribute them.

- *The Astronomical Calendar*, available from ASTRONOMICAL CALENDAR, Department of Physics, Furman University, Greenville, S.C. 29613, USA; Tel: 803-294-2208. In Europe and the U.K., write to: Geoffrey Falworth, 12 Barn Croft, Penwortham, Preston, PR1 0SX, England.
- *The Astronomical Companion*, same sources as for the *Astronomical Calendar*.
- *The British Astronomical Calendar*, from RAS CALENDAR OFFER, Calendar Division, Thomas Forman Ltd., Hucknall Road, Nottingham NG5 1FE; Tel: 0602-608151 x262/272.
- *Moon Phase Calendar*, from ASP.
- *Wonders of the Universe Calendar*, from ASP.

4.1.11 Stamps. Stamps with celestial and space themes have been issued over the years in many different countries. Collectors interested in such stamps should contact: The Astronomy Study Unit of the American Topical Society, P.O. Box 630, Johnstown, PA 15907. They publish *Astronomy & Philately*, a handbook listing astronomical stamps, stationary, and cancellations (order number HB90), and *Astrofax*, a quarterly bulletin.

4.2 Audio-Visual Media

In recent years there has been a veritable explosion in both the quantity and quality of resources available in the audio-visual realm. Nowadays there are multitudes of science companies promoting astronomy by selling slides, books, videocassettes, and other items. This is due in part to the broadening of astronomy to include observations made in the gamma-ray, X-ray, ultraviolet, and infrared regions of the electromagnetic spectrum, as well as to improved imaging (often computer-enhanced) of visible sources. It has also certainly been spawned by the spectacular images obtained from recent space missions to the planets, by technological advances in audio and video products, and by the general public's unceasing appetite for astronomical knowledge.

The most common audio-visual products include phonograph records, audiocassette tapes, still photographs, slides, transparencies, filmstrips, filmloops, films (both silent and sound), videocassette tapes, and videodiscs. These will be discussed in the following subsections, along with a few of the companies which sell or rent them; a general source list of audio-visual products is provided in §A.5.

4.2.1 Audiocassette Tapes. While not the most popular audio-visual resource in astronomy, audiocassette tapes can supply a great deal of verbal information which is especially useful for beginners. Some cassettes provide descriptive information on a number of popular celestial objects in the night sky, while others contain recorded lectures on various subjects. Still others are condensed readings from published books on astronomy. Some of the available tapes include:

- *First Moon Landing—Flight of the Eagle*—Includes audio segments from the Apollo 11 flight to and from the Moon in July 1969. Also includes famous speech by President Kennedy stating the goal of putting a man on the Moon during the 1960s. Available from SPACETAPES (see address below).
- *The Hubble Space Telescope*—Features a 60-minute talk about the HST by Dr. Stephen Maran of the NASA/Goddard Spaceflight Center. Describes HST's history, instruments, capabilities, scientific projects, and safety features. Available from the ASP.
- *The Sky at Night—A Guided Tour of the Constellations*—by Patrick Moore. The 60 minute tape has an introduction followed by four sections for each of the seasons. From George Philip, London.
- *Tapes of the Night Sky*—A series of four half-hour guided "tours" (on two cassettes) of the night sky, one tour for each season. The *Tapes* can be purchased either from the ASP or from SKY PUBLISHING CORPORATION.
- *Telescopes of the World*—A self-contained introduction to modern telescopes and astronomical observing. Can be used as synchronized narration to the ASP slide set of the same name.

The following books and excerpts from books are available on audiocassette from the ASP:

- *A Brief History of Time*—Complete reading of the best-selling popular book by Stephen W. Hawking. (4 cassettes, approximately 6 hours).
- *Coming of Age in the Milky Way*—Selections from the book by that name by Timothy Ferris, read by the author. Tells the story of how the western world arrived at its conception of the universe. (2 cassettes, 168 minutes)
- *The Discovery of the Pulsar*—Selections from the book by Antony Hewish and Jocelyn Bell-Burnell. Recorded by the BBC, this tape includes interviews with the authors, who give a first-hand account of their discovery. (1 cassette, about 56 minutes).
- *To Space and Back*—From the book by Sally Ride with Susan Okie. Written especially for young audiences, tells the story of America's first woman in space, and answers questions frequently asked by space enthusiasts of all ages. (1 cassette, 54 minutes).

Selected astronomy textbooks and other printed materials have been transcribed in their entirety to cassette tapes, and are available for loan to the visually handicapped; see §3.9.

The following companies also sell various cassette tapes:

- FEDERATION OF ASTRONOMICAL SOCIETIES, 1 Tal-y-bont Road, Ely, Cardiff CF5 5EU, Wales. See Slide/Audiocassette Sets.
- INFORMASTRON COMPANY, P.O. Box 262, Belle Vernon, PA 15012, USA. Cassette tapes providing information on the various objects being viewed (e.g., Pleiades, Full Moon, Sun). Free brochure available.
- SPACETAPES, 539 Telegraph Canyon Rd., #777 Chula Vista, CA 92010; Tel: 800-777-6382.
- TERRA FIRMA CASSETTES, 55 Bolingbroke Road, London W14, England.

4.2.2 Phonograph Records. Due to the recent popularity of audiocassette tapes, very little astronomy-related material is available in this medium with the exception of slide or filmstrips with audio narration on record. However, most of these sets now come with cassettes instead of records.

4.2.3 Still Photographs. A simple photograph may in some instances be preferable to motion pictures since in the former the viewer has time to mull over its meaning. There are standard prints and now the high quality laser prints. Sources are listed below, including libraries which loan prints.

United Kingdom

- ARMAGH PLANETARIUM, College Hill, Armagh, Northern Ireland BT61 9DB; Tel: 0861-524725. Sells a wide variety of laser scan prints.
- EARTH AND SKY, 21A West End, Hebden Bridge, West Yorkshire HX7 8UQ.
- MARY EVANS PICTURE LIBRARY, 1 Tranquil Vale, Blackheath, London SE3 0BU; Tel: 01-318-0034.
- SCIENCE MUSEUM LIBRARY, Photo Orders Service, South Kensington, London SW7 5NH; Tel: 01-938-8220.
- SCIENCE PHOTO LIBRARY, 112 Westbourne Grove, London W2 5RU; Tel: 01-727-4712 or 01-229-9847; Fax: 01-727-6041.
- SPACE FRONTIERS LTD., 30 Fifth Avenue, Havant, Hampshire PO9 2PL; Tel: 0705-475313.
- SPACEPRINTS, 17A High Street, Norton, Stockton on Tees, Cleveland; Tel: 0642-584440.

Canada and the United States

- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215, USA; Tel: 919-584-0381. Also Box 187, Gladstone, OR 97027, USA. Tel: 503-656-1641.
- CENTRAL SCIENTIFIC COMPANY (CENCO), 11222 Melrose Ave., Franklin Park, IL 60131-1364, USA; Tel: 312-451-0150 or 800-262-3626.
- FISHER SCIENTIFIC, Educational Materials Division, 4901 W. LeMoyne Street, Chicago, IL 60651, USA; Tel: 800-621-4769.
- ORBITAL PRODUCTIONS, P.O. Box 22202, San Diego, CA 92122; Tel: 619-457-0953.

4.2.4 Slides. Slides are by far and away the most used format in the audio-visual realm. The vast volume of material in this medium makes even a partial listing of offerings prohibitive. Instead, the reader is referred to the selection of companies given in the general list in §A.5, as virtually all of them distribute slides. Also, some of the available slide sets are listed in [14].

4.2.5 Videodiscs. Videodiscs or *laserdiscs* will quite possibly supplant the standard 35-mm slides and 16-mm films (and even videocassettes) in the not-too-distant future. This new technology, which is available for a wide variety of subject areas, provides at one's fingertips a variety of audio-visuals, including still and motion pictures, that can be shown on a color monitor at a selectable speed, forward or backward, with high quality sound. Each disc is provided with an image directory in which every frame is described in detail. A disc can hold several hundred thousand individual images with quick random access via remote keypad.

The ASP, the MMI CORPORATION, and OPTICAL DATA CORPORATION (formerly VIDEO VISION ASSOCIATES) all distribute astronomy videodiscs, but the number of available sources should increase as as this medium becomes more popular. For more information, consult the *Videodisc Compendium for Education and Training*, which is available from EMERGING TECHNOLOGIES, INC., P.O. Box 12444, St. Paul, MN 55112; Tel: 612-639-3973.

4.2.6 Transparencies. Transparencies are in the form of cellophane sheets (overlays) for use with overhead projectors. They are not as ubiquitous as slides, but they can be used to good purpose when they are available. Transparencies for astronomy are sold by a few companies, including the SCIENCE MUSEUM LIBRARY in the U.K. and FISCHER SCIENTIFIC, HUBBARD SCIENTIFIC, SCHOOLMASTERS SCIENTIFIC, and WARDS NATURAL SCIENCE ESTABLISHMENT in the U.S.

4.2.7 Filmstrips and Slide/Audiocassette Sets. Filmstrips are essentially still pictures (slides) which have been put on a continuous roll; to be shown on a screen with or without synchronous audio narration (audiocassette tape or phonograph record). One notable astronomy set aimed at grades 7–12 is *The Universe: Frontiers of Discovery Series* (1984), which is distributed by NATIONAL GEOGRAPHIC, Educational Services, Washington, DC 20036; Tel: 800-368-2728. In Maryland: 301-921-1330. There are also several good series of slide/audio cassettes available, including *Astronomical Observations and Computations*, which is essentially a short course in navigation astronomy available from NATIONAL AUDIOVISUAL CENTER, and *Telescopes of the World*, distributed by the ASP.

In the U.K., the FAS distributes the following slide/audiocassettes sets: *Introducing Black Holes* by Iain Nicolson, *The Truth About UFOs* by Robert Scheaffer, and *Europe in Space* by Neville Kidger. The reader should check the catalogues of various suppliers for other astronomy filmstrips.

4.2.8 Motion Picture Films and Videocassette Tapes. Motion pictures or movies have for many years been one of most important tools for disseminating information in astronomy. They are available in three principal formats:

1) film (16-mm, 8-mm, and Super-8)
2) videocassette (VHS and Beta)
3) videodisc (discussed in §4.2.5 above).

Film, usually in the 16-mm format with light or magnetic tracking, was the *only* format in widespread use until the late 1970s. Recently, however, many films have become available in the Super-8 format. Some films are wound onto reels which are to be mounted with a blank take-up reel on a projector, while others are mounted in a self-winding plastic cassette called a film loop. There are purely silent movies and movies with sound tracks, the latter of which comprises the bulk of the resources available in this medium. 16-mm sound films in particular are rapidly being superseded by videocassettes tapes.

One of the most successful industries in recent years has been the videocassette industry, now considered one of the biggest in the world. The use

of videocassette recorders (VCRs) to record and play back television broadcasts increased exponentially during the 1980s, and, consequently, most sound movies are now being produced exclusively on videocassette, and some of the older conventional movie films have been transferred to this new medium. The number of available videocassette tapes on astronomy subjects is also growing rapidly.

The list of companies which distribute films is far too long to present here, and the reader should therefore check [14] (for materials available as of 1985) or consult one or more of the following film/video catalogues, some of which are updated annually:

- *AAAS Science Books and Films*, subscription $20 per year from AAAS Subscription Dept., 10th Floor, 1101 Vermont Ave., N.W., Washington, DC 20005.
- *A Cinescope of Physics*, published by the American Association of Physics Teachers in 1978.
- *Educational Film/Video Locator of the Consortium of University Film Centers and R.R. Bowker*, published by the R.R. Bowker Company, New York 1986.
- *Educator's Guide to Free Films*, published annually by Educators Progress Service, Inc., 214 Center St., Randolph, WI 53956, USA.
- *Films in the Sciences*, available from the AAAS.
- *Film and Video Finder*, published by the National Information Center for Educational Media, Albuquerque 1987.
- *Media Review Digest*, published by Pierian Press, Ann Arbor.
- *The Video Source Book*, published by National Video Clearinghouse, Syosset (NY).

There was also a listing (with descriptions) of astronomy films compiled in 1977 by C. Smith and published in *Effective Astronomy Teaching and Student Reasoning Ability*, but it is now out of print. A detailed subject index of several hundred astronomy films is contained in *Universe in the Classroom* by Andrew Fraknoi, published by Freeman in 1985.

4.3 Broadcasting and Communications

4.3.1 Radio. In North America, the syndicated daily program *StarDate* has achieved immense success during its decade-long run on radio. A typical segment consists of a 2-minute vignette focusing on events taking place in the night sky, as well as anecdotes from poetry or the the history of astronomy, or news of the latest discoveries. More information can be found in the article by Byrd [25] in *Mercury* magazine.

For precision observing work, time signals from station WWV are broadcast on shortwave radio at 2.5, 5, 10, and 15 MHz. Similar signals are broadcast by Canadian station CHU at 3.330, 7.335, and 14.670 MHz. (See also §4.3.3).

4.3.2 Television. The convenience of television viewing is undeniably a major factor in diverting much of the populace from other, more active pursuits during their leisure time. This can have serious consequences, especially for amateur astronomy, as many would-be sky-watchers are tempted to tune in their favorite programs at night instead of making direct observations of the stars and planets. Nevertheless, the medium of television has, at least in principle, the potential to

disseminate a broad spectrum of scientific principles and results to a significant fraction of the public.

High quality television programs, primarily from PBS and BBC stations, are currently being broadcast in much of North America and Great Britain. Some of these programs, most notably *Discover: The World of Science*, *Innovation*, *NOVA*, and *Smithsonian World*, are oriented specifically toward issues and discoveries in science and technology, and individual programs will sometimes focus on astronomical subjects. In addition, the PBS program *Star Hustler*, a 5-minute segment on happenings in the sky, is broadcast weekly in the U.S. and Canada, while *Earth Calling Basingstoke* is seen in Great Britain.

A very recent offering in educational television is *NASA Select Television*, a cable station which provides informational and educational programming on space and related topics aimed at inspiring young people to achieve, especially in mathematics and science. Broadcasts are made Monday through Friday, and include historical documentaries focusing on America's space program, scientific results from spacecraft, and programs designed specifically for classroom use, covering topics such as biology, geology, the atmospheric and Earth sciences, and math and engineering concepts. NASA Select TV is transmitted on: SatCom F2R, Transponder 13, C Band, 72°W Longitude, Frequency 3954.5 MHz, Vertical Polarization. (Audio on 6.8 MHz). For more information, contact: NASA Select, c/o Associate Administrator for Public Affairs, NASA Headquarters/Code P, Washington, DC 20546, USA; Tel: 202-453-8425.

There are also limited series programs (with usually six or more episodes) some of which are now available on videocassette. These include the following:

- *The Astronomers*, a 6-part international PBS series describing the lives and work of professional astronomers. Available from PBS Video on six, one-hour videocassettes, accompanied by a substantive set of resource materials, including a 16-page reference and referral guide, a 32-page high-school curriculum guide, a poster, a career opportunities brochure, and a companion book.
- *Cosmos*, hosted by astronomer Carl Sagan. One-hour shows, now available on videocassette from numerous sources (e.g., the ASP).
- *The Day the Universe Changed*, hosted by James Burke.
- *Planet Earth*, an 8-part series hosted by Richard Kiley. At least two of the one-hour shows have material on astronomy. Now available on videocassette.
- *Ring of Truth*, hosted by astronomer Philip Morrison.
- *Universe in the Classroom*, a 39-part series produced by KOCE-TV in southern California which premiered on national television in the U.S. in 1979. The interested reader might want to look up the relevant article by Pierce [26] in a past issue of *Mercury* magazine.

4.3.3 Telephone News Services. Telephone "hotlines" on astronomy provide daily, weekly, and monthly reports on phenomena occurring in the sky. The ones listed below are a sampling from [20], which should be consulted for more detailed information and additional hotlines. Long distance rates apply.

- *Abrams Planetarium*: 517-332-7827 (East Lansing, MI).
- *Astronomical Society of the Pacific*: 415-337-1244 (San Francisco, CA).
- *Buehler Planetarium*: 305-475-6734 (Fort Lauderdale, FL).

- *Dial-A-Shuttle*: 900-909-NASA (Washington, DC). Available only during Space Shuttle Missions.
- *Griffith Observatory*: 213-663-8171 (Los Angeles, CA).
- *Hansen Planetarium*: 801-532-7827 (Salt Lake City, UT).
- *Hawaiian Skies*: 808-948-0759 (Honolulu, HI).
- *Maryland Science Center*: 301-539-7827 (Baltimore, MD).
- *NASA-Johnson Space Center*: 713-483-8600 (Houston, TX).
- *National Air and Space Museum*: 202-543-2000 (Washington, DC).
- *Pacific Science Center*: 206-443-2920 (Seattle, WA).
- *Sky & Telescope*: 617-497-4168 (Cambridge, MA).
- *The Skyline*: 602-955-7597 (Phoenix, AZ).
- *Smithsonian Astrophysical Observatory*: 617-497-1497 (Cambridge, MA) or 202-357-2000 (Washington, DC).
- *University of Illinois*: 217-333-8789 (Urbana, IL).

4.3.4 Electronic News Services and Computer Bulletin Board Systems (BBSs). There now exist many local and national computer networks which can be accessed with only a computer and modem. It is possible not only to read news and information, but also to communicate with other users and to run programs.

One of the best known networks is *CompuServe Information Service*, a major international network service which allows the user with a PC and modem to communicate with other astronomy enthusiasts via "Astronomy Forum." The Forums have large message boards and maintain text files and programs in extensive data libraries. To receive a free Inquiry brochure, or to order a Subscription Kit direct, contact: CompuServe Inquiry Brochure, Dept. MA1017, P.O. Box 20212, Columbus, OH 43220, USA; Tel: 800-848-8199. In Ohio or outside the continental U.S.: 614-457-0802. CompuServe memberships are also sold by computer dealers.

A brief sampling of the available "computer bulletin board systems" (BBSs) which contain astronomy and space-related subject material is provided below. A typical BBS contains files of general interest, such as current sky information, upcoming celestial events, astronomical news, ephemerides, and astronomy computer programs. The telephone numbers given are for more information and/or to subscribe. The reader is directed to [20] for a more extensive list of BBSs and more information on individual BBSs.

- *Astronomical Society of the Atlantic BBS*: 404-985-0408 (Snellville, GA).
- *Canadian Space Network BBS*: 416-458-5907 (Brampton, ON).
- *The Comm-post*: 303-534-4646 (Denver, CO).
- *Enviro*: 703-524-1837 (Washington, DC).
- *GEnie*: 800-638-9636. The General Electric Network for Information Exchange.
- *NASA Spacelink*: 205-895-0028 (Huntsville, AL).
- *National Space Society BBS*: 412-366-5208 (Pittsburgh, PA).
- *Starbase One*: 44-71-733-3992 (London, England).
- *Starbase III*: 209-432-2487 (Fresno, CA).
- *Star*Net*: 612-681-9520 (Minneapolis, MN).

- *Yokohama Science Center BBS*: 81-045-832-1177 (Yokohama, Japan).

4.4 Computers and Software

The use of computers has pervaded virtually every segment of our society, and science in particular. The direct effect on research astronomy has been in relieving human laborers of the vast amounts of data reductions that used to be performed by hand and later with calculating machines. For didactic functions (planetarium shows, classroom exercises, etc.), the computer can be used in the following capacities:

- as a programmable computing machine
- to graphically interpret results
- to store and record measured data
- to steer telescopes and other instruments
- to simulate past, future, and hypothetical events
- to present instructional programs (tutorials)
- to present tests and exercises (often with control over the answers)
- as a database
- as a text processor.

The following are some references on the use of computers and programmable calculators:

- Burgess, E.: *Celestial Basic: Astronomy on Your Computer*, Sybex Inc., 1982.
- Duffet-Smith, P.: *Astronomy with Your Personal Computer*, Cambridge University Press, 1985.
- Genet, R.M. (ed.): *Microcomputers in Astronomy, I and II*, Fairborn Observatory (1247 Folk Rd., Fairborn, OH 45324) 1983, 1984.
- Ghedini, S.: *Software for Photoelectric Photometry*, Willman-Bell, 1982.
- Klein, F.: *Pocket Computer Programs for Astronomers*, Klein Publications, 1983.
- Kuhn, W.: *Computer in Experiment*, Aulis Verlag Deubner & Co., 1986.
- Mackenzie, R.: *The Astronomer's Software Handbook*, Sigma Press, 1985.
- Meeus, J.: *Astronomical Formulae for Calculators* (2nd ed.), Willmann-Bell, Inc., 1982.
- Press, W.H., Flannery, B.P., Teukolsky, S.A., Vetterling, W.T.: *Numerical Recipes—The Art of Scientific Computing*, Cambridge University Press, 1986.
- Roy, A.E.: *Orbital Motion* (3rd ed.), Adam Hilger, 1988.
- Schmid, E.W.: *Theoretical Physics on the Personal Computer*, Springer-Verlag, 1988.
- Tattersfield, D.: *Orbit for Amateurs with a Microcomputer*, Stanley Thornes Ltd., 1984.
- Trueblood, M., Genet, R.: *Microcomputer Control of Telescopes*, Willmann-Bell, 1985.
- Vetterling, W.T., Teukolsky, S.A., Press, W.H., Flannery, B.P.: *Numerical Recipes Examples Book (FORTRAN)*, Cambridge University Press, 1986.

The list of software resources has grown enormously in the past decade. Some of these are given in the *Handbook for Astronomical Societies* (for readers in the U.K.) [16] or in the *Astronomy Resource Guide* (Canada and the U.S.) [20]. Mosely and Fraknoi [27] assembled a list of astronomy software available as of 1991, along with a list of software producers in North America. A copy

can be obtained by sending a donation of $3.00 (U.S.) to ASP Software List Dept., 390 Ashton Ave, San Francisco, CA 94112.

In addition, NASA's Educational Affairs Division has produced the publication *Software for Aerospace Education*, PED-106, which identifies aerospace-related software currently available as well as addresses of software vendors and NASA Teacher Resource Centers. It can obtained by writing to the Educational Affairs Division, Code XEP, NASA, Washington, DC 20546.

4.5 Printed Materials

4.5.1 Books and Magazines. The number of astronomy books (textbooks, laboratory manuals, observing guides, childrens's books, etc.) that have been published in English over the past several years is too enormous (and transient) to be treated here in any detail. A listing of some of the available magazines are provided in §A.7. A comprehensive listing (up to 1985) is also given in the aforementioned *The Universe at Your Fingertips* by Robbins and Fraknoi [14], and thereafter in *Astronomy Educational Materials in Print 1985–1987* by Robbins [28]. Also, Fraknoi [29] provides, in the May/June 1989 issue of *Mercury* magazine, a listing of astronomy books which have appeared in 1988, and highlights the dozen best nontechnical books of the year. Readers in the U.K. can obtain some information on printed materials in the *Handbook for Astronomical Societies* [16] and also by writing the Astronomy Section, Old Royal Observatory, National Maritime Museum, London SE10 9NF.

Perhaps the best way to keep apprised of what books have been published is to regularly check the "Book Review" sections of the various weekly, monthly, and quarterly astronomy and science magazines such as *American Scientist*, *Astronomy*, *Astronomy Now*, *Mercury*, *New Scientist*, *The Observatory*, *Physics Today*, and *Sky & Telescope*.

For those who wish to maintain a steady diet of reading in astronomy, the ASTRONOMY BOOK CLUB provides members with substantial savings over the publisher's suggested prices for the books. There are books for both amateurs and professionals, beginners and seasoned observers. They may be contacted at: ASTRONOMY BOOK CLUB, Dept. L-CX3/00087, 3000 Cindel Dr. Delran, NJ 08075, USA.

4.5.2 Teachers' Guides. For those who teach school children, especially those in grades about 4 to 12, the following teachers' guides will be found invaluable:

- DeBruin, J., and Murad, D.: *Look to the Sky: An All-Purpose Interdisciplinary Guide to Astronomy*, Good Apple Books, 1988. Provides ideas and references for teaching astronomy in grades 4–12. Includes puzzles, constellation finders, star-gazing, and time-telling activities, and observing hints for beginners.
- Druger, M. (ed.): *Science for the Fun of It: A Guide to Informal Science Education*, National Science Teachers Association, 1988. A collection of articles on science education outside the classroom includes sections on television programs, science writing, museums, zoos, science fairs, community science, science toys and gifts, and so on. The section on informal astronomy education was written by A. Fraknoi.
- Fraknoi, A.: *Universe in the Classroom: A Resource Guide for Teaching Astronomy*, W.H. Freeman, 1985.

- Pasachoff, J.M., Percy, J.R. (eds.): *The Teaching of Astronomy*, Cambridge University Press, 1990. The report of IAU Colloquium 105, with the following sections: Curriculum, Astronomy and Culture, The Teaching Process, Student Projects, Computers, Textbooks, Teaching Aids and Resources, Conceptions/Misconceptions, High School Courses, Teacher Training, Popularization, Planetariums, and Developing Countries.
- Reynolds *et al.*: *Space Mathematics: A Resource for Teachers*, NASA, 1972.
- Schatz, D., Fraknoi, A., Robbins, R., and Smith, C.: *Effective Astronomy Teaching and Student Reasoning Ability*, Regents of University of California, 1978. From a workshop designed to improve the teaching of introductory astronomy at college and high school levels, especially in courses for non-science majors. Examined are reasoning patterns of students, teaching strategies, texts and other reading materials, films, and laboratory activities.

4.5.3 Booklets and Information Packets on Astronomy. The following booklets are available from the HANSEN PLANETARIUM (address given in §A.1) and are adapted from the texts of their star programs.

- *Footsteps: Man on the Moon* (32 pp.).
- *The People: Sky Lore of the American Indian* (24 pp.).
- *The Universe of Dr. Einstein* (32 pp.).
- *Springtime of the Universe* (24 pp.).
- *Skywatchers of Ancient Mexico* (24 pp.).

The ASP also puts out a series of information packets, some of which are reprinted from the society's *Mercury* magazine. They are designed to provide the beginner with clear, nontechnical information about certain subjects.

- *Astronomy As A Hobby* (28 pp.).
- *Selecting Your First Telescope* (16 pp.).
- *Learning About Quasars* (20 pp.).
- *Introduction to Black Holes* (24 pp.).
- *Astronomy Versus Astrology* (16 pp.).
- *Astronomy on Computers* (8 pp.)
- *Debunking Pseudoscience* (4 pp.)
- *Interdisciplinary Approaches to Astronomy*

4.5.4 Sources for Rare and Out-of-Print Books. The best sources of old and historical books on astronomy are the following:

- WARREN BLAKE, OLD SCIENCE BOOKS, 308 Hadley Dr., Trumbull, CT 06611, USA; Tel: 203-459-0820.
- THE GEMMARY, P.O. Box 816, Redondo Beach, CA 90277, USA; Tel: 213-372-5969. Mail order rare books and antique scientific instruments. Catalogue available.
- HISTORICAL TECHNOLOGY, INC., 6B Mugford Street, Marblehead, MA 01945, USA.
- IAN HOWARD-DUFF, Highfield, Fairview Road, Headley Down, Hants GU35 8HQ, England. Dealer in secondhand and out-of-print books on astronomy, space, and related subjects.
- JANUS PUBLICATIONS, P.O. Box 8705, Wichita, KS 67208, USA; Tel: 316-686-8320. Reproduction of Burritt's *Geography of the Heavens*.
- HERBERT A. LUFT, 46 Woodcrest Dr., Scotia, NY 12302, USA.
- R.A. MARRIOTT, 24 Thirlestane Road, Far Cotton, Northampton NN4 9HD, England, Tel: 0604-65190. This company publishes a listing of available books, monographs, technical papers, and journals in a quarterly catalogue. Authors include such historical

notables as Airy, Arago, John and William Hershel, Huygens, Wollaston, and Thomas Young.

- G.B. MANASEK INC., P.O. Box 961, Hanover, NH 03755, USA; Tel: 603-643-2227.
- WILLMAN-BELL, INC., P.O. Box 1325, Richmond, VA 23235, USA.

4.6 Games

There are several available astronomy items which fall under the category of "games." They include:

- *Earth from Moon Jigsaw* — Available from the LONDON PLANETARIUM.
- *Summer Milky Way Jigsaw Puzzle* — A 1000-piece jigsaw puzzle of the Summer Milky Way in Sagittarius and Scorpius is available from either DEEN PUBLICATIONS, P.O. Box 831991 Richardson, TX 75083, USA; Tel: (214) 231-0338, or from the ASP (Catalogue no. JP 101).
- *Vivid Rings of Saturn* — (PuzSN) A 600-piece jigsaw puzzle featuring Saturn's rings and Earth superposed to scale. Available from SCIENCE NEWS BOOKS, 1719 N St. NW, Washington, DC 20036, USA; Tel: 1-800-544-4565.
- *Good Heavens!* — A card game designed to teach simple facts about astronomy. Includes deck of 54 cards plus 24-page booklet. Available from AMPERSAND PRESS, 691 26th St., Oakland, CA 94612, USA.
- *Liftoff!* — A board came in which four players try to be the first to land a crew of astronauts on the Moon. Intended for ages 12 and up. Available from TASK FORCE GAMES, 14922 Calvert Street, Van Nuys, CA 91411, USA.
- *Sky Challenger* — Games and activities for star gazers. Six different game wheels and a star clock. Available from HUBBARD SCIENTIFIC COMPANY and also CAROLINA BIOLOGICAL SUPPLY COMPANY.
- *Solarquest* — Space-age real estate game, recommended for ages 8 and up. Available from SCIENCE NEWS BOOKS.
- *Space Picture Playing Cards* — Available from THE LONDON PLANETARIUM.
- *Stellar 28/Constellation Games* — Players learn constellations and stars by matching cards and game board. Includes 28 different games. May be played in group or solitaire. Available from HUBBARD SCIENTIFIC COMPANY.

4.7 Music

Not surprisingly, the subject of astronomy has been the inspiration for some of the most beautiful and original musical compositions in both the classical and pop repertoires, and they have been frequently used as background music for films on astronomy. A few of these compositions and their composers will be listed below. For a very extensive listing, the reader should refer to an excellent series of *Mercury* articles by Fraknoi [30] and Ronan [31].

- Braheny, Kevin: *Galaxies*. This piece was composed as the soundtrack to a planetarium show that was written and directed by Timothy Ferris and based on Ferris' book of the same name. It has been reviewed by Robert Burnham in the February 1989 issue of *Astronomy* magazine. It is available on both cassette and CD.
- Holst, Gustav: *The Planets*. There must be nearly two dozen available recordings of this masterful and beguiling composition dating from around 1918. If the reader has not

heard it, then he or she may want to check the record out from the nearest public or school library.

- Scriabin, Alexander: *Universe*. A less familiar composition by a Russian composer of the late 19th century. The recording is on ANGEL SR-40260.
- Serrie, John: *And the Stars Go with You*. Five tracks of synthesized space music, "a tribute to the triumphs and infrequent setbacks in the space program," and dedicated to Christa McAuliffe. Available from MIRAMAR PRODUCTIONS, P.O. Box 15661, Seattle, WA 98115.
- Serrie, John: *Flightpath*. More synthesized space music for deep sky viewing. Available from MIRAMAR PRODUCTIONS.
- Strauss, Johann: *Music of the Spheres*. The only recording of this work that the author is familiar with is the one by Karajan with the Vienna Philharmonic Orchestra, on Deutsche Grammaphone 419 616-2.
- Wright, Gordon: *Symphony in URSA MAJOR*. Composed by a University of Alaska professor. Excerpts of this work, performed by the Fairbanks Symphony Orchestra, are used to provide the sound track for the videotape *Aurora Borealis* (see Motion Picture Films and Videocassette Tapes).

There are numerous other compositions in the classical, pop, and folk realm that have astronomical undercurrents, and the interested reader is encouraged to pursue them.[13]

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[13] An interesting sidenote is that the father of astronomer Galileo Galilei was a noted Renaissance musician, Vincenzo Galilei (ca. 1520–1591). There is on record a performance of a short contropuncto by him; it is available on the Musical Heritage Society label, catalogue number 4152F (LP) or 6152H (cassette).

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2. *Astronomer*, pamphlet published by the Guidance Centre of the University of Toronto, Toronto 1985.
3. *Understanding the Universe: A Career in Astronomy*, brochure published by the American Astronomical Society, Washington 1986.
4. Ellis, S.D.: *1986–87 AIP Graduate Student Survey (AIP Publ. No. R-207.20)*, American Institute of Physics, New York 1988.
5. Ellis, S.D.: *Enrollments and Degrees (AIP Publ. No. R-151.25)*, American Institute of Physics, New York 1988.
6. *1990–91 Graduate Programs in Physics, Astronomy, and Related Fields*, American Institute of Physics, New York 1989.
7. *Directory of Graduate Programs: Volume C*, published by the Educational Testing Service, Princeton, NJ.
8. *Postgraduate Opportunities in Astronomy and Geophysics*, published by the RAS.
9. Ellis, S.D., Mulvey, P.J.: *AIP Employment Survey 1987 (AIP Publ. No. R-151.25)*, American Institute of Physics, New York 1988.
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11. Kruglak, H., and O'Bryan, M.: Astrology in the Astronomy Classroom. *Mercury*, Nov/Dec 1977, p. 18.
12. Kelly, I.: The Scientific Case Against Astrology. *Mercury*, Nov/Dec 1980, p. 135; and Cosmobiology and Moon Madness. *Mercury*, Jan/Feb 1981, p. 13.
13. Pasachoff, J.: Some Tests of Astrology. *Mercury*, Nov/Dec 1980, p. 137.
14. Robbins, R.R., and Fraknoi, A.: *The Universe at Your Fingertips: An Educator's Desktop Reference of Astronomy Education Materials in English*, IAU Commission 46 Report, August 1985.
15. *Directory of the International Planetarium Society*, Hansen Planetarium, Salt Lake City.
16. Jones, B. (ed.): *Handbook for Astronomical Societies*, Federation of Astronomical Societies, 1991.
17. *The Observer's Handbook*, Royal Astronomical Society of Canada, published annually.
18. Kirby-Smith, H.T.: *U.S. Observatories: A Directory and Travel Guide*, Van Nostrand Reinhold Co., New York 1976.
19. *1989 Directory of Observatories, Planetariums, and Museums*. In: *Astronomy*, May 1989, p. 50.
20. *Astronomy Resource Guide*. In: *Sky & Telescope*, September 1991.
21. *Speakers, Tours, and Films: A Program Resource for SPS Chapters*, American Institute of Physics, published annually.
22. *1989 Directory of Astronomy Clubs*. In: *Astronomy*, May 1989, p. 70.
23. *Equipment Directory 1989*. In: *Astronomy*, October 1989.
24. *Astronomy's* 1989 Guide to Telescopes. *Astronomy*, October 1989, p. 71.
25. Byrd, D.: Astronomy on the Air. *Mercury*, Jan/Feb 1980, p. 7.
26. Pierce, D.: Astronomy on Public TV. *Mercury*, Sep/Oct 1978, p. 118.
27. Mosley, J., and Fraknoi, A.: Computer Programs in Astronomy. *Mercury*, Jan/Feb 1985, p. 27; and Computer Software for Astronomy. *Mercury*, May/June 1991, p. 87.
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31. Ronan, C.: Some Other Astronomical Pieces of Music. *Mercury*, Nov/Dec 1979, p. 131.
32. Dworetsky, M.M.: An Astronomy Degree Course in the U.K.: Syllabus and Practical Work. In: Pasachoff, J.M., and Percy, J.R. (eds.): *The Teaching of Astronomy*, IAU Colloquium 105, Cambridge University Press, Cambridge 1990.

Appendix: Supplementary Educational Resource Lists

A.1 Planetariums, Museums, and Exhibits

A.1.1 Planetariums in the United Kingdom

ENGLAND

- *AAC Planetarium*, Amateur Astronomy Centre, Bacup Road, Clough Bank, Todmorden, Lancs. OL14 7HW. Tel: 0706-816964.
- *British Museum*, Great Russell Street, London WC1B 3DG; Tel: 01-323 8395 x395. Astronomical clocks.
- *British Museum (Natural History)*, Cromwell Road, South Kensington, London SW7 5BD; Tel: 01-938 9123. Extensive meteorite collection.
- *Caird Planetarium*, Old Royal Observatory, Greenwich, London SE 10.
- *William Day Planetarium*, Plymouth Polytechnic, School of Maritime Studies, Plymouth PL4 8AA. Tel: 0752-264666.
- *Electrosonic Ltd.*, 815 Woolwich Road, London SE7 8LT.
- *Greenwich Planetarium*, South Building, Greenwich Park, Greenwich, London SE 10. Tel: 01-8581167.
- *William Herschel House and Museum*, 19 New King Street, Bath, BA1 2B1. Contact: Dr. A.V. Sims, 30 Meadow Park, Bathford, Bath; Tel: 0225-859-529. Open Mar-Oct daily 2-5 pm, Nov-Feb Sundays only, 2-5 pm.
- *Jodrell Bank Planetarium and Visitor Center*, Lower Withington, Nr. Macclesfield, Cheshire SK11 9DL; Tel: 0477-71339.
- *Kings Observatory, Kew*, Old Deer Park, Richmond, Surrey TW9 2AZ.
- *University of Leicester, The Planetarium*, Department of Astronomy, University Road, Leicester LE1 7RH. Tel: 0533-522522.
- *Liverpool Museum Planetarium*, William Brown Street, Liverpool, Merseyside L3 8EN. Tel: 051-207-0001 X225.
- *London Planetarium*, Marylebone Road, London NW1 5LR; Tel: 01-486 1121 (9:30–5:30), 01-486 1121 (recording).
- *City of London Polytechnic*, The Planetarium, 100 Minories, Tower Hill, London EC3N 1JY. 01-2831030.
- *London Schools Planetarium*, John Archer School Building, Wandsworth Rd., Sutherland Grove, London SW18, Tel: 01-7884253.
- *Newcastle Planetarium*, Newcastle.
- *The Planetarium at Rickmansworth Masonic School*, Chorleywood Rd., Rickmansworth, Herts. WD3 4HF. Tel: 0923-773168.
- *Royal Greenwich Observatory*, Herstmonceux Castle, Hailsham, E. Sussex BN27 1RP; Tel: 0323-833171. RGO has now officially moved to Cambridge.
- *Science Museum*, Exhibition Road, South Kensington, London SW7 2DD; Tel: 01-589-3456.
- *David W. Shepherd*, 5 Nab Wood Drive, Shipley, W. Yorkshire BD18 4HP.
- *Southend Planetarium*, Central Museum, Victoria Avenue, Southend-On-Sea; Tel: 0702-330214.
- *South Tyneside College Planetarium*, St. Georges Avenue, S. Shields, Tyne & Wear NE34 6ET; Tel: 091-4560403x477.
- *Stonehenge*, near Amesbury, Wiltshire. Remains of an ancient temple or astronomical observatory, built in 3 stages between 2350 BC and 1350 BC. Restricted visiting. Contact: Area Custodian, Historical Buildings and Monuments Commission for England, Bridge House, Sion Place, Clifton, Bristol BX8 4XA; Tel: 0272 734472.

- *"Trillium"*, 206 White Lion Road, Little Chalfont, Bucks HP7 9NU.
- *Whipple Museum of the History of Science*, Free School Lane, Cambridge; Tel: 0223 334540. Old scientific instruments such as orreries, sundials, astrolabes, etc.
- *Yorkshire Museum*, Museum Gardens, York YO1 2DR; Tel: 0904-29745. Observatory on grounds.

IRELAND

- *Birr Castle*, Birr, Co Offaly; Tel: 353 50920056. 72-inch telescope of Third Earl of Rosse and other exhibits.

NORTHERN IRELAND

- *Armagh Planetarium*, College Hill, Armagh BT61 9DB. The Exhibition Hall is open to the public 2 pm-4:45 pm Mon-Sat. Public star shows run on Saturday afternoons, shows for schools held during the week. Public shows also held on most school and public holidays except Good Friday, July 12, and December 25 and 26. Tel: 0861-523689 (reservations), 0861-524725 (administration); FAX: 0861-526187.

SCOTLAND

- *Aberdeen Technical College*, The Planetarium Gallowgate, Aberdeen AB9 1DN; Tel: 0224-640366.
- *Glasgow College of Nautical Studies, The Planetarium*, 21 Thistle Street, Glasgow; Tel: 041-4293201.
- *Jewel & Esk Valley College, The Planetarium* 24 Milton Road East, Edinburgh EH15 2PP; Tel: 031-6698461.
- *Leith Hill Nautical College*, 24 Milton Road East, Edinburgh EH15 2PP; Tel: 031-669-8461.
- *Mills Observatory and Planetarium*, Balgay Park, Glamis Road, Dundee DD2 2UB; Tel: 0382-67138.
- *Royal Museum of Scotland*, Chambers Street, Edinburgh, EH1 1JF; Tel: 031-225 7534.

A.1.2 Planetariums and Museums in Canada

ALBERTA

- *Calgary Centennial Planetarium*, Alberta Science Center, 701-11 Street S.W., P.O. Box 2100, Stn. M, Calgary, Alberta T2P 2M5; Tel: 403-264-4060 or 221-3700.
- *Edmonton Space Sciences Centre*, Coronation Park, 11211-142 Street, Edmonton, Alberta T5M 4A1; Tel: 403-451-7722 or 452-9100. Features planetarium Star Theatre, IMAX film theatre, exhibit galleries, Science Magic telescope shop and bookstore. Open daily.

BRITISH COLUMBIA

- *H.R. MacMillan Planetarium*, 1100 Chestnut Street, Vancouver, BC V6J 3J9; Tel: 604-736-3656. Open daily.

MANITOBA

- *The Lockhart Planetarium*, 394 University College, 500 Dysart Road, The University of Manitoba, Winnipeg, Manitoba R3T 2M8; Tel: 204-474-9785. By reservation only.
- *Manitoba Planetarium*, Museum of Man and Nature, 190 Rupert Avenue at Main Street, Winnipeg, Manitoba R3B 0N2. Tel: 204-943-3142 (program information recording) or 204-956-2830 (switchboard). Shows daily except some Mondays. Museum Gift Shop has scientific books and equipment.

NOVA SCOTIA

- *Burke-Gaffney Planetarium*, Saint Mary's University, Department of Astronomy, Halifax, Nova Scotia B3H 3C3.
- *The Halifax Planetarium*, The Education Section of Nova Scotia Museum, Summer Street, Halifax, Nova Scotia B3H 3A6; Tel: 902-429-4610. Located in the Sir James Dunn Building, Dalhousie University. Free public shows given on some evenings at 8:00 p.m. and group shows can be arranged.

ONTARIO

- *Doran Planetarium*, Laurentian University, Ramsey Lake Road, Sudbury, Ontario P3E 2C6; Tel: 705-675-1151 x2222.

- *McLaughlin Planetarium*, 100 Queen's Park, Toronto, Ontario M5S 2C6; Tel: 416-586-5736 (for show times) or 416-586-5751 (for sky information). Public shows Tues–Fri at 3:00 and 7:30. Additional shows on weekends and during summer. School shows, Astrocentre with solar telescope, and evening courses are available.
- *National Museum of Science and Technology*, 1867 St. Laurent Boulevard, Ottowa, Ontario K1G 5A3; Tel: 613-998-4566. Open daily.
- *Ontario Science Center*, 770 Don Mills Road, Don Mills, Ontario M3C 1T3; Tel: 416-429-4100. Open daily (except Christmas day) from 10:00 a.m. to 6:00 p.m.

QUEBEC

- *Dow Planetarium*, 1000 St. Jacques Street West, Montreal, P.Q. H3C 1G7; Tel: 514-872-4530. Live shows in French and English. Open daily.

A.1.3 Planetariums and Museums in the United States

ALABAMA

- *W.A. Gayle Planetarium*, 1010 Forest Ave., Montgomery, AL 36106; Tel: 205-832-2625.

ALASKA

- *Marie Drake Planetarium*, 1250 Glacier Ave., Juneau, AK 99801; Tel: 907-586-3780.

ARIZONA

- *Barringer Meteor Crater*, Meteor Crater Enterprises, Inc., 121 East Birch, Flagstaff, AZ 86001. Tel: 602-774-8350. Site of a 24,000 year old crater resulted from a gigantic impact. With museum, gift shop, and refreshment stand. Open 8 am to sundown.
- *Flandreau Planetarium*, University of Arizona, Corner of Cherry and University Boulevard, Tucson, AZ 85721. Tel: 602-621-4515. Open Tue-Sun.

CALIFORNIA

- *Chabot Planetarium (and Observatory)*, 4917 Mountain Blvd., Oakland, CA 94619. Very active center for resources and workshops.
- *Reuben H. Fleet Space Theater & Science Center*, P.O. Box 33303, San Diego, CA 92103; Tel: 619-238-1233.
- *Griffith Observatory Planetarium*, 2800 East Observatory Road., Los Angeles, CA 90027. Open fall-winter-spring: Tue-Fri 2-10 pm; Sat 10:30 am to 10 pm; Sun 1-10. During summer: Mon-Fri 2-10 with same Sat-Sun schedule as above. Planetarium shows daily. Considered one of the best centers for popular and amateur astronomy in the U.S.
- *Morrison Planetarium*, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118. Tel: 415-750-7141. Open daily.

COLORADO

- *Denver Museum of Natural History and Charles C. Gates Planetarium*, 2001 Colorado Boulevard, Denver CO 80205. Tel: 303-370-6351. Includes many natural science exhibits, a Foucault Pendulum, a Space Shop, and a book shop. Open Tue-Sun.
- *Fisk Planetarium and Science Center*, University of Colorado, Boulder, CO 80309-0408; Tel: 303-492-5001. Open Mon-Fri.

DISTRICT OF COLUMBIA

- *Albert Einstein Planetarium*, National Air and Space Museum, 6th St. and Independence Ave., Washington, DC 20560; Tel: 202-357-7000. Open daily.

CONNECTICUT

- *Science Museum of Connecticut, Inc., and Gengras Planetarium*, 950 Trout Brook Dr., West Hartford, CT 06903; Tel: 203-236-2961.

FLORIDA

- *Bishop Planetarium*, 201 10th St. W., Brandenton, FL 33505; Tel: 813-746-4132.
- *Miami Museum of Science & Space Transit Planetarium*, 3280 South Miami Avenue, Miami, FL 33129; Tel: 305-854-4242. Open daily.
- *Museum of Science and History and Alexander Brest Planetarium*, 1025 Gulf Life Dr., Jacksonville, FL 32207; Tel: 904-396-7062.
- *NASA Kennedy Space Center*, FL 32899; Tel: 305-452-2121. Open daily.

- *South Florida Science Museum and Aldrin Planetarium*, 4801 Dreher Trail N., West Palm Beach, FL 33405. Tel: 407-832-1988.
- *John Young Museum and Planetarium*, 810 East Rollins St., Orlando, FL 32803; Tel: 407-896-7151.

GEORGIA

- *Fernbank Science Center*, 156 Heaton Park Drive, NE, Atlanta, GA 30307; Tel: 404-378-4311. Open daily.

HAWAII

- *Bernice P. Bishop Museum*, P.O. Box 19000-A, Honolulu, HI; Tel: 808-847-3511.

ILLINOIS

- *Adler Planetarium*, 900 E. Achsah Bond Dr., Chicago, IL 60605; Tel: 312-322-0304. Open daily.
- *Museum of Science and Industry and Crown Space Center*, 57th Street and Lake Shore Drive, Chicago, IL 60637. Tel: 312-684-1414. Open daily.

INDIANA

- *SpaceQuest Planetarium*, Children's Museum, 3000 N. Meridian St., Indianapolis, IN 46208; Tel: 317-924-5431.

IOWA

- *Science Center of Iowa*, 4500 Grand Ave., Des Moines, IA 50312; Tel: 515-274-4138.

LOUISIANA

- *Louisiana Arts & Science Center*, P.O. Box 3373, Baton Rouge, LA 70821; Tel: 504-344-9465.

MARYLAND

- *Davis Planetarium*, Maryland Academy of Sciences, 601 Light St., Baltimore, MD 21230; Tel: 301-685-5225. Open daily.
- *Howard B. Owens Science Center*, 9601 Greenbelt Rd., Seabrook, MD 20706; Tel: 301-577-8718.

MASSACHUSETTS

- *Charles Hayden Planetarium*, Museum of Science, Science Park, Boston, MA 02114; Tel: 617-723-2500. Open daily.
- *Seymour Planetarium Observatory*, Springfield Science Museum, 236 State St., Springfield, MA 01103; Tel: 413-733-1194. Open Tue-Sun.

MICHIGAN

- *Abrams Planetarium*, Michigan State University, East Lansing, MI 48824; Tel: 517-355-4676. Open daily.
- *Detroit Science Center*, 5020 John R. Street, Detroit, MI 48202; Tel: 313-577-8430. Open Tue-Sun.
- *Robert T. Longway Planetarium*, Flint Board of Education, 923 E. Kearsley St., Flint, MI 48503; Tel: 313-762-1181. Open daily.

MINNESOTA

- *Minneapolis Planetarium*, 300 Nicolet Mall, Minneapolis, MN 55401; Tel: 612-372-6644.
- *The Science Museum of Minnesota*, 30 E. 10th St., St. Paul, MN 55101; Tel: 612-221-9403.

MISSISSIPPI

- *Russell C. Davis Planetarium & Ronald E. McNair Space Theater*, 201 E. Pascagoula St., Jackson, MS 39201. Tel: 601-960-1550.

MISSOURI

- *McDonnell Planetarium*, City of St. Louis, 5100 Clayton Rd., St. Louis, MO 63110; Tel: 314-535-5810.

NEW JERSEY

- *Newark Museum Planetarium*, 43-53 Washington St., Newark, NJ 07101; Tel: 212-596-6609. Open Tue-Sun.
- *New Jersey State Museum*, 205 W. State St., CN 530, Trenton, NJ 08625; Tel: 609-292-6333.

NEW MEXICO

- *Space Center*, Top of N.M. Hwy. 2001, Alamogordo, NM 88311; Tel: 800-545-4021.

NEW YORK

- *Hayden Planetarium and American Museum*, 81st St. at Central Park West, New York, NY 10024; Tel: 212-769-5912. Open daily.
- *Link Planetarium-Kopernik Observatory*, 30 Front St., Binghamton, NY 13905; Tel: 607-772-0660. Open Tue-Sun.
- *Rochester Museum & Science Center*, 657 E. Ave., Rochester, NY 14603; Tel: 716-271-4320.
- *Vanderbilt Planetarium*, 180 Little Neck Rd., Centerport, Long Island, NY 11721; Tel: 516-262-7800. Open Tue-Sun.

NORTH CAROLINA

- *Morehead Planetarium (and Observatory)*, University of North Carolina-Chapel Hill, Morehead Building, CB 3480, NC 27599-3480; Tel: 919-962-1236. Open daily.

OHIO

- *Cincinnati Museum of Natural History and Planetarium*, 1720 Gilbert Ave., Cincinnati, OH 45202; Tel: 513-621-3889. Open Tue-Sun.
- *Mueller Planetarium (and Observatory)*, Cleveland Museum of Natural History, Wade Oval, University Circle, Cleveland, OH 44106; Tel: 216-231-4600.
- *Ritter Planetarium (and Astrophysical Research Center)*, The University of Toledo, 2801 Bancroft, Toledo, OH 43606; Tel: 419-537-2650.

OKLAHOMA

- *Omniplex Science Museum and Kirkpatrick Planetarium*, 2100 NE. 52nd St., Oklahoma City, OK 73111; Tel: 405-424-5545.

OREGON

- *Oregon Museum of Science & Industry*, 4015 SW. Canyon Rd., Portland, OR 97221; Tel: 503-222-2828.

PENNSYLVANIA

- *Buhl Planetarium and Institute of Popular Science*, Allegheny Square (north side), Pittsburgh, PA 15212; Tel: 412-321-4302. Open daily.
- *Fels Planetarium*, The Franklin Institute, 20th and the Parkway, Philadelphia, PA 19103; Tel: 215-448-1293. Open daily.

TENNESSEE

- *Cumberland Science Museum*, 800 Ridley Blvd, Nashville, TN 37203; Tel: 615-259-6099.
- *Memphis Pink Palace Museum*, 3050 Central Ave., Memphis, TN 38111; Tel: 901-454-5609.

TEXAS

- *Houston Museum of Natural Science*, #1 Hermann Circle Dr., Houston, TX 77030; Tel: 713-526-4273.
- *Lyndon B. Johnson Space Center*, Olin Teague Visitor Center, 2101 NASA Road 1, Public Services Branch, AP4, Houston, TX 77058; Tel: 713-483-4241. Open daily

UTAH

- *Hansen Planetarium*, 15 South State Street, Salt Lake City, UT 84111; Tel: 801-538-2104. Open daily.

VIRGINIA

- *Science Museum of Virginia*, 2500 W. Broad St., Richmond, VA 23220; Tel: 804-257-0211.
- *Science Museum of Western Virginia*, One Market Sq., Roanoke, VA 24011; Tel: 703-342-5710.

WASHINGTON

- *Eastern Washington Science Center*, Riverfront Park, Spokane, WA 99202; Tel: 509-359-6391. Open daily.
- *Pacific Science Center*, 200 2nd St. N., Seattle, WA 98109; Tel: 206-433-2001. Open daily.

WISCONSIN

- *Milwaukee Public Museum*, 800 W. Wells St., Milwaukee, WI 53233; Tel: 414-278-2702. Open daily.

A.2 Observatories and Research Laboratories

A.2.1 Observatories in the United Kingdom

ENGLAND

- *University of Cambridge*, Institute of Astronomy, The Observatories, Madingley Road, Cambridge CB3 0HA; Tel: 0223 337548.
- *Greenwich Old Royal Observatory*, Greenwich Park, London SE10 9NF; Tel: 01-858-1167. Open daily.
- *Hatfield Polytechnic Observatory*, Bayfordbury, Lower Hatfield Rd., Hertford, SG13 8LD; Tel: 0992-558451 x334.
- *Jodrell Bank Radio Telescope*, Lower Withington, Nr. Macclesfield, Cheshire SK11 9DL; Tel: 0477-71339.
- *Lancashire Polytechnic Observatories*, Jeremiah Horrocks Observatory, Moor Park, Preston, Lancs. PR1 6AD.
- *Norman Lockyer Observatory*, Salcombe Hill, Sidmouth, Devon. Contact: Secretary, Sidmouth AS, Ross Meadows, 1 Green Mount, Sidmouth EX10 9DB; Tel: 03955 2928.
- *University of London Observatory*, Mill Hill Park, London NW7 2QS. Observatory Annexe, 33/35 Daws Lane, London NW7 4SD; Tel: 01-959 0421. Open Oct-Mar 1st & 3rd Fridays at 2:30 pm for schools, 6:30 pm and 7:30 pm for general public.
- *Mullard Radio Astronomy Observatory*, University of Cambridge, Physics Department. Contact: Dr. Kenderdine, Cavendish Laboratory, Madingley Road, Cambridge CB3 0HE.
- *Orwell Observatory*, Orwell Astronomical society, 41 Melbourne Road, Ipswich IP4 5PP; Tel: 0473 271818. One of the largest amateur observatories in the country.
- *Royal Greenwich Observatory*, Herstmonceux Castle, Hailsham, E. Sussex BN27 1RP; Tel: 0323-833171.
- *Planetary Science and Remote Sensing Group*, Dept. of Environmental Science, University of Lancaster, Lancaster LA1 4YQ; Tel: 0524-65201 x4671.
- *Somerset Schools Observatory*, Education Department, County Hall, Taunton, Somerset; Tel: 0823-73451 x5759.

IRELAND

- *Dunsink Observatory*, Castelknock, Dublin 15: Tel: 387911/387959.

NORTHERN IRELAND

- *Armagh Observatory*, College Hill, Armagh BT61 9DB; Tel: 0861 522928.

SCOTLAND

- *University of Glasgow Observatory, The Planetarium*, Acre Hill/Maryhill Road, Glasgow G20 0TL; Tel: 041-946-5213.
- *Mills Observatory and Planetarium*, Balgay Park, Glamis Road, Dundee DD2 2UB; Tel: 0382-67138. Open Mon-Sat.
- *Royal Observatory*, Blackford Hill, Edinburgh EH9 3HJ.
- *University of St. Andrews Observatory*, Department of Physics and Astronomy, University Observatory, Buchanan Gardens, St. Andrews, Fife; Tel: 0334-76161.

A.2.2 Observatories In Canada

ALBERTA

- *Devon Observatory*, Department of Physics, University of Alberta, Edmonton, Alberta T6G 2J1.
- *Rothney Astrophysical Observatory*, Physics & Astronomy Dept., University of Calgary, Calgary, Alberta T2N 1N4; Tel: 403-220-5385.

BRITISH COLUMBIA

- *University of British Columbia Observatory*, 2219 Main Mall, Vancouver, BC V6T 1W5. Free public observing on clear Saturday evenings; Tel: 604-228-6186 (observing) or 604-228-2802 (tours).

- *Climenhaga Observatory*, Department of Physics and Astronomy, University of Victoria, Victoria, BC V8W 2Y2. Tel: 604-388-0001. Open daily.
- *Dominion Astrophysical Observatory*, 5071 West Saanich Road, Victoria, BC V8X 4M6. Open: *May-Aug*: Daily 9:15 am-4:30 pm, *Sep-Apr*: Mon-Fri 9:15 am-4:30 pm Public Observing: Saturday evenings, Apr-Oct; Tel: 604-388-0012.
- *Dominion Radio Astrophysical Observatory*, Penticton, BC V2A 6K3. Conducted tours: Sundays, Jul-Aug only, 2-5 pm. Visitors' Centre: Open year round during daytime; Tel: 604-497-5321.
- *Gordon MacMillan Southam Observatory*, 1100 Chestnut St., Vancouver, BC V6J 3J9. Open Fri-Sun, and statutory holidays 12 pm-5 pm, 7 pm-11 pm, weather and volunteer staff permitting. Extended hours during school holidays; Tel: 604-738-2855.

NOVA SCOTIA

- *Burke-Gaffney Observatory*, Saint Mary's University, Halifax, Nova Scotia B3H 3C3. Open hours: *Oct-Mar*: Saturday evenings 7 pm, *Apr-Sep*: Saturday evenings 9 pm. Monday evening or daytime tours by arrangement. Tel: 902-420-5633.

ONTARIO

- *Hume Cronyn Observatory*, University of Western Ontario, London, Ontario N6A 3K7; Tel: 519-661-3183.
- *David Dunlap Observatory*, Richmond Hill, Ontario L4C 4Y6. Open Tuesday mornings 10 am throughout the year, Saturday evenings Apr-Oct by reservation; Tel: 416-884-2112.
- *National Museum of Science and Technology*, 1867 St. Laurent Blvd., Ottowa, Ontario K1A 0M8. Open: *Oct-Jun*: Group tours Mon-Thu, Public visits Fri (in French 2nd Fri); *Jul-Aug*: Public visits: Tue (French), Wed, Thu (English). Evening tours by appointment only. Tel: 613-991-3073.
- *Science North Solar Observatory*, 100 Ramsey Lake Road, Sudbury, Ontario P3A 2K3. Viewing of the solar spectrum and the Sun in hydrogen-alpha and white light in a darkened theatre. Open most days. Tel: 705-522-3701.

QUEBEC

- *Observatoire astronomique du mont Mégantic*, Notre-Dame-des-Bois, P.Q. J0B 2E0; Tel: 514-343-6718 (information on summer programs).

SASKATCHEWAN

- *University of Saskatchewan Observatory*, Saskatoon, Saskatchewan S7N 0W0; Tel: 306-966-6434.

A.2.3 Observatories In the United States

ARIZONA

- *Kitt Peak National Observatory*, 950 North Cherry Avenue, Tucson AZ 85719; Tel: 602-620-5350. Open daily.
- *Lowell Observatory*, 1400 West Mars Hill Road, Flagstaff, AZ 86001; Tel: 602-774-2096. Open Mon-Sat.
- *Lunar and Planetary Laboratory*, University of Arizona, Tucson AZ 85721; Tel: 602-621-4861.
- *Steward Observatory*, University of Arizona, Tucson, AZ 85721; Tel: 602-621-2288.
- *U.S. Naval Observatory*, Flagstaff Station, P.O. Box 1149, Flagstaff, AZ 86002; Tel: 602-779-5132.
- *Fred Lawrence Whipple Observatory*, P.O. Box 97, Amado, AZ 85645; Tel: 602-629-6741.

CALIFORNIA

- *Jet Propulsion Lab*, California Institute of Technology, 4800 Oak Grove, Pasadena, CA 91103. Public visits last Sun of each month, 1-4 pm.
- *Lick Observatory*, P.O. Box 85, Mount Hamilton, CA 95140; Tel: 408-274-5062. Open daily.
- *Mount Laguna Observatory*, San Diego State University, San Diego, CA 92115; Tel: 619-265-6182.

- *Palomar Observatory*, Palomar Mountain, CA 92060. Has the famous Hale 200-inch reflecting telescope.
- *Stony Ridge Observatory*, P.O. Box 874 Big Bear, CA 92314; Tel: 714-585-5486. Located on North Shore Drive, Big Bear Lake. Public visiting hours every Friday afternoon.

CONNECTICUT

- *Van Vleck Observatory*, Wesleyan University, Middletown, CT 06457; Tel: 203-347-9411.

COLORADO

- *High Altitude Observatory*, National Center for Atmospheric Research, Boulder, CO 80302.
- *Joint Institute for Laboratory Astrophysics*, University of Colorada, CB 390, Boulder, CO 80309; Tel: 303-492-6952.

DELAWARE

- *Bartol Research Institute and Physics Department*, University of Delaware, Newark, DE 19716; Tel: 302-451-8116.

DISTRICT OF COLUMBIA

- *Derwood Observatory*, Radio Astronomy Group, Carnegie Institute of Washington, 5241 Broad Branch Rd., N.W. Washington, D.C. 20015.
- *U.S. Naval Observatory*, 34th and Massachusetts Avenue NW, Washington, DC 20392. Telephone 202-653-1541. Open Monday evenings only.

GEORGIA

- *Fernbank Science Center Observatory*, Dekalb County Board of Education, 156 Heaton Park Dr., Atlanta, GA 30307. Large (36-inch) research telescope plus several telescopes for visual observing; Tel: 404-378-4311.

HAWAII

- *Canada-France-Hawaii Telescope*, Mauna Kea, Hawaii 96743, USA. Arrangements to visit should be made in advance by writing to Canada-France-Hawaii Telescope Corporation, P.O. Box 1597, Kamuela, HI 96743, USA; Tel: 808-885-7944.
- *Haleakala Observatories*, University of Hawaii, P.O. Box 135, Kula, Maui, HI 96790.
- *Kauai Observatory*, operated by Radio Astronomy Branch, Goddard Space Flight Center, Greenbelt, MD 20771. Located at Kauai, Hawaii.
- *Mauna Kea Observatory*, Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI 96822. Observatory office: 180 Kinoole St., Hilo, HI 96720; Tel: 808-935-3371.

ILLINOIS

- *Dearborn Observatory*, Northwestern University, Evanston, IL 60201; Tel: 312-491-5633. Open Friday evenings Apr-Oct by reservation only.
- *Laboratory for Astrophysics and Space Research*, University of Chicago, Chicago, IL 60637; Tel: 312-702-7823.
- *Lindheimer Astronomical Research Center*, Northwestern University, Evanston, IL 60201; Tel: 312-491-5633. Open Sat 2-4 pm.

INDIANA

- *Goethe Link Observatory*, Indiana University, Brooklyn, IN 46111; Tel: 812-335-6911.

IOWA

- *Erwin F. Fick Observatory*, Iowa State University, Ames, IA 50010; Tel: 515-294-5440.
- *Hills Observatory*, University of Iowa, Iowa City, IA 52240; Tel: 319-335-1686.
- *Space Physics Laboratory*, University of Iowa, Iowa City, IA 52242; Tel: 319-335-1918.

KANSAS

- *University of Kansas Observatory*, Lawrence, Kansas 66045. Open each clear Friday night.

LOUISIANA

- *Louisiana State University Observatory*, Baton Rouge, LA 70803; Tel: 504-388-2261.

MARYLAND

- *NASA/Goddard Space Flight Center*, Visitor Center, Greenbelt, MD 20771; Tel: 301-286-8103.

MASSACHUSETTS

- *Five College Radio Astronomy Observatory*, Five College Astronomy Dept., Room 127, Hasbrouck Lab, University of Massachusetts, Amherst, MA. (Also: Amherst, Hampshire, Mt. Holyoke, and Smith Colleges.)

- *Harvard College Observatory and Smithsonian Astrophysical Observatory*, Cambridge, MA 02138. Tel: 617-495-7461. Open third Thursday evening and by reservation.
- *Hopkins Observatory*, Williams College, Williamstown, MA 01267; Tel: 413-597-2105.
- *Maria Mitchell Observatory*, Maria Mitchell Association, P.O. Box 712, Nantucket, MA 02554; Tel: 508-228-9273.

MICHIGAN

- *Space Physics Research Laboratory*, University of Michigan, 2455 Hayward, Ann Arbor, MI 48109; Tel: 313-763-6200.

NEBRASKA

- *Behlen Observatory*, Dept. of Physics & Astronomy, University of Nebraska, Lincoln, NE 68588; Tel: 402-472-2770.

NEW JERSEY

- *Princeton University Observatory*, Princeton, NJ 08540; Tel: 609-452-3801.

NEW MEXICO

- *NASA-Langley Research Center Meteor Observatory*, Hampton, VA 23365. Located 12 miles east of Las Cruces, New Mexico.
- *Clyde W. Tombaugh Observatory*, New Mexico State University, Dept. of Astronomy, P.O. Box 4500, Las Cruces, NM 88003; Tel: 505-646-4438.
- *Tortugas Mountain Observatory*, New Mexico State University, Dept. of Astronomy, P.O. Box 4500, Las Cruces, NM 88003.
- *Very Large Array*, National Radio Astronomy Observatory, P.O. Box O, Socorro, NM 87801-0387. Open daily.

NEW YORK

- *Hartung Boothroyd Observatory*, Space Science Center, Cornell University, Ithaca, NY 14853. 607-255-4206.
- *Dudley Observatory*, 69 Union Ave., Schenectady, NY 12308; Tel: 518-382-7583.
- *C.E. Kenneth Mees Observatory*, University of Rochester, Rochester, NY 14627; Tel: 716-275-4385 for Sat appointment May through Oct only.
- *Vassar College Observatory*, Poughkeepsie, NY 12601; Tel: 914-452-7000 x2060. Visits by appointment.

NORTH CAROLINA

- *Morehead Observatory*, University of North Carolina, Chapel Hill, NC 27514; Tel: 919-962-2079.

OHIO

- *Perkins Observatory*, Ohio Wesleyan and Ohio State University, Deleware, OH 43015; Tel: 614-363-1257.
- *Ritter Astrophysical Research Center*, The University of Toledo, 2801 Bancroft, Toledo, OH 43606; Tel: 419-537-2650.
- *Warner and Swasey Observatory*, Case Western Reserve University, 1975 Taylor Road, East Cleveland, OH 44112. Tel: 216-451-5624.

OREGON

- *Pine Mountain Observatory*, Dept. of Physics, University of Oregon, Eugene, OR 97403; Tel: 503-382-8331. Open Fri-Sun evenings.

PENNSYLVANIA

- *Allegheny Observatory*, 159 Riverview Avenue, Pittsburgh, PA 15214; Tel: 412-321-2400.
- *Astrophysics Computer Laboratory*, Department of Physics & Atmospheric Science, Drexel University, Philadelphia, PA 19104; Tel: 215-895-2707.
- *Sproul Observatory*, Swarthmore College, Swarthmore, PA 19081. Tel: 215-328-8272.
- *Villanova University Observatory*, Villanova, PA 19085; Tel: 215-645-4820.

PUERTO RICO

- *Arecibo Observatory*, National Radio and Ionospheric Center, P.O. Box 995, Arecibo, Puerto Rico 00612. Operated by Cornell University.

TENNESSEE

- *Arthur J. Dyer Observatory*, Vanderbilt University, 1000 Oman Drive, Brentwood, TN 37027; Tel: 615-373-4897. Open Mon-Fri.

TEXAS

- *McDonald Observatory/W.L. Moody Visitor's Center*, P.O. Box 1331, Fort Davis, TX 79734; Tel: 915-426-3263. Open daily.

VIRGINIA

- *Leander McCormick Observatory*, University of Virginia, P.O. Box 3818, Charlottesville, VA 22903; Tel: 804-924-7494. Open 1st and 3rd Fridays of each month.
- *NASA Langley Research Center*, Mail Stop 480, Hampton, VA 23365. Tel: 804-865-2855. Open daily.

WASHINGTON

- *Battelle Observatory*, Battelle-Northwest Labs, P.O. Box 999, Battelle Blvd., Richland, WA 99352. Located 20 miles west of Richland; Tel: 509-946-2383 or 942-7301 about tours.
- *Goldendale Observatory*, 1602 Observatory Dr., Goldendale, WA 98620; Tel: 509-773-3141.

WEST VIRGINIA

- *National Radio Astronomy Observatory*, P.O. Box 2, Green Bank, WV 24944-0002; Tel: 304-456-2011. Open daily, mid-June to mid-August.

WISCONSIN

- *Washburn Observatory*, University of Wisconsin, 1401 Observatory Drive, Madison, WI 53704; Tel: 608-262-WASH. Open Wednesday evenings.
- *Yerkes Observatory*, P.O. Box 258, Williams Bay, WI 53191-0258; Tel: 414-245-5555.

WYOMING

- *Wyoming Infrared Observatory*, Department of Physics and Astronomy, University of Wyoming, Laramie, WY 82071; Tel: 307-766-6150.

A.3 Astronomical Societies and Clubs

INTERNATIONAL

- *International Amateur-Professional Photoelectric Photometry Association* (IAPPPA) — An organization which coordinates photometric observations by serious amateurs and small colleges, with the goal of producing scientifically useful data. They publish a *Communication* which is of especial interest to smaller observatories interested in carrying out research. Contact: Dr. Douglas S. Hall, Dyer Observatory, Vanderbilt University, Nashville, TN 37235, USA; Tel: 615-373-4897.
- *International Astronomical Union* (IAU) — The primary international federation of professional astronomers. Commission 46 of the IAU deals with educational matters and supports a variety of worldwide educational activities. It also publishes a regular newsletter on international astronomy education which is sent regularly to its members. The editor of the newsletter is Professor John Percy, Dept. of Astronomy, University of Toronto, Canada.
- *International Dark-Sky Association* — Non-profit organization devoted to fighting light pollution. Contact: David Crawford, 3545 N. Stewart, Tucson, AZ 85716.
- *International Occultation Timing Assn.* (IOTA) — Contact: Terri and Craig McManus, 1177 Collins, Topeka, KS; Tel: 913-232-3693.
- *International Planetarium Society* (IPS) — Holds local and national conferences, publishes a comprehensive listing of planetariums, and runs a job information service. Also publishes *The Planetarian*. Contact: Hansen Planetarium, 15 S. State St., Salt Lake City, UT 84111, USA.
- *International Union of Amateur Astronomers* (IUAA) — Formed in 1969 to coordinate the activities of amateur astronomers worldwide. Membership is open to individuals and corporations. Contact: The Secretary, Mr.V. Deasy, Ard Faill, 633 Howth Road, Raheny, Dublin 5, Eire.
- *Society of Amateur Radio Astronomers* (SARA) — An international organization which seeks persons interested in radio astronomy research. Contact: SARA Membership Services, P.O. Box 6319, Long Island City, NY 11106; Tel: 718-545-3455.

CANADA

- *Canadian Astronomical Society* (CAS) — A professional organization which supports many astronomy education activities. Contact: Norman Broten, CAS Secretary, 48 Pineglen Crescent, Nepean, Ontario, Canada K2E 6X9.
- *NCL CAN AM (Noctilucent Cloud Observers)* — Contact: Mark Zalcik, #2 14225 82nd St., Edmonton, Alberta T5E 2V7.
- *The Planetarium Association of Canada* (PAC) — 190 Rupert Ave., Winnepeg R3B 0N2.
- *Royal Astronomical Society of Canada* (RASC) — A Canadian society open to amateurs and professional astronomers. Sponsors a bimonthly *Journal of the RASC*, the *National Newsletter*, and the *Observer's Handbook*. Address: 136 DuPont St., Toronto, Ontario M5R 1V2.

UNITED STATES

- *Amateur Satellite Observers* — Contact: Jim Hale, HCR 65, Box 261-B, Kingston, AR 72742.
- *American Association of Physics Teachers* (AAPT) — An organization of physicists who are also teachers. They have an Astronomy Committee which is very active in astronomy education. Address: Executive Office, Dept. of Physics and Astronomy, University of Maryland, College Park, MD 20742.
- *American Association of Variable Star Observers* (AAVSO) — An organization composed of both amateur and professional astronomers interested in variable stars. Contact: Janet Mattei, 25 Birch Ave., Cambridge, MA 02138; Tel: 617-354-0484.
- *American Astronomical Society* (AAS) — An organization of professional astronomers primarily in North America. Holds regular semi-annual meetings and sponsors publication of several technical journals. Main address: 1816 Jefferson Place, NW, Washington, DC 20036. Its education officer is Dr. Mary Kay Hemenway, Department of Astronomy, University of Texas, Austin, TX 78712-1083.
- *American Lunar Society* (ALS) — Contact: Francis Graham, P.O. Box 209, East Pittsburgh, PA 15112; Tel: 412-829-7455.
- *American Meteor Society* — Contact: David Meisel, Dept. of Physics & Astronomy, S.U.N.Y.–Geneseo, NY 14454.
- *Association of Astronomy Educators* (AAE) — Affiliated with the NSTA, it sponsors a newsletter of interest to astronomy educators, workshops and short courses in astronomy in connection with NSTA meetings. Contact: Robert Allen, Physics Dept., Cowley Hall, University of Wisconsin, La Cross, WI 54601.
- *Association of Lunar and Planetary Observers* (ALPO) — An amateur organization specializing in solar system phenomena. Contact: Harry D. Jamieson, P.O. Box 143, Heber Springs, AR 72543; Tel: 501-362-7624.
- *Astronomical League* (AL) — A federation of local amateur astronomy clubs. Contact: Merry Edenton-Wooten, 6235 Omie Circle, Pensacola, FL 32504; Tel: 904-477-8859.
- *Astronomical Society of the Pacific* (ASP) — An association of amateur and professional astronomers committed to the goal of public education in astronomy. Publishes a technical journal *Publications of the ASP* and also a non-technical magazine *Mercury*. ASP is one of the best general sources of teaching materials. (books, information packets, audio-visual aids, etc.) on astronomy education. Address: 390 Ashton Ave., San Francisco, CA 94112; Tel: 415-337-1100.
- *Aurora Alert Hotline* (AAH) — Contact: David Huestis, 57 Manley Dr., R.R. #1, Box 232A, Pascoag, RI 02859; Tel: 401-568-9370.
- *Earthwatch* — Contact: Blue Magruder, 680 Mt. Auburn St., Box 403N, Watertown, MA 02272; Tel: 617-926-8200.
- *Independent Space Research Group* (ISRG) — P.O. Box 23083, Rochester, NY 14692; Tel: 716-464-0125.
- *Meteoritical Society* (MS) — Contact: H.Y. McSween, Geological Sciences Dept., University of Tennessee, Knoxville, TN 37996.
- *National Aeronautics and Space Administration* (NASA) — A major government agency from which is available a copious amount of astronomy education material such as slides,

prints, movies, and publications that have resulted from NASA activities. Publishes *Educational Briefs* and *Report to Educators* free of charge to interested educators. Write: NASA Educational Programs Division, Office of Public Affairs, Code FC-9, NASA, Washington, DC 20546.

- *National Space Society* (NSS) — Contact: Aleta Jackson, 922 Pennsylvania Ave., SE., Washington, DC 20003; Tel: 202-543-1900.
- *Niagra Frontier Council of Amateur Astronomical Associations* — Contact: Ed Lindberg, 113 Maple Dr., Bowmansville, NY 14026; Tel: 716-633-6725.
- *Piedmont Advocacy for Space* (PAS) — Contact: S.J. Redhead, P.O. Box 337, Fair Play, SC 29643; Tel: 803-972-3026.
- *Planetary Society* — Address: 65 N. Catalina Ave., Pasadena, CA 91106; Tel: 818-793-5100.
- *Problicom Sky Survey* (PSS) — Contact: Ben Mayer, 1940 Cotner Ave., Los Angeles, CA 90025; Tel: 213-478-2524.
- *Society for Scientific Exploration* (SSE) — Contact: L.W. Fredrick, P.O. Box 3818, Charlottesville, VA 22903; Tel: 804-924-4905.
- *Spaceweek National Headquarters* — Address: P.O. Box 58172, Houston, TX 77258.
- *Sunsearch-Supernova Search* — Contact: Steve Lucas, 14400 S. Kolin Ave., Midlothian, IL 60445.
- *Webb Society North America* — Contact: Ronald J. Morales, 1440 S. Marmora Ave., Tucson, AZ 85713; Tel: 602-628-1077.
- *Western Amateur Astronomers* (WAA) — Contact: Margaret Matlack, 13617 E. Baily, Whittier, CA 90601.
- *World Space Foundation* (WSS) — Contact: Jack Child, P.O. Box Y, South Pasadena, CA 91030; Tel: 818-357-2878.

UNITED KINGDOM

- *Association for Astronomy Education* (AAE) — Formed in 1981 to promote greater interest in Astronomy in education. Contact: Bob Kibble, AAE Secretary, 34. Aeland Crescent, Denmark Hill, London SE5 8EQ.
- *British Association of Young Scientists* (BAYS) — Though not specifically an astronomical society, it is aimed at persons aged 11 to 18 who are interested in science and technology. Contact: BAYS Officer, British Association for the Advancement of Science, Fortress House, 23 Savile Row, London W1X 1AB.
- *British Astronomical Association* (BAA) — Founded in 1890, it is the leading national society for amateur astronomers. Contact: The Secretary, BAA, Burlington House, Picadilly, London W1V 0NL.
- *British Interplanetary Society* (BIS) — Formed in 1933, it aims to investigate the possibilities of interplanetary flight and to promote relevant engineering and scientific research. Contact: The Secretary, BIS, 27/29 South Lambeth Road, London SW8 1SZ.
- *British Meteor Society* (BMS) — Since 1969 the society has strived to further the advancement of meteor astronomy and allied sciences. Contact: The Director, BMS, 26 Adrian Street, Dover, Kent CT17 9AT.
- *British Society for the History of Science* (BSHS) — Though not specifically devoted to astronomy, this society will appeal to those with a scholarly interest in the history of astronomy. Contact: The Secretary, BSHS, 31 High Street, Stanford-in-the-Vale, Faringdon, Oxon, SN7 8LH.
- *Federation of Astronomical Societies* (FAS) — Formed in 1974 to bring together astronomical societies and groups for their mutual benefit, and to give help and advice to member societies and groups. Publishes a regular newsletter and an annual handbook which contains information on places to visit, equipment suppliers, visual aid sources, speakers, and societies, and also addresses of organizers of local societies. Contact: FAS Secretary, 1 Tal-y-bont Road, Ely, Cardiff CF5 5EU.
- *The Institute of Physics* (IP) — Publishes *Physics Education*. Address: 47 Belgrave Square, London SW1 8QX.
- *Junior Astronomical Society* (JAS) — Intended for beginners of all ages in astronomy. The Society publishes the quarterly magazine *Popular Astronomy* and circulars with

the latest news, and organizes meetings and visits. Contact: The Secretary, JAS, 10 Swanwick Walk, Tadley, Basingstoke, Hants RG26 6JZ.

- *Royal Astronomical Society* (RAS) — Founded in 1820, the major society for professional astronomers and geophysicists in the UK, but with members worldwide. Publishes the *Memoirs*, *Monthly Notices*, and the *Quarterly Journal*. Applications for Fellowship must be supported by three other Fellows in the Society. Application to Junior Membership is open to persons between ages 18 and 25 and need to be supported by one Fellow of the Society. For further details, contact: Membership Secretary, RAS, Burlington House, Piccadilly, London W1V 0NL.
- *Scientific Instruments Society* (SIS) — Formed in 1983 to bring together people with a specific interest in historic scientific instruments. Contact: SIS Executive Secretary, Neville House, 42/46 Hagley Road, Birmingham B16 8PZ.
- *Webb Society* — Formed in 1967 and named after the Rev. T.W. Webb, the Society aims to unite amateur observers of double stars and deep sky objects. Contact: The Secretary, S.J. Hynes, Webb Society 8 Cormorant Close, Sydney, Crewe, Cheshire OW1 1LN.
- *William Herschel Society* (WHS) — Founded in 1978, aims to continue maintaining Herschel's house and workshop in Bath and to further research into Herschel's life and work. Write: WHS Secretary, 19 New King Street, Bath BA1 2BL.

AUSTRALIA

- *Astronomical Society of Australia* (ASA) — Contact: President A.G. Little, University of Sydney, Sydney, NSW 2006.
- *Astronomical Society of Western Australia* (ASWA)
- *Royal Society of New South Wales* (RSNSW)

INDIA

- *Astronomical Society of India* (ASI) — Contact: Pres. J.V. Narlikar, Tata Institute, Homi Bhabha Road, Colaba, Bombay 400 005.
- *Indian Academy of Sciences* (IAS)

JAPAN

- *Japan Astronomical Study Association* — Contact: Keiichi Saijo, National Science Museum, Ueno Park, Taito, Tokyo 110.
- *Oriental Astronomical Association* (OAA) — Contact: Ichiro Hasegawa, 2-3-11, Saidaiji-Nogamicho, Nara 631.

SOUTH AFRICA

- *Astronomical Society of Southern Africa* (ASSA)

NEW ZEALAND

- *Royal Astronomical Society of New Zealand* (RASNZ) — P.O. Box 3181, Wellington.

A.4 General List of Sources for Mechanical Models and Exhibit Items

United Kingdom

- ARMAGH PLANETARIUM, College Hill, Armagh, N. Ireland.
- ASTRO INSTRUMENTS, 45 Derby Road, Portsmouth, Hants.
- BRETMAIN LTD., 99b Hamilton Road, Felixstowe, Suffolk IP11 7BL.
- DAILY TELEGRAPH, 135 Fleet Street, London EC4 or bookshops.
- GEORGE PHILIPS, Stanfords Ltd., Long Acre, London EC2 or bookshops.
- LONDON PLANETARIUM, Marylebone Road, London NW1 5LR; Tel: 01-486-1121.
- LONDON SCHOOLS PLANETARIUM & ADVISORY CENTRE, Wandsworth School, Sutherland Grove, London SW18 5PT. Tel: 01-788-4253.

- MACDONALD EDUCATIONAL, Paulton, Bristol BS18 5BR. (Learning through Science packs).
- MACMILLAN EDUCATIONAL, Houndmills, Baskingstoke, Hants.
- MILLS OBSERVATORY, Balgay Park, Glamis Road, Dundee DD2 2UB; Tel: 0382-67138.
- SPACE FRONTIERS LTD., 30 Fifth Avenue, Havant, Hants.

Canada and the United States

- ASTROSYSTEMS, 1536 Meeker Dr., P.O. Box 1183, Longmont, CO 80501; Tel: 303-678-5339.
- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215, USA; Tel: 919-584-0381. Also Box 187, Gladstone, OR 97027, USA. Tel: 503-656-1641.
- CENTRAL SCIENTIFIC COMPANY (CENCO), 11222 Melrose Ave., Franklin Park, IL 60131-1364, USA; Tel: 312-451-0150 or 800-262-3626.
- DAVID CHANDLER CO., P.O. Box 309, La Verne, CA 91011, USA; Tel: 714-946-4814.
- EDMUND SCIENTIFIC CO., 101 E. Gloucester Pike, Barrington, NJ 08007-1380; Tel: 609-573-6259.
- FARQUHAR GLOBES, 5007 Warrington Ave., Philadelphia, PA 19143. Celestial and other globes.
- FISHER SCIENTIFIC, Educational Materials Division, 4901 W. LeMoyne Street, Chicago, IL 60651, USA; Tel: 800-621-4769.
- HUBBARD SCIENTIFIC COMPANY, P.O. Box 104, Northbrook, IL 60065, USA.
- KLINGER EDUCATIONAL PRODUCTS CORP., 83-45 Parsons Boulevard, Jamaica, NY 11432, USA.
- MMI CORPORATION, Dept. ST89, P.O. Box 19907, Baltimore, MD 21211; Tel: 301-366-1222. Extensive film list
- NEPTUNE PACIFIC, 953 E. Colorado Blvd., Suite 201, Pasadena, CA 91106, USA; Tel: 818-794-4531.
- PASCO SCIENTIFIC, 1876 Sabre Street, Hayward, CA 94545, USA; Tel: 415-786-2800. TWX: 910-383-2040.
- SARGENT-WELCH SCIENTIFIC CO., 7300 Linder Ave., Skokie, IL 60076. Educational and demonstration equipment.
- SCHOOLMASTERS SCIENCE, 745 State Circle, Box 1941 Ann Arbor, MI 48106; Tel: 800-521-2832; FAX: 313-761-8711.
- SCIENCE KIT, INC., Tonawanda, NY 14150. Educational and demonstration materials.
- SCI/SPACE CRAFT INTERNATIONAL, 953 E. Colorado Blvd., No. 201, Pasadena, CA 91106; Tel: 818-794-0177. High resolution laser-cut educational model kits.
- WARD'S NATURAL SCIENCE ESTABLISHMENT, INC., 5100 W. Henrietta Road, P.O. Box 92912, Rochester, NY 14692-9012, USA. Tel: 800-962-2660.

A.5 General List of Sources for Audio-Visual Aids

United Kingdom

ENGLAND

- ASTRO ART, 99 Southam Road, Hall Green, Birmingham B28 0AB; Tel: 021-7771802. Variety of illustrative material, original paintings, prints, etc. by David A. Hardy.
- ASTRO SLIDES, 58 California, Nine Mile Ride, Finchampstead, Berkshire RG11 5HT. Sets of slides of planets, etc. from US originals. List available, mail order only.
- BRETMAIN, 99B Hamilton Road, Felixstowe, Suffolk IP11 7BL.
- BRITISH UNIVERSITIES FILM & VIDEO COUNCIL, 55 Greek Street, London, W.1.
- DAILY TELEGRAPH, 135 Fleet Street, London EC4.

- EARTH AND SKY, 21A West End, Hebden Bridge, West Yorkshire HX7 8UQ; Tel: 0422-845443. Wide range of astronomical photographs, slides, charts, books, etc., available in the shop or by mail order. Send two first class stamps for current lists.
- FEDERATION OF ASTRONOMICAL SOCIETIES, Mr. Ken Marcus, 5 Cedars Gardens, Brighton, East Sussex BN1 6YD. Set of 73 general slides taken by amateur observers.
- FOCAL POINT AUDIO-VISUAL LTD., 251 Copnor Rd., Portsmouth, Hants. PO3 5EE; Tel: 0705-665249. Slides and tape/slide sets.
- THE GEOLOGICAL MUSEUM, Exhibition Rd., South Kensington, London SW7 2DE; Tel: 01-938-8765. Small reference collection of NASA prints of the planets which may be available for loan. Contact Mr. Pulsford 01-938-9035. Museum Bookshop sells 35-mm slides of space subjects; Tel: 01-938-9123.
- HAMMONDS A/V & VIDEO SERVICES, 60 Queens Road, Watford, Herts. WD1 2LA; Tel: 0923-39733.
- HATFIELD POLYTECHNIC OBSERVATORY, c/o Dr. Chris Kitchin, Bayfordbury, Nr Hertford, Herts SG13 8LD; Tel: 0992-558451x334. Slides covering all the constellations visible from the UK.
- JODRELL BANK VISITOR CENTRE, Lower Withington, Macclesfield, Cheshire; Tel: 0477-71339.
- LIVERPOOL MUSEUM PLANETARIUM, National Museums & Galleries on Merseyside, William Brown Street, Liverpool L3 BEN. Telphone: 051-207-0001.
- THE LONDON PLANETARIUM, Merchandise Department, London Planetarium, Marylebone Road, London NW1 5LR; Tel: 01-486-1121. Offers posters, charts, books, etc.
- LONDON SCHOOLS PLANETARIUM & ADVISORY CENTRE, Wandsworth School, Sutherland Grove, London SW18 5PT. Tel: 01-788-4253.
- MACDONALD EDUCATIONAL, Paulton, Bristol BS18 5BR. Learning through Science packs.
- MACMILLAN EDUCATIONAL, Houndmills, Baskingstoke, Hants.
- NATIONAL PORTRAIT GALLERY, 2 St. Martins Place, London WC2. Sells slides.
- THE OBSERVATORY MAGAZINE, The Editors of *The Observatory*, Rutherford Appleton Laboratory, Chilton, Didcot, Oxon, OX11 0QX; Tel: Abingdon 0235-21900.
- GEORGE PHILIPS, Stanfords Ltd., Long Acre, London EC2.
- THE ROYAL ASTRONOMICAL SOCIETY, Burlington House, London, W1V 0NL. Limited quantities of posters.
- THE ROYAL GREENWICH OBSERVATORY, Herstmonceux Castle, Hailsham, East Sussex BN27 1RP. Wide range of material.
- THE SCIENCE MUSEUM, South Kensington, London SW7 2DD. Museum Shop sells some postcards and prints; Tel: 01-938-8186 or 01-938-8187. May also be obtained from Mail Order Department.
- SCIENCE MUSEUM LIBRARY, Photo Orders Service, South Kensington, London SW7 5NH; Tel: 01-938-8220 (Photographic Order Service). Sells black-and-white photographs, black-and-white slides, and color transparencies, mainly of objects in the Museum's collections. Lists available.
- THE SLIDE CENTRE LTD., Ilton 5H, Ilminster, Somerset, TA19 9BR; Tel: 0460-57151. Slide sets and some computer software for educational use.
- SPACECHARTS, Newton Tony, Salisbury, Wilts SP4 OHF. Tel: 098-064-672. Full color wall charts of planets, Halley's comet, space shuttle.
- SPACE FRONTIERS LTD., 30 Fifth Avenue, Havant, Hants.
- SPACEPRINTS, 117A High Street, Norton, Stockton on Tees, Cleveland; Tel: 0642-555401. Supplier of NASA photographs, slide sets, videos, and posters. Produces Spaceprints Calendar.
- TERRA FIRMA CASSETTES, 55 Bolingbroke Road, London, W14.
- WOODMANSTERNE LTD., Watford Business Park, Watford WD1 8RD. Color slides.

NORTHERN IRELAND

- ARMAGH PLANETARIUM, College Hill, Armagh BT61 9DB; Tel: 0861-524725. Offers exceptionally wide range of materials, including slide sets on astronomy and spaceflight subjects, videotapes and laser discs, posters, and postcards.

SCOTLAND

- MILLS OBSERVATORY, Balgay Park, Glamis Road, Dundee DD2 2UB; Tel: 0382-67138.
- THE ROYAL OBSERVATORY EDINBURGH, The Visitor Centre, ROE, Blackford Hill, Edinburgh EH9 3HJ; Tel: 031-667-3321. Books, posters slides, charts, etc. Also prints, slides and postcards from UK Schmidt Telescope Unit.

WALES

- DRAKE EDUCATIONAL PRODUCTIONS, St. Fagans Road, Fairwater, Cardiff CF5 3AE; Tel: 0222-560333. Sound filmstrips, tape/slide sets, and astronomical wallcharts.
- DS LTD., The George Building, Normal College, Bangor, Gwynedd.

Canada and the United States

- APOLLO SPACE SYSTEMS, 675 Station Rd., Bellport, NY 11713; Tel: 516-467-8033.
- ASTRO CARDS, P.O. Box 35, Natrona Hts., PA 15065; Tel: 412-295-4126.
- ASTRO-INFO, 1090 Ch Pincourt, Mascouche, Quebec J7L 2X7.
- ASTRONOMICAL SOCIETY OF THE PACIFIC, 390 Ashton Ave., San Francisco, CA 94112.
- BFA EDUCATIONAL MEDIA, 468 Park Ave. S., New York, NY 10016.
- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215; Tel: 919-584-0381. Also Box 187, Gladstone, OR 97027. Tel: 503-656-1641.
- CENTRAL SCIENTIFIC COMPANY (CENCO), 11222 Melrose Ave., Franklin Park, IL 60131-1364; Tel: 312-451-0150 or 800-262-3626.
- DAVID CHANDLER CO., P.O. Box 309, La Verne, CA 91750; Tel714-946-4814.
- EDUCATIONAL AUDIOVISUAL, INC., Pleasantville, NY 10570.
- E.M.E. (Science), P.O. Box 17, Pelham, NY 1083.
- EVERYTHING IN THE UNIVERSE, 5248 Lawton Ave., Oakland, CA 94618; Tel: 415-547-6523.
- FISHER SCIENTIFIC, Educational Materials Division, 4901 W. LeMoyne Street, Chicago, IL 60651; Tel: 800-621-4769.
- HALE OBSERVATORIES, Caltech, Bookstore 1-51, 1201 East California, CA 91109.
- HANSEN PLANETARIUM, 15 South State St., Salt Lake City, UT 84111.
- HUBBARD SCIENTIFIC COMPANY, P.O. Box 104, Northbrook, IL 60065.
- INDIANA UNIVERSITY AUDIOVISUAL CENTER, Bloomington, IN 47401.
- KALMIA COMPANY, 21 West Circle, Concord, MA 01742.
- KAROL MEDIA, 625 From Rd., Paramus, NJ 07652.
- KITT PEAK NATIONAL OBSERVATORY, Photo Dept., P.O. Box 4130, Tucson, AZ 85717.
- LANDMARK PICTURES, INC., 72 Mallard Dr., Greenwich, CT 06830.
- LEARNING CORP. OF AMERICA, 1350 Ave. of the Americas, New York, NY 10019.
- LICK OBSERVATORY, University of California, Santa Cruz, CA 95064.
- MEDIA GUILD, 11526 Sorrento valley Rd., Suite J, San Diego, CA 92121.
- MMI CORPORATION, 2950 Wyman Parkway, P.O. Box 19907, Baltimore, MD 21211; Tel: 301-366-1222.
- MODERN LEARNING AIDS, Box 92912, Rochester, NY 14692.
- NATIONAL AUDIOVISUAL CENTER, General Services Administration, Washington, DC 20409.
- NATIONAL FILM BOARD OF CANADA (Commercial Division), P.O. Box 6100 Station A, Montreal, P.Q. H3C 3H5.
- NATIONAL OPTICAL ASTRONOMY OBSERVATORY, Public Inf. Office, P.O. Box 26732, Tucson, AZ 85726.
- NATIONAL SCIENCE FOUNDATION, Public Affairs & Public., Washington, DC 20036.
- OPTICAL DATA CORPORATION (formerly VIDEO VISION ASSOCIATES), 30 Technology Dr., P.O. Box 4919, Warren, NJ 07060; Tel: 800-524-2481 or 201-668-0022.
- OPTIKEN INTERNATIONAL, 900 S. San Gabriel Blvd., San Gabriel, CA 91776.
- RHR FILMEDIA, 1212 6th Ave., New York, NY 10036.
- SARGENT-WELCH SCIENTIFIC CO., 7300 N. Linder Ave., Skokie, IL 60076.
- SCHOOLMASTERS SCIENCE, 745 State Circle Box 1941, Ann Arbor, MI 48106; Tel: 800-521-2832.

- SCIENCE GRAPHICS, P.O. Box 7516, Bend, OR 97708; Tel: 503-389-5652.
- SKY PUBLISHING CORP., 49 Bay State Road, Cambridge, MA 02238. Sky maps and visual materials.
- SPACE PHOTOS, Dept. V-3, 2608 Sunset Blvd., Houston, TX 77005.
- TERSCH ENTERPRISES, P.O. Box 1059, Colorado Springs, CO 80901; Tel: 719-597-3603.
- UC EXTENSION MEDIA CENTER, Univ. of Calif., Berkeley, CA 94720.
- UNIVERSITY OF ILLINOIS VISUAL AIDS SERVICE, 1325 S. Oak St., Champaign, IL 61820.
- WALT DISNEY EDUC. MEDIA MARKETING DIVISION, 500 S. Buena Vista St., Santa Barbara CA 91521.
- WARD'S NATURAL SCIENCE ESTABLISHMENT, INC., 5100 W. Henrietta Road, P.O. Box 92912, Rochester, NY 14692-9012. Tel: 800-962-2660.

A.6 Sources for Telescopes and Observing Equipment

A.6.1 Telescopes and Accessories

United Kingdom

- ASTRO INSTRUMENTS, 45 Derby Road, Portsmouth, Hants.
- ASTRO PROMOTIONS LTD., 24 Old Bedford Road, Luton, Beds.
- BEACON HILL TELESCOPES, 112 Mill Road, Cleethorpes, South Humberside, DN35 8JD; Tel: 0472 692959.
- BROADHURST, CLARKSON & FULLER, Telescope House, 63 Farringdon Road, London EC1M 3JB; Tel: 01-405 2156.
- NORMAN FISCHER LTD., 5 Dagmar Road, London SE25 6HZ; Tel: 01-771 0477.
- CHARLES FRANK, Head Office, Ronald Lane, Saxmundham, Suffolk, IP17 2NL; Tel: 0728 3506.
- H.N. IRVING & SON, 258 Kingston Road, Teddington, Middx.
- KAY OPTICAL, 89b London Road, Morden, Surrey.
- LONDON PLANETARIUM, Marylebone Road, London NW1 5LR. Telphone: 01-486-1121.
- OPTICAL INSTRUMENTS (BALHAM) LTD., 6 Weir Road, Balham, London, SW12 0NA; Tel: 01-673 8513.
- OPTICRAFT LTD., Unit 4, Queen Street Mill, Harlesyke, Burnley; Tel: 0282 412215.
- OPTICRON, P.O. Box 81, St. Albans, Herts. AL1 3NT; Tel: 0727 56516.
- ORION OPTICS, Unit 3M, Zan Industrial Park, Wheelock, Sandbach, Cheshire CW11 0QD; Tel: 0270 768474.
- OSBORNE OPTICS, 139 Dean House, Eastfield Avenue, Walker, Newcastle upon Tyne NE6 4UU; Tel: 091 263-8826.
- HENRY WILDEY, 34 Warners Avenue, Broxbourne, Herts. EN11 8LR; Tel: 0992 465886.
- WISE INSTRUMENTS LTD., Unit 9, Hollins Business Centre, Marsh Street, Stafford ST16 3BG; Tel: 0785 223535.

Canada

- COSMAN & ASSOCIATES, Islington, Ontario M9B 1A8.
- EFSTONSCIENCE, 3350 Dufferin Street, Toronto, Ontario M6A 3A4; Tel: 800-263-2935 or 416-787-4581.
- KHAN SCOPE CENTRE (Formerly SCOPE CITY "CANADA"), 247 Marlee Ave., Unit 201, Toronto, Ontario M6B 4B8. Tel: 416-783-4140.
- NORTHERN LITES, 801 Stanehill Place, R.R.1, Victoria, BC V8X 3W9.
- PERCEPTOR, Brownsville Junction Plaza, Box 38, Suite 103, Schomberg, Ontario L0G 1T0; Tel: 416-939-2313.
- QUASAR OPTICS, 7220A Fairmount Dr. S.E., Calgary, Alberta T2H 0X7; Tel: 403-255-7633.
- RUBY OPTICS, Box 2136, Kingston, Ontario K7L 5J9, Canada; Tel: 613-544-5857.
- SCIENCE CITY, 50 Bloor Street West, Toronto, Ontario.
- SKY INSTRUMENTS, M.P.O. Box 3164, Vancouver, BC V6B 3X6; Tel: 604-270-2813.
- SPARTAN SCIENTIFIC LTD., 116 Viceroy Rd., Unit 5, Bldg. A, Concord, Ontario L4K 2M1; Tel: 416-738-0393.
- STAR TRAK INSTRUMENTS, P.O. Box 3234, Stn. C, Hamilton, Ontario L8H 7K6.
- TELESCOPES TRANSCANADA, P.O. Box 823, Aurora, Ontario L4G 4J9; Tel: 416-939-8274.
- WIN OPTIC VISION INC., 620 Alden Rd., Suite 102, Markham, Ontario L3R 9R7.

United States

- AD-LIBS ASTRONOMICS, 2401 Tee Circle, Suite 105, Norman, OK 73069; Tel: 405-364-0858 or 800-422-7876.
- ADORAMA, 42 W. 18th St. New York, NY 10011. Tel: 212-741-0052.
- ARIES OPTICS, Rt. 1, Box 143G, Palouse, WA 99161. Tel: 509-878-1713.
- ASTRO-COMPUTER CONTROL, RD #1, Alexandria, PA 16611. Tel: 814-669-4483.
- ASTRONOMICS, 2401 Tee Circle, Suites 105/106, Norman, OK 73069; Tel: 405-364-0858.
- ASTRO-PHYSICS, 7470 Forest Hills Road, Loves Park, IL 61111; Tel: 815-282-1513.
- ASTRO-SYSTEMS, P.O. Box 1183 M, Longmont, CO 80501. Tel: 303-678-5339.
- ASTRO-TECH, 101 West Main, P.O. Box 2001, Ardmore, OK 73402. Telephone 405-226-3074.
- ASTROWORKS, P.O. Box 86, Cloudcroft, NM 88317. Tel: 505-682-2218.
- ASTRO WORLD, 5126 Belair Rd., Baltimore, MD 21206. Tel: 301-483-5100.
- BASIC CONCEPTS IN ASTRONOMY, 11278 East Meadow Glen Way, Escondido, CA 92026.
- BERGER BROS. CAMERA EXCHANGE, 209 Broadway (Route 110), Amityville, NY; Tel: 800-262-4160 or 516-264-4160.
- CALIFORNIA TELESCOPE COMPANY, P.O. Box 1338, Burbank, CA 91507; Tel: 800-843-4780.
- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215; Tel: 919-584-0381. Also Box 187, Gladstone, OR 97027. Tel: 503-656-1641.
- CELESTRON INTERNATIONAL, 2835 Columbia Street, Torrance, CA 90503; Tel: 213-328-9560, or 800-421-1526 (Continental USA); Fax: 213-212-5835; Telex: 182471.
- CENTRAL SCIENTIFIC COMPANY (CENCO), 11222 Melrose Ave., Franklin Park, IL 60131-1364; Tel: 312-451-0150 or 800-262-3626.
- CENTURY TELESCOPE, 12555 Harbor Blvd., Garden Grove, CA 92640. Telephone 714-530-3861.

- CHICAGO OPTICAL, P.O. Box 1361, Morton Grove, IL 60053. Tel: 312-827-4846.
- CITY CAMERA, 15336 W. Warren, Dearborn, MI 48126. Tel: 313-846-3922.
- COSMIC CONNECTIONS, 1460 N. Farnsworth, Aurora, IL 60505; Tel: 312-851-5353, 800-634-7702.
- COULTER OPTICAL, INC., P.O. Box K, Idyllwild, CA 92349-1107; Tel: 714-659-4621.
- D & G OPTICAL, 6490 Lemon St., East Petersburg, PA 17520; Tel: 717-560-1519.
- DENNY'S ASTRO MART, 832 Sydney Baker, Kerrville, TX 78028; Tel: 512-896-6377.
- DOBBINS INSTRUMENT CO., 5168 Lynd Ave., Lyndhurst, OH 44124; Tel: 216-449-5730 or 216-631-6611.
- E & W OPTICAL INC., 2420 E. Hennepin Ave., Minneapolis, MN 55413; Tel: 612-331-1187.
- EAGLE OPTICS, 6109 Odana Rd., Madison, WI 53719; Tel: 608-271-4751.
- EASTERN TELE-OPTICS, P.O. Box 426, Springfield, PA 19064; Tel: 215-284-1725.
- EDMUND SCIENTIFIC, 101 E. Gloucester Pike, Barrington, NJ 08007-1380; Tel: 609-573-6259.
- FISHER SCIENTIFIC, Educational Materials Division, 4901 W. LeMoyne Street, Chicago, IL 60651; Tel: 800-621-4769.
- FOCUS CAMERA, 4421 13th Ave., Brooklyn, NY 11219. Tel: 718-436-6262.
- FUJINON INC., 10 High Point Drive, Wayne, NJ 07470. Tel: 201-633-5600. Specializes in high quality astronomical binoculars.
- GALAXY OPTICS, P.O. Box 2045, Buena Vista, CO 81211. Tel: 719-395-8242. Supplier of mirror optics for reflecting telescopes.
- GREAT PLAINS INSTRUMENTS, 2321 C. Court, Enid, OK 73703; Tel: 405-237-4034.
- A. JAEGERS, 691S Merrick Rd., Lynbrook, NY 11563. Telescope making equipment and accessories.
- JENA SCIENTIFIC INSTRUMENTS, INC., 820 2nd Ave., New York, NY 10017; Tel: 212-867-3051.
- JIM'S MOBILE IND., 1960 County Road 23, Evergreen, CO 80439; Tel: 303-277-0304; Fax: 303-526-9140.
- JUPITER TELESCOPE CO. INC., 818 S., U.S. Highway 1, Suite 4-237, Jupiter, FL 33477; Tel: 407-881-1365. Advanced design large telescopes.
- KENNETH NOVAK & CO., Box 69X, Ladysmith, WI 54848. Tel: 715-552-5102.
- KRAUTH PRECISION INSTRUMENTS, 528-30 Main St., South Weymouth, MA 02190; Tel: 617-331-3795.
- LEWIS-MICHAELS ENGINEERING, 48 Delemere Blvd., Fairport, NY 14450; Tel: 716-425-3470. Telescope-making supplies and accessories.
- LORRAINE PRECISION OPTICS, 1319 Libby Lane, New Richmond, OH 45157.; Tel: 513-553-4999. Source of Schiefspieglers.
- LUMICON, 2111 Research Dr. #5S, Livermore, CA 94550. Tel: 415-447-9570. Major distributer of telescopes and supplies.
- MEADE INSTRUMENTS CORPORATION, 1675 Toronto Way, Costa Mesa, CA 92626; Tel: 714-556-2291.
- F.C.MEISCHNER CO., 182 Lincoln St., Boston, MA 02111; Tel: 617-426-7092, or 1-800-321-VIEW.
- MMI CORPORATION, 2950 Wyman Parkway, P.O. Box 19907, Baltimore, MD 21211. Tel: 301-366-1222.
- NATIONAL CAMERA EXCHANGE, 9300 Olson Memorial Highway, Golden Valley, MN 55427; Tel: 612-546-6831.
- NEW ENGLAND ASTRO-OPTICS, INC., Box 834, Simsbury, CT 06070; Tel: 203-658-0701.
- NORTHERN SKY TELESCOPES, 5667 Duluth Street, Golden Valley, MN 55422. Tel: 1-800-345-4202, or 612-545-6786, Fax 612-545-9297.

- OHARA CORP., 50 Columbia Rd., Somerville, NJ 08876; Tel: 201-218-0100.
- OPTICA b/c COMPANY, 4100 MacArthur Blvd., Oakland, CA 94619.
- OPTICAL GUIDANCE SYSTEMS, 2450 Huntingdon Pike, Huntingdon Valley, PA 19006; Tel: 215-947-5571.
- THE OPTICAL POINT, 8016 Gonzaga Avenue, Los Angeles, CA 90045.
- ORION TELESCOPE CENTER, 421 Soquel Ave., Dept. N, P.O. Box 1158, Santa Cruz, CA 95061. Telephone 800-447-1001, in California 800-443-1001.
- PARKS OPTICAL, 270 Easy St., Simi Valley, CA 93065. Tel: 805-522-6722.
- PAULI'S WHOLESALE OPTICS, 29 Kingswood Road, Danbury CT 06811; Tel: 203-746-3579.
- RESEARCH INSTRUMENTS, 15000 S.W. Barcelona Way, Beaverton, OR 97007; Tel: 503-641-5551.
- SAFARI TELESCOPES, 110 Pascack Rd., Pearl River, NY 10965; Tel: 212-621-9199. Innovative lightweight, large-apeture telescopes.
- SCOPE CITY, 679 Easy St., Simi Valley, CA 93065. Tel: 805-522-6646.
- SEILER INSTRUMENT & MANUFACTURING CO., 170 E. Kirkham Ave., St. Louis, MO 63119-1791; Tel: 800-444-7952.
- SHARPSHOOTERS PHOTOGRAPHIC, 1034 W. Hillsborough Ave., Tampa, FL 33603, USA; Tel: 800-272-9899.
- SKY DESIGNS, 4100 Felps, #C, Colleyville, TX 76034. Tel: 817-656-4326. Lightweight, rigid truss design telescopes.
- SKY OPTICAL, 12428 Gladstone, Sylmar, CA 91342. Tel: 818-361-6576. Telescope making supplies.
- SPECTRA ASTRO-ACCESSORIES, 8726-D So. Sepulveda Blvd. Suite 441, Los Angeles, CA 90045; Tel: 818-343-1352. Free catalogue.
- STAR-LINER CO., 1106 S. Columbus, Tucson, AZ 85711. Tel: 602-795-3361.
- SUNWEST SPACE SYSTEMS, P.O. Box 20500, St. Petersburg, FL 33742; Tel: 813-577-0629. Mail order telescopes and accessories. Publishes *Astronomy Industry Newsletter & Catalogue*.
- SWIFT INSTRUMENTS INC., 952 Dorchester Ave., Boston, MA 02125; and P.O. Box 562, San Jose, CA 95106.
- TECTRON TELESCOPES, 2111 Whitfield Park Avenue, Sarasota, FL 34243; Tel: 813-758-9890.
- TELESCOPICS, P.O. Box 98, La Canada, CA 91011. Tel: 818-952-0953.
- TEXAS NAUTICAL REPAIR CO., 2129 Westheimer, Houston, TX 77098; Tel: 713-529-3551 or 529-8480.
- T.R. INC., P.O. Box 65, Mooers, NY 12958; Tel: 514-672-5697.
- ROGER W. TUTHILL, INC., 11 Tanglewood Lane, Box 1086, Mountainside, NJ 07092; Tel: 1-800-223-1063, in N.J. 1-201-232-1786, FAX 1-201-232-3804.
- UNITRON INC., 175 Express Street, Plainview, NY 11803. Tel: 516-822-4601. FAX: 516-931-7660.
- UNIVERSITY OPTICS INC., P.O. Box 1205, Ann Arbor, MI 48106; Tel: 800-521-2828.
- USA SPORT OPTICS, P.O. Box 8015-304, Redondo Beach, CA 90277.
- VERNONscope & Co., Candor, NY 12743; Tel: 607-659-7000.
- WARD'S NATURAL SCIENCE ESTABLISHMENT, INC., 5100 W. Henrietta Road, P.O. Box 92912, Rochester, NY 14692-9012. Tel: 800-962-2660.
- WHOLESALE OPTICS OF PENNSYLVANIA, Box 15, Sterling, PA 18463-0015; Tel: 717-842-1500 or 717-344-5217.

In addition, the following Italian company has clientele worldwide:

- OTTICA E MICROMECCANICA SNC, Via del Perlar, 29/B-ZA1, 37135 Verona, Italy.

A.6.2 Telescope Mounts and Drives

- A.B. MACHINING, 5734 Industrial Rd., Fort Wayne; IN 46825, USA; Tel: 219-483-1418.
- ARRICK ROBOTICS, P.O. Box 1574, Hurst, TX 76053, USA. Tel: 817-571-4528.
- ASTRO-COMPUTER CONTROL, RD#1, Alexandria, PA 16611, Tel: 814-669-4483.
- ASTROTECH, 39 Periwinkle Lane, Dunstable, Beds. LU6 3NP, England; Tel: 0582-605464.
- ASTRO-TRACK ENGINEERING, 3900-B East Mira Loma Ave., Anaheim, CA 92807; Tel: 714-630-7381.
- BEACON HILL TELESCOPES, 112 Mill Road, Cleethorpes, South Humberside, DN35 8JD, England; Tel: 0472 692959.
- BYERS CO., 29001 West Highway 58, Barstow, CA 92311, USA; Tel: 619-256-2377.
- CELESTIAL INNOVATIONS, HCR Box 3228, Oracle, AZ 85623. Tel: 602-896-9109.
- CHESHIRE INSTRUMENT CO., P.O. Box 65, Mableton, GA 30059; Tel: 404-438-9200.
- CONTRAVES GOERZ CORP., 610 Epsilon Dr., Pittsburgh, PA 15238, USA; Tel: 412-967-7989.
- DAVIONX, 3535 Schafer Dr., Santa Clara, CA 95051, USA. Tel: 408-244-4660.
- DFM ENGINEERING INC., 1035 Delaware Ave., Longmont, CO 80501; Tel: 303-678-8143. Installs professional computer-controlled telescopes.
- DOBBINS INSTRUMENT CO., 5168 Lynd Ave., Lyndhurst, OH 44124, USA.
- EPOCH INSTRUMENTS, 2331 American Avenue, Hayward, CA 94545, USA; Tel: 414-784-0391.
- HOLLYWOOD GENERAL MACHINING INC., 1033 N. Sycamore Ave., Los Angeles, CA 90038, USA; Tel: 213-462-2855.
- JENA SCIENTIFIC INSTRUMENTS, INC., 820 Second Ave., New York, NY 10017; Tel: 212-867-3051.
- JIM'S MOBILE IND., 1960 County Road 23, Evergreen, CO 80439, USA; Tel: 303-277-0304; Fax: 303-526-9140.
- OPTICAL GUIDANCE SYSTEMS, 2450 Huntingdon Pike, Huntingdon Valley, PA 19006; Tel: 215-947-5571.
- THOMAS MATHIS CO., 830 Williams St., San Leandro, CA 94577, USA; Tel: 415-483-3090.
- F.C. MEISCHNER CO., 182 Lincoln St., Boston, MA 02111, USA; Tel: 617-426-7092, or 1-800-321-VIEW.
- MOORE TECHNOLOGY, P.O. Box 2281, Morgan Hill, CA 95038-2281, USA; Tel: 408-848-2649.
- OPTIC-CRAFT MACHINING, 33918 Macomb, Farmington, MI 48024; Tel: 313-476-5893.
- PURUS ASTRO MECHANIC, Postbox 31, 6800 Mannheim 71, West Germany.
- TRAX INSTRUMENT CORP., 10100 Cochiti Rd. SE, Albuquerque, NM 87123, USA; Tel: 505-292-3366.
- TRESCO MACHINING, 4009 Pacific Coast Hwy., M.S. 486, Torrance, CA 90505; Tel: 213-373-1427.
- VISTA INSTRUMENT COMPANY, 307 E. Tunnell St., Santa Maria, CA 93454, USA. Telphone: 805-922-2545.
- VOGEL ENTERPRISES, INC., P.O. Box 3717, Oak Park, IL 60303, USA; Tel: 800-457-TRAK.

Astronomers living in Canada and the U.S. who are interested in purchasing or selling used equipment and supplies may want to subscribe to newsletters such as *The Starry Messenger* or *The Astro-Trader*. In addition, there are

noncommercial advertising sections in magazines such as *Sky & Telescope* ("Sky Gazers Exchange") and *Astronomy* ("Reader Exchange") where the reader can obtain multifarious information regarding used equipment (sometimes from professional observatories) as well as job opportunities in astronomy.

A.6.3 Telescope Repairs, Cleanings, Tune-Ups

- COSMIC CONNECTIONS, INC., 1460 N. Farnsworth Ave., Aurora, IL 60505; Tel: 312-851-5353 or 800-634-7707.
- KAY OPTICAL, 89b London Road, Morden, Surrey, England:
- OPTICAL INSTRUMENTS (BALHAM) LTD., 6 Weir Road, Balham, London, SW12 0NA; Tel: 01-673 8513.
- PHOTON INSTRUMENT LTD./ Photon Observatory, 30 King Street, Port Jefferson Station, L.I., NY 11776; Tel: 516-331-3869.
- TEXAS NAUTICAL REPAIR CO., 2129 Westheimer, Houston, TX 77098; Tel: 713-529-3551.

A.6.4 Testing of Optical Surfaces

- DAVID HARBOUR & ASSOC., 2321 C. Ct., Box 6081, Enid, OK 73702; Tel: 405-237-4034. Testing of parabolic surfaces for amateur astronomers.
- ORION OPTICS, Unit 3M, Zan Industrial Park, Wheelock, Sandbach, Cheshire CW11 0QD, England; Tel: 0270 768474.

A.6.5 Radio Telescopes

The firms listed below specialize in the manufacture of custom radio receivers and observatories:

- ASTROTECH, 39 Periwinkle Lane, Dunstable, Beds. LU6 3NP, England; Tel: 0582 605464.
- BOB'S ELECTRONIC SERVICE, 7605 Deland Ave., Fort Pierce, FL 34951, USA; Tel: 305-464-2118. Supplies mainly schools and colleges.

A.6.6 Spectrographs, Photometers, Astrocameras, Micrometers, and Other Auxiliary Instruments

For more serious observing, starlight can be analyzed quantitatively by means of spectrographs, photometers, micrometers, and other devices which are mounted on the telescope in place of the eyepiece. Sources include:

- ASTRO LINK, P.O. Box 1978, Spring Valley, CA 92077. Supplies image intensifiers and housings, digitizers for IBM AT, analog RGB monitors, CCD cameras, and Baker-Schmidt optical systems.

- RON DARBINIAN, 1681 12th Street, Los Osos, CA 93402, USA; Tel: 805-773-0421. Sells filar micrometers.
- ELECTROPHYSICS CORP., 48 Spruce St., Nutley, NJ 07110, USA; Tel: 201-667-2262. Offers, among other things, an image intensifier for use with visual and photographic observations: Astrolight Viewer (Model 9100C).
- FARADAY & WHEATSTONE COMPUTER GRAPHICS, 194 Main St., Marlborough, MA 01752. Supplies videocameras for astronomy. Free catalogue.
- KL-9 ENGINEERING, 935 Glenhaven, Pacific Palisades, CA 94619. Mail order dealer in blink comparators.
- OPTOMECHANICS RESEARCH, INC., P.O. Box 87, Vail, AZ 85641; Tel: 602-647-3332. Spectrographs.
- OPTEC, Inc., 199 Smith, Lowell, MI 49331; Tel: 616-897-9351. Stellar photometers.
- PHOTOMETRICS LTD., 2010 Forbes Blvd, Tucson, AZ 85745; Tel: 602-623-6992. Manufacturer of cooled CCD digital imaging systems
- SKY SCIENTIFIC, 28578 Hwy 18, #184, Skyforest, CA 92385; Tel: 714-337-3440. Astrocameras.
- THORN EMI GENCOM INC., 23 Madison Rd., Fairfield, NJ 07006; Tel: 201-575-5586. Photomultiplier tubes.
- ROGER W. TUTHILL INC., Box 1086-A, Mountainside, NJ 07092-0086. Sells **Star-Trap** Video CCD Camera System to view stars, planets etc. on a TV set and record the images on a VCR.

A.6.7 Mirror Coatings

Companies which perform this service include:

- DENTON VACUUM INC., Cherry Hill Ind. Center, Cherry Hill, NJ 08003.
- E & W OPTICAL INC., 2420 E. Hennepin Ave., Minneapolis, MN 55413; Tel: 612-331-1187.
- EVAPORATED METAL FILMS, 701 Spencer Rd., Ithaca, NY 14850, USA. Telephone 607-272-3320.
- DAVID HINDS LTD., Unit 34, Silk Mill, Brook Street, Tring, Herts. HP23 5EF, England.
- MORVAC OPTICAL COATING, 2300 Walnut, #B, Signal Hill, CA 90806, USA; Tel: 213-424-2062.
- ORION OPTICS, Unit 3M, Zan Industrial Park, Wheelock, Sandbach, Cheshire, CW11 0QD, England; Tel: 0270 768474.
- P.A. CLAUSING, 8038 Monticello Ave., Skokie, IL 60076, USA; Tel:312-267-3399. Beral coatings.
- P.A.P. COATING SERVICES, 1112 Chateau Ave., Anaheim, CA 92802, USA; Tel: 714-535-4460.
- VACUUM COATINGS LTD., 25 Lea Bridge Road, London E.5 9QB, England; Tel: 01-806 7335.
- WISE INSTRUMENTS LTD., Unit 9, Hollins Business Centre, Marsh Street, Stafford ST16 3BG, England; Tel: 0785 223535.

A.6.8 Photographic Equipment, Film Sensitizing and Processing

- ADVANCE CAMERA CORP., 15 West 46 St., New York, NY 10036; Tel: 800-248-0234. Full-service photographic and optical supply house.
- BEACON HILL TELESCOPES, 112 Mill Road, Cleethorpes, South Humberside, DN35 8JD, England; Tel: 0472 692959.
- KENMORE CAMERA, P.O. Box 82467, Kenmore, WA 98028; Tel: 206-485-7447. Photofinishing and camera equipment sales.
- LAKESIDE PHOTOGRAPHY, P.O. Box 370027, Bearss Station #15, Tampa, FL 33697; Tel: 813-968-9307. Photographic processing.
- LUMICON, 2111 Research Dr. #5S, Livermore, CA 94550. Tel: 415-447-9570. Provides a variety of hypersensitized film as well as kits for do-it-yourself hypersensitizing.
- PHOTOKINESIS, 1359 Fox, Ferndale, MI 48220; Tel: 313-398-1510. Custom photographic lab-film processing, prints from slides.
- SPACE TECHNOLOGIES AND RESEARCH, 700 Seminola Blvd, Casselberry, FL 32707. Dealer in hypered film and lens warmers.
- SPEEDIBREWS, 54 Lovelace Drive, Pryford, Woking, Surrey GU22 8QY, England; Tel: 093 2346942. Special films and developers for astronomical use.
- STELLAR GRAPHICS, INC., 7989 Canadice Road, Springwater, NY 14560, USA; Tel: 716-426-1577. Offers full range of services from hypersensitized film to giant prints in color and B&W. Free catalogue.

A.6.9 Filters

- COLE ENTERPRISES, 40714 E. Acacia Ave., Hemet, CA 92344, USA; Tel: 714-654-8991. Chroma-Scan Pocket Filters.
- DAYSTAR FILTER CORP., P.O. Box 1290, Pomona, CA 91769, USA; Tel: 714-591-4673. Sub-angstrom filters, solar and nebula filters.
- HC DESIGNS, INC., Box 33245, Baltimore, MD 21218; Tel: 301-889-0460. Dealer in shade No. 14 welder's lenses for naked-eye solar observations.
- EDWIN HIRSCH, 168 Lakeview, Dr. RR2, Tomkins Cove, NY 10986, USA; Tel: 914-786-3738.
- LUMICON, 2111 Research Dr. #5S, Livermore, CA 94550. Tel: 415-447-9570.
- ORION TELESCOPE CENTER, 421 Soquel Ave., P.O. Box 1158, Santa Cruz, CA 95061; Tel: 800-447-1001; California: 800-443-1001.
- PATON HAWKSLEY ELECTRONICS LTD., Rockhill Laboratories, Wellsway, Keynsham, Bristol BS18 1PG, England; Tel: 0272 862364.
- THOUSAND OAKS OPTICAL, Box 248098, Farmington, MI 48024, USA; Tel: 313-353-6825. Full aperture glass and Mylar solar filters.

A.6.10 Observing Gear and Clothing

The winter months can make long nights of observing uncomfortable and even outright unbearable. Below are listed a few companies which sell cold-weather gear.

- L.L. BEAN, INC., Freeport, ME 04033, USA.

Sells a variety of outdoor gear (coats, shoes, jackets, etc.). Catalogue published quarterly; Tel: 800-221-4221 (24 hours, 7 days).

- DAMART THERMAWEAR, Dept. 70057, 1811 Woodbury Ave., Portsmouth, NH 03805, USA; Tel: 603-742-7420.
  Manufacturer of Thermolactyl thermal underwear and other cold-weather garments.
- SPECTRA ASTRO-ACCESSORIES, Suite 441 Los Angeles, CA 90045, USA; Tel: 818-343-1352.
  Sells a 3-piece, industrial-grade observing outfit for observing in sub-zero temperatures. Spectra also offers other astronomical accessories.

A.6.11 Domes

There are several companies which specialize in the manufacture and construction of observatory domes for individuals, groups, or schools. A few of these are listed below and may be contacted for a brocure or catalogue.

- ACE DOME, 3186 Juanita, Las Vegas, NV 89102; Tel: 702-853-5790. Manufactures portable domes.
- ASH MANUFACTURING COMPANY, INC., Box 312, Plainfield, IL 60544, USA; Tel: 815-436-9403. Manufactures permanently anchored domes in a variety of sizes.
- JENA SCIENTIFIC INSTRUMENTS, INC., 820 Second Ave., New York, NY 10017; Tel: 212-867-3051.
- KINARD MANUFACTURING CO., P.O. Box 971, Hillsboro, TX 76645; Tel: 817-582-8154. Manufactures the "Hexadome" (described on p. 492 in the May 1989 issue of *Sky & Telescope*).
- OBSERVA-DOME LABORATORIES, INC., 371 Commerce Park Drive, Jackson, MS 39213, USA; Tel: 601-982-3333, or 800-647-5364; Telex: 585438.

A.6.12 Miscellaneous Observing Aids

Various observing aids such as planispheres, star dials, star finders, and so on can be ordered from the following:

- ASP
  - SD203 The Night Sky Star Dial. For latitudes 20°–32° N.
  - SD204 Same, but for latitudes 30°–40° N.
  - SD205 Same, but for latitudes 38°–50° N.
  - SD206 Same, but for latitudes 30°–40° S.
  - Also available from DAVID CHANDLER CO. (See below).
- ASTRO CARDS, P.O. Box 35, Natrona Heights, PA 15065.
  - Index card finder charts.
- ASTRONOMY Order Department, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612.
  - 30097 Philips' Planisphere for 32°N.
  - 30098 Philips' Planisphere for 42°N.
  - 30177 Pocket Starguide Set for 32°N.
  - 30178 Pocket Starguide Set for 42°N.
  - 30189 Miller Planisphere for 40°N.
  - 30190 Miller Planisphere for 30°N.
- BASIC CONCEPTS IN ASTRONOMY, 11278 East Meadow Glen Way, Escondido, CA 92026.
  - "Dewmaster" moisture controller (currently available only for Celestron-8 and Meade-8 telescopes.

- BAUSCH & LOMB, 135 Prestige Park Circle, East Hartford, CT 06108, USA; Tel: 203-282-0768.
  - Starwatcher's Decoder Set. For beginners who want to learn the constellations. Kit contains a plastic frame which is held up to the sky with transparent insert sheets that show the stars and constellations.
- CAROLINA BIOLOGICAL SUPPLY COMPANY, 2700 York Road, Burlington, NC 27215, or Box 187, Gladstone, OR 97027, USA.
  #61-2405W Telescope-Astronomy Kit. Includes all components for a six-element lens system, 15× refractor telescope. With instruction manual.
- DAVID CHANDLER CO., P.O. Box 309, La Verne, CA 91750, USA.
  - The Night Sky Star Dial.
- GREENWICH STAR DISC, P.O. Box 88, Brentford, Middlesex TW8 8PD, England.
  - Greenwich Star Disc for latitudes 50°N to 58°N (British Isles and Canada).
- HARRIS HOBBIES, P.O. Box 850237, Richardson, TX 75085-0237, USA; Tel: 214-690-4943.
  - "Geek-Lite" hands-free adjustable red light worn on the head.
- THE M31 COMPANY, 1 Shepard Springs Ct., Durham, NC 27713, USA; Tel: 919-943-6385.
  - "Light Blocker" black cape.
- ROSE STAR PRODUCTS, 2913 Teague Dr., Tyler, TX 75701; Tel: 214-592-5218.
  - Red Lens Dark-Adaptation Astrogoggles.
  - Reusable Heat Packs.
- SKY PUBLISHING CORPORATION, P.O. Box 9111, Belmont, MA 02178-9111, USA.
  - S0008 Precision Planet and Star Locator, available for latitudes 30°, 35°, 40°, 45°, 50°, or in a variable 30°–60° design.
- SMITHSONIAN INSTITUTION, Department 0006, Washington, DC 20073-0006.
  - 6080 Cosmic Constellation Viewer.
  - 6032 Smithsonian Star Finder.

A.7 Printed Materials

The following is a list of selected available astronomy handbooks, textbooks, magazines, and other printed items. Names of frequently-referred-to publishers appear in abbreviated form, the coding being as follows:

AcdP Academic Press, New York/ London.
AdHr Adam Hilger, Bristol/ Philadelphia.
AdWs Addison-Wesley, Menlo Park, California.
AltP Althone Press, London.
ASP Astronomical Society of the Pacific, San Francisco.
BlkS Blackwell Scientific Publishers, Oxford.
CaUP Cambridge University Press, Cambridge/ New York.
CoUP Columbia University Press, New York.
DovP Dover Publications, New York.
EnsP Enslow Publ., Aldershot/ Hillside.
FbFb Faber & Faber, London.
FrbP The Fairborn Press, Mesa, Arizona.
FrmC W.H. Freeman and Company, New York/ San Francisco/ Oxford.
GdBr Gordon and Breach Scientific Publishers, New York/ Paris/ London.
HaRo Harper & Row, New York.
HaUP Harvard University Press, Cambridge (MA).

HoMf Houghton-Mifflin Co., Boston.
JHUP Johns Hopkins University Press, Baltimore.
JoWS John Wiley & Sons, New York/ Chichester.
KlwA Kluwer Academic Publishers, Dordrecht.
McMi MacMillan Co., New York/ Toronto/ London.
MGrH McGraw-Hill Book Co., New York.
MITP MIT Press, Cambridge (MA)/ London.
NorC W.W. Norton and Co., New York.
OxUP Oxford Univerisity Press, Oxford.
PaPH Pachart Publishing House, Tucson.
PlnP Plenum Press, New York.
PngB Penguin Books, London/ New York.
PerP Permagon Press, Oxford.
PrHl Prentice-Hall Press
PrUP Princeton University Press, Princeton.
ReiP Reidel Publishing, Dordrecht.
SaCP Saunders College Publishing, Philadelphia.
ScrS Charles Scribner's Sons, New York
SiSh Simon & Schuster, Inc., New York.
SkyP Sky Publishing Corp., Belmont.
SpVg Springer-Verlag, Berlin/ Heidelberg/ New York.
VNoR Van Nostrand Reinhold Co., New York.
UAzP University of Arizona Press, Tucson.
UCaP University of California Press, Berkeley.
UChP University of Chicago Press, Chicago.
UScB University Science Books, Mill Valley, California.
UTxP University of Texas Press, Austin.
WadP Wadsworth Publishing Co., Belmont, California.
WlmB Willmann-Bell, Inc., Richmond.
YaUP Yale University Press, New Haven/ London.

A.7.1 Observing Handbooks, Guides, Almanacs, Calendars, Catalogues, Atlases, Charts, and Maps

- Acker, A. (ed.): *Catalogue des étoiles les plus brillantes*, Observatoire de Strasbourg Centre de Données Stellaires, Strasbourg (France) 1984.
- Alter, D., Cleminshaw, C.H., Phillips, J.G.: *Pictorial Astronomy* (5th ed.), HaRo 1983.
- *Apparent Places of Fundamental Stars - 1989*, Astronomisches Rechen-Institut, 1989.
- Arp, H.C., Madore, B.F.: *A Catalogue of Southern Peculiar Galaxies, Vols I and II*, CaUP 1987.
- Asimov, I.: *The Universe: From Flat Earth to Quasar* (3rd ed.), Walker, New York 1980.
- *The Astronomical Almanac for the Year 1991*, Nautical Almanac Office, Washington, D.C. 1990.
- *The Astronomical Calendar*, available from Sky Publishing Corp, Belmont. Published yearly.
- *The Astronomical Companion*, available from SkyP. Published yearly.
- Audouze, J., and Israel, G. (eds.): *The Cambridge Atlas of Astronomy*, CaUP 1988.
- Bečvář, A.: *Atlas Coeli 1950.0*, Czechoslovak Academy of Sciences, Prague 1956.
- Bečvář, A.: *Atlas Eclipticalis 1950.0*, Czechoslovak Academy of Sciences, Prague 1958.
- Bishop, R.L. (ed.) : *The Observer's Handbook 1991*, Royal Astronomical Society of Canada, 1990. (Available from SkyP).
- *Bonner Durchmusterung (BD)* of Argelander and Schönfield, 1855.
- Clark, R.N.: *Visual Astronomy of the Deep Sky*, CaUP 1991.
- Consolmagno, G., Davis, D.M.: *Turn Left at Orion*, CaUP 1989.
- Dickinson, T.: *NightWatch: An Equinox Guide to Viewing the Universe*, Camden House/Harrowsmith, Charlotte 1989.

- Duerbeck, H.W.: *A Reference Catalogue and Atlas of Galactic Novae*, ReiP 1987.
- Dunlop, S.: *Astronomy: A Step by Step Guide ot the Night Sky*, Hamlyn, Feltham 1985.
- Dunlop, S. (ed.): *Atlas of the Night Sky*, Newnes, Feltham 1983.
- Eicher, D.J.: *Deep-Sky Observing with Small Telescopes*, EnsP 1989.
- Eicher, D.J.: *The Universe from Your Backyard*, CaUP and SkyP 1988.
- Fjermedal, G.: *New Horizons in Amateur Astronomy*, G.P. Putnam & Sons, 1989.
- Harrington, P.S.: *Touring the Universe Through Binoculars*, JoWS 1991.
- Harmann, W.K., Miller, R.: *Cycles of Fire: Stars, Galaxies, and the Wonders of Deep Space*, Workman Publishing, 1987.
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- *Sky Gazer's Almanac*, SkyP. Published yearly.
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- *Wonders of the Universe Calendar*, available from SkyP. Published yearly.
- Wray, J.: *Color Atlas of Galaxies*, CaUP 1988.

A.7.2 Selected Astronomy Textbooks and Exercise Manuals

- Acker, A., Jaschek, C.: *Astronomical Methods and Calculations*, JoWS 1986.
- Birney, D.S.: *Observational Astronomy*, CaUP 1990.
- Block, D.: *Starwatching*, Lion Publishing Corp, Batavia 1988.
- Brewer, S.G.: *Do-It-Yourself Astronomy*, Edinburgh University Press (available from CoUP) 1988.
- Brück, M.T.: *Exercises in Practical Astronomy Using Photographs*, AdHg 1990.
- Chaisson, E.: *Universe*, PrHl 1988.
- Ferguson, D.C.: *Introductory Astronomy Exercises*, WadP 1990.
- Gainer, M.K.: *Astronomy Laboratory and Observation Manual*, PrHl 1989.
- Gingerich, O. (ed.): *Laboratory Exercises in Astronomy*, available from SkyP.
- Graham-Smith, F., Lovell, B.: *Pathways to the Universe*, CaUP 1988.
- Hartmann, W.K.: *Astronomy: The Cosmic Journey* (4th ed.), WadP 1989.
- Karttunen, H., Kroger, P., Oja, H., Poutanen, M., Donner, K.J. (eds.): *Fundamental Astronomy*, SpVg 1987.
- Kaufmann, W.J.: *Discovering the Universe* (2nd ed.), FrmC 1990.
- Kitchin, C.R.: *Stars, Nebulae, and the Interstellar Medium*, AdHg 1987.
- Kleczek, J.: *Exercises in Astronomy*, KlwA 1987.
- Kutner, M.L.: *Astronomy: A Physical Perspective*, JoWS 1988.
- Moché, D.: *Astronomy — A Self-Teaching Guide*, available from SkyP.
- Moeschel, R.: *Exploring the Sky: 100 Projects for Beginning Astronomers*, Chicago Review, Chicago 1988.
- Moore, P.: *Stars and Planets*, Merehurst, London 1988.
- Pasachoff, J.M.: *Astronomy: From the Earth to the Universe* (4th ed.), SaCP 1991.
- Pasachoff, J.M.: *Contemporary Astronomy*, SaCP 1985.
- Roy, A.E., and Clarke, D.: *Astronomy: Principles and Practice* (3rd ed.), AdHg 1988.
- Roy, A.E., and Clarke, D.: *Astronomy: Structure of the Universe* (3rd ed.), AdHg 1989.
- Schlosser, W., Schmidt-Kaler, T., Milone, E.F.: *Challenges of Astronomy: Hands-on Experiments for the Sky and Laboratory*, SpVg 1991.
- Seeds, M.: *Foundations of Astronomy*, WadP 1990.
- Shu, F.: *The Physical Universe*, UScB 1982.
- Tattersfield, D.: *Projects and Demonstrations in Astronomy*, JoWS 1979.
- Unsöld, A., and Baschek, R.B.: *The New Cosmos*, SpVg 1983.
- Vorontsov-Vel'yaminov, B.A.: *Essays About the Universe*, Mir Publishers (distributed by Imported Publications, Inc., Chicago), 1985.
- Waxman, J.: *A Workbook for Astronomy*, CaUP 1984.
- Zeilik, M., Smith, E.: *Introductory Astronomy and Astrophysics*, SaCP 1989.

A.7.3 Advanced Textbooks and Monographs

- Aller, L.H.: *Atoms, Stars, and Nebulae* (3rd ed.), CaUP 1991.
- Aller, L.H.: *Physics of Thermal Gaseous Nebulae*, ReiP 1984.
- Böhm-Vitense, E.: *Introduction to Stellar Astrophysics Vol. 1: Basic Stellar Observations and Data*, CaUP 1989.
- Böhm-Vitense, E.: *Introduction to Stellar Astrophysics Vol. 2: Stellar Atmospheres*, CaUP 1989.
- Böhm-Vitense, E.: *Introduction to Stellar Astrophysics Vol. 3: Stellar Structure and Evolution*, CaUP 1991.
- Bowers, R.L., Wilson, J.R.: *Numerical Modeling in Applied Physics and Astrophysics*, Jones and Bartlett, 1991.
- Celnikier, L.M.: *Basics of Cosmic Structures*, Editions Frontières, France 1989.
- Chandrasekhar, S.: *An Introduction to the Study of Stellar Structure*, DovP 1939.
- Chandrasekhar, S.: *Radiative Transfer*, DovP 1950.
- Chandrasekhar, S.: *Selected Papers, Vol. 1: Stellar Structure and Stellar Atmospheres*, UChP 1989.
- Collins, G.W.: *The Fundamentals of Stellar Astrophysics*, FrmC 1989.
- Davies, P.C.W.: *Superforce*, Heinemann, London 1984.

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- Dalgarno, A., Layzer, D.: *Astrophysical Plasmas*, CaUP 1987.
- Demianski, M.: *Relativistic Astrophysics*, Pergamon, Oxford 1985.
- Eddington, A.S.: *The Internal Constitution of the Stars*, reissued by CaUP 1988.
- Eddington, A.S.: *Space, Time and Gravitation*, reissued by CaUP 1987.
- Encrenaz, T.: *The Solar System*, SpVg 1990.
- Gaisser, T.K.: *Cosmic Rays and Particle Physics*, CaUP 1990.
- Ginzburg, V.L.: *Physics and Astrophysics, a Selection of Key Problems*, Pergamon Press, Oxford 1985.
- Goldberg, H.S., Scadron, M.D.: *Physics of Stellar Evolution and Cosmology*, GdBr 1981.
- Gribbin, J.: *In Search of Schrödinger's Cat*, Wildwood House, 1984.
- Harwit, M.: *Astrophysical Concepts* (2nd ed.), SpVg 1988.
- Hey, T., Walters, P. (eds.): *The Quantum Universe*, CaUP 1987.
- Katz, J.I.: *High Energy Astrophysics*, AdWs 1988.
- Kippenhahn, R., Weigert, A.: *Stellar Structure and Evolution*, SpVg 1990.
- Kitchin, C.R.: *Astrophysical Techniques*, AdHg 1984.
- Kormendy, J. (ed.): *Dark Matter in the Universe* (IAU Symposium No. 117), ReiP 1987.
- Léna, P.: *Observational Astrophysics*, SpVg 1988.
- Longair, M.S.: *Theoretical Concepts in Physics*, CaUP 1984.
- Osterbrock, D.E.: *Astrophysics of Gaseous Nebulae and Active Galactic Nuclei*, UScB 1989.
- Piddington, J.H.: *Cosmic Electrodynamics*, Krieger, Florida 1981.
- Rolfs, C.E., Rodney, W.S.: *Cauldrons in the Cosmos: Nuclear Astrophysics*, UChP 1988.
- Roy, A.E.: *Orbital Motion*, AdHg 1988.
- Rybicki, G.B., and Lightman, A.P.: *Radiative Processes in Astrophysics*, JoWS 1985.
- Sanchez, F., Vazquez, M. (eds.): *New Windowns on the Universe* (2 vols.), CaUP 1991
- Saslaw, W.: *Gravitational Physics of Stellar and Galactic Systems*, CaUP 1985.
- Scheffler, H., Elsässer, H. (trans. A.H. Armstrong): *Physics of the Galaxy and Interstellar Matter*, Astronomy and Astrophysics Library, SpVg 1987.
- Sexl, R., and Sexl, H.: *An Introduction to Relativistic Astrophysics*, Academic Press, San Diego 1979.
- Seymour, P.: *Cosmic Magnetism*, AdHg 1986.
- Shapiro, S.L., and Teukolsky, S.A.: *Black Holes, White Dwarfs, and Neutron Stars*, JoWS 1983.
- Shapiro, S.L., and Teukolsky, S.A. (eds.): *Highlights of Modern Astrophysics*, JoWS 1986.
- Stephani, H.: *General Relativity*, CaUP 1982.
- Unsöld, A.: *Physik der Sternatmosphären* (Reprint of 2nd ed.), SpVg 1968.
- Vangioni-Flam, E., Cassé, M., Audouze, J., Tran Thanh Van, J. (eds.): *Astrophysical Ages and Dating Methods*, Editions Frontières, France 1990.
- Wehrse, R. (ed.): *Accuracy of Element Abundances from Stellar Atmospheres*, SpVg 1990.

A.7.4 General Reference Books and Encyclopedias

- Allen, C.W.: *Astrophysical Quantities*, AltP 1973.
- *Apparent Places of Fundamental Stars - 1991*, Astronomisches Rechen-Institut, 1990.
- Cotardière, P. de la (ed.): *Larousse Astronomy*, Hamlyn, 1987.
- Curtis, A.R.: *Space Almanac*, Arcsoft Publishers, 1989.
- Flügge, S. (ed.): *Handbuch der Physik. Gruppe XI. Astrophysik* (5 vols.), SpVg 1958-60.
- Heck, A.: *Acronyms & Abbreviations in Astronomy & Space Sciences*, Observatoire Astronomique, Strasbourg 1990.
- Illingworth, V. (ed.): *The Facts on File Dictionary of Astronomy*, McMi and SkyP 1990.
- Illingworth, V. (ed.): *The Macmillan Dictionary of Astronomy*, Macmillan, London 1985.
- Landolt-Börstein: *Zahlenwerte und Funktionen aus Naturwissenschaft und Technik, Neue Serie, Gruppe VI: Astronomie, Astrophysik und Weltraumforschung*, SpVg 1982.

- Lang, K.R.: *Astrophysical Formulae*, SpVg 1980.
- Lang, K.R.: *Astrophysical Data: Planets and Stars*, SpVg 1991.
- Lang, K.R.: *Astrophysical Data: Galaxies* SpVg 1991.
- Makower, J. (ed.): *The Air and Space Catalogue*, Vintage Books, 1989.
- Man, J., Wace, M. (eds.): *The Astronomer's Library* (2 vols.), W.H. Smith Publ., New York 1989.
- Meyers, R.A. (ed.): *Encyclopedia of Astronomy and Astrophysics*, Academic Press, San Diego 1988.
- Moore, P.: *The Guinness Book of Astronomy*, Guinness Books, 1988.
- Moore, P.: *Patrick Moore's A–Z of Astronomy*, Stephens, Wellingborough 1986.
- Qudouze, J., Israel, G., Falque, J.-C.: *The Cambridge Atlas of Astronomy*, CaUP 1988.
- Parker, S.P. (ed.): *McGraw-Hill Encyclopedia of Astronomy*, MGrH 1983.
- Plant, M.: *Dictionary of Space*, Layman, Harlow 1986.
- Rycroft, M.: *The Cambridge Encyclopedia of Space*, CaUP 1991.
- Shore, S. (ed.): *Encyclopedia of Astronomy and Astrophysics*, AcdP 1989.
- Time-Life Books, Editors of: *Voyage Through the Universe* (approx. 20 vols.), Time-Life Books, Inc., Richmond 1990.
- Tyson, N.: *Merlin's Tour of the Universe*, CoUP 1989.
- Walker, P.M.B: *Cambridge Air and Space Dictionary*, CaUP 1990.
- Williamson, M.: *Dictionary of Space Technology*, AdHg 1990.
- Zombeck, M.V.: *Handbook of Space Astronomy and Astrophysics* (2nd ed.), CaUP 1990.

A.7.5 Reviews, Overviews, and Collections

- *Annual Review of Astronomy and Astrophysics*, Annual Reviews Inc., Palo Alto. Published annually.
- Asimov, I.: *The Secret of the Universe*, Doubleday Books, New York 1991.
- Beatty, J.K., Chaikin, A. (eds.): *The New Solar System* (3rd ed.), CaUP 1990.
- Beer, P. (ed.): *Vistas in Astronomy, Volume 26*, Pergamon, Oxford 1985.
- Bertola, F., Sulentic, J.W., Madore, B.F. (eds.): *New Ideas in Astronomy*, CaUP 1988.
- Blanco, V.M., Phillips, M.M.: *Progress and Opportunities in Southern Hemisphere Optical Astronomy*, Brigham Young University Press, Provo 1988.
- Cordova, F. (ed.): *Multiwavelength Astrophysics*, CaUP 1988.
- Dunlop, S., Gerbaldi, M. (eds.): *Stargazers: The Contributions of Amateur Astronomers*, Proceedings of Colloquium 98 of the IAU, 1987 June 20–24, SpVg 1988.
- Dyson, F.: *Infinite in all Directions*, PngB 1989.
- Fabian, A.C. (ed.): *Origins: The Darwin College Lectures*, CaUP 1988.
- Gustaffsson, B., Nissen, P.E. (eds.): *Astrophysics: Recent Progress and Future Possibilities*, The Royal Danish Academy of Science and Letters, Cophenhagen 1990.
- Henbest, N. (ed.): *Observing the Universe*, Blackwell, Oxford, and New Scientist 1984.
- Klare, G. (ed.): *Reviews in Modern Astronomy 1*, SpVg 1988.
- Klare, G. (ed.): *Reviews in Modern Astronomy 2*, SpVg 1989.
- Lang, K.R., Whitney, C.A.: *Exploration and Discovery in the Solar System*, CaUP 1991.
- Lugger, P. (ed.): *Asteroids to Quasars: A Symposium for the 60th Birthday of William Liller*, CaUP 1991.
- McNally, D. (ed.): *Highlights of Astronomy, Vol. 8*, KlwA 1989.
- Morrison, D., Wolff, S.C.: *Frontiers of Astronomy*, SaCP 1990.
- Morrison, P.: *Philip Morrison's Long Look at the Literature*, FrmC 1990.
- National Research Council (ed.): *The Decade of Discovery in Astronomy and Astrophysics*, National Academic Press, 1991.
- Osterbrock, D. (ed.): *Stars and Galaxies: Citizens of the Universe*, FrmC 1990.
- Philip, A.G.D., Upgren, A.R. (eds.): *Star Catalogues: A Centennial Tribute to A.N. Vyssotsky*, L. Davis Press, Schenectady, New York 1989.
- Preiss, B., Fraknoi, A. (eds.): *The Universe*, Bantam Books, 1988.
- Smoluchowski, R., Bahcall, J.N., Matthews, M. (eds.): *The Galaxy and the Solar System*, UAzP 1986.
- Sutton, C. (ed.): *Building the Universe*, Basil Blackwell, Oxford 1985.
- Swings, J.-P. (ed.): *Transactions of the IAU Vol. XXA (Reports 1988). Reports on Astronomy*, KlwA 1988.

- Wall, J.V., Boksenberg, A.: *Modern Technology and its Influence on Astronomy*, CaUP 1990.
- West, R.M. (ed.): *Reports on Astronomy, Transactions of the International Astronomical Union Vol. XIXA*, ReiP 1985.

A.7.6 Children's Books

There are quite a few books on the market today which are especially suitable for young children (ages 3 to 12) and adolescents. Suggested ages are given when they have been provided by the publisher. For more complete listings of books for juveniles, refer to R.R. Robbins and A. Fraknoi: *The Universe at Your Fingertips* (IAU Commission 46 Report, August 1985) and R.R. Robbins: *Astronomy Education Materials in Print 1985–1987* (IAU Commission 46 Report, August 1988).

- Apfel, N.: *Astronomy Projects for Young Scientists*, 1984.
- Apfel, N.: *The Moon and its Exploration*, Watts, 1982.
- Asimov, I.: *Isaac Asimov's Library of the Universe*. 4 volumes: The Earth's Moon, *The Sun*, *Our Solar System*, and *Our Milky Way and Other Galaxies*. For ages 8–12, available from the ASP.
- Becklake, S.: *Space – Stars, Planets & Spacecraft*, Dorling Kindersley, 1988. Ages 11–14 years.
- Berger, M.: *Bright Stars, Red Giants, and White Dwarfs*, Putnam, 1983.
- Blumberg, R.: *The First Travel Guide to the Moon*, Four Winds, 1980.
- Branley, F.: *Comets*, HaRo. Also available from ASP.
- Branley, F.: *The Sky is Full of Stars*, HaRo 1981. Ages 3–9. Available from the ASP as part of a two book set with Branley's book on the planets (see below).
- Branley, F.: *The Planets in Our Solar System*, HaRo 1981. Ages 3–9 years.
- Branley, F.: *Sunshine Makes the Seasons*, HaRo. Ages 3–9. Available from ASP.
- Branley, F.: *Uranus: The Seventh Planet*, Comwell/HaRo 1988.
- Branley, F.: *What the Moon Is Like*, HaRo. Ages 3–9. Available from ASP.
- Burnham, R.: *The Star Book*, CaUP 1983.
- Butterfield, M.: *Satellites and Space Stations*, Usborne Publishing Ltd., 1985.
- Chandler, D.: *Exploring the Night Sky with Binoculars*, David Chandler Co. For older children and teens.
- Deutsch, K.: *Space Travel in Fact and Fiction*, Watts, 1980.
- Embury, B.: *The Dream is Alive: A Flight Aboard the Space Shuttle*, HaRo 1990. Ages 9 and up. Available from ASP.
- Gatland, K.: *The Young Scientist Book of Spaceflight*, Usborne Publishing Ltd., 1982.
- Goldsmith, D.: *What is a Star?*, Interstellar Media, 1979.
- Hadley, E. and T.: *Legends of the Sun and Moon*, CaUP 1983.
- Henbest, N.: *Spotter's Guide to the Night Sky*, Mayflower, 1979.
- Hirst, R., Hirst, S.: *My Place in Space*, Orchard Books, 1988. Available from ASP.
- Krupp, E., Krupp, R.: *The Big Dipper and You*, Morrow, 1989. Ages 5–12. Available from ASP.
- Lewellen, J.: *Moon, Sun, and Stars*, Children's, 1981.
- Maynard, C.: *The Young Scientist Book of Stars and Planets*, Usborne Publishing Ltd., 1977.
- McGowan, T.: *Album of Space Flight*, Rand McNally, 1982.
- Moché, D.: *Astronomy Today*, Kingfisher (Random House in U.S.), 1984. Ages 9–15.
- Moché, D.: *My First Book About Space*, Random House, 1982.
- Moore, P.: *Astronomy for the Under Tens*, George Philip, 1986.
- Moore, P.: *The Space Shuttle Action Book*, Random House, 1983.
- Moore, P.: *Space Travel for the Under Tens*, George Philip, 1988.
- Moore, P.: *Travellers in Time and Space*, Park Lane Press, 1983. Aimed at youngsters but suitable for beginners of any age.

- Myring, L., and Snowden, S.: *Sun, Moon, and Planets*, Usborne, 1982.
- Neri, R.: *The Blue Planet: A Trip to Space*, Vantage Press, New York 1989.
- Osman, T.: *Space History*, Michael Joseph, 1983.
- Ottewell, G.: *To Know the Stars*, Furman University, 1982.
- Parker, E.: *The Universe*, CUP/Dinosaur, 1983. For children 7 and younger.
- Pasachoff, J.: *Peterson First Guide to Astronomy*, HoMf, 1988.
- Porcellino, M.R.: *A Young Astronomer's Guide to the Night Sky*, TAB Books, Blue Ridge Summit, PA 1990.
- Rey, H.A.: *The Stars: A New Way to See Them*, HoMf 1975.
- Ridpath, I.: *Secrets of the Sky*, Hamlyn Publ., 1985. For ages 11–13 years.
- Ridpath, I.: *The Young Astronomer*, Hamlyn Publ., 1981. Suitable for beginners of all ages.
- Ronan, *The Practical Astronomer*, Pan, 1981. Ages 11–14.
- Schaaf, F.: *Seeing the Sky: 100 Projects, Activities, and Explorations in Astronomy*, JoWS 1990. Ages 12 and up.
- Schaaf, F.: *Seeing the Solar System: Telescopic Astronomy Projects*, JoWS 1991.
- Seymour, P.: *Adventures with Astronomy*, Murray, 1983. (a book of projects). Ages 11–14 years.
- Simon, T.: *The Search for Planet X*, Scholastic Book Services, 1962.
- Sullivan, N.: *Pioneer Astronomers*, Scholastic Book Services, 1964.
- Taylor, G.J.: *Volcanoes in Our Solar System*, Dodd, 1983.
- Thompson, C.E.: *Glow in the Dark Constellations*, Science News Books, 1989. Contains glow-in-the-dark illustrations of major constellations. Ages 6 to 10.
- Usborne Explainers Series: *First Guide to the Universe*, Usborne Publishing Ltd, 1982. Actually contains three books in one volume: *Finding Out About Rockets and Spaceflight*, *Finding Out About Sun, Moon, and Planets*, and *Finding Out about Our Earth.*
- Usborne Hobby Guides: *The Young Astronomer*, Usborne Publishing.
- VanCleave, J.P.: *Astronomy for Every Kid: 101 Easy Experiments that Really Work*, JoWS 1989.
- Vautier, G.: *The Way of the Stars*, CaUP 1983.
- Whitney, C.: *Whitney's Star Finder*, Knopf, 1984. For "older" children.
- Zim, H., and Baker, R.: *Stars*, Golden Books, 1975.

A.7.7 Magazines, Periodicals, and Newsletters

The following are devoted almost exclusively to astronomy (particularly the observing aspect) and astronomy education:

- *Abrams Planetarium Sky Calendar* — A one-page calendar of celestial events, backed by a star chart of the entire visible sky. Contact: Abrams Planetarium, Michigan State University, East Lansing, MI 48823. Also available free with membership in the ASP (see below)
- *Astrofax* — A quarterly bulletin which details all postal items with astronomical or space-related designs. Write: George G. Young, P.O. Box 632, Tewksbury, MA 01876, USA, or Dr. Michael A. Seeds, Astronomy Program, Franklin & Marshall College, Lancaster, PA 17604-3003, USA.
- *The Astrograph* — A magazine devoted exclusively to astrophotography. Write: THE ASTROGRAPH, Box 2283, Arlington, VA 22202, USA; Tel: 703-830-2229.
- *The Astronomer* — A monthly magazine devoted primarily to reporting observations and discoveries of amateurs worldwide. Write: John Colls, 177 Thunder Lane, Norwich, NR7 0JF; Tel: 0603-36695.
- *Astronomy* — Published monthly, provides news and information on all aspects of astronomy with emphasis on observations. Write: ASTRONOMY, 21027 Crossroads Circle, P.O. Box 1612, Waukesha, WI 53187-1612; Tel: 414-796-8776 (ask for Customer Service).
- *Astronomy Industry Newsletter & Catalogue* — Published by SUNWEST SPACE SYSTEMS, P.O. Box 20500, St. Petersburg, FL 33742; Tel: 813-577-0629.

- *The Journal of Astronomy Education* — Published by the AAE. Contact: Dr. Wayne Osborn, Physics Dept., Central Michigan University, Mt. Pleasant, MI 48858, USA.
- *Astronomy Educator* — Published 9 times a year as a supplement to *Astronomy* magazine. Provides news on astronomy and space education, a forum of ideas from astronomy educators, an activities section designed for use in the classroom, and a teachers' resource section. Write: same address and number as *Astronomy* magazine.
- *Astronomy Now* — A monthly periodical edited by astronomer Patrick Moore. Write: ASTRONOMY NOW, 193 Uxbridge Road, London W12 9RA, England.
- *The Astronomy Quarterly* — Devoted especially to astronomy education and historical astronomy. Contact: PACHART PUBLISHING, 1130 San Lucas Circle, Tucson, AZ 85704, USA.
- *The Astro-Trader* — Publishes bi-weekly classified advertisements for astronomy. Write: ASTRO-TRADER, P.O. Box 155 Casa Grande, AZ 85222, USA. Tel: 602-836-6890.
- *Celestial Computing: A Journal for Personal Computers and Celestial Mechanics* — A new publication aimed at owners of personal computers who wish to do their own programming of orbital calculations, occultations, eclipses, etc. Published quarterly, each issue (at an additional cost) is accompanied by an IBM PC diskette containing programs discussed in the issue. Write: SCIENCE SOFTWARE, 7370 S. Jay St., Littleton, CO 80123, USA.
- *Deep Sky* — Published quarterly and devoted to deep-sky observing and astrophotography. Write: TELESCOPE MAKING/DEEP SKY, Subscription Department, 1027 North Seventh Street, Milwaukee, WI 53233-9968.
- *Final Frontier* — Published bi-monthly. Magazine devoted to all facets of space exploration. Write: FINAL FRONTIER, P.O. Box 3803, Escondido, CA 92025-9562, USA.
- *Gnomon* — Newsletter of the AAE, sent three times yearly. Contains information on activities within the AAE and articles on pure astronomy as well as on current educational issues.
- *Griffith Observer* — Published monthly. Write: GRIFFITH OBSERVATORY, 2800 E. Observatory Rd., Los Angeles, CA 90027, USA.
- *Guide to the Night Sky* — A free monthly guide. Write: Astronomy Department, National Museum of Science and Technology, 1867 St. Laurent Blvd, Ottawa, Ontario, Canada K1A 0M8.
- *IAU Circulars* — Postcard-sized notifications (approximately 10 per month) of information about astronomical phenomena that requires prompt dissemination. Also available via "computer service" (see Section 28.4.3.4). Contact: Central Bureau for Astronomical Telegrams, Smithsonian Astrophysical Observatory, Cambridge, MA 02138, USA.
- *International Comet Quarterly* — Information and news on comets. Write: Mail Stop 18, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge MA 02138, USA.
- *Journal for the History of Astronomy* — Features scholarly papers, book reviews, and notes. Published three times a year by SCIENCE HISTORY PUBLICATIONS LTD., Halfpenny Furze, Mill Lane, Chalfont St. Giles, Bucks HP8 4NR, England. A supplement *Archeoastronomy* is published annually.
- *Mercury* — Published bimonthly by the ASP. Write: ASTRONOMICAL SOCIETY OF THE PACIFIC, 390 Ashton Ave., San Francisco, CA 94112, USA.
- *News! from the Naval Observatory* — A monthly newsletter which includes a guide to the sky. Write: U.S. Naval Observatory, 34th & Massachusetts Ave., NW, Washington, DC 20390, USA.
- *Night Skies* — An astrophotography magazine from: HOBBY PUBL., P.O. Box 1567, Lynwood, CA 90262, USA.
- *Odyssey* — A colorful astronomy magazine for children. Published by Kalmbach Publishing, 1027 N. 7th St., Milwaukee, WI 53233.
- *The Planetarian* — Published quarterly by the IPS.
- *The Planetary Report* — Magazine available to members of the PLANETARY SOCIETY.
- *Radio Astronomy* — A monthly publication by SARA for radio astronomers.

- *The Reflector* — An extensive newsletter from the Astronomical League (see Section 28.3.8 Societies and Clubs) containing a consumer column evaluating astronomical equipment.
- *Sky & Telescope* — A monthly magazine devoted to most aspects of observational astronomy in the northern hemisphere. Write: SKY PUBLISHING CORPORATION, P.O. Box 9111, Belmont, MA 02178-9111, USA.
- *Sky Views* — A monthly newsletter containing charts, calendars, letters, etc. Write: SKYVIEWS, 130 E. Main St., Suite 168, Medford, OR 97501, USA; Tel: 503-772-8776.
- *Space Education* and *Spaceflight* — Publications of the BIS.
- *Space World Magazine* — Published in cooperation with the National Space Institute, P.O. Box 7535, Ben Franklin Station, Washington, DC 20044, USA.
- *The Starry Messenger* — A monthly publication containing advertisements for buying and selling used telescopic equipment. Write: THE STARRY MESSENGER, P.O. Box 4823-N, Ithaca, NY 14852, USA; Tel: 201-992-6865.
- *StarDate* — Published bimonthly by the McDonald Observatory of the University of Texas, and containing scientific articles as well as star charts, sky calendars, and advice on star gazing. Also explores the human aspects of astronomy. Sample copies available. Write: STARDATE, The University of Texas, RLM 15.308, Austin, TX 78712, USA.
- *The Strolling Astronomer* — Published by ALPO. Contains articles, book and film reviews, etc.
- *Telescope Making* — Published quarterly. Title tells the content. Write: same as *Deep Sky* above.
- *The Universe in the Classroom* — A quarterly free newsletter on teaching astronomy in grades 3–12. Cosponsored by all three of the professional astronomical organizations in North America (the AAS, ASP, and the CAS), the newsletter is distributed to about 20,000 teachers and curriculum specialists around the world. Contact: ASTRONOMICAL SOCIETY OF THE PACIFIC, Teacher's Newsletter, Dept. N, 390 Ashton Ave., San Francisco, CA 94112.

The following science periodicals frequently contain news, information, and articles on astronomy:

- *American Scientist* — Published bimonthly by Sigma Xi, The Scientific Research Society, 345 Whitney Ave., New Haven, CT 06511, USA; Tel: 203-624-9883.
- *Discover* — From TIME-LIFE BOOKS, INC.
- *Mosaic* — Published by the NATIONAL SCIENCE FOUNDATION.
- *National Geographic* — Published monthly by the NATIONAL GEOGRAPHIC SOCIETY.
- *Nature* — Published monthly.
- *New Scientist* — British weekly science magazine but containing science news from all around the world. Write: HOLBORNE PUBLISHING, Commonwealth House, 1-19 New Oxford St., London WC1A 1NG England.
- *Physics Today* — Published monthly by the AIP and distributed to members of AIP societies.
- *Report to Educators* — A quarterly periodical of the EDUCATIONAL AFFAIRS DIVISION, Code XE, NASA, Washington, DC 20546. Contact: Dr. Robert W. Brown, Director.
- *Science News* — A weekly newsmagazine for science. Almost always contains articles on astronomy as well as latest discoveries. Write: SCIENCE SERVICE, INC., 1719 N. St., N.W., Washington, DC 20036.
- *The Sciences* — From the NEW YORK ACADEMY OF SCIENCES.
- *Scientific American* — Published monthly.
- *Smithsonian* — Published monthly by the Smithsonian Associates, 900 Jefferson Dr., Washington, DC 20560.