PART 2. PUBLICATION AND ACQUISITION OF BOOKS AND JOURNALS

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THE FUTURE OF ASTRONOMICAL LITERATURE

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I. INTRODUCTION

This is a historic occasion for astronomical librarians because, in many cases, this is your first opportunity to meet each other in person and to discuss mutual problems. Astronomical librarians have always been more internationally minded than most librarians and people, because you are used to exchanging literature with even the most distant observatories and countries, independent of political and transportation barriers. However, some of the problems that you now face cannot be solved alone, so we meet partly to cooperate in finding solutions. This meeting was also planned to learn what is being done in new technologies and information retrieval so that we will become aware of current and coming opportunities and changes.

A college president was once asked what are the greatest problems that he faced. Without hesitation he said "Salaries for the faculty, parking for the students, and football for the alumni!" So what are the greatest problems for astronomical libraries? As I see them, they are (1) our journals and books are growing so rapidly that most libraries have run out of shelf space, (2) the costs of those journals and books are growing faster than most library budgets, and (3) we wonder about the coming technologies, and how our library will change in coming years. Therefore I would like to discuss these three problems of space, costs, and future technologies with regard to journals and other publications.

II. SPACE

Many, but not all, journals are growing at exponential rates with doubling times as short as about 10 years. Most libraries cannot expand that fast. What is to be done? Will this growth rate continue indefinitely? If so, how can journals fit onto the shelves?

First let us look at the current growth rate and what drives it. The first graph shows data for the interval 1970 to 1985. At the bottom are the numbers of American astronomical papers and

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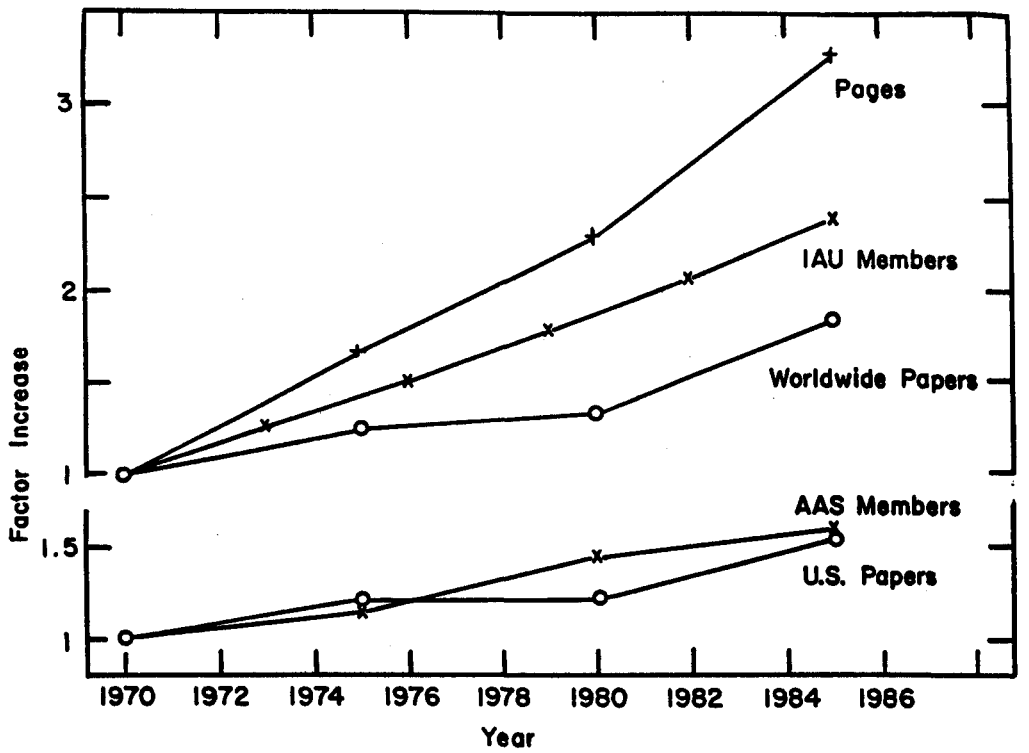


monographs as listed in Astronomy and Astrophysics Abstracts; they have grown from 2923 papers in 1970 to 4527 papers in 1985, an increase of 55%. But during that time the number of members of the American Astronomical Society grew by 60%. So in general, the number of papers published is proportional to the number of astronomers, or the average number of papers published per astronomer is constant. I do not see a leveling off in the number of professional astronomers, so you can expect a continued increase in the size of our literature.

If we look at the worldwide astronomical literature, we see a parallel growth until about 1980 and then a more rapid growth; all the papers listed in Astronomy and Astrophysics Abstracts grew from 7772 in 1970 to 14302 in 1985, an increase of 84%. But during that time the number of IAU members increased by 139%. Evidently the IAU is accepting more people who are not frequent publishers of research papers. But we see that the number of worldwide papers is increasing steadily because of increasing numbers of astronomers. Again there is no evidence in sight of a leveling or decrease of astronomers, so the literature will continue to increase.

But you librarians are not concerned with numbers of papers, but rather with numbers of pages published. That is increasing even faster than the number of astronomers because the papers are increasing in length. The top curve shows the data for the Ap.J., A.J., and PASP combined, and shows an exponential increase with a doubling in 9.3 years. So that is the problem faced by your librarians. Some of this is diminished by journals growing taller, not just fatter, and printing more words per page, but the number of cubic meters of journals is growing at an exponential rate.

Why are papers getting longer? I do not know for sure. Astronomical papers were constant in content from 1900 to World War II but since then they have grown from an average of three pages to 11 pages, normalized to 1000-word contents. I hope that it is because authors can now do much more with their data with their new computer and detector technology and increased astrophysical capabilities. Also the accumulation of knowledge requires more intercomparisons of results. I do not see this trend changing.

I see three solutions to the space problem. One is to share collections. If two astronomical libraries exist in the same city, they can split between them some of the journal subscriptions that they need. Or through electronic mail the needed papers can be transmitted quickly from one city to another, so libraries no longer have to be as complete as before. Second, a solution that the physics librarians are looking forward to is having journals produced on compact disks, such as CD-ROMs. They propose subscribing to both paper and compact disk forms, and then throwing away the paper editions after about two years. A third solution is to have most or all libraries connected to a central memory bank. Then to read, or make a copy of, a given paper, one needs only to know the 30- or 40- digit code to find it in the memory. Undoubtedly at some future time most or all of the scientific literature of the world will be available in a central memory bank. Then the astronomical librarians will have to decide what part they wish to keep on their shelves and what part to access by computer. I suspect that the choice will be determined by cost or usage. For those journals and books used frequently, it may be cheaper to buy them on compact disk. For those used rarely, it may be cheaper to connect with the central memory bank.

Compact disks are cheap; a $15 CD can store as much material as a cubic meter of printed material. But the costs of journals involve funding the whole editorial, typesetting, and printing operation. Compact disks may save only the paper costs, which are typically 5% of the total production costs. Therefore compact disk subscriptions will not be significantly cheaper than paper editions.

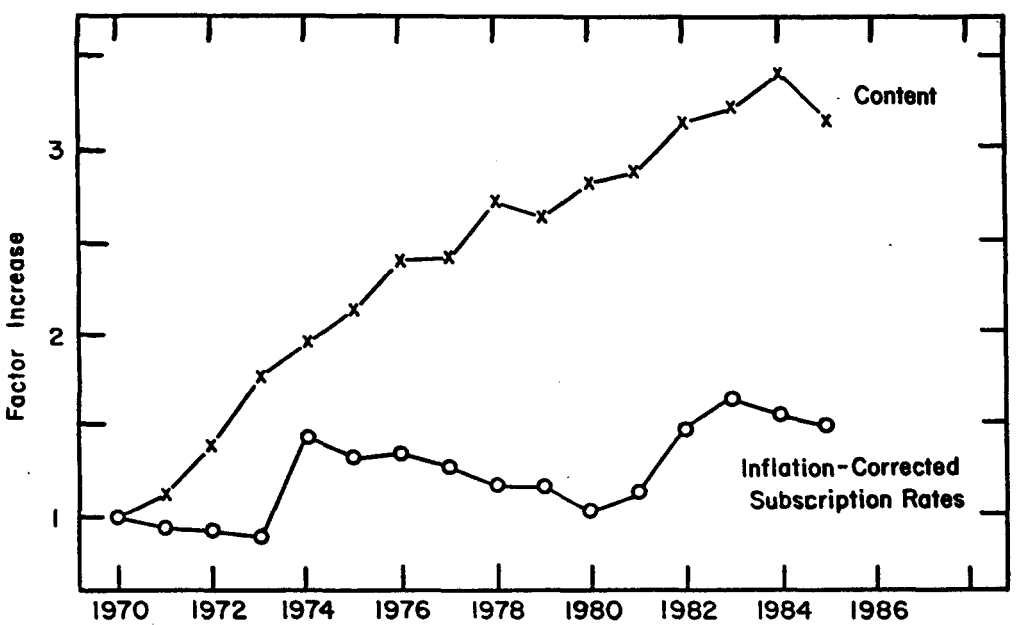
One thing that I do not recommend is intermediate or dead-end solutions. For instance, we started publishing the Astrophysical Journal on microfiche because I thought that librarians would welcome the large reduction in shelf space. We found that essentially no libraries subscribe to the microfiche edition because, I am told, the microfiche sheets "walk out of the libraries." Will compact disks walk out of libraries? They probably contain so much material that it will be worthwhile devising a security system for them. Microfilm is too slow for access to be practical.

What we learn from this discussion of space is: do not expect journals to grow smaller and do not expect a relief until we have journals on compact disks or by access to a central memory bank of literature. In the meantime, share collections.

III. COSTS

Why are journal costs increasing by about 16% per year, which is faster than most library budgets are increasing, and what can librarians do about that?

The next graph shows, at the bottom, the library subscription rates, corrected for inflation, for the Astrophysical Journal. We see that the rate has increased by only 55% in 15 years, or an average of 3% per year. At the top is the relative Journal content, normalized to 1000-word pages; it has grown by more than a factor of 3. What has happened is that improvements in technology have nearly paid for the increased content. Those improvements include computerized typesetting, competitive bidding, larger printing presses, and the most efficient page size for the presses. If your journal expenditures are growing more rapidly than 3% per year, it is due mainly to inflation, adverse money exchange rates, and the proliferation of small expensive journals. Secondary factors are increasing numbers of journals, inefficient production techniques, and profit taking.



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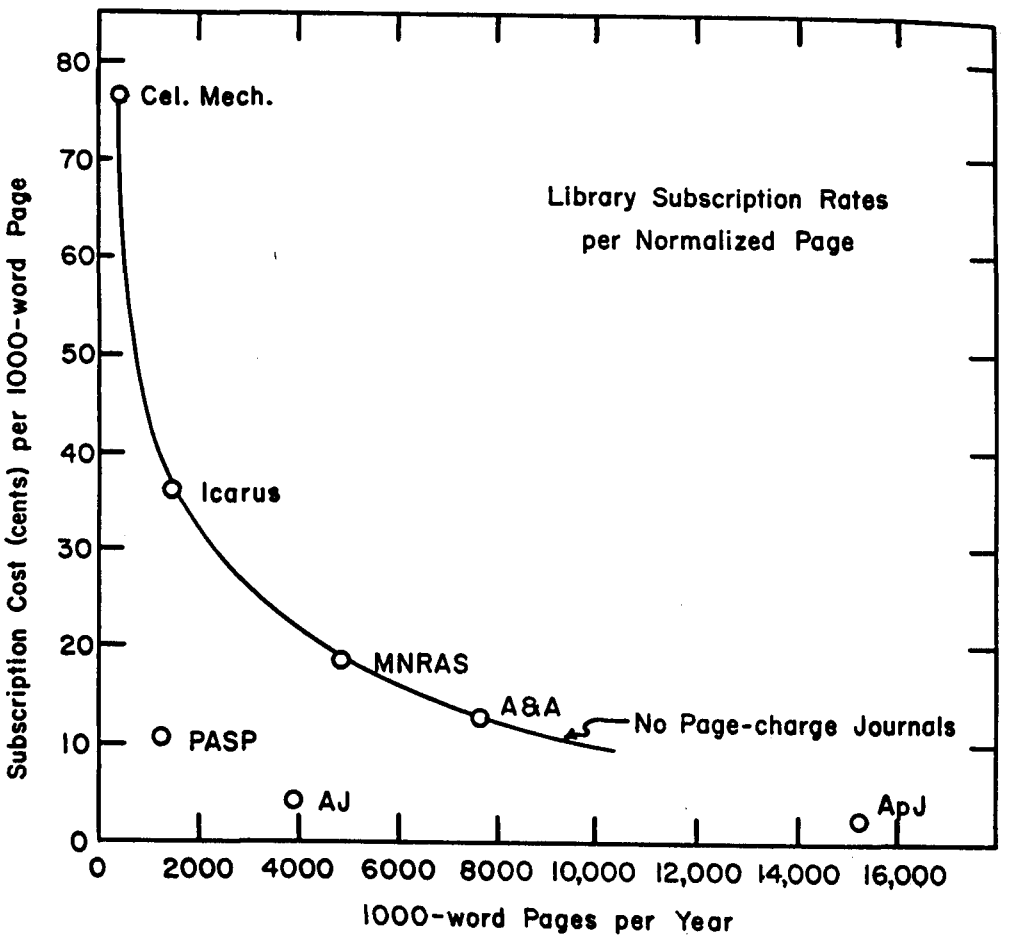
The next graph shows the library subscription costs for various astronomical journals. The costs are expressed as cents per page of 1000 words content. At the bottom are the journal contents in 1000-word pages per year. We see two things. First, for the journals with no page charges, there is a simple inverse relation between cost and size. It is such that if you double the journal content, the cost per page is divided by two. You could have guessed that because the subscription rates are roughly the same for all these journals, namely between $350 and $1000 per year, but the contents range over a factor of 20. This relation tells you that small journals are inefficient and that you get much more for your money in the large general journals. Of course individual astronomers like small specialty journals because they are interested in a larger fraction of the papers contained. But individuals do not pay for the production of the journals. They pay only for the paper, printing, and mailing of their own copies, while the libraries pay in addition for all of the editorial and composition costs. So to save your budgets, campaign against small inefficient journals.



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Let me give an example. Celestial Mechanics and the Astrophysical Journal had nearly identical subscription rates in 1987 of $349 and $375, respectively. If all the Celestial Mechanics papers were put into the Ap.J., the subscriptions rates for the Ap.J. would not change, the Celestial Mechanics papers would be published in half the time, individuals and libraries subscribing to only one of these journals would pay the same amount for the combined material, but libraries subscribing to both journals would save 50%.

The other thing shown by this graph is that the journals charging page charges are cheaper by a factor of about 4. That occurs because they tend to receive 2/3 of their income from page charges and, as non-profit journals, they do not have the 30% profit that commercial publishers strive to attain.

The system of page charges is such that the organizations that publish the most papers pay a much larger share of the costs of producing the journals than the organizations that publish very few papers. For instance, Harvard, Goddard Space Flight Center, Colorado, Caltech, and Arizona each pay more than $50,000 per year to support the Ap.J. while small organizations publishing only one or two papers per year pay $1000-$2000. Yet ironically it is the small organizations that resent the system of page charges and would prefer that all the income come from subscription costs, which means that all organizations pay the same amount.

What we conclude from this discussion of costs is (1) hope for further improvements in technology, (2) favor the larger journals as the more efficient method of publication, and (3) campaign against the subdivision of journals and small specialty journals.

IV. FUTURE TECHNOLOGY

Looking first at the distant future, I can guess what journals will be like. The reviewing process will probably be similar to the present one except that most transmissions between authors, editors, and referees will be by electronic mail and will progress much quicker. Then once a paper is acceptable scientifically, it will still go to the publisher for editing and composition. But because papers will be in a computer-readable form, the editing, composition, and input from the authors should take less than 10 days. Once that has been achieved, the paper will be placed into the central memory bank and all readers can read it on their computer screens. Journals will not consist of issues of several dozen papers published at regular intervals, but will rather be a continuing sequence of papers to which are added new papers as they are processed. A reader will ask his computer what has been added in, for instance, the previous week; he will be given the list and allowed to read the papers that he wishes to see. I am not sure how journals will charge the readers - perhaps by annual fees or by the number of times they are called.

But that long-term goal cannot be attained immediately because (1) most papers are not submitted in a computer-readable form using the same software, (2) readers are not connected to a central memory bank, and (3) that central memory bank does not yet exist.

The intermediate system may be journals like the present ones but available on compact disks and paper. A difficult question to answer is whether most readers will be willing to read papers on computer screens or on paper copies that are computer printouts. The reluctance of most astronomers to use microfiche suggests that the current generations, at least, may not adapt. But the possibility of producing hard copies does not involve expensive equipment and can be a backup.

On a short-term basis let us look at current developments. I am glad to report that the editors of the three largest astronomical journals met in Paris in May and came to tentative agreements for similar requirements of authors in 20 areas. For instance, why should authors have to remember, or program their word processors to remembers, that some journals use Roman numerals for table numbers and others use Arabic numbers? Or some use capital letters for section headings while others use decimal numbers? The editors even tentatively agreed on using short abbreviations for astronomical journals to save journal space and authors' time in writing papers. The aim is not to make all journals look alike, but rather to minimize the differing requirements of authors.

Another current development is the increased use of electronic mail for communications. About 10% of our referee reports now come by electronic mail and three-quarters are done on word processors.

A third current development is the submission of manuscripts on diskettes or computer-readable form. Some physics journals have been accepting those for several years and may be at the point that those manuscripts are cheaper to process. Astronomical journals are starting to experiment. The main difficulty is that there are many software systems (Tex, MATHOR, TROFF, etc.) and we are waiting to see which dominates. Because typesetting constitutes about one-third of the journal expenses, there is potenetially a similar saving in journal costs.

Finally, this meeting will discuss at length the progress that has been made in the indexing of papers and the retrieval of information about papers and astronomical objects. For 15 years the Astrophysical Journal has been placing the appropriate subject headings directly on the published papers so (1) the compilation of annual and five-year indexes can proceed continuously, using only clerical help, and (2) readers will become used to where those papers will be indexed. But much more is now being done, such as the system developed by Dr. Avrett of on-line computer access of titles and abstracts of papers accepted or published recently by several journals; the data centers in Strasbourg and Goddard to provide computer-readable catalogs, sources of information, and to sort out duplicate designations of astronomical objects; the abstracting services of Astronomy and

Astrophysics Abstracts and similar services in the other sciences; the SPIN network and other search systems, plus the Institute for Scientific Information's Science Citation Indexes and other services to locate information. Without these important tools, we waste time in duplication and fail to realize relevant facts. We will learn much at this meeting about all these services.

To summarize this discussion of future technologies, I see changes occurring nearly monthly in the direction of common styles requirements of authors, computer-readable manuscripts, and greatly improved data retrieval sources. At some future date most or all of our journal reading may be via computers.

I close with the question whether our libraries will gradually change from having neat shelves of books and friendly librarians who add more books and maintain order, to a roomful of computer terminals and an expert on how to retrieve information from them?

Thank you for listening and I wish you an enjoyable and informative meeting!