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Training Our Cites on the Stars: Helmut Abt's Observations on Astrosociology. Part 2. Paper Rejection and Citation Rates, Awareness of International Literature, and Other Trends

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Last week we published the first part of an essay in which Helmut A. Abt, Kitt Peak National Observatory, Tucson, Arizona, summarized a series of studies on the literature of astronomy he has published in the *Publications of the Astronomical Society of the Pacific* over the last decade.[1] That essay discussed his findings on age and productivity of astronomers, the differences between more prolific and less prolific authors, peer review of more prominent and lesser known authors, and the productivity and impact of large and small telescopes as well as university and government centers.

In the essay that follows, Abt continues his summary by comparing paper rejection rates and citation rates in astronomy and other scientific journals, the citation of international literature by US astronomers and those in other nations, and the growth of publications and multinational collaborations in astronomy. There can be little doubt that, in all research areas where collaboration can occur, there has been a significant increase.

One of the points examined by Abt has been discussed in previous *Current Contents®* essays: whether US researchers are any more or less "provincial" than others in citing the world's literature.[2] I have always been annoyed at the claim of US provinciality by scientists from other nations. In the past this has been due primarily to alleged language barriers. At least for astronomy, Abt puts this myth to rest. Examining citations between five astronomy journals and defining "nationality" by where each was published, he found that all countries tend to cite their own literature more frequently than foreign papers and that Americans are slightly less provincial than others.

ISI® recently created a database that enables us to explore international citation patterns with a high level of sensitivity and detail. It is based on nearly 900,000 source articles from virtually all fields of science that were published in about 7,000 journals indexed by ISI in 1984 and more than 2.9 million citations they received from 1984 through 1988. For both source and citing articles, nationality has been defined as where the first author's institution is based. Thus, not only can the file be sorted to show how various nations rank on productivity and impact across different research specialties, it also identifies and ranks nations by their citation of both domestic and foreign publications.

These data were recently used in *Science Watch™* (*SW*), ISI's monthly newsletter reporting on research trends and performance, to examine how provincial or cosmopolitan different nations were in their use of the literature.[3,4] The results were discussed by David Pendlebury, *SW* editor, and are illustrated in the reprinted table and figure.

Table 1 shows the number of 1984 ISI articles indexed from Japan, North America (the US and Canada), the European Community (EC) (Belgium, Denmark, the Federal Republic of Germany, France, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, and the UK), and the rest of the world, as well as 1984-1988 citations. North America clearly dominates, accounting for 37 percent of

Table 1: Cross tabulation of citations between nations and regions. Data are based on 1984-1988 *SCI*® citations to articles indexed in the 1984 *SCI*. Reprinted with permission from *Science Watch*™ (see reference 4), ©1990 ISI®.

Worldwide Citation Flows 1984-1988

Citations from:	Citations to:				
	N. America	EC	Japan	Rest of World	Total
N. America	1,078,339	207,019	41,913	123,383	1,450,654
EC	292,197	402,295	26,927	83,576	804,995
Japan	60,448	25,462	75,681	12,641	174,232
Rest of World	185,915	98,760	18,321	185,381	488,377
Total	1,616,899	733,536	162,842	404,981	2,918,258
# 84 papers	335,794	187,106	39,840	334,000	896,740

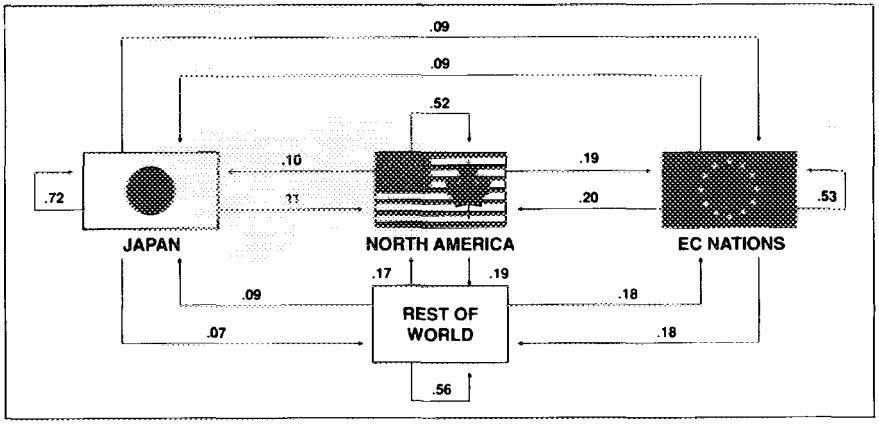
SOURCE: ISI's *Science Citation Index*, 1984-1988

articles and 50 percent of citations. The great disparities between the regions were weighted in an iterative normalization program, which resulted in each region having an equal opportunity to cite and be cited.

Figure 1 shows these results graphically. North American papers cited EC papers only slightly less than EC papers cited theirs—0.19 compared to 0.20, or 5 percent. Both regions cited their own papers about equally. North American papers cited the rest of the world more often than the reverse, while the citation "trade balance" was equal between the EC and the rest of the world.

Pendlebury also observed that "North America was the only region that had a 'trade surplus' in citations (1.45 million citations given out but 1.62 million citations received).... [It] was a scientific 'creditor' while the EC, Japan, and the rest of the world were scientific 'debtors.' "[4] We will provide an update on *SW* in the coming weeks and will reprint several of its features that have recently attracted attention and comment in the media.

Figure 1: Size-weighted citation flows between nations and regions. Data are based on 1984-1988 *SCI*® citations to articles indexed in the 1984 *SCI*. Reprinted with permission from *Science Watch*™ (see reference 4), ©1990 ISI®.



ISI is creating an even more refined and powerful database that will enable the analysis of scientific trends by nation, institution, language, specialty, and other perspectives over a 10-year period. In this database, nationality is defined by the institutional address of *any* and *all* authors, not just the first author, of both source and citing articles. It will be updated annually to provide a "moving window" covering progressive 10-year periods. When the programming and processing are complete by year's end, we will be able to answer the question ending Abt's essay: Are international collaborations becoming prevalent in other sciences?

* * * * *

My thanks to Al Welljams-Dorof for his help in the preparation of this essay.

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The Use of Publication Studies to Affect Policies and Attitudes in Astronomy. Part 2

Back to Introduction

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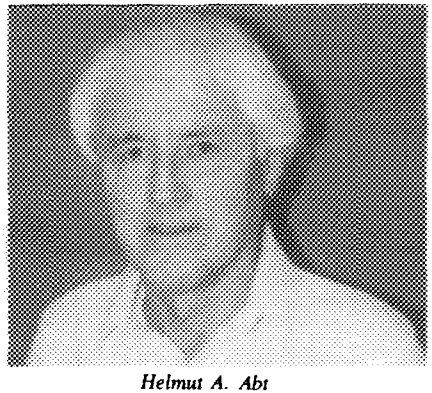
In the series of studies summarized here and in Part 1, published last week, we used counts of papers, citations to them, paper lengths, numbers of authors, their affiliations, and other data obtained mostly by scanning large numbers of papers, all for the purpose of exploring commonly held ideas about science. This is applied to astronomy. These facts challenge impressions that people have about such things as a scientist's most productive years, the partiality of peer reviews, the tendency for Americans to ignore foreign papers, the effectiveness of telescopes of various sizes, and many others.

Paper Rejection Rates in Astronomy and Other Sciences

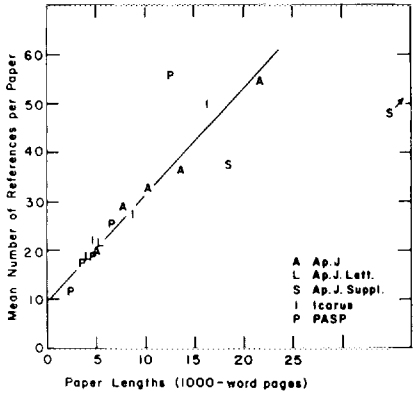
The final rejection rates for papers submitted to the three general American astronomical journals is very low, namely, 10 percent.[1] In contrast, Harriet Zuckerman and Robert K. Merton, Columbia University, New York, who surveyed 83 journals in 14 fields, found rates of 20-90 percent.[2] Are the referees and editors of astronomical journals uniformly and unusually soft?

Not so. But there are two effects occurring to cause the low rejection rates in astronomy. One is called "journal hopping," which rarely occurs in astronomy because there are so few journals. In fact, of the 10 percent of papers rejected, 7 percent were never published anywhere and only the remaining 3 percent appeared in conference proceedings and other journals.



Helmut A. Abt

Figure 1: The relation between the mean numbers of references per paper and their normalized lengths. The key (lower right) identifies the five American astronomical journals. Each point is an average of about 40 papers and has a statistical error of about 2.2 references. The straight line is a least-squares fit to all the points except for the longest *Publications of the Astronomical Society of the Pacific* papers and those two for the *Astrophysical Journal Supplement Series*. The remaining 14 points fit the line within 1 σ. (Courtesy of the *Publications of the Astronomical Society of the Pacific*. See reference 4.)



In contrast, Stephen Lock, editor, *British Medical Journal*, studying practices in medicine, quotes colleagues who do not even bother to revise a manuscript in the light of a referee's comments until they have received rejections from three journals.[3] His study of the *British Medical Journal* showed that 79 percent of the submissions were rejected, but 73 percent were eventually published elsewhere and only 20 percent had been revised in the process. Thus only 6 percent were never published, just as with the astronomical journals. But we prefer the astronomical system in which 95 percent of the accepted papers are revised by varying amounts and therefore improved in accuracy, clarity, or strength in the process.

The second factor causing different rejection rates is that, as Zuckerman and Merton found, the observational sciences (math, chemistry, biology, physics, geology) had rejection rates of 20-50 percent whereas the humanities and social sciences (history, literature, philosophy, sociology) had rejection rates of 78-90 percent.[2] In astronomy we expect referees to give factual objections to publication (e.g., equation [1] is wrong because...; this result has already been published by...; this contradicts the results by..., and those should be discussed; the authors are inconsistent in that....), rather than a pure value judgment.

We suspect that in the observational sciences the rates of eventual publication somewhere are not very different but that in astronomy the authors tend to revise their manuscripts to achieve referee acceptance, rather than to submit the original manuscript elsewhere.

Citation Rates in Astronomy and Other Sciences

One person told me that, in his joint physics-astronomy department, when candidates are proposed for faculty positions or promotions, as soon as astronomers mention citation totals for their candidates, they are told that "astronomers put more references in their papers, so of course their citation rates are higher." Do astronomers put more references in their papers than do other scientists?

We explored this in five American astronomical journals, three foreign astronomical journals, and five American journals in physics, chemistry, and geophysics.[4] We quickly found that the average number of references in papers forms a tight and unique dependence on paper length. Long papers have more references than short papers. In fact, if [R] is the mean number of references in a paper of mean length [P] where P is counted in 1,000-word pages, then [R] = 9.9 + 2.18 [P]. That is, a paper averages about 10 references plus 2.2 for each page.

This is shown in Figure 1 for the five domestic American astronomical journals. We grouped the papers in each journal by length in bins indicated by similar symbols in Figure 1, e.g., the five As (for the *Astrophysical Journal*) represent the 20 percent shortest papers, the next 20 percent by length, etc., to the 20 percent longest. For the two journals representing only short

Figure 2: The relation between the average numbers of references and paper lengths for three non-American astronomical journals identified in the key. The straight line is taken from Figure 1 for the American astronomical journals. The data points fit within 2 σ. (Courtesy of the *Publications of the Astronomical Society of the Pacific*. See reference 4.)

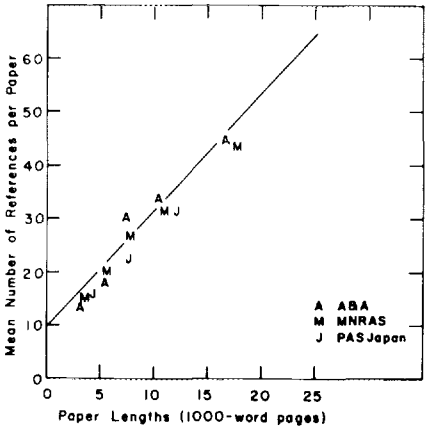
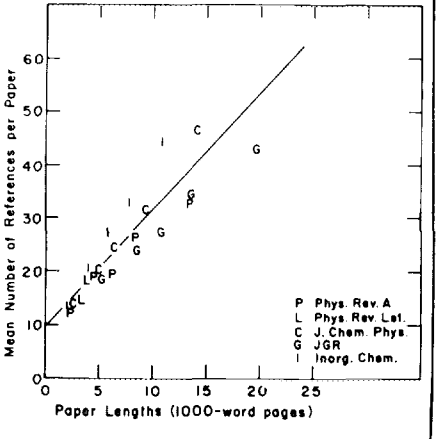


Figure 3: The relation between average numbers of references and paper lengths for five physics, chemistry, and geophysics journals identified in the key. The line is taken from Figure 1 for the American astronomical journals. Most of the data points fit the line except those for *Inorganic Chemistry* are 2.3 σ high and for the *Journal of Geophysical Research* are 2.6 σ low. (Courtesy of the *Publications of the Astronomical Society of the Pacific*. See reference 4.)



papers (*Astrophysical Journal Letters*) and long papers (*Astrophysical Journal Supplement Series*), only two bins were used for each. The data points fall on a well-defined line with two exceptions: the longest papers in the *Publications of the Astronomical Society of the Pacific* are mostly review papers that tend to have more references than the average research paper, and the *Supplement Series* papers represent many compilations of data and tend to have fewer references for their lengths.

The same thing was done for the foreign astronomical journals, and Figure 2 shows those results with the same line taken from Figure 1. Finally, Figure 3 shows the results for the five journals in physics, chemistry, and geophysics together with the same line taken from Figure 1. All show that the data points fit the same curve within statistical accuracy.

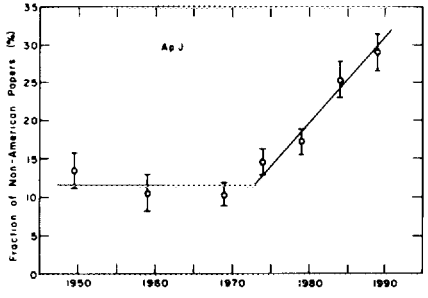
In conclusion, nearly all journals average the same number of references per 1,000-word page! The difference between astronomy and physics papers is, then, that the former are longer. If, as is the editorial policy of most journals, longer papers must have their greater lengths justified by more or more important results, the more important papers average more references, regardless of the field of science.

Do Americans, More So Than Others, Tend to Ignore Papers from Other Countries?

Europeans often complain that Americans ignore their published work, and I have heard Americans make similar complaints about Europeans. In a rapidly growing field, where it becomes increasingly difficult to read and to be aware of all the papers published in one's own specialty, there is probably some truth in both complaints, although referees frequently point out overlooked papers in original submissions. But is one nationality more guilty of myopia than others?

We surveyed nine English-language astronomical journals that are general in content, i.e., not limited to special fields.[5] Of those, three are American and one each are from

Figure 4: The fractions of non-American papers in the *Astrophysical Journal* are plotted as a function of time. The data points and error bars are based on an average of 414 papers per point. The sloped line is a least-squares fit. (Courtesy of the *Publications of the Astronomical Society of the Pacific*. See reference 8.)



Europe, the UK, the USSR (in translation), Mexico, Japan, and India. In a statistically significant sample of each, we counted the numbers of references to each of the nine journals plus "others" (all other publications). The numbers were converted to percentages.

We found that, in each case but one (*Astrophysical Journal*), the papers in a journal cited papers in the same journal more often than other journals cited that journal. For instance, 21.5 percent of the references in the European journal were to papers in that journal, but the other eight journals cited the European journal only an average of 8.8 percent of the time, indicating an excessive self-citation rate of 12.7 percent. For the British journal, the excessive self-citation rate was 10.1 percent, for the Soviet journal 11.7 percent, and for the three American journals, 5.6 to 9.5 percent. The only low self-citation rates occurred for two relatively new journals, which could not refer very often to their own papers.

Of course, part of these excessive self-citation rates are justified because one-quarter of the papers in most of these journals are partly or totally by foreign authors, and each journal, albeit general, tends to be the international choice for papers on certain topics. Nevertheless, we conclude that all nationalities are guilty of some degree of myopia and that Americans are, if anything, slightly less guilty of that than other nationalities, perhaps because they tend to have more complete libraries.

Trends in Astronomical Papers

Finally, let us describe various trends in astronomical papers during this century. A comparison of these trends for astronomy with other sciences will be the subject of a separate paper. Some of these trends are undoubtedly common to other fields, but some seem surprising.

The total American literature, as represented by its three major general journals, was constant in content per year from the turn of the century until World War II; thereafter it has grown to date at a logarithmic rate with a factor of 2.4 increase per decade or a doubling time of 7.8 years.[6]

The average lengths of papers, counted in 1,000-word pages, was also constant at 3 pages from the turn of the century until World War II and then increased steadily to the current 11 pages.

At the same time, the fraction of papers that occupied less than one 1,000-word page decreased from 42 percent of the papers early in the century to the current less than 1 percent. There is little evidence in astronomy of a disease called "the least publishable unit."

The number of authors per paper varied from 1.1 early in the century to the current 3.2. At the same time, the fraction of single-authored papers decreased from 90 percent early in the century to the current 10 percent.

The fraction of astronomical papers that are primarily theoretical increased from 5 percent early in the century to the current 45 percent, indicating a maturing of this science.

A surprising result is the sudden increase in papers from abroad. We distinguished three kinds of papers: those with purely American affiliations, those with purely foreign affiliations (from one or more countries), and the mixed American-foreign authorships. For statistical counting we

called the last "half foreign," regardless of the individual ratios between foreign and American authors.

From early in this century until the early 1970s, a steady 11 percent of the papers were foreign, and they were generally purely foreign.[7,8] Starting in the early 1970s (see Figure 4), the foreign input increased by 1.1 percent per year to the current 30 percent. Moreover, by the 1980s the mixed authorships outnumbered the purely foreign ones.

We then looked at journals from the UK and Europe and found the same results: papers from outside the British Commonwealth or from outside Europe, respectively, were constant at about 10 percent until the early 1970s and then increased with the same slope to the current 35 percent. Not only are authors publishing in journals published outside their own countries, but about one-quarter of the astronomical papers worldwide are the result of international collaborations.

The reasons for this sudden internationalization of the astronomical literature are several: (1) the growth of research in developing countries, (2) the desire of astronomers to publish in the major journals, (3) the availability of foreign currency in developed countries to fund page charges, (4) the occurrence of international meetings in which researchers with similar interests meet and decide to collaborate, and (5) astronomers usually build observatories at the best sites, which are often in foreign countries, so travel abroad and collaborations become frequent.

Are international collaborations becoming prevalent in other sciences?

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