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EUGENE GARFIELD
INSTITUTE FOR SCIENTIFIC INFORMATION®
3501 MARKET ST., PHILADELPHIA, PA 19104

The 1986 NAS Award for Excellence in Scientific Reviewing Goes to Virginia L. Trimble for Her Reviews in Astronomy and Astrophysics

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The 1986 National Academy of Sciences (NAS) Award for Excellence in Scientific Reviewing has been awarded to Virginia L. Trimble, professor, Department of Physics, University of California, Irvine, and visiting professor, Astronomy Program, University of Maryland, College Park. Trimble, an astronomer and astrophysicist, received the award for her reviews on supernovae, binary stars, the origin of chemical elements in the galaxy, and other topics in astronomy. J. Ross Macdonald, Department of Physics and Astronomy, University of North Carolina, Chapel Hill, chairman of this year's selection committee at the NAS, characterized Trimble's contributions as follows: "By her numerous, comprehensive, scholarly, and literate reviews, which have elucidated many complex astrophysical questions, Virginia L. Trimble has informed and enlightened the astronomical community."[1]

ISI® and Annual Reviews, Inc., established the NAS award in 1979 in honor of James Murray Luck, founder of Annual Reviews. The purpose of the award is to recognize and encourage high quality in the writing of scientific reviews. Although ISI and Annual Reviews jointly sponsor the award and provide funding for the $5,000 honorarium, the actual selection of winners is performed independently by the committee at the NAS.

Trimble is the third author in the physical sciences to be honored. In 1980 the award recognized Conyers Herring, Stanford University, for his reviews in solid-state physics.[2] The 1983 winner, Michael Ellis Fisher, Cornell University, Ithaca, New York, received the award for his reviews on the theory of equilibrium critical phenomena.[3] In addition to the physical sciences, the NAS award honors authors in the life sciences and the social and behavioral sciences, on a rotating basis.

Scientific reviews, as I have often pointed out, are invaluable in making large areas of research accessible and meaningful. Some years ago, in fact, I proposed the creation of a new profession: scientific reviewer.[4]

Biographical Information

Trimble was born in Los Angeles, California, in 1943 and received a BA in astronomy and physics from the University of California at Los Angeles (UCLA) in 1964. She received her MS in 1965 in astronomy and physics from the California Institute of Technology (Caltech) and a PhD in astronomy from the same institution in 1968. She also holds an MA from Cambridge University, UK. Trimble was an assistant professor of astronomy at Smith College, Northampton, Massachusetts, from 1968 to 1969 and a visiting fellow at the Institute of Theoretical Astronomy, Cambridge, from 1969 to 1971. She joined the physics department at the University of California, Irvine, in 1971, becoming a full professor in 1980. In 1973 she became a

Virginia L. Trimble

visiting faculty member at the University of Maryland, where she is now a visiting professor in astronomy.

As Trimble tells it, she entered astronomy virtually by chance. She was seeking admission to UCLA, and at that time the application process involved selecting a field of study. UCLA had no undergraduate program in archeology, Trimble's first choice, so she scanned the available subjects and selected astronomy. Chance, she says, seemed to guide her graduate studies as well. Her dissertation topic, essentially selected by the astronomy department at Caltech, dealt with a gaseous mass known as the Crab Nebula, a remnant of a supernova, which is an exploded star.

In 1968, not long after Trimble completed her doctorate, a pulsating radio source, called a pulsar, was discovered in the Crab Nebula, creating great excitement in the astronomical community. "When pulsars came along," says Trimble, "and everybody wanted a young postdoc to talk about the significance of the pulsar in the Crab Nebula, there I was just having finished a thesis on the subject."[5]

It should be noted that few of Trimble's colleagues would agree with her modest assertions that her career has been favored heavily by luck and chance. Helmut A. Abt, Kitt Peak National Observatory, Tucson, Arizona, for example, characterizes Trimble as "a very remarkable person." He points out that her decision to study the Crab Nebula at Caltech was certainly not an accident, but a result of her extraordinary intellect and capabilities. "She is so intelligent," he says, "and has such a broad background in astrophysics and related sciences, that she can review a field much more capably than most people."[6]

On Writing Reviews

Trimble's first published paper was an astronomical investigation of the Great Pyramid of Khufu in Giza, Egypt.[7] Her career as an author of astronomy reviews began at Cambridge. Her first efforts were reports on meetings held at the university while she was there as a postdoctoral fellow. She found that once she had written a few reviews, conference organizers and editors began to ask for more.

"I always learn an enormous amount from writing reviews," she says. "What typically happens in the process is that I see a couple of interesting problems that are ripe for solutions, and the next couple of research things I do are sort of triggered by the review as I wrote it. After I did a review on binary stars, I thought of a few binary star problems, and a similar thing happened after I did a supernova review."[5]

Table 1 provides a selected list of Trimble's publications, listed in descending order by number of citations. Two of the papers, "New gravitational radiation experiments" and "A low-mass primary for Cygnus X-I?", were coauthored by Trimble's husband, Joseph Weber, Department of Physics, University of Maryland. Each review article is marked by an asterisk. An extensive two-part paper in *Reviews of Modern Physics*, for example, covers the history

Table 1: A selected list of articles published by V. Trimble listed in descending order by number of citations. An asterisk (*) indicates that it is a review article. A = citations from the *SCI®*, 1955-1985. B = bibliographic data.

A	B
163	*__Trimble V.__ The origin and abundances of the chemical elements. *Rev. Mod. Phys.* 47:877-976, 1975.
137	*-----. Motions and structure of the filamentary envelope of the Crab Nebula. *Astron. J.* 73:535-47, 1968.
57	__Greenstein J L & Trimble V.__ The Einstein redshift in white dwarfs. *Astrophys. J.* 149:283-98, 1967.
49	__Trimble V & Greenstein J L.__ The Einstein redshift in white dwarfs. III. *Astrophys. J.* 177:441-52, 1972.
48	__Trimble V & Thorne K S.__ Spectroscopic binaries and collapsed stars. *Astrophys. J.* 156:1013-9, 1969.
45	__Trimble V.__ On the distribution of binary system mass ratios. *Astron. J.* 79:967-73, 1974.
43	__Trimble V & Rees M.__ The expansion energy of the Crab Nebula. *Astrophys. Lett.* 5:93-7, 1970.
37	*__Trimble V & Reines F.__ The solar neutrino problem—a progress(?) report. *Rev. Mod. Phys.* 45:1-5, 1973.
31	__Weber J, Lee M, Gretz D J, Rydbeck G, Trimble V & Steppel S.__ New gravitational radiation experiments. *Phys. Rev. Lett.* 31:779-83, 1973.
25	__Trimble V.__ $q(\alpha)$ reconsidered. *Observatory* 98:163-6, 1978.
24	*-----. Binary stars in globular and open clusters. (Hesser J E, ed.) *Star clusters. Proceedings of the International Astronomical Union Symposium No. 85*, 27-30 August 1979, Victoria, B.C., Canada. Dordrecht, The Netherlands: Reidel, 1980. p. 259-79.
22	__Davidson K, Gull T R, Maran S P, Stecher T P, Fesen R A, Parise R A, Harvel C A, Kafatos M & Trimble V.__ The ultraviolet spectrum of the Crab Nebula. *Astrophys. J.* 253:696-706, 1982.
22	*__Trimble V.__ Supernovae. Part I: the events. *Rev. Mod. Phys.* 54:1183-224, 1982.
22	__Trimble V.__ Ionization and excitation in the Crab Nebula. *Astron. J.* 75:926-32, 1970.
22	__Trimble V, Rose W K & Weber J.__ A low-mass primary for Cygnus X-1? *Mon. Notic. Roy. Astron. Soc.* 162:1-3, 1973.
21	__Trimble V.__ Dynamics of the Crab Nebula. (Davies R D & Smith F G, eds.) *The Crab Nebula. Proceedings of the International Astronomical Union Symposium No. 46*, 5-7 August 1970, Jodrell Bank, England. Dordrecht, The Netherlands: Reidel, 1971. p. 12-21.
21	__Trimble V & Woltjer L.__ On the mass of the Crab Nebula. *Astrophys. J.* 163:L97-8, 1971.
20	__Greenstein J L & Trimble V.__ The gravitational redshift of 40 Eridani B. *Astrophys. J.* 175:L1-5, 1972.
16	*__Trimble V.__ Supernovae. Part II: the aftermath. *Rev. Mod. Phys.* 55:511-63, 1983.
12	*-----. Optical observations of the Crab Nebula. (Davies R D & Smith F G, eds.) *The Crab Nebula. Proceedings of the International Astronomical Union Symposium No. 46*, 5-7 August 1970, Jodrell Bank, England. Dordrecht, The Netherlands: Reidel, 1971. p. 3-11.
10	*-----. A field guide to the binary stars. *Nature* 303:137-42, 1983.
8	*__Trimble V & Bell R A.__ Spectroscopic determination of stellar masses: Mene, Mene, Tekel, Arcturus. *Quart. J. Roy. Astron. Soc.* 22:361-79, 1981.

and likely future of supernova research.[8,9] The first part deals with the mechanisms of supernova explosions, including the presupernova evolution of stars and the observed properties of supernova events.[8] The second part discusses the aftermath of supernova events, including such by-products as gamma rays, X rays, nucleosynthesis, and supernova-induced star formation.[9]

Another review, appearing in *Nature* in 1983, discusses binary stars, which are systems in which two or more luminous bodies orbit a common center of gravity.[10] More than half the stars in our galaxy are binary systems. Trimble has also reported on astronomy meetings and symposia, such as the first European Conference on Astronomy held at the University of Leicester, UK, in 1975.[11]

In addition to writing reviews and conducting her own research in astrophysics, Trimble has studied patterns and trends in astronomical literature. She reported in *Nature* on two studies done by Abt.[12] In one study Abt charted the publication histories of a cohort of 115 astronomers who received their doctorates between 1945 and 1960. He also studied the citation histories of 22 outstanding astronomers.[13,14] Results showed that the active members of the

1945-1960 cohort had publication records that increased monotonically with time. Data from the *Science Citation Index®* (*SCI®*) on the 22 astronomers, compared with biographical information, demonstrated that several of them were well past middle age when they wrote their most-cited works. In general, the studies showed that astronomers do not seem to fit the stereotype of the scientist who is most productive early in a career.[12] Abt, incidentally, was one of the authors featured in our 1984 study of astronomy journals.[15]

In another study, Trimble examined the lengths of papers published in a selection of English-language journals in astronomy, chemistry, physics, and mathematics. She concluded that the average length of scientific papers has increased by 64 percent since World War II. Trimble presents various interpretations for this increase. One view holds that longer papers in these disciplines reflect greater scientific content. Other interpretations point to changing editorial practices and other sociological factors that reward long articles. For example, methods of evaluating scientists for promotion and tenure have tended to attach high value to longer papers in recent years. Trimble, who tends to favor this sociological view, concludes by suggesting that authors, editors, referees, and sponsoring agencies reach some kind of agreement to limit the drastic growth in the length of papers and letters.[16] However true this may be for astronomy, it does not appear to be true in other fields, where one hears regular complaints about the use of the least publishable unit.

Trimble also used the *SCI* to analyze citations to papers by a sample of authors from the American Astronomical Society (AAS). The study concentrated on number of citations as a function of career length, subdiscipline, gender, and institution of employment. She found, among other things, that X-ray and radio astronomers are cited less often than optical astronomers. She also determined that the average number of citations per person was proportional to career length.[17]

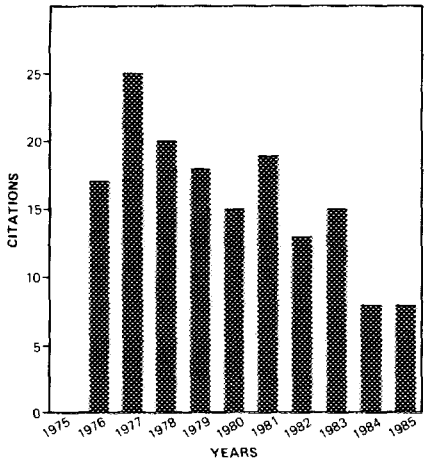
In another recent study, to appear in the *Czechoslovak Journal of Physics*, Trimble set out to determine what fraction of citations in astronomy are a result of personal influence—citations, for example, that authors give to the work of colleagues and friends. She compared citations to two groups: a sample of recently deceased astronomers and a control group of those still living and active. Trimble determined that approximately 40 percent of citations can be traced to personal influence.[18] Incidentally, the executive editor of the *Czechoslovak Journal of Physics* is Jan Vlachý, a citation analyst *extraordinaire*.

Research-Front Data

According to our data, Trimble is the author (or coauthor) of approximately 180 publications. Through 1985, her work has received about 950 citations. One lengthy review on "The origin and abundances of the chemical elements" appeared in *Reviews of Modern Physics*.[19] This 1975 review summarizes efforts to determine the distribution of chemical and isotopic abundances in the galaxy, to identify relevant nuclear processes and their sites, and to formulate a model of the evolution of galaxies that would account for these processes and the observed abundances. One of the authors cited by Trimble is Harold C. Urey, the 1934 Nobel laureate in chemistry. Trimble mentions an important 1956 compilation of cosmic abundances, of which Urey was a coauthor.[20] I discussed this paper in my tribute to Urey and his work.[21]

Trimble's review has been cited about 160 times. Figure 1 presents a chronological distribution of 1975-1985 *SCI* citations to this paper. It was co-cited frequently enough in 1981 to be included

Figure 1: Chronological distribution of 1975-1985 *SCI*® citations to V. Trimble's 1975 paper in *Rev. Mod. Phys.*



in the core of a 1981 ISI C1 research front on "Isotopic anomalies in meteorites in relation to solar-system formation" (#81-1062). A C1-level research front consists of current papers that cite any of a group of high-impact books or articles that were frequently cited together (co-cited). Table 2 lists the core papers for this research front.

Figure 2 is a historiograph, a string of annual research fronts, showing research on the formation of the solar system. As I've explained previously, we are able to detect the linkages between research fronts from year to year by identifying the core documents that continue to be co-cited.[22] As research in a particular field diversifies, the fronts themselves split, merge, or disappear, and new fronts appear.

The historiograph in Figure 2 shows the link between front #81-1062 and more recent research fronts, such as a 1984 front on "Photometry and other studies of nuclear fission and evolution of stars, globular clusters, and other celestial bodies" (#84-0837). To demonstrate the relationship between front #84-0837 and other subspecialty areas in astrophysics, we have included the multidimensional-scaling map in Figure 3. By clustering research fronts we can create these higher level maps, in this case representing a second level, or C2, research front, "Determination of elemental abundances and other aspects of stars, nebulae, and galaxies" (#84-0075). Of all the fronts represented here, #84-0837 is the largest, with 60 core documents and 557 citing documents.

Why Write Reviews?

Trimble believes that review articles are particularly valuable in education. "A student who's getting geared up to do a thesis needs to find out quickly where his thesis work fits into the great scheme of things. The same applies to someone

Table 2: A list of core documents for C1-level research front #81-1062, "Isotopic anomalies in meteorites in relation to solar-system formation."

Burbidge E M, Burbidge G R, Fowler W A & Hoyle F. Synthesis of the elements in stars. *Rev. Mod. Phys.* 29:547-650, 1957.

Cameron A G W. Abundances of the elements in the solar system. *Space Sci. Rev.* 15:121-46, 1973.

Clayton D D. *Principles of stellar evolution and nucleosynthesis.* New York: McGraw-Hill, 1968. 612 p.

Clayton R N, Grossman L & Mayeda T K. A component of primitive nuclear composition in carbonaceous meteorites. *Science* 182:485-8, 1973.

Clayton R N, Onuma N & Mayeda T K. A classification of meteorites based on oxygen isotopes. *Earth Planet Sci. Lett.* 30:10-8, 1976.

Grossman L & Larimer J W. Early chemical history of the solar system. *Rev. Geophys. Space Phys.* 12:71-101, 1974.

Lee T, Papanastassiou D A & Wasserburg G J. Aluminum-26 in the early solar system: fossil or fuel? *Astrophys. J.* 211:L107-10, 1977.

Lewis R S, Srinivasan B & Anders E. Host phase of a strange xenon component in Allende. *Science* 190:1251-62, 1975.

Trimble V. The origin and abundances of the chemical elements. *Rev. Mod. Phys.* 47:877-976, 1975.

Figure 2: Historiograph of research on the formation of the solar system. The numbers given in parentheses following the research-front titles refer to the numbers of core/citing items for each research front. An asterisk (*) next to the research-front number indicates the research front for which Trimble's 1975 paper in *Rev. Mod. Phys.* is part of the core.

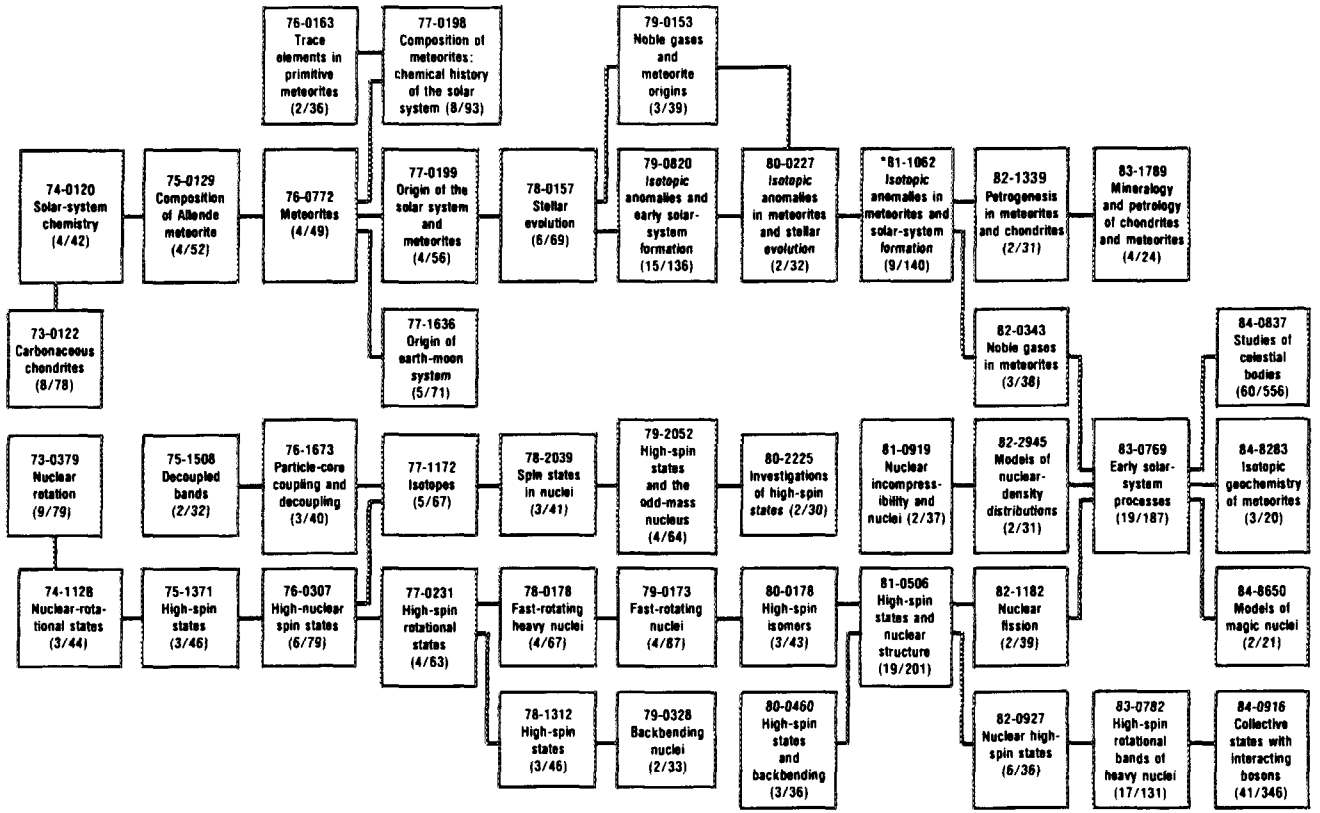
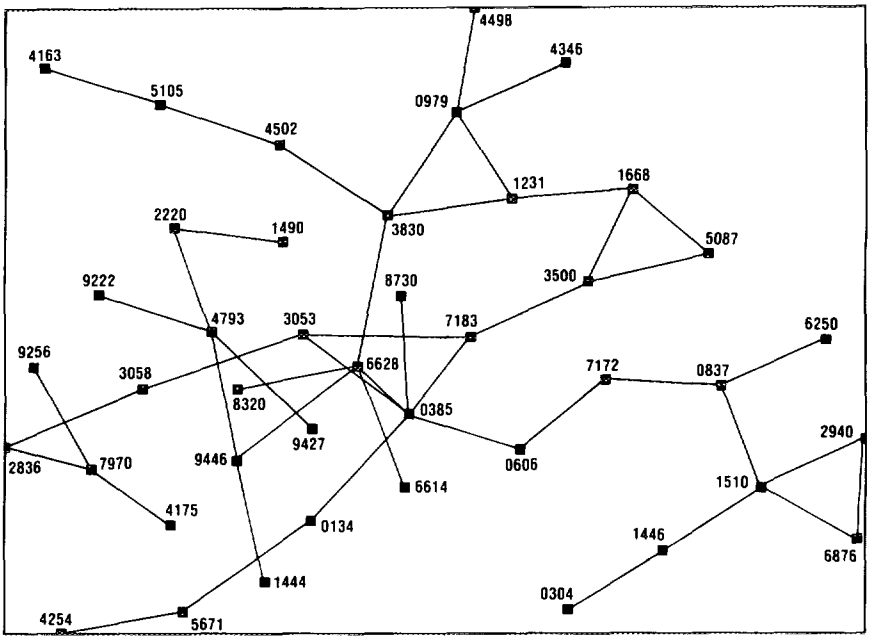


Figure 3: Multidimensional-scaling map of C2-level research front #84-0075, "Determination of elemental abundances and other aspects of stars, nebulae, and galaxies," showing links between C1-level research fronts on the map. An asterisk (*) indicates the C1-level research front found on the historiograph in Figure 1. A = 1984 research-front number. B = research-front name. The numbers of core/citing items are given in parentheses.



Key

A	B
84-0134	Spectroscopic studies of gravitational waves, radial velocity, and other properties of binary stars, black holes, and other binary bodies (3/39)
84-0304	Pre-equilibrium emission of protons and neutrons in heavy-ion reactions (7/71)
84-0385	Infrared, ultraviolet, magnetic, and other spectroscopy of binary stars (19/210)
84-0606	Observations of infrared radiation from Wolf-Rayet binaries and evolution process, and mass loss in supergiant and massive stars (20/263)
*84-0837	Photometry and other studies of nuclear fission and evolution of stars, globular clusters, and other celestial bodies (60/557)
84-0979	Structure and evolution of galaxies and the universe based on observations of radio jets, quasars, and other radio sources (31/458)
84-1231	Observations of optical, radio, and infrared emission from M82 and other spiral galaxies (8/197)
84-1444	Magnetic, optical, and radio observations of sunspot umbrae (3/18)
84-1446	Light nucleon emission and momentum transfer during uranium-238 and gold-197 fission (5/51)
84-1490	Theory and observation of the solar magnetic field and stellar dynamos (9/95)
84-1510	Fusion-fission cross sections and fission fragment angular distributions in uranium-238 and other heavy-ion collisions (15/156)
84-1668	Observations of radio emissions associated with galactic nuclei from Seyfert galaxies (5/88)
84-2220	Variations in solar rotation, sunspot cycles, and analysis of photospheric Doppler patterns (9/50)
84-2836	Observations and calculations of C-4, carbon monoxide, cyanoradical, formaldehyde, and other species in interstellar clouds (3/53)
84-2940	Mass exchange in dissipative heavy-ion collisions and theoretical approaches to heavy-ion reaction mechanisms (4/50)
84-3053	IUE and ultraviolet observations of stars and galaxies (4/114)
84-3058	Ultraviolet, optical, and infrared observations of interstellar elements in diffuse clouds, stars, and galaxies (3/70)
84-3500	Spectrophotometry and radio emissions from planetary nebulae, stars, and galaxies (4/135)

(continued on next page)

A	B
84-3830	X-ray observations and radio emissions from galaxies, quasars, and supernova remnants (5/144)
84-4163	Optical observations of R136, NGC-3603, and other massive objects (2/22)
84-4175	Mass loss and emission in stars and stellar clusters (2/39)
84-4254	Gravitational collapse and relaxation dynamics in globular clusters (3/30)
84-4346	Broad absorption lines in spectra of quasi-stellar objects, and observations of quasars and galaxies (5/53)
84-4498	High-resolution observation of radio emission in W51 and other radio sources (2/17)
84-4502	Observation and evolution of supernova remnants (7/77)
84-4793	Spectroscopic determination of chemical abundances in the sun, other stars, planetary nebulae, and interstellar environments (8/191)
84-5087	X-ray, ultraviolet, radio, and other observations of quasars, galaxies, quasi-stellar objects, and other emission sources (2/49)
84-5105	X-ray, optical, and other observations of supernova remnants and other stars in large Magellanic Clouds (7/75)
84-5671	Evolution and photometry of globular clusters and galaxies (6/85)
84-6250	Primordial nucleosynthesis and the evolution of stars in the big bang (3/81)
84-6614	Near-infrared and infrared photometry of stars and galaxies (2/41)
84-6628	X-ray and other studies of coronal structure, magnetic activity, and chromospheric emission in main sequence, solar, and binary stars (15/182)
84-6876	Generator coordinate and other methods in nuclear scattering and collective models (2/48)
84-7172	Photometry and studies of the evolution of stars and clusters in the Magellanic Clouds (8/90)
84-7183	Spectrophotometric determination of temperature and other properties of white dwarfs and other stars (2/41)
84-7970	Distribution of molecules and molecular fragments in the circumstellar envelope of IRC+10216, Mira, and other stars (3/42)
84-8320	Observations of chromospheric activity in flare stars (2/15)
84-8730	Photometry of Wolf-Rayet and early-type binary stars (2/24)
84-9222	Elemental abundance analysis of stars, measurement, and calculation of oscillator strengths and atomic spectroscopy (2/16)
84-9256	Polarization and emission variations in α-Orionis (2/20)
84-9427	Digital angiography, optical detectors for spectroscopy, and determination of chemical abundance in stars (3/25)
84-9446	Observations and structure of the solar chromosphere (2/48)

starting a post-doctoral project in a new subject or somebody teaching a new subject for the first time. The actual audience that reads reviews is larger than that, but that's where I think reviews are particularly needed. And those are the people I try to keep in mind when I write them."[5]

In her teaching as well as in preparing her reviews, Trimble places a great deal of emphasis on good, clear writing. "When I've taught undergraduate courses I've tended to ask the students to write a lot of essays," she says, "even if the course was something fairly technical. I feel that in addition to being able to solve various problems, students should be able to tell others what they've learned."[5]

Trimble's extreme care about her writing, in fact, has often led to what she calls "the single most difficult part of writing reviews": dealing with editors and their ubiquitous blue pencils. She notes that in some instances editors seem to apply different standards to review articles and want to make changes in style and content that they wouldn't ordinarily make in other papers.

"I think that this may be the largest obstacle to writing reviews," she says. "The people who are really capable of doing it, the ones who are working actively in a subject, just can't be bothered with the editorial squabbles. They may do one review article and then decide it just isn't worth the bother." She adds, with a laugh, "One effect I've noticed since winning this award is that editors have become unexpectedly more respectful of my wishes. I hope it lasts."[5]

I take special pleasure in writing about and paying tribute to a starry-eyed citation analyst. It was also a pleasure to

speak with Dr. Trimble recently and discuss a range of topics. She noted, for example, that the proportion of female astronomers in the US has remained at around 10 percent since the AAS was founded in the 1890s. This proportion is evident in the very first group photograph of AAS members, in fact, as well as when one examines the 4,000-odd names in the current AAS directory. Trimble also says she is continuing her citation studies and recently completed a study on the self-citation rate in astronomy.[23]

Next year's NAS award will be presented for reviews in the social and behavioral sciences. Nominations should be submitted before September 1986, to the Office of the Home Secretary, National Academy of Sciences, 2101 Constitution Avenue, Washington, DC 20418.

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My thanks to Christopher King and Amy Stone for their help in the preparation of this essay.

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