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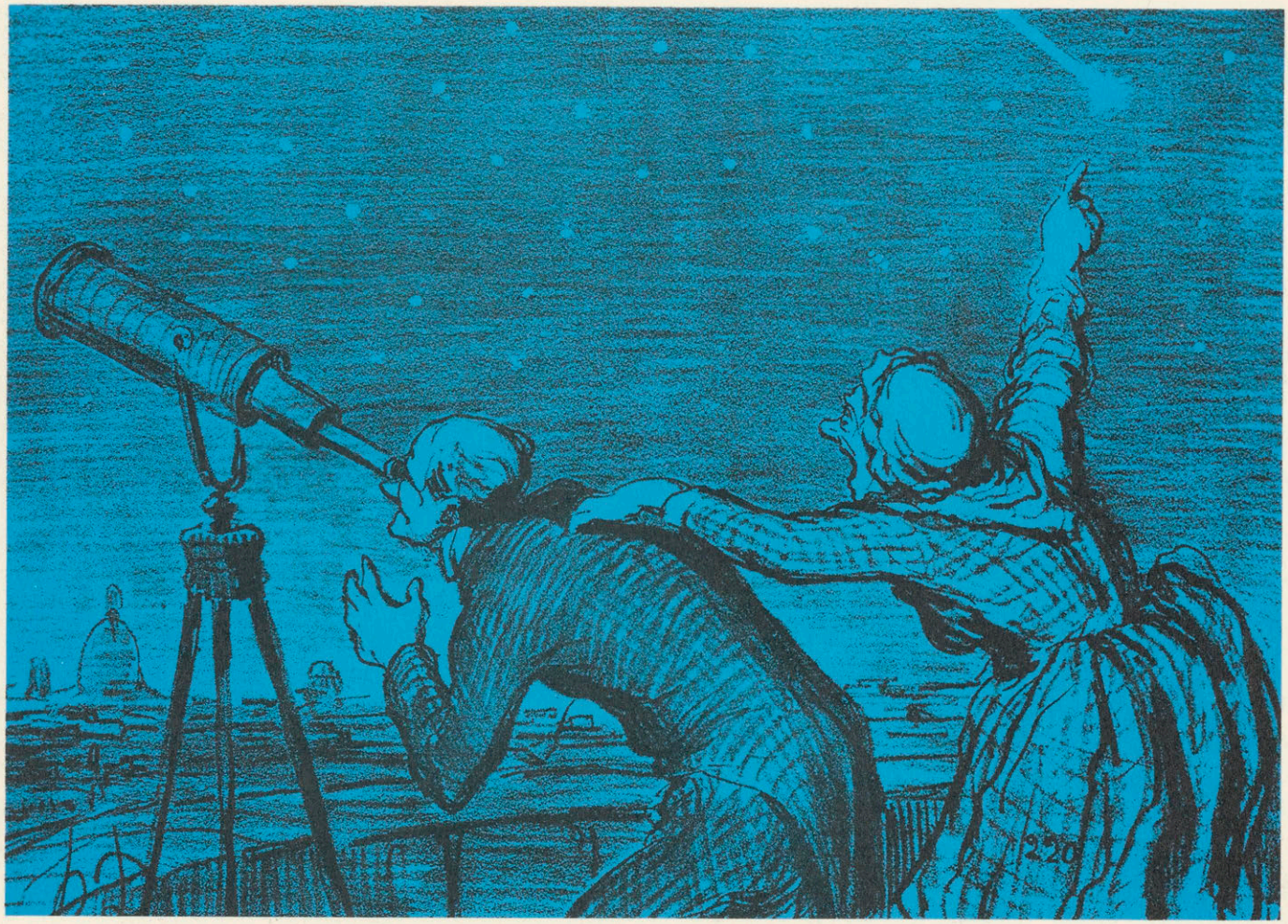
"Space for Women: Perspectives on Careers in Science"

Space for women

Perspectives on Careers in Science



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Inside cover: *The Rosette Nebula*

Space for women

Perspectives on Careers in Science

Derived from

The Earth in the Cosmos: Space for Women

a Symposium for Women
on Careers in
Astronomy, Astrophysics, and Earth and Planetary Sciences

Sponsored by Center for Astrophysics, Harvard University, Radcliffe College, and Smithsonian Institution

Nothing can be more absurd
than the practice which prevails
in our country of men and women
not following the same pursuits
with all their strength and with one mind,
for thus the state, instead of being a whole,
is reduced to a half.

— Plato.

Space for Women

The changing world of science

The world of science has often been viewed as something apart from everyday life, a world where only a genius is likely to distinguish himself (we use the word "himself" intentionally because, aside from Marie Curie, women scientists are rarely heard of). This popular view of science is no accident. In the past, a career in science required a special kind of devotion to hard work and a willingness to spend lonely years designing an experiment or perfecting a theory, with little hope of reward beyond the personal satisfaction of making a new contribution to knowledge. There was a monastic austerity to research that served to exclude women except in times of crises, such as during World Wars I and II.

Women — an untapped resource

Within the past twenty years, however, science has undergone changes that have received little notice. Scientists no longer work alone or in isolated groups. Research in the physical sciences and life sciences has become a widely dispersed, well-funded national priority. Hundreds of laboratories are maintained by universities, industries, and Federal, state, and private agencies; they employ thousands of scientists and many more thousands of persons with the technical and administrative skills that are essential to productive research. Today, scientists tend to keep in touch with their colleagues and follow developments in their fields by attending large national or international meetings one or more times each year. A career in science or a science-related field still requires much hard work and creative imagination. Nevertheless, as scientific investigations have multiplied and become increasingly concerned with everyday problems, the scientific enterprise itself has lost much of its Olympian remoteness and has come to resemble, in some respects, the more familiar worlds of business and the professions.

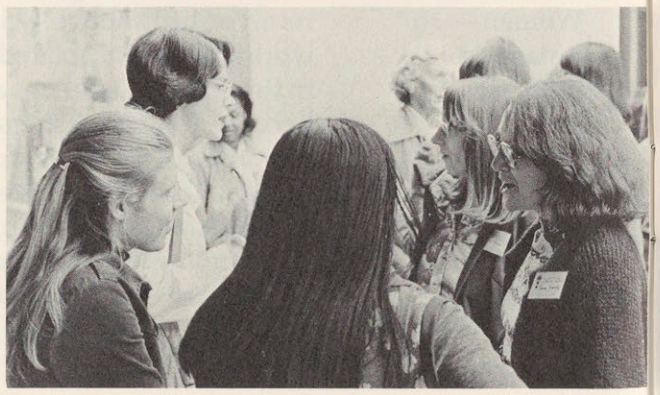
This new world of science holds opportunities for many more young people than at any time in the past. It is a realm that is still dominated by men, but it is beginning to open to women. And so it should. As Plato pointed out over 2000 years ago, the whole society is the loser when its intellectual life is closed to half the population. Springing from the same genetic reservoirs as men, women are born with the same array of potential talents and abilities. A great national resource lies untapped while women are discouraged, from childhood onward, from fully using their energies and intellects.

The Symposium — Space for Women

In order to share with young women some of our thoughts on both the difficulties and the rewards of science and science-related careers, a group of women at the Center for Astrophysics in Cambridge, Massachusetts, held a symposium in October 1975 in celebration of International Women's Year. The Symposium, *The Earth in the Cosmos: Space for Women*, was sponsored by the Center for Astrophysics, Harvard University, Radcliffe College, and the Smithsonian Institution.

The Symposium was experimental in several respects. In contrast to a standard symposium format, in which experts talk mainly to other experts, we had women speakers and panelists, working in many capacities, outline their career-building experiences to high school and college students. Our speakers included research scientists from several parts of the country, plus science writers, editors, teachers, administrators, computer programers, librarians, secretaries, mathematicians, research assistants, and engineers. Although some of the women aspired to be scientists from an early age, others described how they entered science or science-related jobs after majoring in seemingly unrelated subjects such as music, history, languages, or graphic arts. We established an informal atmosphere and encouraged open discussion among the speakers and the audience.

George B. Field, Director of the Center for Astrophysics, addresses a group of Symposium participants

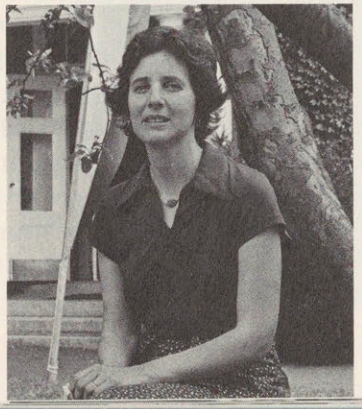


A unifying theme of the Symposium was the consideration of careers related to those sciences pursued at the Center for Astrophysics — astronomy, astrophysics, and earth and planetary sciences. We were not in a position to cover other sciences such as biology, chemistry, and medicine, and it is our hope that the Symposium and this booklet will encourage women in other branches of science to plan similar meetings. However, it is very clear that many of the experiences and feelings expressed are applicable to careers in almost any science, or in almost any field, for that matter. The reasons for choosing a career as opposed to a series of jobs, the joys and difficulties of combining a career and a family, the problems of where and how a young woman should start — all these are general concerns that young people should hear about and talk about.

Concerns and considerations

This booklet does not report the individual speeches given at the Symposium. Rather, it poses several of the major questions that were raised and juxtaposes the thoughts expressed by different participants. It also contains concrete suggestions regarding steps you can take if you are interested in pursuing a science or science-related career. In order to help you know the women who took part and whose comments are quoted, thumbnail sketches for them are supplied on page 41.

The Symposium: Space for Women



Judy Walzer

Do You Want a Space?

One of the purposes of the Space for Women Symposium was to discuss some of the realities of careers for young women. We hope to make you aware that in all probability you will have to work for a significant portion of your life and to encourage you to pursue a career of your choice and enjoy the sense of satisfaction and accomplishment that comes with a meaningful career. This is not to say that you must decide from the very beginning what you will do and how you will progress, but chances are that you will either want to work or have to work, and for a number of years. "Economic need is the single most compelling force that drives people into careers. A lot of people might say something else, but most people, including a lot of eminent ones, are not that driven by ambition and the need for power. They like to enjoy life, and we do, too. But we all also want to eat, and we may as well eat well. You are much better off thinking of your future in terms of a profession and a career rather than a series of jobs with which you'll make do in between your father and your husband, and maybe your second husband, supporting you. Women are also thinking seriously about careers because they feel a true moral obligation to pull their own weight in the world." *Hornig*.

A career versus a series of jobs

"You have yourself to think of."

More than 40% of all working-age women in the United States are employed today; most seek jobs because they need to support themselves or dependents. In addition, women who work outside their homes generally do so for a large part of their lives—somewhere between 25 and 30 years. "Most of you have a life expectancy of around 80 years. Most of you will marry, but two out of five will get divorced, and if you happen to live in California, it will be one out of two. And, on the average, divorced men pay child support for one year. So, if you are somewhere between one-half and two-fifths of all women, you will be left with children as well as yourself to support." *Hornig*. Furthermore, many women who choose to stay home with small children and are financially able to do so are unprepared for the emptiness in their lives after the children grow up. "The time you actually devote to a young family is only a very small segment of your whole life. You have yourself to think of after that." *Hornig*. Moreover, some women do not marry and others are widowed while still of working age; a large percentage of this group must also seek gainful employment.

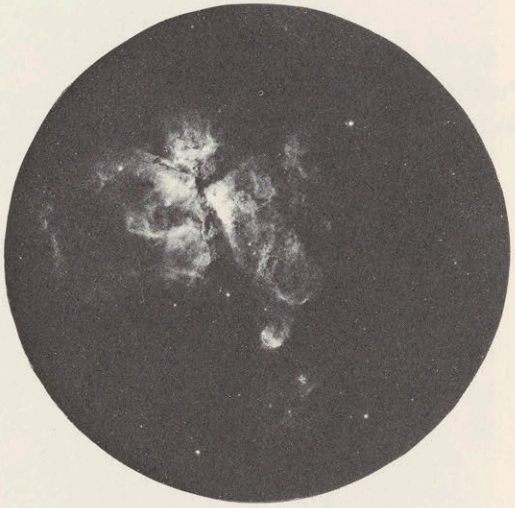
The globular cluster 47 Tucanae

Women have choices

In spite of their ever-growing numbers, working women face many issues that do not exist for men. "The inner conflict you will experience when making a choice — not just between whether or not to have a career, but which career and how much of a time commitment it calls for — can be tremendous." *Hornig.* "Most men assume they are going to work all their lives. They often have no choice; they have people to feed at home. For many of them, their whole identities and egos are mixed up in their success at work — how much money they'll make or how much prestige they can gain. For them, it's straightforward; it's simple compared to the kind of thing that faces us. Lots of work days are just plain drudgery, but for me, there's always a choice. At any time, it would be perfectly acceptable in our society if I just quit. So, why should I keep going? To make the same success as a man, women have to have a little more stick-to-itiveness just to get over the rough places." *Atwater.*

Among some women who overcome their early struggles and find success in a career, certain constant factors are apparent. "They're usually people who have developed a strong sense of themselves, a strong idea of their self-worth, and a certain, very important amount of grit. They often take risks and keep themselves open to possibilities that come their way." *Walzer.* Of course, not everyone is born with these qualities, and many successful people remain timid or unaggressive all their lives. "The confidence you may not now feel as students will grow as you learn to do something well. It's unrealistic to think that everyone must do everything brilliantly. Most of us ultimately settle down in one small corner." *Rubin.*

Careers are becoming easier for women to achieve. People are realizing "that women have something particularly unique to offer. There is a great pool of brains that has never been tapped." *Rubin.*



The great nebula near Eta Carinae

Is There Space for Both Career and Family?

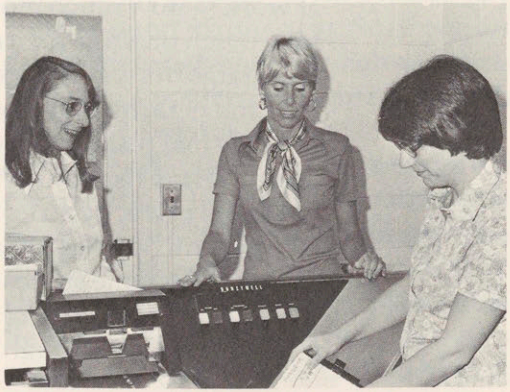
Although perhaps you have received encouragement to pursue a career, whether in a science or science-related field or in some other area, the chances are good that you still face serious questions about your role as a family woman versus your role in the working world. Is it easy to combine a career with a family? Is it practical? Is it acceptable? What are the difficulties? If you combine both, do you have to make a conscious decision as to whether one has a higher priority? Most men don't have to deal with these issues, but for women, such decisions can be crucial. The Symposium participants have asked themselves these same questions and have come up with a variety of answers.

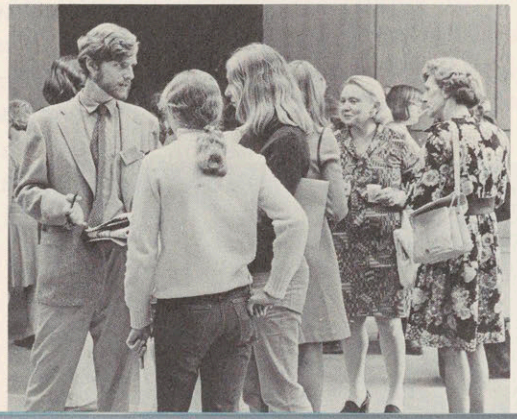
Public opinion shifting

The old attitudes are relaxing. No longer does a woman have to pick only one — a career *or* a family. "When my first child came along, it never occurred to me that there was any choice. I stayed home." *Karlin.* "The weight of public opinion is gradually shifting in favor of women having careers as well as families. We are a long way from full endorsement, but at least things are better than they were." *Hornig.*

Vera Rubin

Pat Thomas, Peggy Anderson, and Linda Kirschner

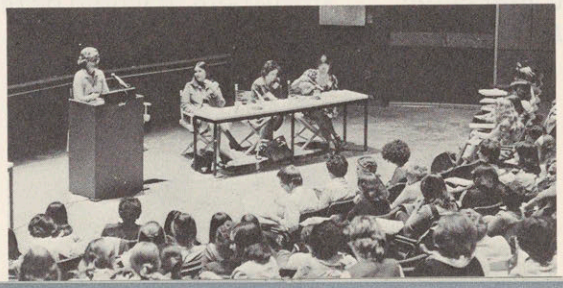




Diversity of lifestyles

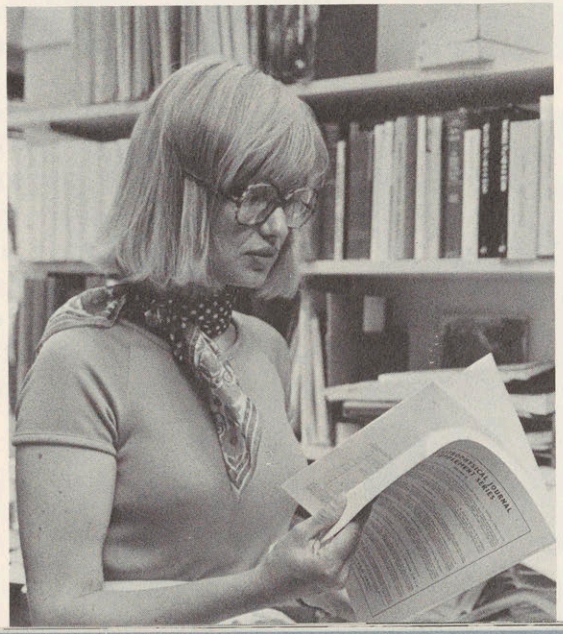
Today, a woman is respected for choosing her own lifestyle. "Having families can be and in the future will be increasingly easy to combine with careers. There are other lifestyles, however. Some women decide not to marry or are divorced or widowed; others elect not to have children. When we got married, we rather assumed, as most people do, that we would have a family. But we immediately went to Brazil to work, and life every year seemed so full and exciting that we thought, 'We won't start a family yet; we'll do it later.' Looking back, I think there's very little accident about these things. With us, we were enjoying our own lives and each other so much that having a child was not a priority. Family members and friends told us that if we did not have children, we would be lonely when we were older. Well, we're older now, and we're not lonely. Life is still exciting and full. I just want to urge young women to make it a matter of choice. Don't have children because somebody else thinks you should. By all means, if having a family as well as a career is what you want to do, you can do it and you should do it." *Marvin.*

Children — a personal decision



The first question, of course, is where to start. "When I got my Ph.D. in 1970, my daughter was a year old and I finally had to face the question that everyone had been asking me for years: How am I going to combine a career in science with raising a family? My answer was to find a part-time job, but it certainly wasn't easy. In 1970, even full-time jobs in science were very scarce indeed. I finally got a job as a programer. A year later, I found a part-time position as a mathematician and became a supervisor of the data-analysis group in 1975. I still work only four days a week because I like to be home Wednesdays with my children." *Williamson.*

Andrea Dupree



Part-time careers

Though scarce, part-time work is becoming increasingly available and seems to be the answer for many family women. "When our daughter was born, I began working part time. This was possible in large part because I had a fairly well-established position as a computer programer. Until recently, I worked three days a week and now have increased to four. My husband and I have spent the last four years trying to work out the logistics of having a two-career family and being parents at the same time. We've also been very involved with the day-care center our daughter has attended since she was an infant." *Kirschner.*

Most mothers who work part time extend their hours as the children get older and eventually return to full-time employment. "Since the children have gotten older and some other commitments are no longer with us, I am now back to working full time. Before I went to Chile in 1974, I had not observed at a telescope for twenty years. I used to hate observing, and now I've discovered it is one of the most fun things in the world. This is a good example of how someone can get back into a field after being away from it for some time." *Liller.*

Sharing responsibilities

Some women are fortunate enough to find that an already established career can fit right into raising a family. "If you're in the right place and if the financial circumstances are right, editing is a skill that lends itself nicely both to part-time and to free-lance work and thus combines well with raising a family." *Wong.*

Combining a family and a career doesn't end with finding a job. "The choices are day-to-day — if a child is sick, someone has to stay home, and that person may get it from the boss. It's a day-in, day-out sort of thing." *Williamson.* If the job requires extensive travel, who will take care of the children? "Last summer, I was away for a month doing research. My husband stayed home and took care of the baby. He was pretty tired when I came home. Since then, he's gotten even; he's now in Afghanistan for two months." *Atwater.* How does the housework get done? "Bill and I started working together when I was just beginning graduate school, and we still work together. We share most of the household chores, cooking and things like that. If I had to do both, it would be really difficult." *Jones.*

The two-career family

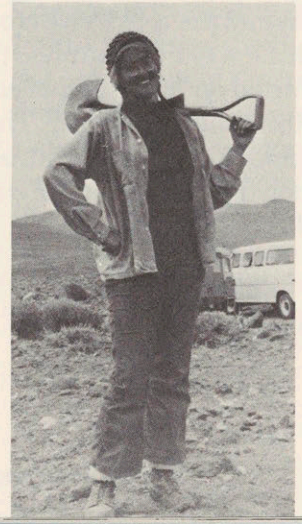
The most important problem that a two-career family may have to face is whose job comes first — if one member must relocate, can and will the other also pick up stakes? Even today, the following attitude prevails: "My life has always taken me where my husband has a job. It's one of those marriages where the man gets the primary position." *Liller.* Another participant recalled, "I made up my mind very early that since my husband's future lay in Washington, I had to find a career for myself there." *Rubin.* In some instances, however, it works out the other way around. "My husband is an independent geological consultant. He would probably find life a little easier if we were living somewhere in the Southwest. But he can still operate well enough in Cambridge, where we live because I have the more structured job here." *Marvin.*

"I think my family has not suffered."

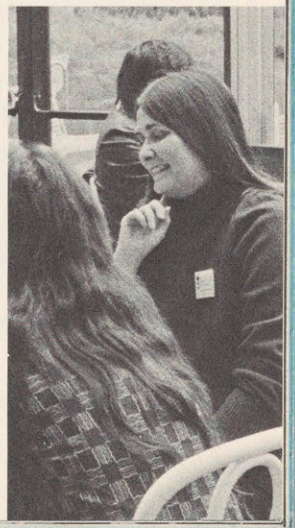
Although there are concomitant problems in combining careers with families, the women participating in the Symposium felt that the satisfactions and compensations far outweighed the difficulties. "My life really has revolved around nothing but science and my family. I think my family has not suffered. In fact, I think they've done very well. They have camped on almost every observatory ground in the country and in many foreign countries. They have lived a life where foreign astronomers were constantly showing up at the supper table. I believe they have learned very much from their parents, and we've learned a lot from them. It's really been quite a way to live." *Rubin.*

Joan Jordan and Estelle Karlin

Tanya Atwater



Marlene Williamson, right



The dual role—problems and benefits

Certain careers have built-in side benefits for women. "Both Martha and I, who have families at home, refer to astronomical observing at an isolated mountain site as the rest cure. Most of the men there just sort of drag around thinking, 'Oh, it's so hard to stay up and work all night!' Meanwhile, for us, there's no laundry to be done nor meals to be prepared, and no children you have to tell to get up and go to school and this kind of thing. It's terrific! You get a change of scene. It also makes your husband appreciate you more; when you get home, he's usually tearing his hair out and saying, 'How do you manage these things?' " *Cowley*.

Naturally, the path is not always smooth. One participant, who took time off between her graduate courses and her thesis writing to have her first of four children, reflected, "If I were to do it over again, I would either have all the children before I began my Ph.D. work or complete the Ph.D. and get started on professional employment before fitting the children in. That, of course, is a personal decision, and, as you well know, such decisions don't always work out as planned." *Hornig*.

A lot of progress has indeed been made regarding society's acceptance of women as salary earners and career builders, but it is interesting to note from some of the above statements that even highly successful women may have mixed feelings about their dual role.

The realities are there. You will probably work for a large part of your life, and you may well want and have children. Although the problems inherent in doing both are not insurmountable, they should not be ignored. Start thinking about them now. "One of the most important decisions you will make is whom you will marry, and it's helpful in the long run to go over some of these questions as you get acquainted. You probably will anyhow, but it tends to be something that's in the background in the early stages of a relationship. Start finding out how he's going to feel about really sharing those rewards of family life with you, including the dishes and the diapers." *Hornig*.

Missy Mink, Peggy Anderson, and Ursula Marvin

Should You Choose a Space in Space Science?

Astrophysics can be beautiful, exciting, challenging, and satisfying — all at once. The beauty of the night sky, the fascination of black holes, and the many mysteries of the universe are only some of its attractions. Astronomers attempt to answer the "why" and "how" of all the phenomena observed in the skies. "Groups studying the sun are discovering enormous holes in the very high-temperature solar atmosphere, holes that we now think may have contributed substantially to the solar wind that envelops the earth. Such structures may have profound effects on our climate. Other researchers have found that the space between the stars is much hotter than anyone ever expected. Instead of being 'cold' at temperatures of 1000°K or so, it may be a million degrees. Certain more exotic species of stars and objects are being studied. There are also objects such as black holes, pulsars, and quasars, which are giving out tremendous amounts of energy in very strange ways. Researchers are challenged in trying to figure out what's going on. One of the greatest puzzles of all concerns the closest star, the sun. Scientists have long had theories about energy generation in the sun, and particles have recently been observed that originate in its very center. However, there is an enormous discrepancy between what has been predicted and what we actually measure. This is a fundamental problem. If we can't understand how the sun makes its energy, how are we going to understand what happens in stars?" *Dupree.*

Puzzles — black holes, pulsars, quasars, and the sun

Some studies concentrate on stars — how they are formed, what their properties are, how they evolve, what they will look like in 1000 years or a million years, how they die, and what happens then. These astronomers try to understand how the universe behaves from knowing the life histories of individual stars. Other scientists are interested in the evolutionary patterns of galaxies or entire groups of galaxies. "At present, astronomers think that our galaxy formed from a gas cloud during the early stages in the expansion of the universe. They believe that somehow the gas cloud, which consisted of atoms and molecules moving in random fashion, developed inhomogeneities that were sufficient to start star formation. Stars that formed early in the history of the galaxy have noncircular orbits, illustrating the motions of the gas from which they

were formed." *Rubin.* But then these stars eventually die, and new ones are born with different constituents, different properties, and different orbits.

Interrelated disciplines

Although our knowledge of astronomy is growing rapidly, "There are many, many things that astronomers don't know; many more than they do. Fifty years ago, no one even knew what a galaxy was." *Rubin.* There is so much about which we know so little that anyone entering the sciences can hope and expect to make significant contributions to our understanding.

Alice Weeks

Meteorites—"samples delivered without charge"

A special fascination of astronomy is that it overlaps with many scientific disciplines. Principles of biology, chemistry, geology, and physics are applied to understanding the evolution of our solar system and the formation of life on earth, as well as to speculating about life on other planets in other solar systems in other galaxies. "Astronomy is certainly intimately connected with the origin of life in terms of what elements are present in the earth's atmosphere and in the atmospheres of other planets that may have life on them. We are concerned with the way things worked on the earth and other planets millions of years ago, how the conditions have changed, and how life has changed." *Liller.* Radio astronomers are perhaps even more directly involved in this topic. "They're actually looking at the building blocks of life itself. They're finding very complicated molecules in space. They hope to find clues as to how these molecules, which are necessary to form life, occur and where and why." *Dupree.*

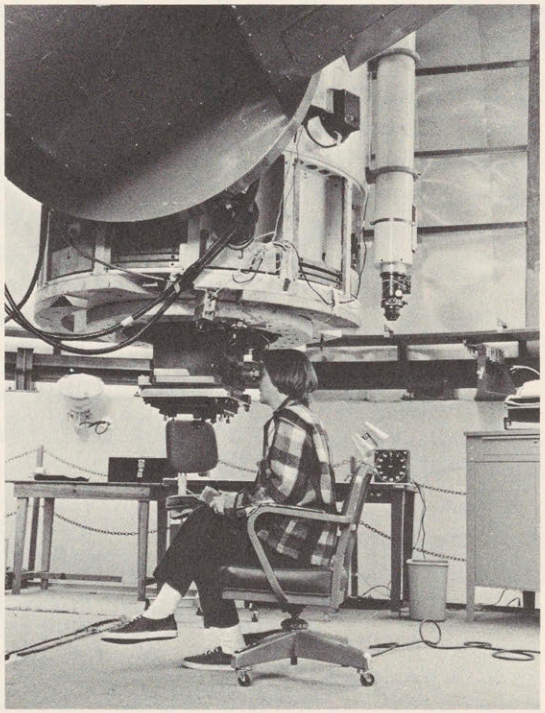
A branch of the planetary sciences, meteoritics, is also concerned with the origin and evolution of our solar system. Meteorites, believed to be fragments of asteroids or comets, are "samples delivered to

us without charge from various parts of our solar system. They are the oldest rocks known. Most of those that have been measured are 4.5 billion years old, close to what we think is the age of the earth, moon, and planets. But chemical recycling on the earth has erased all traces of rocks older than 3.7 billion years. Therefore, meteorites help us decipher the history of what happened during the first 800 million years after the formation of the solar system." *Wilkening*.

Space missions for earth studies

The planetary sciences are a good example of the interdisciplinary nature of the space sciences. "The field of planetary sciences is no longer limited to astronomers, although it grew around planetary astronomy. Most of the information relayed from exploratory spacecraft should be studied by people with different backgrounds in various physical sciences. The Apollo missions returned rocks and soil samples from the moon, which hundreds of geologists, geochemists, and geophysicists have been studying for the last several years. Here's a whole new field of space science that's open to people with different backgrounds." *Wilkening*. One speaker took advantage of this interdisciplinary aspect. "In 1961, after years of geological field mapping and searching for ore minerals in South America and Africa, I began studying meteorites. It was an ideal time for a geological-mineralogical background to be applied to the space sciences. Today, inspired by the Apollo, Mariner, and Viking missions, many young geologists are entering planetology." *Marvin*.

Martha Liller



Concerns for the preservation of our environment

But it is the study of the planet earth itself that is of overriding importance to most scientists who choose geology or geophysics. They are attempting to comprehend how the earth evolved from a cloud of dust and gas into a solid body with a few small, irregularly shaped continents standing high amid the deep oceans. The space program has brought with it a new appreciation of the earth's uniqueness to scientists and to the public at large. The first photographs of the earth taken by astronauts in orbit brought home to us in dramatic fashion the reality of our isolation in space and our total dependence on the viability of our small planet. Suddenly, a profound concern for the preservation of our environment became part of our everyday life. Comments on the subject filled our newspapers, magazines, and television programs, and many of us felt an urgent need for a fuller scientific understanding of the earth and the life it supports.

Fortunately for scientists, the public is often willing to pay for such knowledge to be researched. "I wake up every morning amazed that someone will pay me to do astronomy. One hopes that this is something society will support, and one is enchanted when it does. Perhaps the day may be coming when astronomers may have to live like poets. But I hope that there are some among you who will want to do this so much, for whom getting these answers will be so important, that what you eat will be of no consequence." *Rubin.* "There often seems to be a dichotomy between basic science and applied science. However, I've noticed that sciences that are basic to begin with tend to find applications sooner or later. Geology at one time seemed widely separated from the concerns of everyday life unless someone specialized in mining. Indeed, sometime in the 1930s, a well-known mineralogy manual stated that uranium 'was a rare element of scientific interest only.' A decade later, research into the uses of uranium floated the whole Atomic Energy Commission and half the U.S. Geological Survey. Today, the geosciences are ready to grapple with the fuel, energy, and environmental crises in large part because someone in earlier decades pursued research that seemed esoteric at the time." *Marvin.*

Tanya Atwater and colleagues

Fascinating new research areas

All the studies referred to so far comprise only a very narrow selection of topics that interest space scientists. The variety of research itself is "astronomical," and new fields are continually opening up. Although theoreticians had long ago suggested the existence of very dense objects called neutron stars, it is just in the last ten years that radio astronomers have observed this phenomenon, in the form of rapidly rotating neutron stars called pulsars. Observational evidence for matter in an even more exotic state called a black hole was obtained only a few years ago through the young field of x-ray astronomy. As mentioned, analysis of lunar samples is another new area of study. Close-up photographs of several planets have recently been taken by long-distance satellite missions. Earth scientists were electrified about ten years ago when a radically new theory called plate tectonics was proposed. One exciting aspect of science is that there is always something new to study.

"For me, research is a very personal thing."

But what makes an individual decide on a scientific career? The reasons are as numerous as the people. "At a very early age, I started wondering about the universe. It seemed to me that this was really an unimaginably lovely place, and I tried to comprehend the order in the planets and stars and galaxies. And the more I wondered, the more I learned, and the more I read, the more I realized that there were no answers to many of my questions. And so my life has really consisted of trying to find these answers." *Rubin.* Virtually the same feelings were expressed in a different way. "I knew that maybe someday we could get a piece of the moon or go out and measure part of the solar wind or look at a spectrum of a star. I had a feeling that I could actually confront some of the things I saw in the universe and perhaps understand them. For me, research is a very personal thing. It's a satisfaction to want to do it and to do it." *Dupree.*

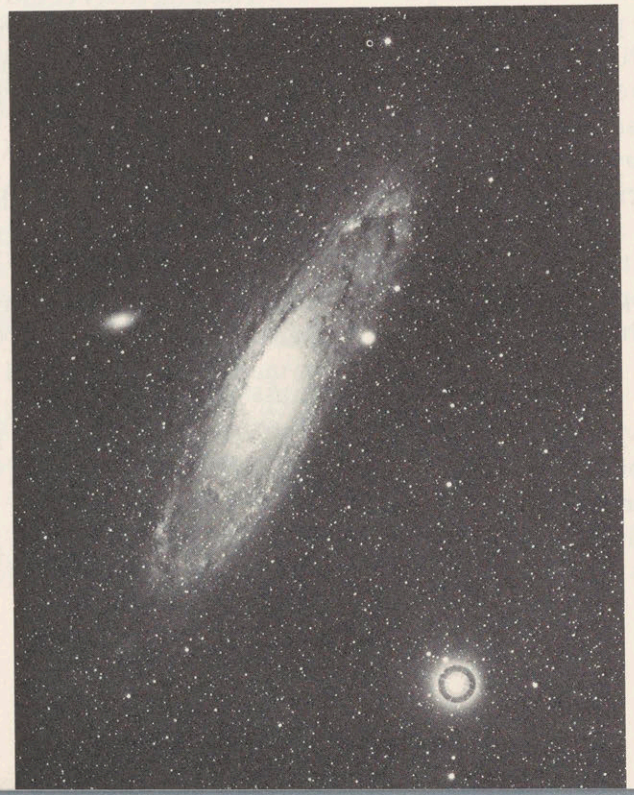
Among many, the enthusiasm of working in science can be all-encompassing. "The first couple of years of graduate work in marine geology were so exciting I almost got frantic. I couldn't sleep at night. There were so many things we could suddenly figure out if we could just hurry up and do more work. It's a good thing it has slowed down a little or I'd die young." *Atwater.*

One image we hope to dispel is that of a grim woman scientist working alone. Many

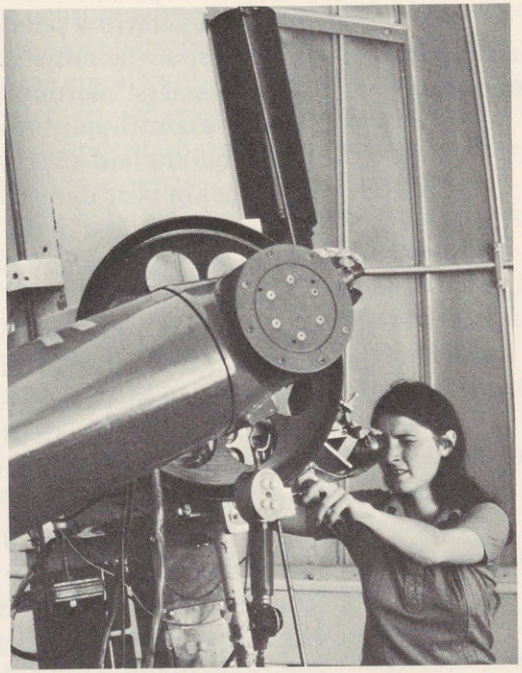
Working with people

people who might otherwise have pursued a science career have said, "But I want to work with people." In science, you will indeed work, and work closely, with people of all kinds. "Most of us go into marine geology because we love big wide-open spaces, mountains, and oceans, yet we spend a lot of time crammed into a small hot space on a ship surrounded by sweaty people. If you think scientists don't deal with people, you couldn't be more wrong." *Atwater.*

The spiral galaxy Messier 31



Christine Jones



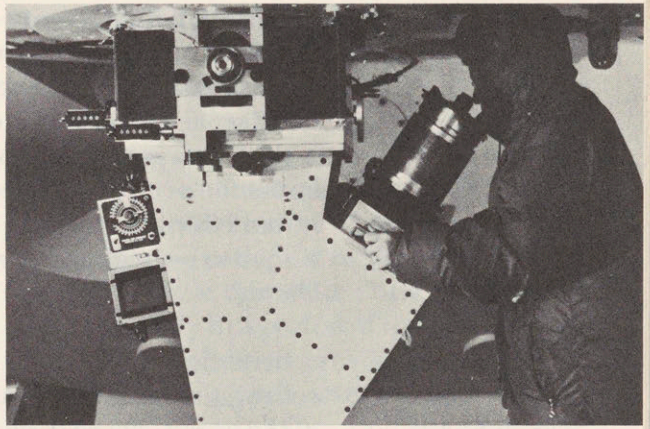
Anne Cowley

Sharing the excitement of a discovery

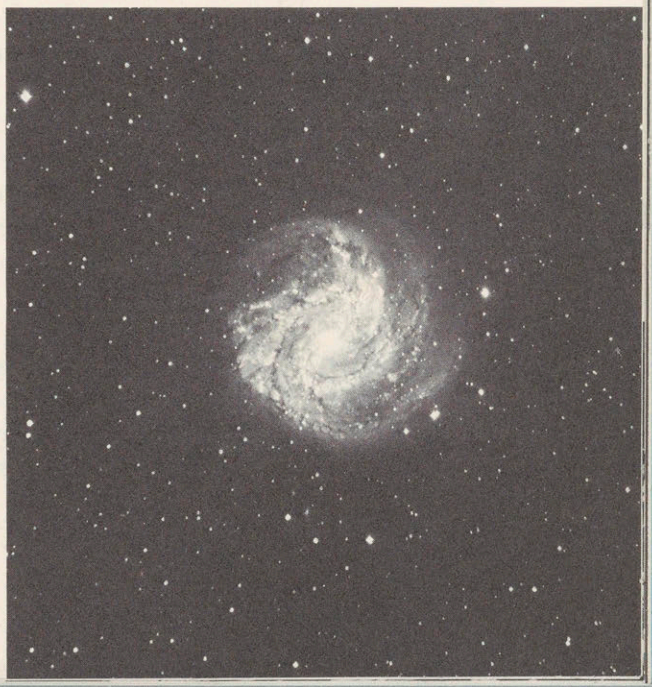
Most scientists collaborate with others, so there is usually someone to share the excitement of a new discovery, be it great or small, or to help solve problems. "I enjoy working in a group. When I discover something really exciting, I can go and tell somebody about it. It's nice to have other people around who have varied backgrounds and different experiences and who are interested in the same kinds of problems and can help steer you in the right direction. The people I work with have taught me more, both how to solve problems and how to find which problems are important to solve, than any of the physics courses I took." *Jones.*

Part of the necessity of working in groups stems from the increasingly sophisticated and expensive equipment required to probe deeper into space or into the earth's interior. For example, satellite experiments cost millions of dollars, involve years of planning, and thus can be undertaken only by people working together. "There is really no aspect of modern science that is isolated from people or from what's going on in the world. That's one of its fascinations. Even the most abstract subspecialties have a very direct relation to the physical world, and the

Vera Rubin



The spiral galaxy Messier 83



"People-oriented nature of science"

physical world includes people. The problems with which science will deal in the future are going to be much more people-related than they have been in the past, for the simple reason that there are a great many more people around. The reason I stress the people-oriented nature of science is that I think women are far more conditioned to be people-oriented than men are." *Hornig.*

Science — an international club

Scientists often attend meetings or visit colleagues in other, sometimes exotic parts of the world. These trips offer breaks from the normal routine and may seem more like vacations than work. Meeting and collaborating with scientists from other countries can offer new insights into old problems. "Science is rather like an international club. I have studied in laboratories in several different countries, and everywhere I go, I find people who have interests and goals similar to mine. Cultural differences begin to fall away while we discuss our mutual interests." *Wilkening.*

Of course, not every day is exciting. Some days are frustrating because no problem seems solvable; others are pure drudgery when the tedious aspects of a job appear never ending. But these days are overshadowed by those when all the pieces of a puzzle fit.

Laurel Wilkening

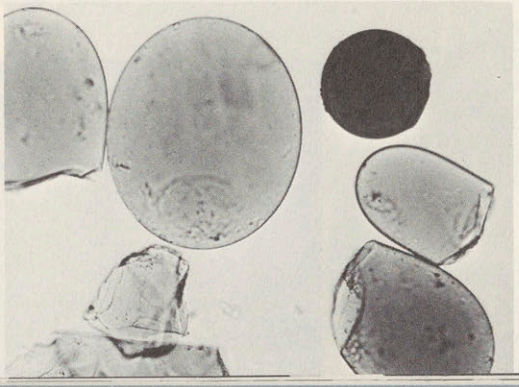
Competition and discrimination

What are other problems for women wishing to pursue careers in science? "Science is dreaming up new ideas and criticizing other people's ideas. And people aren't always nice about it. If you're sensitive to criticism, it can be uncomfortable." *Wilkening.* By its very nature, science is competitive. "I think a scientist can never really prove that anything is true, only that something is not true. Of course, you have your own pet theories — that's where the fun is, trying to guess what is going to be true. Science progresses mostly by proving that someone else is wrong. Well, it's a touchy business to be disproving someone's favorite idea. The ideal for women that I grew up with is that we are gentle and pliable and unassertive; our function is to build up a man's ego and make him feel smart and wonderful. Just try to do that while you're smashing his best theory." *Atwater.*

"It's great fun to be an astronomer and go observing, but there are drawbacks as well. Astronomy is a field that is composed primarily of men. Historically, this has led to some discrimination. For example, until recently, a major observatory in California didn't allow women to observe, and the reason was completely silly: There weren't separate living and toilet facilities — in any case, that's what they said. Furthermore, we're currently in a period of financial insecurity. Many jobs were created during the boom in the early 1960s after Sputnik went up. There certainly isn't as much money to spend any more, and some people who entered the field recently are still looking for jobs. So, you have to be sure it's what you want to do. Job scarcity is not a reason for not entering astronomy, but no one is automatically guaranteed a job." *Cowley.*

Ursula Marvin

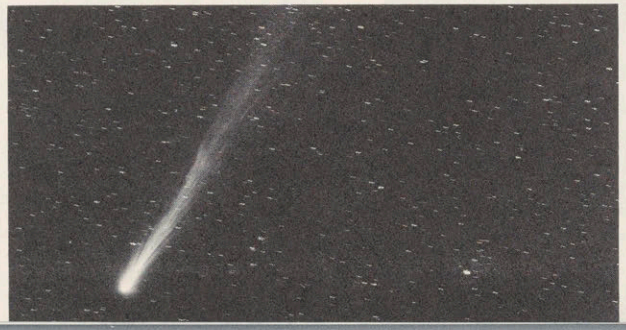
Green glass spherules from the lunar soil at Hadley Rille (Apollo 15)



Discrimination — real and imagined

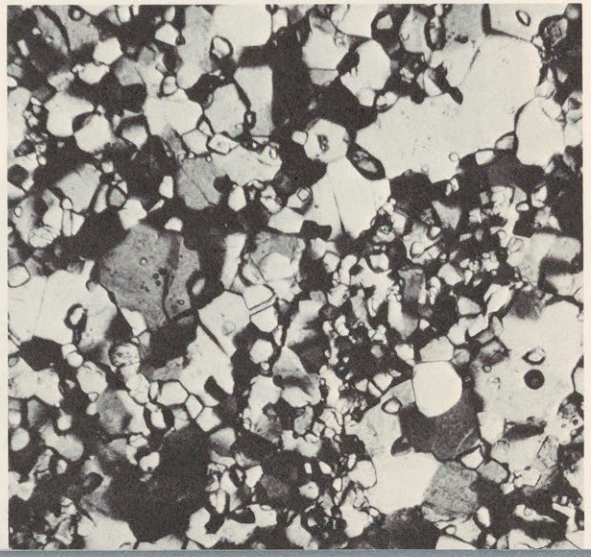
Had any of the Symposium participants felt discriminated against? "Events can happen that appear to be discrimination, and you don't know whether they are or not. Through a negative self-image, you may think it's all your fault." *Williamson.* "I feel that I've encountered acts of omission rather than commission. I haven't been encouraged to go ahead. I wasn't encouraged to go to graduate school. People have been happy to have me stay put and do my job well, whereas a man would have had more overt encouragement to advance." *Kirschner.* "There's this prevailing climate where nobody expects women to want to go into science, and consequently people are a little surprised. They don't quite know what to do with you." *Mink.* In another case, a science writer sent her article on superheavy elements to a leading physicist for a final check. "He sent back a cable saying that the story was fine, and he closed with: 'I wish all women understood physics as well as you do.' I didn't know whether to be flattered or insulted." *Lubkin.*

Comet Morehouse



It is also important to look at some of the statistics of women in the sciences in the United States. In the past, discrimination has often hindered women from advancing in their careers, yet there have been and there are many outstanding women scientists. According to the U.S. Department of Health, Education, and Welfare, 18% of the bachelor's degrees and 7% of the Ph.D. degrees awarded in astronomy for the years 1972 through 1974 went to women. Other respective figures are 8% and 4% for physics and 14% and 5% for geology. Female membership in the professional science societies has grown, having proportions similar to the number of women holding Ph.D.s in each field.

A fine-grained crystalline rock from the lunar highlands; thin section in polarized light



Other problems to ponder

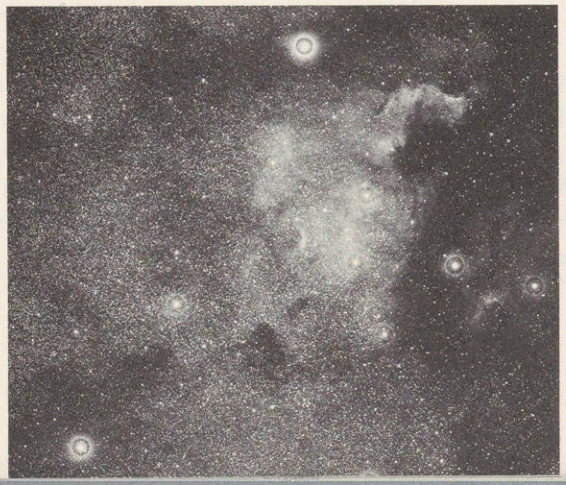
Interestingly enough, an American Astronomical Society survey found that 65% of the professional women in astronomy are married to astronomers, physicists, or scientists in some other field. "Marriage of this sort is great, in that it gives you an opportunity to share your work with your spouse. But it creates a problem when there are two people looking for jobs. Many institutions will not hire both a husband and a wife even if two jobs are open. The survey showed that the person who usually comes out with the poorer situation is the woman. Moreover, a very high percentage of the women surveyed felt that their jobs were dead end and that they had no job security. But I would think that by now the situation is beginning to change, partly because this survey and others have created an awareness of the problem." *Cowley*.

Positive trends

From other statistics, it is evident that further progress is definitely required. "I'm working in an academic environment, and one thing you find there is unequal pay for equal work. The American Association of University Professors' statistics revealed that full professors who are male earn two to three thousand dollars per year more than their female colleagues, and if you multiply that by a career of 40 years, that's a considerable amount of money." *Wilkening*. Other surveys show that a salary differential is not limited to academic institutions.

All signs point to positive changes being made — we are hopeful that this trend will continue, rapidly. For younger women, discrimination will probably be much less of a problem, primarily as a result of society's changing attitudes.

The North American nebula



Spherules of orange lunar glass containing black crystallites of ilmenite ($FeTiO_3$) (Apollo 17)

Should You Choose a Science-Related Space?

Parallel careers

So far, we have offered a variety of research areas that we hope will prove interesting to aspiring women scientists. Now we will focus on some of the science-related careers that women have found both challenging and worthwhile, careers that are vital to the day-to-day operation of a scientific organization. Some of these women desired scientific careers from an early age, but perhaps were impatient with the prospect of graduate school or really didn't want or couldn't afford further training. Many others ended up in a science environment quite by accident. But most enjoy using their own talents to support scientific research, and scientists readily admit that their own work could not progress at the rate it does without the valuable contributions of these people.

Scientific programer

Many of the rapid advances made in science over the past 25 years are due to the development of the electronic computer. Problems that used to require years of hand calculation can now be solved in a matter of seconds. But not all scientists have learned to communicate directly with the computer; many turn to a scientific programer for assistance. "As a research scientist, I feel that programers are absolutely indispensable; they are our right hands. We work closely with them, and in many cases, they are collaborators on the research. A scientist might devise an incredible system of equations, but programers have the unique ability of being able to analyze a problem mathematically and think of the most efficient way of finding a solution." *Dupree.*

What does a programer do, and what are some of the satisfactions? "I translate the mathematical formulation of a scientific problem into a language the computer understands. This is very precise, detailed work and can be nerve-racking at times. However, a program that is well written and finally works is quite beautiful and rewarding. I also enjoy the detective work of searching out errors in the program. This involves thinking very logically and is never boring. Each problem is new and requires a fresh approach. Also, I work very closely with scientists and other programers, which gives me a chance to learn constantly about various aspects of science and computers." *Kirschner.*

A variety of applications

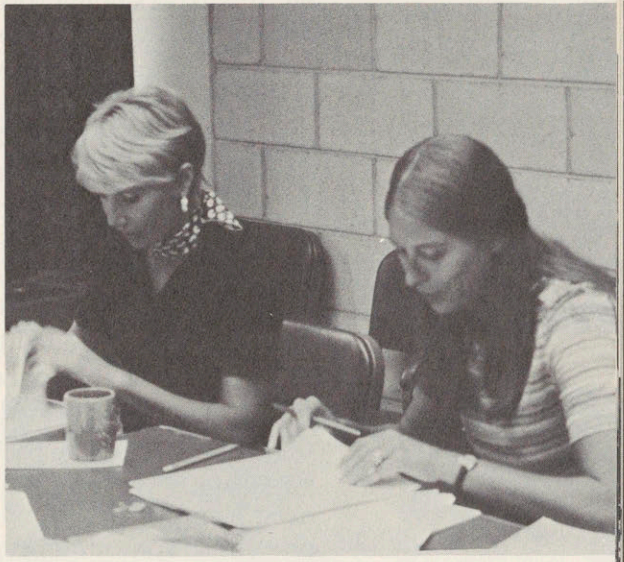
An example of the applications of programing can be seen in the following: "When a scientist wants to use the extensive capabilities of a computer to solve a particular problem — for example, to create a temperature or a pressure model of the sun — I design the program, code it for the computer, and debug it. The most exciting thing I'm doing right now is working on a color display system, driven by a small minicomputer. Color adds a whole new dimension to the study of the sun." *Flagg*.

Programing is perhaps one of the fields most wide open to women in science-related careers today, partly because it still is relatively new. But this then raises other issues. "I sometimes worry that programing is becoming women's work." *Kirschner*. What is wrong about making a field a women's field? "It seems that it begins to lose status as soon as that happens. There was a time when typing was strictly a man's field." *Mink*. On the whole, however, programers feel a great deal of satisfaction with their careers. "You don't have to be exploited unless you let yourself be. If you have goals and stick to them, and if you look for opportunities, you should do all right. If you just sit there and let yourself be exploited, then you will be." *Kirschner*.

Judy Flagg

Alice d'Entremont, left

Peggy Anderson and Cindy Wong



Mathematician

Scientists also depend on mathematicians and research assistants. Whereas a scientist may develop the theory and approach to a problem, it is often a mathematician who actually handles the calculations and manipulates the formulas. Analyzing data obtained from satellites is one example of this sort of work. "Our group prepares models of the upper atmosphere. We do this by collecting observations of different satellites orbiting the earth at different heights. From these data, we compute and analyze precise orbits by means of a computer. We have identified a number of things that are happening to these satellites and therefore to the medium in which they are traveling, the upper atmosphere. For example, although the upper atmosphere is practically a vacuum, there is still enough gas to slow down a satellite. This is called air drag. When a satellite is launched, it's very important to know what its lifetime will be and how much effect air drag and other variations will have on it." *Anderson.*

Research assistant

A research assistant may be involved with numerous aspects of a research program. "I control the storage and retrieval of data from a variety of satellites. I work with the scientific staff, searching for particular types of data, running scientific programs on the computer, plotting graphs, and preparing figures for reports." *Thomas.*

Engineer

Most scientific research involves various kinds of equipment. If a particular instrument does not exist, it must be designed and built, and this responsibility falls into the hands of an engineer. "I build the equipment that scientists get their theories from. Depending on how well I build it, they may or may not get good theories. My career in engineering was not really planned, but just sort of happened. I wanted to do science, but soon found that I was very skeptical about the quality of other people's equipment. I was not sure that the instruments were really going to give me the answers I was looking for. So, I thought, let me find out for myself, let me learn engineering first and then go on to science. Then I discovered that, in point of fact, I am a very impatient person and I could not wait around to get more degrees for science. Engineering gave immediate results. Building a piece of equipment takes a relatively short amount of time, and it is very satisfying to start out from nothing and build something that works." *d'Entremont.*

Dale Cohen

Handling the red tape

However, a lot of work goes on in the background long before the research ever reaches this stage. Research takes money, and someone must be responsible for procuring it. This is no minor matter, especially where multimillion-dollar projects are concerned. Project administrators and administrative assistants help seek and monitor funds. "I take care of the business end of things, handling the red tape. To analyze the spectrum of copper is one thing, but to find what agencies might be interested in funding that research is another. I also deal with questions such as where can we find personnel with the skills to handle a particular job? Can we offer them competitive salaries? If we can get someone by November, will we have the funding then or not until January?" *Cohen.* "My job is to see that the department has sufficient funds to do the research and that its contractual obligations and reporting schedules are fulfilled. I also make sure that our administrative staff and procedures lend effective support to the scientific research." *Williams.*

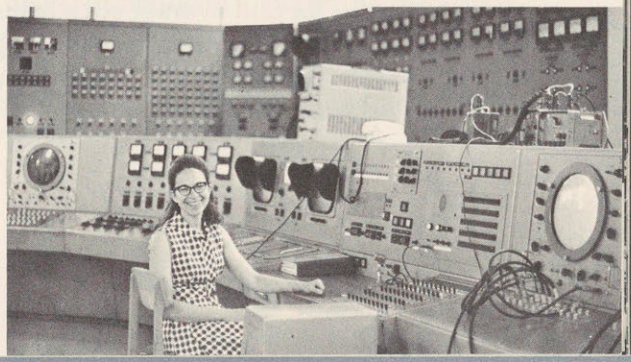
Project administrator

Fiscal responsibility is only one aspect of a project administrator's job. "My group operates a network of astrophysical observing stations that collects satellite data for

Peggy Bush and Jan Williams

Jean Andersen and Joyce Rey

Gloria Lubkin



Budgeting and reporting

people doing research in the upper atmosphere, geodesy, and geophysics. These stations are located in very remote areas of the world. Each is run in cooperation with a local institution. In addition to more usual administrative projects such as budgeting and reporting, I help administer these overseas stations. We hire personnel from the host country, and we have to make sure that we neither overpay nor underpay with respect to local standards. We have to see that we're operating within the laws of the country regarding employment rights, benefits, and salaries." *Bush.*

Science librarian

The tasks of an administrator are very wide ranging and can run the whole gamut from one end of the day to the other. "I am responsible for all nonscientific administrative and policy decisions in the Associate Director's absence. That's no small order. Something I do may really change the direction of the group. On the other hand, I am also responsible for maintenance of the physical plant within the division. I arrange for and oversee such tasks as telephone installation and removal, light-bulb replacement, and special cleaning and repairs as necessary." *Andersen.*

Another resource required by scientific investigators is the research library and its sometimes unheralded science librarian. "Unlike public libraries, the services provided in a scientific library are very specialized indeed." *Rey.* A science librarian must ensure that the collection is kept current and that all facets of a particular discipline are represented. In the process of assisting scientists, a certain closeness and informality develops in a science library. "Most special libraries have very small staffs of perhaps two to five people. Consequently, you get involved in almost every phase. You're never really stuck in the back room. You have a select clientele, anywhere from 200 to 2000 people, so you get to know their interests and their needs. You get to know them personally, and that's rather comfortable." *Karlin.*

Sara Yorke and Diane Jarmac-Kirk

A librarian often has to fill requests for obscure references, a duty that is sometimes more in the domain of a Sherlock Holmes. "This may require a considerable amount of ingenuity because half the time people cannot remember who wrote a paper or when or what it is called, but they know it exists." *Rey*. However, in the future, this role of science sleuth may become less taxing with the advent of large computerized data bases and interlibrary electronic communications networks. "Knowledge of computers and technology would be a tremendous asset if you are looking for a higher paying job in a library." *Rey*.

Travel coordinator

The Pleiades and surrounding nebulosity

Although much scientific work is done in the office, with computers and libraries right at hand, a lot of other valuable research requires traveling to distant locations, such as Tucson or Chile for astronomical observing, Mauritania for witnessing a solar eclipse, or anywhere in the world for international scientific meetings. A travel coordinator arranges all the necessary transportation and accommodations. Other tasks involved in this job vary from seeing that a delicate research instrument is placed on the airplane seat next to the scientist to reminding people to get their shots and have their passports updated. "We work out an appropriate itinerary and make the necessary reservations. This applies to simple one-day trips as well as to complicated trips around the world. We also make sure travelers have enough money in their contracts to cover the trip. If they don't, we work with the appropriate project administrator to see if adequate funding can be obtained. At the end of the trip, we make up the proper papers to reimburse expenditures. In addition to planning the actual trip, we take care of all the administrative details from beginning to end in the hope of freeing up a scientist's time for research." *Yorke*.

Science editor

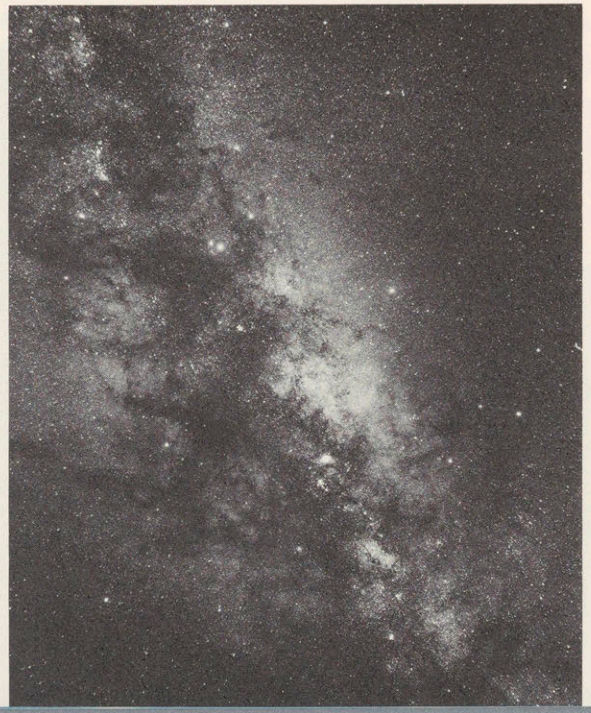
Once research has been completed, the findings are generally prepared for publication. At this time, a rough manuscript often falls into the hands of a science editor. "An editor's function is basically to clarify the text, not to do the actual writing." *Wong.* Part of the job includes rewording vague sections; determining the proper format according to the purpose of the paper; checking tables, figures, footnotes, and references for completeness; and coordinating the final manuscript with typists, artists, photographers, and printers. This activity requires frequent contact with scientists and offers first-hand opportunities to learn about new and exciting discoveries. "Although many of the individual details of editing are tedious, I particularly enjoy the organizational aspects, pulling all sorts of things together from various sources and meeting deadlines." *Wong.*

Technical secretary

No research could proceed without the assistance of secretaries. "Being a secretary isn't just typing and taking shorthand. Like any other field, you have to get yourself totally involved in what you're doing. I started working with my boss several years ago, at which time he had an idea for a joint satellite with the Dutch. I've been with him through the complete development and actual launch. Now the data are coming back, and I'm helping him with the results he's writing up for publication. I've been able to share the excitement all the way through and feel as if I've really contributed." *Jarmac-Kirk.*

By now, it must be apparent that research scientists do not and cannot function alone. They rely heavily on the expertise of many others whose work is vital to the ultimate success of a scientific endeavor.

The Milky Way in the direction of the galactic center



How Do You Make a Space for Yourself?

Suggestions versus guidelines

If you think you might be interested in a career in science or a science-related area, you must be wondering what you should do to get there and what you can do right now. Many of the following suggestions were given at the Symposium by Joanne Tondryk, a personnel management specialist. Direct quotes from her and others are duly noted, but she deserves further acknowledgment for the ideas and concepts given herein.

Throughout this booklet, and particularly in this section, it is our intention to give guidelines and suggestions as to how to find a space for yourself. Of course, no one actually follows *all* the advice and recommendations she is given so freely by "those who've been through it." And no one should feel she must; after all, "It's a very tall order to ask a teenager to plot the course of her life for the next 50 years. I really don't think anyone is capable of making such decisions, but somehow we have to muddle through." *Wilkening*. Therefore, we try to counterbalance the concrete suggestions with actual experiences of women who "somehow have muddled through."

Setting goals

First, you should set some kind of goals for yourself. This may mean deciding what you want to do for the next ten years or only for the next month. You may choose to set long-term goals — and certainly you should at least start considering them — but meanwhile, set realistic short-term goals, such as doing well on an upcoming exam, being admitted into a particular college, or obtaining a summer job related to your career interests. Whatever your goals, set high standards and persist until you reach your goals. Remember, you're competing not so much with others as with yourself.

LaVerne Love, left

Various and individual routes

Although long-range goals may be the ideal, the routes by which talents are discovered are various and individual. For certain people, decisions are clear cut from an early age. "I can't remember when I didn't want to be an astronomer. I can recall thinking how Columbus, Magellan, and all those people had a marvelous opportunity because the world wasn't known then and how disappointing it was that the whole surface of the earth was now known and mapped. I guess this is why I looked out into the universe and said, 'There's a place that people haven't been.' I wasn't thinking in terms of being an astronaut, simply that there must be an awful lot out there to learn." *Liller*.

Environmental influences

Other people are influenced by particular events. "I have friends who knew from childhood that they were going to be scientists. They popped out of the womb and said, 'I'm a physicist.' That wasn't true of me at all. I took mostly college-prep courses, including science, but I thought I would be a commercial artist. Then, the first Russian satellite, Sputnik, went up, and suddenly the whole world was crazy about science and technology. I was doing fine in my science courses, so I decided to give it a try. Each time I made a decision, it seemed random at the time. I just did what seemed exciting or interesting. I wasn't driven by duty or any desire to prove myself. I changed majors three or four times; I changed schools a couple of times, and I quit school twice. I didn't become a geophysicist until my senior year in college." *Atwater*. "In my last year in college, I started reading in other fields besides chemistry to see what possibilities existed. I came across what I call the great meteorite debate, a hot argument being carried out in the scientific literature between two very famous meteoriticists concerning whether or not there were materials in meteorites that had biological origins. This debate generated so much heat on paper that I thought certainly the field must have something to it. It sounded very exciting, and I have since found that it really is." *Wilkening*.

Some people are influenced by their environment. "Most of us are influenced by people we know, people we admire, or lifestyles that appeal to us. My father is a scientist, and I did like his lifestyle. We always had a lot of visitors from different countries, and I liked the laboratory environment. For a while I thought I would be an M.D.; but no

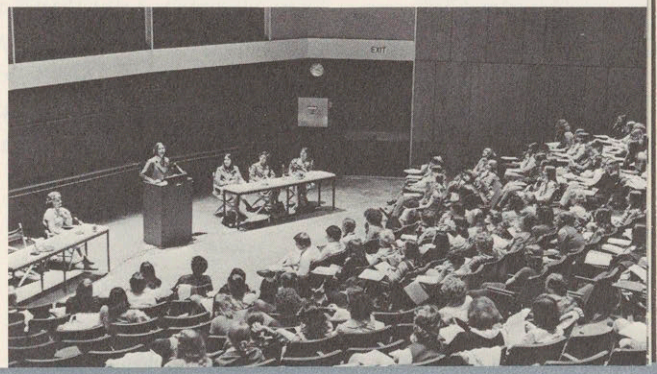
one really encouraged me to become one, and there were no role models. Being in premed, I had to take a chemistry course; my professor was very supportive and engaged me in some interesting research projects, so I fell into being a chemist. I think I was fortunate that I went to a college where a number of women were on the faculty, and most of the faculty were very supportive. It's always been important to me to have role models, to see other women who have achieved what I would like to achieve." *Wilkening*.

"I think you need to know that you want to do something special and to be serious about that."

Finally, for some, the choice of path is largely accidental. "I didn't plan anything. It just happened. Why did I choose geology? It found me. I never heard of geology until my senior year in college. In fact, when I was admitted into graduate school, I almost panicked, thinking, 'What have I gotten myself into?' " *Weeks*.

Although some people know all along what careers they may want to pursue, their routes may still be roundabout. "Even though I always wanted to be a scientist, I changed majors and departments many times; I ended up in electrical engineering but nearly dropped out of that in my last term. I worked as a programer for a few years and now plan to go on to graduate school in biology. I've been awhile getting where I am and figuring out where I'm going, but I've learned an awful lot in the process, so I really can't say that any of that circuitous path has been wasted." *Mink*.

It appears that you can evolve your plan as you go along, provided that at each point you're headed in one direction. "Some of us like a lot of structure and a lot of planning, even if we make plans that we discard regularly every six months or every five years, but we feel more comfortable when we have them. Others take life a step at a time and proceed that way with some digressions, although we all understand that there are some things we must do to get the results we want. Different people do get very good results from very different means." *Walzer*. "You don't have to know exactly what it is you want to do. But I do think you need to know that you want to do something special and to be serious about that." *Marvin*.



A broad scientific education

If you think you might be interested in pursuing a career in science, try to get a broad scientific education; many of the sciences are interrelated. Dabble in new sciences, too. One speaker was required to take a laboratory science in college and chose astronomy since it was different from the several sciences she had had in high school. "That was the beginning of a love affair. Astronomy combined two areas that I enjoyed very much, mathematics and physics. Yet to me, it was real." *Dupree.*

Mathematics is the base of most sciences. But it is only the foundation, not the whole. Some speakers admitted to a distaste or poor ability in math. "Don't go into science if you absolutely hate mathematics, because you're going to need it, although I never did very well in math and so far I have managed." *Hornig.*

Changes—new opportunities

You may want to get the required courses out of the way, so that you can concentrate on subjects more related to your interests. Don't be afraid of taking a course simply because someone else says it's rough. "My friends in high school told me that physics was tough, so I was scared off. Fortunately, I had a different set of friends when I got to college; they knew I was interested in mathematics and suggested that I might also like physics. As soon as I took my first physics course, I discovered that I really adored the subject, and I never changed my mind." *Lubkin.* But if you do find a course difficult, seek help. Generally, each theory builds on a previous one, and if you miss the early ones, you're in for further trouble.

Furthermore, don't be afraid of changing your direction. Several speakers changed majors as often as three or four times as undergraduates, while others changed in graduate school. "If an opportunity knocks, open the door and have a try. If you don't like it, get out fast and do something else. Some people get bogged down and feel they can't change. But I think it's a good idea to change." *Weeks.* "I never meant to be a scientist at all. I believed all the way through high school that I had no aptitude for it. In those days, to get a humanities degree, you had to take two full years of elementary sciences. As a freshman, I took biology and disliked it so intensely that if only one year of science had been required, that would have been my brush with science forever. I put off the second science course until my junior year, and it was geology. And that

subject lighted a fire within two or three weeks. By that time, I knew what I would like to do if I could. I still had to finish as a history major, but I took every geology course that was offered plus some math and basic sciences." *Marvin.*

Choice of college — a supportive atmosphere for women

How do you choose a college to prepare you for a career? One of the issues raised during the Symposium concerned large universities versus small women's colleges. "As a general statement, I would say to avoid the big state universities. They care less. *Science* magazine recently published a study entitled 'Social Origins of American Scientists,' in which are listed the most productive colleges and universities in terms of the number of Ph.D.s they ultimately produce, that is, the number of students who go on and get Ph.D.s. High on the list you will find many small private colleges, including women's colleges. I think women should be encouraged to go to those schools; they tend to be more supportive of all their students." *Wilkening.* On the other hand, some speakers were enthusiastic about large universities. "I truly enjoyed my four years at a Big-10 school. I became friends with students representing a wide variety of cultural backgrounds, and I found countless opportunities for involvement in diverse social, political, and academic activities. I did not feel like a number; what may have made a difference was living in a dorm and studying in a department that both contained a small number of students." *Tondryk.*

But the key to choosing a school seems very much to lie in the word "supportive." All agreed strongly that you should investigate a college from the point of how supportive it is for women — women as individuals, women as achievers, and women earnest in their desire for an education. Are women's groups active on campus? How many women are on the faculty? The correlation between number of women faculty members and support given to women students is apt to be very high.

Karen Motylewski, Joanne Tondryk, and Christine Jones

Learning—formal and informal

Also, if a career as a research scientist is what you desire, it is not necessary to go straight through until you have earned a Ph.D. In fact, one speaker got her Ph.D. 23 years after her master's degree, meanwhile carrying on a full-time career as a scientist. Several others worked for extended periods between phases of their education or began families and then returned to school.

The learning process doesn't stop with formal education. "The way science works, you never know everything you must know as you attack each new problem. When you discover that you're up against a blank wall, you find out who has written a book on that point or who knows something about it; you read the papers, you read the texts, and you learn what you must to go on to the next step. In a sense, I'm just as much of a student as all of you are. Unfortunately, I don't have a teacher to guide me. That's really the only difference. I must somehow decide myself where the problems lie." *Rubin.*

"Much of science is having confidence."

Learning to decide where the problems lie will come as your confidence grows. It is important to believe in yourself and in your unique talents and abilities. Don't let anyone tell you that you aren't capable of achieving. "Be able to do one thing so well that you have the confidence that this is something you know and in fact this is something that your colleagues ultimately will want to learn from you. Much of science really is having confidence, having enough confidence that you are willing to invest years of your life gathering data for a particular problem. Very often, you're investing a great deal of yourself. And if you're worried that it might not work or that you might do it wrong, it's very hard to make these commitments. You must be able to contribute to your colleagues, and this kind of contribution takes place at all levels." *Rubin.*

Part of building self-confidence is taking yourself seriously. At the same time, make sure that other people, including your parents, friends, teachers, and advisors, take you seriously. too. "When I was in high school, I explained to my advisor that I wanted to take chemistry, solid geometry, Latin, and English composition; at the same time, I wanted to be a member of the debating team and editor of the weekly school newspaper. He accepted my explanation. Later, however, I heard him telling another counselor my intentions. The other coun-

selor didn't take me seriously. I was shocked and hurt, and then I really got angry when I heard her reply, 'Oh, come on, she'll never amount to anything; after all, she is a girl.' Well, I think that was the first time in my life that I became conscientiously ambitious. I attained my goals that year, and I smiled proudly the following year when I delivered the commencement address and was awarded three scholarships." *Tondryk.*

Mutual dependency of women

Your positive self-image will grow as you talk with other women; take them seriously, too. "We as women have to help each other; recognition of our mutual dependency is an absolute necessity. Talk with your peers about your dreams; exchange your ideas; share your joys and your disappointments; encourage and support each other." *Tondryk.*

Achievement and femininity — not incompatible

Most importantly, seek success — don't be afraid of it; achievement and femininity are not mutually exclusive. Matina Horner, President of Radcliffe College, in conducting a study of women in science, found that women have a definite fear of success; they believe that achieving is somehow incompatible with being a woman. Furthermore, "Social scientists have found that we women generally expect less of ourselves than men do. If someone says, 'I don't think you can do it,' we are likely to agree that indeed we can't. We need to develop the self-confidence to say that we can do it and that we want to do it, and then we need to go ahead and do it." *Cowley.*

But how can you make others take you seriously and how can you not be afraid of success if you may still be unsure of yourself and your ambitions? Talk with people, and seek advice. Your advisors and teachers can help you as you think about courses and schools you may be interested in, the time and financial commitments you may have to make, and employment possibilities. Also, if they get to know you, they may be able to serve as future references.

When you have the opportunity, talk to professional women about their careers. Look to them for encouragement and guidance, as well as for information regarding the realities of being a woman in your chosen career. Get a sense of what women have accomplished and how their experiences differ from each other's and from men's in the same field.

The visible woman—dispelling stereotypes

Advice and ideas may also come from conferences and discussion meetings dealing with careers for women, such as the one on which this booklet is based. Informal symposia of this type are particularly valuable because, "I think we're used to dealing with people most of the time as they present themselves in their working aspect, and not so used to hearing their life stories, which is a pity, because those are usually fascinating. But it may also be that we don't quite yet expect the lives of women to be as interesting as they generally are. Too, women have traditionally had relatively few opportunities to observe other women working outside the family environment. I think it's commonly recognized that most men, at least by the time they go to college, find themselves in contact with other men who do interesting things in the world. What I find most striking about a meeting such as this is the special way in which it dispels the old stereotypes that even the most enlightened of us may have hidden away somewhere." *Walzer*. "There has recently been an attempt to make women visible—not just to give them jobs, but to include them on scientific committees. This all helps. For example, when I judged a junior high science fair, one embarrassed young girl said, 'I didn't know that women were scientists.' Seeing that some scientists are women may have made some of the girls with exhibits there think, 'Maybe this is something I could do after all.'" *Cowley*.

Space for Women booklet committee. Seated: Ursula Marvin, Cindy Wong, Peggy Anderson; standing: Joanne Tondryk, Christine Jones, Janice Bower, Martha Liller, Karen Motylewski

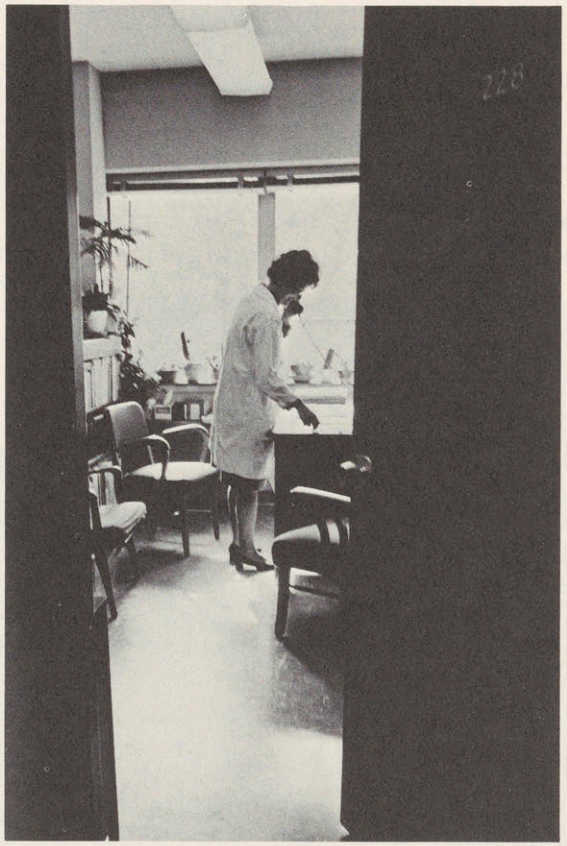
Weighing advice

On the other hand, although we encourage you to talk with others, weigh advice carefully. People may discourage you for the wrong reasons. Some may be overprotective of women. "When I told a male colleague that I was coming to this Symposium, he remarked, 'Why, you know I always discourage women from going into astronomy because astronomers have to work at night in cold, drafty observatories.' " *Wilkening*. Other people may view you only as a woman, not as a person. "In my second year of graduate school, I asked a professor to be my dissertation advisor. He said, 'Well, forget it; I don't want any more women graduate students. I have had two, and they both got married and quit.' On rather poor statistics, he couldn't see beyond the fact that I was a woman and would therefore quit, just like the others." *Wilkening*.

It's your decision

In the long run, however, no matter how much advice you get, "It is you as an individual, without anyone sitting with you, who must decide what you want to do. Other questions to consider are, What do you do well? What do you do least well? What do you like to do? What do you dislike? Where do you want to live? How important to you are such things as security, responsibility, money, challenge, freedom, service, and status?" *Love*.

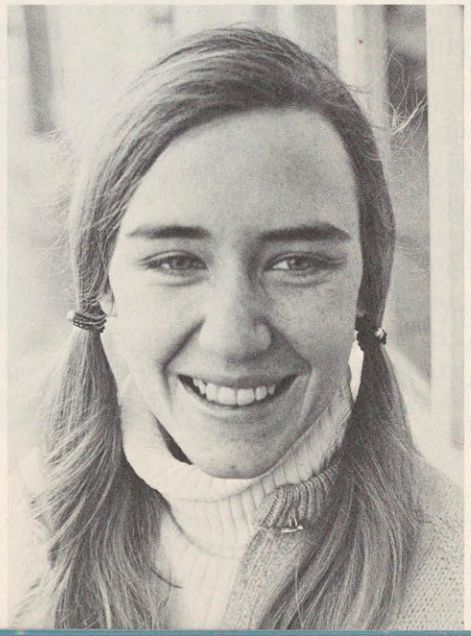
Ursula Marvin



Jobs as a testing ground

An excellent way to find out whether you're really going to like what you think you're interested in is to find related part-time or summer work. Though difficult to find, it's worth searching for. Such jobs are often obtained through word of mouth, so tell everyone you know — family, friends, and, most importantly, teachers — that you are interested. Many teachers and professors employ students as aides or assistants. One speaker talked about a time when she had a part-time job open for a student; the one who got the job was not an A student or even a B student, but rather a C student who was highly motivated. She was always in the laboratory and very eager in her work.

Barbara Moran



Check with placement offices, state employment offices, youth centers, and the Federal Job Information Center. Use the Yellow Pages and try museums, colleges, science laboratories, chemical and drug companies, computer organizations, or hospitals. Some institutions have summer intern programs. Don't forget the library. There are books and catalogs listing sources of jobs for teenagers, intern programs, and work-study programs.

Another possibility is to tutor. Not only does it pay well, but it gives you very good experience, whether teaching is your ambition or not. "Teaching was something I avoided like the plague almost all my early years. Then I started tutoring friends in chemistry. And somehow I realized that I was good at it and it was enjoyable, and that changed my mind about teaching." *Moran.*

You can't visit every potential employer, but your resume can; it represents you. If you haven't yet written one, start a personal information file now. The file should include your formal education, dates and topics of conferences or extra courses you have attended, salaried and unsalaried work experience, honors, names of persons who

may serve as references, skills, interests, and hobbies. The last three are particularly important if you have never worked. "I can't overemphasize interests; they're not always as unjob-related as you think." *Love.* Once you've culled your information, write your resume and keep it current; you never know when someone may ask you for it.

Job hunting—a positive approach

If you inquire about a job by mail, a cover letter should state why you are interested in the job and why you believe you are qualified. "Stress what you can do for the employer rather than what the company can do for you. Take a generally positive approach." *Love.* Cite your job goals, keeping them broad enough so as not to eliminate yourself unnecessarily.

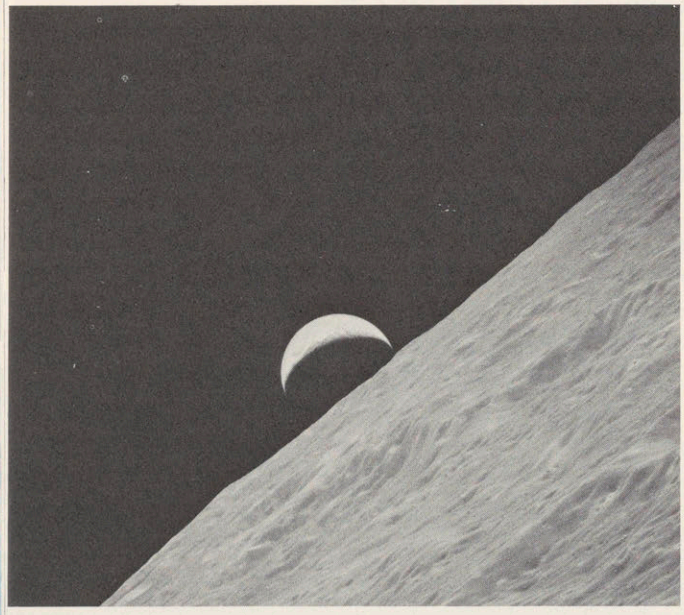
When you are interviewed, exhibit honesty and self-confidence and show enthusiasm for your field of interest and the potential job. If your strong points don't come out during an interview, try to work them in by asking questions. Some people research a prospective employer before an interview. It is a good idea to follow up the interview with a letter or a phone call. If you really are interested, be persistent.

There's a space for you

To find a space for yourself, outline your options and think seriously about them. Make some decisions and set goals, long-range or short. Career goals and high aspirations are not sex-dependent. Work hard to achieve your aims; don't fear success. Pursue your career goals and ambitions; be persistent. "No one is going to come up to you and say. 'Here's a job; try it.' You have to go after it yourself." *Jordan.* You and you alone are responsible for building your own successful career. We hope you will do it.

The great nebula in Orion

Earth rising over the moon (NASA photograph)



We hope we have persuaded you that if you have an interest in science you should follow it up and explore the possibilities of a career. The old attitudes that the world of science is too rigorous, or competitive, or unfeminine for women are changing. Your participation can help push such attitudes into oblivion. Despite the many uncertainties surrounding predictions of the future, we believe that a wide variety of opportunities that were formerly closed to women are opening in science and science-related areas. The astronomer Vera Rubin spoke for all of us at the Symposium when she said, "I would like to leave you with the feeling that there are those among you who, in the next twenty years, will make contributions to the world of science. That may be hard for you to imagine right now, but I would like to assure you that it is so. I do not think that I ever expected twenty years ago that I would have as interesting and exciting and as fun-filled a life as I have had, and I really could wish nothing more than that for all of you."

Biographical Sketches of the Symposium Participants*

Jean Andersen, Program Manager, Smithsonian Astrophysical Observatory

After receiving a bachelor's degree in music and zoology from Ohio University, Jean served for 3 years as organist and choir director in several U.S. Army military chapels in Europe. She later became a research assistant at HCO and then a secretary at the University of Maryland. Since her return to Cambridge, Jean has advanced from secretary to program manager. Her current responsibilities include administrative and financial management of the Radio Astronomy Division of the Center for Astrophysics.

Margaret P. Anderson, Applied Mathematician, Smithsonian Astrophysical Observatory

Peggy has worked at SAO since earning a B.S. in physical science from Stonehill College in 1965. As an applied mathematician, she provides data-processing and analytical support to scientists attempting to modify and improve mathematical models of the earth's atmosphere by means of observations obtained from artificial earth satellites.

Tanya Atwater, Deep-Ocean Geologist, Department of Earth and Planetary Sciences, Massachusetts Institute of Technology

Tanya studied electrical engineering for 3 years at MIT before she transferred to the University of California at Berkeley. After working for a year in Chile in earthquake seismology, she received her Ph.D. in marine geology at Scripps Institute of Oceanography. She taught and continued research at Scripps and then did exchange work in the Soviet Union. She has been on the faculty at MIT since 1974, where she works and teaches in their combined program with Woods Hole Oceanographic Institution. Tanya considers herself fortunate to share her career with her life mate, an earthquake seismologist. Among the several projects they have undertaken jointly are field work and child raising.

Margaret A. Bush, Project Administrator, Smithsonian Astrophysical Observatory

As project administrator in the Geoastronomy Division of the Center for Astrophysics, Peggy coordinates personnel administration at headquarters and various field stations. She has responsibility for budgets, contractual matters, and liaison with the international cooperating agencies that participate in the Division's worldwide data-gathering operation. Peggy received a B.A. from Stanford University and an M.A. in French from Harvard before joining SAO in 1965.

Dale Cohen, Administrative Assistant, Harvard College Observatory

Dale graduated from the University of Maryland with a B.A. in English. She taught in the Washington, D.C., school system for a semester and then joined the District's Department of Human Resources, where she served on the first Commission on the Status of Women. Dale has worked in a variety of administrative and clerical positions at Harvard, taking a brief time off to become a mother. She has recently been promoted to administrative assistant in the Atomic and Molecular Physics Division of the Center for Astrophysics.

Anne P. Cowley, Spectroscopist, University of Michigan

Anne graduated from Wellesley and the University of Michigan, where she and her husband both completed their Ph.D.s in 1963. After summer appointments at Harvard and a few years at Yerkes Observatory, she returned to Michigan, where she does research in stellar spectroscopy. She also observes at Kitt Peak National Observatory. She recently spent 2 years studying the spectra of x-ray sources and interacting binary stars at the Dominion Astrophysical Observatory in British Columbia. Anne is a member of several panels and committees, which, she finds, makes her job more varied and interesting.

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*These women can be contacted in care of The Women's Program, Center for Astrophysics, 60 Garden Street, Cambridge, Massachusetts 02138. The Harvard College Observatory (HCO) and the Smithsonian Astrophysical Observatory (SAO) are members of the Center for Astrophysics.

Alice d'Entremont, Electrical Engineer, Harvard College Observatory.

Although her interests were in the arts and math, Alice obtained a bachelor's degree in electrical engineering from MIT "in order to earn a living." She worked for General Electric, Control Data Corporation, and American Science & Engineering before joining the staff at HCO. Alice always had a desire to make her own experimental equipment, which is what she does at Harvard, where she is designing instrumentation for satellite and rocket experiments.

Andrea K. Dupree, Astrophysicist, Harvard College Observatory

In a freshman astronomy course at Wellesley, an enthusiastic teacher started Andrea on the road to becoming an astronomer. She tested out her career plans summers at observatories on Nantucket, in England, and at Harvard. She has been doing research at HCO ever since she completed her Ph.D. at Harvard. Her research interests concern the structure of the sun, stars, x-ray sources, and the interstellar medium. Although Andrea works with a variety of people of many disciplines, she maintains that research is basically a very personal endeavor. Andrea is married and currently works part time in order to care for and enjoy her two preschool children.

Judith C. Flagg, Scientific Programer, Harvard College Observatory

Judy worked for a year as a research assistant at HCO in between a B.A. at Wellesley and an M.A.T. at Harvard in mathematics. She taught high school and worked summers at HCO for 2 years and then returned full time to the Observatory as a senior programer. Her stay there was again interrupted for a while when she and her husband relocated to Connecticut, where she did programing for Perkin-Elmer Corp. Most recently, Judy has been designing a computer program at HCO to display color-processed pictures of the sun and other objects.

Lilli Hornig, Chairperson, National Academy of Sciences' Committee on Education and Employment of Women in Science and Engineering

Lilli received her A.B. from Bryn Mawr in chemistry and taught at Bryn Mawr, Radcliffe, and Brown while earning master's and doctoral degrees from Harvard and "fitting in" the first of four children. She has held many positions in the chemistry department at Trinity College, including department chairman. She has served as a consultant for the U.S. Department of State, a trustee for Woods Hole Oceanographic Institution, and a member of presidential missions to explore bilateral science cooperation. Lilli is currently Executive Director, Higher Education Resource Services, Brown University, and is a past director of Catalyst, a nonprofit organization to promote the retraining and return of mature women to the labor force.

Diane Jarmac-Kirk, Secretary, Smithsonian Astrophysical Observatory

Though not specifically trained in science, Diane's work in the scientific field extends over 8 years. She has attended business college and has taken many other day and evening courses. Among her many secretarial and administrative duties, she helps arrange scientific colloquia, types, and assists in editing technical proposals and manuscripts. Diane is married and is involved in church and civic activities.

Christine Jones, Astronomer, Harvard College Observatory

Christine is currently a Harvard Junior Fellow, her primary research interest being the study of x-ray-emitting systems in our own galaxy. She has studied several binary x-ray sources, including Cygnus X-1, which is believed to be a binary system in which a black hole orbits a normal star. Christine also discovered the binary nature of and optically identified the x-ray source 341700-37. After majoring in astronomy at Radcliffe, she entered graduate school at Harvard, where she received her Ph.D. in astronomy. She collaborates in her research with her husband in the High-Energy Astrophysics Division of the Center for Astrophysics.

Joan C. Jordan, Administrative Secretary, Smithsonian Astrophysical Observatory

After completing a 2-year course in 1 year at Chandler School for Women, Joan worked for a number of years at RCA

& Whirlpool Distributors before coming to SAO in 1966. Always looking to realize her potential, Joan has switched jobs within SAO several times and is currently working for a professor of astronomy and of the history of science. She is the mother of two children and treasurer of the Young Adults Division of the Massachusetts State Union of Women's Clubs, Inc.

Estelle Karlin, Librarian, Harvard College Observatory
Estelle enjoyed her career as a research chemist in the 1950s, but after her first child was born, she stayed home. During this time, she joined study groups and political-action groups — "the self-expanding projects you find little time for when you are working." Eventually wanting to find a part-time niche, she was attracted to library science. She took one course at a time, obtained a master's degree, and started working for HCO in 1966 as an information specialist.

Linda Kirschner, Scientific Programer, Smithsonian Astrophysical Observatory
Linda's interest in math and programing stems from high school. Following her B.A. in mathematics at the University of Michigan, Linda came to SAO as a computer programer. She particularly enjoys the detective work of searching out "bugs" and getting all the pieces to fit. Working part time since her daughter was born, Linda maintains that programing pays well enough to make the expense of good child care tolerable.

Martha H. Liller, Astronomer, Harvard College Observatory
After graduating from Mount Holyoke and receiving her doctorate in astronomy from the University of Michigan, Martha worked full time in college teaching and research until the first of her two children was born. She then had a series of part-time jobs, first as researcher and more recently as curator of HCO's large collection of original astronomical photographs. During the past few years, she has once again been able to devote full time to astronomy; in addition to her curatorial duties, she is undertaking research in the fields of variable stars and globular clusters. She is also Women's Program Coordinator at HCO.

LaVerne Love, Federal Women's Program Coordinator, Smithsonian Institution
As Federal Women's Program Coordinator at Smithsonian Institution, LaVerne is principal advisor to management on all matters pertaining to the equal employment status of women. She was previously employed as a consultant by the U.S. Department of the Treasury, where she helped lay the groundwork for what is today the Federal Women's Program. LaVerne has also served as Executive Director of ECCO, a community action agency in Columbus, Ohio, and as National Projects Coordinator for the United Planning Organization in Washington, D.C. Other activities include membership on the boards of many community organizations.

Gloria B. Lubkin, Senior Editor, *Physics Today*
Gloria's scientific background began with an A.B. in physics from Temple University and an M.A. in nuclear physics from Boston University. She became an associate editor of *Physics Today* in 1963 and senior editor in 1970. In the academic year 1974-75, she was also a Nieman Fellow at Harvard University. Gloria previously held positions as mathematician, nuclear-physics researcher, and acting chairperson of the Physics Department at Sarah Lawrence College. She recalls reading galley proofs in her hospital bed while on maternity leave.

Ursula B. Marvin, Geologist, Smithsonian Astrophysical Observatory
In her junior year at Tufts, Ursula discovered geology while fulfilling a science requirement. Although she completed her B.A. in history, she obtained a master's degree in geology from Harvard. Her Ph.D. degree was postponed for 23 years, however, when she and her mining-geologist husband left for Brazil and other exotic locations in search of ore deposits. Ursula joined SAO in 1961 to do research on the mineralogy of meteorites and, more recently, lunar samples. She is also the author of a book on the history of the continental-drift hypothesis, lectures in geology at Harvard, and is a member of the American Geological Institute's Committee on Women in the Geosciences. Ursula is Women's Program Coordinator at SAO.

Catherine A. H. Mink, Scientific Programer, Smithsonian Astrophysical Observatory

"I can't remember when I didn't assume I would become a scientist," says Missy, but she changed majors at MIT several times and nearly dropped out in her last term. Since graduating, she has worked as a programer at SAO and elsewhere while studying zoology part time. Missy has now returned to graduate school together with her husband; she hopes eventually to become the director of a zoo.

Barbara S. Moran, Teacher of Earth Sciences, Lincoln-Sudbury Regional High School

Barbara earned a B.A. in chemistry from Randolph-Macon Women's College and spent the next 2 years teaching high school chemistry and getting an M.A.T. from Johns Hopkins. After teaching at Thayer Academy, taking a summer astronomy course, and spending a summer at the National Radio Astronomy Observatory and a year at HCO as a research assistant, Barbara received her M.A. in astronomy from Harvard. She has since been trying to inject more astronomy into the earth-science curriculum at Lincoln-Sudbury Regional High School. She has recently taken a semester off to become a mother.

Joyce Rey, Librarian, Smithsonian Astrophysical Observatory

Joyce trained in library science in England, where she started in government documents control and then became head librarian for two engineering companies. After coming to the United States and taking a child-raising break, she started and operated a small research library at Lowell Technological Institute. She has been the SAO branch librarian since 1969. Having moved from heavy transformers through electronics through radiation physics to the stars, Joyce wonders, "Is this what is known as upward mobility?"

Vera C. Rubin, Astronomer, Department of Terrestrial Magnetism, Carnegie Institution

Following her bachelor's, master's, and doctoral degrees in astronomy from Vassar, Cornell, and Georgetown, Vera did research and taught at Georgetown, where she became assistant professor. She has been at Carnegie Institution since 1965. Notable in her career is the fact that Vera was the first woman ever permitted to observe at the Palomar Observatory. Vera has also found time to be a mother, to serve as an associate editor of *The Astronomical Journal* and as a member of national scientific advisory boards, and to do volunteer teaching of college-level astronomy courses.

Patricia A. Thomas, Research Assistant, Harvard College Observatory

Pat became interested in computer science while working in the computing center at a bank. Before obtaining her current position as research assistant at HCO, she completed a 1-year course at the Plus School of Business. She is attending Northeastern University at night and hopes to receive her B.S. in management information systems. She intends to continue in the field of data management and reduction.

Joanne L. Tondryk, Personnel Management Specialist, Smithsonian Astrophysical Observatory

Until she took Russian in college, Joanne had wanted to be a surgeon. She changed her major, obtained a scholarship to study Russian in the Soviet Union, and graduated from the University of Wisconsin with a B.S. in Russian language and literature. She spent a summer in Germany as an aide/translator in a U.S. Army Hospital before joining SAO as a clerk-typist in 1968. With a great deal of determination and hard work on her part, further academic training, and the willingness to assume increased responsibilities, she is a supervisory personnel management specialist today. Joanne authored the Observatory's affirmative-action plans and planned, developed, and directed the first Center for Astrophysics' Summer Intern Work/Learn Program for women and minority students interested in pursuing careers in science.

Judith Walzer, Director of Women's Education, Radcliffe College

Judy received her B.A. in history and an M.A. and Ph.D. in English and American literature at Brandeis. Before coming to Harvard in 1973, she taught in the humanities program at MIT. She was appointed Director of the Office of Women's Education at Radcliffe in 1974. Judy has also served as senior advisor to the freshmen at South House.

Alice Weeks, Professor, Department of Geology, Temple University

During her 12 years as chairperson, Alice completely reorganized the Geology Department at Temple University, building it from "a box of rocks" to a full-fledged academic program and establishing a master's degree program. Alice previously taught geology at Bryn Mawr and Wellesley, while earning her Ph.D. at Harvard, and hunted for uranium for the U.S. Geological Survey. She is a former member of the American Geological Institute's Committee on Women in the Geosciences. Having worked for many years in a "man's world," Alice still expresses surprise at never having been refused entry to a mine.

Laurel L. Wilkening, Chemist, Department of Planetary Sciences, University of Arizona

After graduating from Reed College, Laurel earned her Ph.D. from the University of California at San Diego, doing most of her graduate research at Scripps Institute of Oceanography. Her thesis dealt with the early history of meteorites as recorded by their composition and radiation effects. She spent a postdoctoral year abroad at the Tata Institute in Bombay, the National Museum of Natural History in Paris, and the Max-Planck Institute in Mainz. Following 2 years as a research associate at the Enrico Fermi Institute, University of Chicago, she has been an assistant professor of planetary sciences at the University of Arizona since 1973.

Janis L. Williams, Project Administrator, Smithsonian Astrophysical Observatory

Jan received a B.A. in French, Russian, and secondary education from MacMurray College. Currently a project administrator in the Geoastronomy Division of the Center for Astrophysics, her responsibilities include coordinating and administering all contracts and grants and general nonscientific activities in her department. Jan is now pursuing an M.B.A. in financial management at Boston University, which, in combination with a full-time job and a husband, is very much of a challenge.

Marlene Williamson, Geophysicist, Smithsonian Astrophysical Observatory

Marlene studied applied mathematics at Brown and received her M.S. and Ph.D. in physics from Tufts. After working as a scientific programer at IBM while earning her Ph.D. and as a systems analyst at MIT for 1 year, Marlene joined SAO in 1971 as a mathematician, where she works part time in order to have time with her two young children. She was recently promoted to supervisor of a data-analysis group. Her research involves the application of mathematics and the development of computer programs for studying properties of the earth primarily from satellite-tracking data.

Cynthia B. Wong, Editor and Writer, Smithsonian Astrophysical Observatory

With a B.A. in music from Colby College, Cindy never expected to become an editor. "Editing was the last thing I wanted; I thought editors had to write!" Following a year at a job advertised as "editorial assistant, no writing," Cindy began work in the Publications Department at SAO in 1963; she later became managing editor, working part time in order to be home after school hours with her stepdaughter. She recently transferred to the Geoastronomy Division of the Center for Astrophysics, where, in addition to editing, she is involved in writing research reports and proposals. Cindy coauthored a textbook on technical typing.

Sara R. Yorke, Project Administrator and Travel Supervisor, Smithsonian Astrophysical Observatory

After majoring in history and receiving an M.A.T. at Radcliffe, Sara became an assistant in the Travel Office at SAO. Soon promoted to supervisor, she oversees arrangements and reimbursements for all trips by SAO staff members. During the last few years, she has taken on the additional job of project administrator of several grants and contracts. The birth of Sara's son has added a new dimension to her life, and she enjoys combining motherhood and a career.

Suggested Reading

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Light-colored fragments from the lunar highlands (millimeter scale)

Photographs courtesy of Harvard College Observatory, Smithsonian Astrophysical Observatory, and Peter Vandermark.