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ABSTRACT

Project ASTRO is an innovative program to support science education by linking teachers and students in grades 4-9 with amateur and professional astronomers with the overall goal being to increase students' interest in astronomy and science in general. This manual was designed for teachers, amateur and professional astronomers, youth group leaders, and others who teach astronomy to students. It contains tips and suggestions about: what makes a successful partnership, finding a partner teacher or astronomer, partnership strategies and possibilities, expectations and planning, integrating the astronomer into the classroom, getting started and the first visit, roles and responsibilities for teachers and astronomers, involving the school and the community, getting support and publicity, star parties and astronomy clubs, and other good ideas. (JRH)

PROJECT ASTRO

HOW-TO MANUAL FOR TEACHERS AND ASTRONOMERS

PROJECT
ASTRO

Project ASTRO

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Project ASTRO How-To Manual for Teachers and Astronomers

Project ASTRO and You

Welcome to Project ASTRO: Astronomers and Teachers as Partners in the Classroom! This *How-To Manual* is for teachers, amateur and professional astronomers, youth group leaders, and others who teach astronomy to students. It contains tips and suggestions about starting and carrying out a Project ASTRO teacher/astronomer partnership. As a Project ASTRO partner, a professional or amateur astronomer agrees to make ongoing school visits, and to work with a partner teacher and a group of students over time to assist them in learning more about astronomy in and out of the classroom.

If you're reading this manual, you are probably either a teacher who wants an astronomer to visit your classroom, or an astronomer who wants to spend some time sharing your love of the stars with teachers and young people. You may be seeking a partner astronomer or teacher, or you may already have a partner and be planning your first classroom visit together. This manual is intended to give you some ideas about how to get started, and how to develop a successful partnership over the coming months and years.

You are about to embark on a rewarding and sometimes challenging partnership to improve science education. If you're a teacher in a school or community organization, working with "your" astronomer is a way to bring new experiences and expertise to your students. If you are an astronomer, volunteering to visit a school can be as valuable to you as to the students—putting you in touch with youngsters and doing something meaningful for your community. You'll find that most students have a natural fascination with space that can be sparked through hands-on activities and your own enthusiasm. And you'll see that you can readily integrate other sciences and subjects, from biology, to art, to history into your astronomy lessons.

Photo by Catherine Lombard

How to Use This Manual

The purpose of this manual is to give you guidance to help your partnership be as successful as possible. We know that such manuals have less meaning if you've never visited a classroom or worked with a visiting scientist before. Even so, we encourage you to read

In this manual we'll give tips on:

- What makes a successful partnership
- Finding a partner teacher or astronomer
- Partnership strategies and possibilities
- Expectations and planning
- Integrating the astronomer into the classroom
- Getting started and the first visit
- Roles and responsibilities for teachers and astronomers
- Involving the school and community
- Getting support and publicity
- Star parties, astronomy clubs, and other good ideas

this manual at least once before you begin your partnership, and then return to it after you've started. We suggest that you also read the sections intended for your partner—whether teacher or astronomer—to help you understand your partner's potential concerns. See the Table of Contents for specific sections that meet your needs.

We welcome your comments and suggestions. As you read and use this manual, we hope your will make your own notes and share them with us. Please send your feedback to Project ASTRO, Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112. ■

— Jessica Richter
& Andrew Fraknoi

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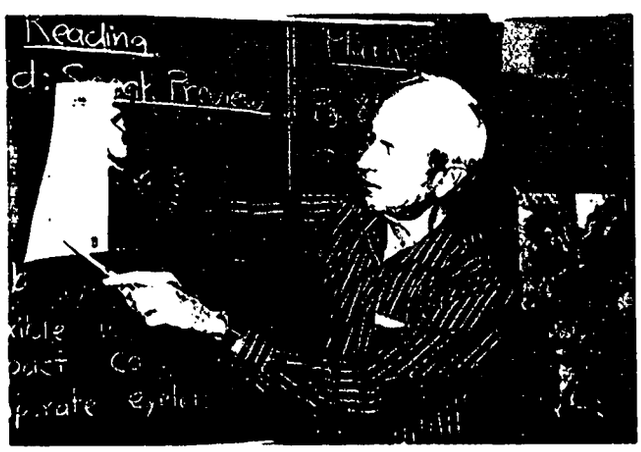


1 Introduction: What is Project Astro?

Project ASTRO is an innovative program to support science education by linking teachers and students in grades 4-9 with amateur and professional astronomers. The overall goal of Project ASTRO is to increase students' interest in astronomy and science in general. Funded by the National Science Foundation and by two branches of NASA, Project ASTRO was developed by the Astronomical Society of the Pacific, a century-old, nonprofit scientific and educational membership society for amateur and professional astronomers, teachers, and the public.

Because of its attractiveness for students, astronomy is an ideal entree to teach about the process of science. Many teachers recognize their students' interest in astronomy and want to teach more of it, but lack adequate background and training in the subject. At the same time, professional and amateur astronomers, concerned about the crisis in science education in the U.S., have wanted to do more to help teachers, but have often been unsure how to make a meaningful contribution. On their own, many astronomers make a one-time visit to a local classroom, but such quick interactions have only a limited impact on students.

Project ASTRO was developed to address these needs in astronomy and science education by preparing astronomers to make *multiple* visits to the same classroom (and to do meaningful activities while they are there), while at the same time, providing professional development opportunities for teachers. Project ASTRO helps teachers and astronomers form partnerships, offers them training and support, and provides a range of materials for classroom use. The focus of Project ASTRO is on grades 4-9, because it is in these grades that students' long-term attitudes about science are first formed.

After being trained, astronomers agree to make at least four (and often many more) school visits, assisting with hands-on activities, giving talks on astronomical discoveries, helping with science projects, organizing "star parties" for students and families, lending a hand with curriculum development, and serving as role models. Whenever possible, teachers and astronomers together establish links with local astronomy institutions and science centers.

Project ASTRO began in 1993 as a pilot program involving 45 schools throughout California. This *How-To Manual* draws on the experiences of teachers and astronomers who participated in the pilot phase. Two replications of Project ASTRO are underway in Stockton and Santa Barbara, California, initiated by enthusiastic pilot project teachers and astronomers. Working with science centers, research institutions, and universities, Project ASTRO is now expanding to several other metropolitan areas throughout the U.S. Please contact us to find out if there is a Project ASTRO expansion site near you.

The national Project ASTRO office provides the following services to support teacher-astronomer partnerships and astronomy education:

- **Training teachers and astronomers** in doing age-appropriate, hands-on astronomy

activities (both at expansion sites and astronomical meetings).

• **Providing guidance, advice, and training** to organizations and individuals interested in starting their own Project ASTRO program or partnership.

• **Creating and disseminating materials** to support teacher/astronomer partnerships, including selections of the best activities for the classroom, and a wide range of resources about astronomy and astronomy teaching.

• **Conducting ongoing evaluation** of Project ASTRO partnerships and materials to continue to learn what works best.

• **Producing a newsletter** and providing electronic networking for Project ASTRO expansion sites.

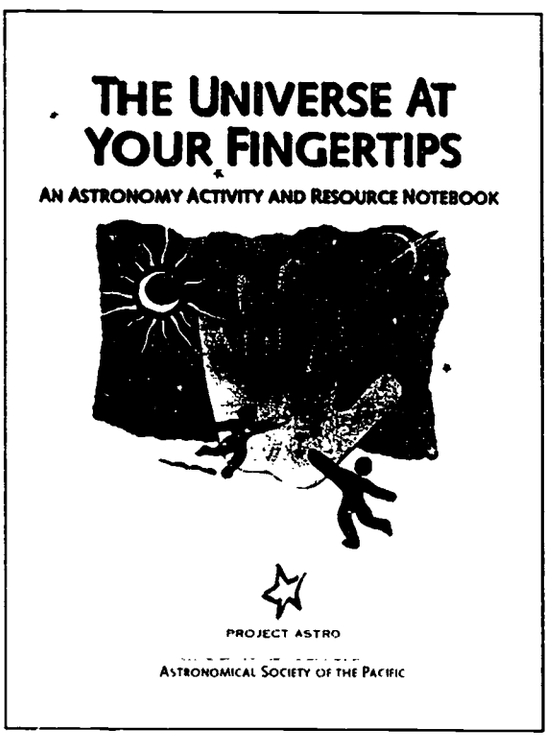
Project ASTRO Materials

Another Project ASTRO publication is available to help you with your partnership. *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook* contains more than 90 hands-on astronomy activities for grades 4-9. These activities were selected from a variety of exemplary sources by a team of teachers and astronomers, and pilot tested with Project ASTRO participants. Designed for teachers, astronomers, and others who want to improve or increase the astronomy they teach, the loose-leaf notebook also contains a host of resource lists on a wide range of astronomical topics, articles about teaching and learning, and astronomy background material. It is the essential companion to this *How-To Manual* for anyone interested in teaching more astronomy. (Information about how to order *The Universe at Your Fingertips* is provided at the end of this manual.)

Future materials will include a *Training Manual* for Project ASTRO expansion site coordinators, and a Project ASTRO informational video.

About the Astronomical Society of the Pacific

The Astronomical Society of the Pacific (ASP) is an international nonprofit scientific and educational organization, founded in 1889, whose mission is to advance the science of astronomy and help disseminate the results of astronomical research to students, teachers, and the public. Begun on the Pacific Coast of the U.S. (hence its name), the Society today has members in every state and more than 60 other countries, and is one of the largest astronomical organizations in the world. Among its many activities, the ASP has offered summer workshops on teaching astronomy in grades 3-12 since 1980. Several thousand teachers have taken these workshops and returned to their schools with new resources, activities, and enthusiasm. Many of the materials and techniques in Project ASTRO grew out of these summer workshops. ■



2 Kids and Science: The Project ASTRO Philosophy

Children are born with a curiosity about the natural world. Like scientists, they explore, observe, experiment and classify (if you've ever taken sand out of a curious toddler's mouth, you know what we mean). Sadly, for many children as they go through school, science begins to lose its fascination—often because it is taught as a series of disparate facts. Students don't always learn about the connection between these facts and the natural world. They may no longer experience the link between their own curiosity and the science they learn in school. They only know it seems boring (or not relevant to their lives, or too abstract to understand), and when something is boring, not relevant, or too abstract it's tough for kids to put their minds to work. The overall purpose of Project ASTRO, is to help students see that science can be interesting and fun while still getting them to think about the process and results of discovery. The goal of Project ASTRO is not to make all kids into professional, or even amateur, astronomers (although some students may eventually follow these paths). Rather, we want to use the wonder and fascination of astronomy to engage all students in the process of science and logical reasoning.

"I tell my students, do scientists know everything? No they don't, but they are always willing to find out and correct their mistakes, and try and try again. That's what I want you to do."

–Fifth Grade Teacher

This means we want students to behave like "short scientists" by making observations, gathering and classifying data, drawing conclusions, and asking new questions. We want students to consider multiple explanations for a phenomenon, and use their data to reach the best conclusion. We want students to consider that sometimes there isn't one correct answer, or that people may disagree on the answer, or that we don't always know what the answer is, but that we can devise ways to find out.

Toward these ends, the focus of Project ASTRO is on helping kids learn by doing. By using hands-on, concrete activities where students make discoveries for themselves, students think more like scientists and are more likely to really learn about astronomy. If you are serious about involving students in astronomy in an active way, we encourage you to get Project ASTRO's, *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook*, or other curriculum guides that contain specific astronomy activities for grades 4-9.

Being a Project ASTRO Partner: Suggested Approaches

One of Project ASTRO's main agendas is to help teachers improve their astronomy and science teaching by working closely with someone with special knowledge about astronomy. Teachers are called upon to teach many subjects. Many teachers, particularly elementary teachers, may not be comfortable teaching science and may be eager to improve their understanding of science content and processes. Even teachers who are

Promote hands-on student discovery experiences

Kids learn by doing! Hands-on activities in which students discover things for themselves are the highest quality learning experiences. Students forget most of the things their teachers tell them. But when adults lead kids in experiences where they wrestle with an interesting personal observation and then figure it out "by themselves"—those things are remembered forever. Seek to be more of a guide to discovery than a conveyor of information and a provider of answers.

From *Preparing and Presenting Effective K-12 Science and Math Education Activities,* Sandia National Laboratories.

familiar with science may not know enough astronomy to teach it effectively. For teachers, having a visiting astronomer in their classroom can be a valuable resource to improve and increase the astronomy they teach.

We use the term *partnerships* to describe Project ASTRO because the astronomers and teachers work together as equal partners to develop their own program. Together, they decide what specific projects and activities to do, based on each partner's interests and the students' needs. In this way, teachers learn more about astronomy, and astronomers become more familiar with students and schools. Teachers who are inspired by learning and doing more astronomy can go on to share their new knowledge with colleagues and use new skills with other classes. As astronomers learn more about what teachers, kids, and schools need, they become more effective agents for improving science education in general and creating meaningful and lasting links between schools and the outside community.

By making the commitment to work together in this way, some of the following things may start to happen:

- **Students may ask their teacher** over and over, "When is our astronomer coming? When is our astronomer coming?"

- **A usually reserved eighth grade class** may create an elaborate astronomy display, complete with the astronomer's picture, a box for students' astronomy questions, and model planets.

- **A reluctant principal may attend** an evening "star party," and become so enthralled by the sight of Saturn's rings through a telescope that eager students have to push him out of the way to see for themselves.

- **A teacher may finally persuade** her school to provide a phone line connection to her classroom so that she and her students can communicate with their astronomer through the Internet.

- **A busy parent may stop** to look at the sky with his child, helping to chart the moon's phases over the course of a week.

- **A university astronomer** may change

"Our amateur astronomy club has worked with schools for a while, but we usually brought in slides or a telescope for day viewing, or invited children to a star party. Project ASTRO has given us a whole new perspective and a set of activities that have improved our efforts tremendously"

–Project ASTRO Amateur Astronomer

the way she teaches college level astronomy, adapting activities that worked with her ASTRO seventh graders.

• **An amateur astronomer**, telescope in tow, may run into his partner teacher on a local mountain top, looking through her new telescope.

• **Other teachers**, research astronomers, graduate students, and fellow astronomy club members may decide they want to become part of Project ASTRO in some way; and finally...

• **It may all happen again the next year!** ■

I have been doing this alone for about five years... but sometimes I wondered whether what I was doing was of any value to the schools. Working with Project ASTRO has given me some validation. I used to wonder, does this work? Does it not work?...Kids naturally love astronomy, but I am much better now at emphasizing science thinking. It wasn't so much any specific activity that has made the difference, but the philosophy.

–Debra Scherrer, Project ASTRO Astronomer

Fifth grade teachers, Jeannie Kohl and Laurie Wingate at Sequoia Elementary School in Oakland, California were interested in Project ASTRO because they wanted their inner city students to be comfortable with the night sky. "Every year we take our students to science camp for a week. During the camp, we take the students on a night hike, but many of them resist going because they're afraid of the dark." After a year teaching astronomy and working with astronomers Isabel Hawkins and Nahide Craig from the University of California at Berkeley, Jeannie and Laurie's students had entirely different attitudes. "This year, every single kid went out during the night hike. They were eager to point out the constellations that they knew and one student, Germain, excitedly kept us informed about the phase of the Moon. Learning more about astronomy ahead of time really prepared the students for the nighttime experience."

3 Key Ideas About Partnerships

Ten Steps to a Successful Partnership

1. Plan and make at least 4 classroom visits, plus an extra first visit for the astronomer to observe the class anonymously.

Make multiple visits to the school or classroom, and begin with an observation visit so that the astronomer can see what the school and classroom are like. We've found that four visits are the minimum number for the astronomer and students to have time to get to know each other. With at least four visits, the astronomer can do longer term projects with students, and can join the teacher at key points in the curriculum. Because each school visit may take some preparation, making more than four visits may not be possible for busy astronomers. Of course, we encourage you to make more than four visits if possible—some Project ASTRO astronomers have enjoyed visiting as often as once a week for the entire school year.

2. Visit the same classroom over time.

When he or she works with the same students over time, the astronomer really gets to know the kids (and vice versa). We suggest that the astronomer work with one (or at the most two) self-contained elementary classrooms during a school visit, or in middle or high school, with no more than two science periods. Go for depth rather than exposure.

3. The teacher should be responsible for student discipline and classroom management.

Visiting astronomers, as volunteers in the classroom, should not be expected to manage student behavior in the classroom. Rather, teachers should stay actively involved in the classroom, both to model learning and curiosity to students and to assist the astronomer with any discipline or logistics. At the same time, astronomers need to be aware of classroom rules and routines, and use them appropriately during their visits (such as having students raise their hands before speaking). It's a good idea to clarify what these rules are before the first visit.

4. Commitment and communication are the keys to a successful partnership.

Strong partnerships develop when everyone has a high level of enthusiasm and commitment to the project. You will need to devote enough time to communicate and plan with your partner, to get ready for visits, and of course, to be in the classroom. Be careful not to overcommit at first. But, do follow through by keeping in touch with your partner teacher or astronomer. It's also important to communicate clearly and openly about any concerns, needs, or suggestions you may have.

"I thought I was going to have to teach astronomy and my teachers would go off for a bagel and coffee, but this was not the case. We worked together in partnership."

–Project ASTRO Astronomer

"I learned that lecture style is not the way to go with kids. It has its place but Project ASTRO is more about hands-on activities and having fun."

–Rich Combs, Amateur Astronomer

5. Teachers and astronomers should enter the partnership as equal, but differently skilled, partners.

Teachers are likely to be more knowledgeable about how students learn, what students need to know, and about how to structure and manage a classroom activity. Astronomers are likely to know more about astronomy and technology. Your partnership will be more successful if you enter it with respect and an expectation of equality. But don't expect your partner to know everything or to do everything perfectly the first time. Let your partnership and your own skills develop as you get to know each others' strengths.

"The most difficult part of our partnership for us was scheduling the time to meet together. There was also the added problem of playing phone tag or delaying getting back to each other. I know this was a big frustration for everyone."

–Project ASTRO Teacher

6. Provide adequate time for planning and follow-up.

Focus on a few themes and goals and add more ambitious activities (field trips, star parties, site visits, simulated missions to Mars, etc.) after you have been working together for a while. An initial planning meeting or two will help you understand each others' needs and interests. It is important for astronomers to listen and respond to teachers' needs—you will be stronger allies this way. Build from your strengths. And, check in with each other about students' reactions and how the activity went after each visit.

7. Children learn best when they are actively involved and engaged in learning, by observing, measuring, discussing, etc.

The philosophy and focus of Project ASTRO is to involve students in active, hands-on astronomy activities, as opposed to listening to lectures (although an occasional lecture may have a place in a well-thought-out program). Doing hands-on activities may require a more cooperative approach with both partners actively engaged.

8. Involve school administrators, other teachers, and families.

It's always a good idea to keep the school principal and other administrators informed about Project ASTRO. Be sure the principal meets the visiting astronomer, and invite school administrators to special events and visits. If other teachers express interest in the program, invite them as well. In addition, you'll find that astronomy offers great opportunities to involve families in their children's science learning. "Star parties" for families and nighttime observing as homework activities are opportunities to get families out to look at the night sky, making science fun for all. Also, make use of other resources in your community. See Sections 9 and 11 of this manual for more ideas.

9. Involve community resources when possible.

Don't feel that the two of you need to do it all alone, especially if you are planning a special event. Seek out astronomy resources in your community, such as:

- the local amateur astronomy club
- public or private observatories
- a planetarium or science museum
- a NASA facility (including one of NASA's Teacher Resource Centers or Space Grant College programs)
- college or university astronomy departments
- a community college with an astronomy program
- parents with telescopes

See the sections on finding an astronomer and involving the community for specific ideas.

10. Create a plan that addresses both the teacher's and the astronomer's needs and interests, and don't forget to keep the students in mind!

Sometimes, teachers and astronomers find that they want different things from the partnership. For example, the teacher may want students to learn about scale and distance, and the astronomer may want to share his or her knowledge and enthusiasm about telescopes and observing. It is important that both the teacher's and the astronomer's interests get met to some degree. You may need to clarify what the underlying issue is and make a few compromises so that the teacher's classroom needs are met and the astronomer does what he or she is most enthusiastic about. The best solutions often involve working more closely together or sharing roles.

Communication Tips

- Initiate contact with your partner. Don't wait for him or her to call you!
- Follow through on plans. Call two days before visits. Call well in advance if you need to re-schedule.
- Return phone calls and messages promptly.
- Be flexible, listen, and expect difficulty reaching each other sometimes.

Start Small

We know that teachers who see more than one class each day ideally want to expose all of their students to the astronomer. Resist this kind impulse! This can place a great time demand on the astronomer (who is, after all, a volunteer) and make it more difficult for him or her to learn the children's names, let alone form relationships with them. Although you will initially involve a smaller group of students, these kids will benefit much more from the astronomer's multiple visits and personal contact. (In our pilot program, the visiting astronomers who faced many classes each time reported that they had a much less satisfying experience than those who "adopted" one class.) Teachers can use the new skills they develop to enhance astronomy with other classes. If all partners agree, you can add additional students after you have been working together for a while. To reach more students, consider inviting them to special events (the entire sixth grade to a star party), have a one-time assembly for more kids, or have your students teach other classes.

More About Communication

Communication and follow-through with your partner are essential. Sometimes partners are surprised by the problems they experience in communicating. Keep in mind that:

- **Few teachers have e-mail or phones** in their classrooms. Most teachers are exceedingly busy during the school day. Some schools are better than others in getting messages to teachers. So, it can be difficult to reach teachers during the day.

- **Astronomers may be less available** in the evenings and may travel for periods of the year. Volunteer visits may not be their top priority every day. Professional astronomers especially are used to communicating via electronic mail, and may be impatient with people who don't yet have an Internet connection.

It's nice to meet students and parents on common ground outside of the school facility. At the middle school level, so often the only time we get to meet parents is when something is wrong. Project ASTRO was a great way to have a more positive experience with students and parents."

–Project ASTRO Teacher

"Our astronomer, Ellis Miner, a senior scientist at the Jet Propulsion Lab, went above and beyond the call of duty. He even went to the store to buy light bulbs when the bulbs for the slide projector went out before his visit. I just think he's a terrific person and we're very lucky to be working with him."

–Kathryn Bernardo, Project ASTRO Teacher

• **Together you will need to figure out** the best way and time to communicate (work phone, home answering machines, fax, modem, Saturday mornings). If multiple teachers are involved, designate one teacher to be the contact person.

More About Time Commitment

It's very important for the success of your partnership that you have a clear understanding of the time involved. As a Project ASTRO participant, you will need time to:

• **Have an initial planning meeting** (away from the school, if possible) and additional meetings or phone calls to plan as needed.

• **Make or host at least four classroom visits**, plus a classroom observation before the first visit. One of the four visits might be a star party or other type of field trip. These special activities involve additional planning.

• **Make multiple phone calls**, or send faxes and e-mail to arrange visits. You should expect to play "phone tag" and to talk with your partner during the evening or on weekends.

• **Follow-up each visit** with a phone call or brief meeting.

• **(For the astronomer) Prepare and practice** activities before visiting the school.

• **(For the teacher) Prepare and follow up** with students after the astronomer visits. Fit the visits into your overall program. Make arrangements for materials and logistics. ■

To Astronomers: If you are an astronomer, be sure you have the time to devote to the project and can take the time off during the school day as needed. Remember that school schedules are not very flexible. Many companies support their employees' involvement in community service, so check into your employer's volunteer policy. You might also make school visits early in the day or during an extended lunch hour. Sometimes a letter from the Project ASTRO coordinator or school principal can help smooth the way with your employer. See Section 10 for more ideas about getting support.

To Teachers: It may take some additional time and effort at first to "fit" the astronomer into your program. Once you get started, this time will decrease as the astronomer becomes more familiar with your needs. Try asking your administrator for release time to plan with your astronomer, and look into the use of Eisenhower funds to support your release time. Also, remember that the astronomer is volunteering his or her time, probably taking time off from work. You will likely need to be the one to handle any additional logistics or dealings with the school bureaucracy.

4 Finding a Partner

By now you've decided you want to start a Project ASTRO partnership, but you don't have a partner. Having the interest is the first step; finding a partner may require some initiative and persistence. Even if the first person you contact does not work out, he or she may be able to refer you to the perfect person. Here are some ideas about where to begin.

For Astronomers: Finding a Partner Teacher

Among the ways to find a partner teacher are:

1. **Make contact** with an individual teacher.
2. **"Network"** through school personnel and other people you know.
3. **Publicize** your availability through written material.

Making contact with an individual teacher is perhaps the best approach. Information left with school administrators can get lost before it reaches interested teachers. A good way to find the names of teachers is to start with people you know (see below) because they will have a greater interest in helping you. When you contact a teacher, explain that you want to volunteer as a Project ASTRO astronomer and describe some of what you'd like to offer. Be aware that not all teachers cover astronomy, so it may take some persistence to find a teacher who does, or wants to. Here are some suggestions about whom to approach as a first point of contact:

- **Your child's classroom teacher or science teacher.** Your friends' children's teachers, especially those who are interested in science.

- **Classroom or science teachers in your local area** (especially a neighborhood school). The principal, school counselor, or school science coordinator (if there is one) may be able to connect you with an interested teacher.

- **County or District level Science Coordinator** or Volunteer Coordinator. Contact the County or District Superintendent's office for names.

- **A local planetarium or science center.** Teachers who are interested in astronomy may be involved with special programs there. Ask for the education coordinator at these organizations.

- **Your state science teachers' association** (check the phone book, ask a teacher, or contact the National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201 (703)243-7100). Ask the officers or staff of the state organization how to reach interested teachers. They may be able to pass your name along to people in your area.

- **Science education faculty** at a local university School of Education. These faculty members may be familiar with teacher professional development programs, and may be able to steer you toward a network of interested teachers.

• **Graduates of national astronomy education programs** for teachers. These teachers may be interested in working with an astronomer, or may be able to refer you to other teachers in their area. Contact the organization that runs each astronomy program for names of teachers in your area. A complete catalog of national astronomy education projects is included in *The Universe at Your Fingertips*. Organizations with experience running teacher education programs in astronomy include:

American Astronomical Society, Suite 400, 2000 Florida Avenue, Washington, DC 20009 (202) 328-2010.

Harvard-Smithsonian Center for Astrophysics, Education Department, MS 71, 60 Garden Street, Cambridge, MA 02138 (617) 495-9798.

Lawrence Hall of Science, Astronomy & Physics Education Program, University of California, Berkeley, CA 94720. (510) 642-5134.

NASA Teacher Resource Centers (located at various locations across the country). Contact NASA CORE, Lorain County JVS, 15181 Route 58 South, Oberlin, OH 44074 (216) 774-1051 for a list of centers.

National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201 (703) 243-7100

• **Call us at Project ASTRO** (415) 337-1100. We may be able to connect you with a Project ASTRO expansion site, or give you the names of teachers in your area from our growing database of participants in our programs and others across the country.

How to Approach School Personnel

• When you call or write, communicate your desire to have an ongoing relationship with the school and to have an impact on astronomy and science education. Let the teacher, counselor, or administrator know that you would like to provide ongoing enrichment to the classroom lessons (not just a one-time lecture). Describe some of the specific ways you think you can be of help, and discuss your availability and commitment.

• Bring a copy of the Project ASTRO *How-To Manual, The Universe at Your Fingertips*, and other Project ASTRO resource materials you may have to a meeting with the school principal or classroom teacher. Summarize or photocopy the brief description of Project ASTRO at the beginning of this manual.

• Ask what ideas the teacher, counselor, or administrator has about how you can help with astronomy and science education. Emphasize that the focus of Project ASTRO is on astronomy, but the broader goal is to help students develop enthusiasm in science and logical reasoning skills.

• Follow-up with a note and phone call. Teachers and administrators get extremely busy and may have difficulty getting back to you as soon as you would like. Take it upon yourself to make follow-up contact.

Adapted from *One Small Step...An Education Outreach Resource Guide* produced by AIAA and NASA

For Teachers: Finding a Partner Astronomer

Because Project ASTRO encourages both amateur and professional astronomers to visit schools, there are several avenues to pursue to find a partner astronomer.

1. Contact local astronomy club

Many amateur astronomers belong to local astronomy clubs. Each club usually has some members who are interested in education and explaining astronomy to the public. Often, astronomy clubs hold star parties for the public, or go to local schools for one-time visits.

You will want to find the club members who are interested in conveying astronomy to others and have at least some experience with children. Call the club president, attend a local meeting, or show up at an evening star gazing session and talk to the members. Most likely you will find someone who is enthusiastic. To find amateur astronomy clubs in your area, contact your local planetarium, community college astronomy department, or a local telescope store. Lists of amateur clubs also appear each year in a supplement section included in *Sky & Telescope* and *Astronomy* magazines, available in many libraries.

2. Contact astronomy educators

Call your local planetarium, science center, or community college to find astronomy educators. Many of these institutions have at least one person on staff who teaches astronomy, usually someone with a Master's degree in astronomy. Staff and faculty at these organizations can be quite busy, but may be interested in visiting your school to enhance their teaching skills and experience, and to link with the community. If the main astronomer or faculty member is not available, he or she may be able to refer you to advanced students, amateur astronomers, or others in the local astronomy community.

3. Contact professional or research astronomers

The involvement of professional astronomers in K-12 education is gaining legitimacy as scientists in astronomy and other fields recognize the importance of supporting science education in the early grades. You can find professional astronomers through local colleges and universities, research labs, NASA centers, and industry.

About Amateur Astronomers

Amateur astronomers come from all walks of life and pursue astronomy as a hobby. Most amateurs have other careers—they may be doctors, or contractors, or business people, or software engineers (one dynamic amateur astronomer we know is a butcher). Some amateurs are retired professional astronomers, and, while the majority of amateur astronomers are men, there are increasing numbers of women involved in astronomy clubs. Amateur astronomy is an exciting hobby because amateur astronomers can actually make scientific discoveries and contribute to the field of astronomy. Since the sky is so large, there is room for many telescopes to keep watch for astronomical events. In fact, many new comets are discovered by amateur "comet hunters" and some exploding stars were first noticed by amateur observers. Many amateurs know a lot about the night sky, constellation lore, and observing through a small telescope. And their enthusiasm for astronomy can be contagious.

Graduate students and postdoctoral level professionals may be particularly interested in working with schools. At the university level, the best initial contact is the astronomy and physics department secretary. He or she should be able to give you names of faculty members or graduate students who have an interest in education. Ask if the secretary can post an announcement on electronic mail (astronomers use electronic mail as one of their main vehicles of communication), or distribute letters to all faculty and graduate students. If you need help finding astronomy programs and research centers in your area, contact the American Astronomical Society (2000 Florida Avenue, Suite 400, Washington, DC 20009, (202)328-2010). The AAS is the main professional society for astronomers in the U.S.

4. Call the Astronomical Society of the Pacific

We have a growing database of astronomers interested in Project ASTRO, and can help refer you to other organizations. You can reach us at (415)337-1100. ■

5 Partnership Strategies

Integrating the Astronomer into the School Program

Before you begin your partnership, it will help to decide how you want to fit the astronomer's visits into the school program. There are two general approaches. You could:

1. Link the visits closely with the curriculum

You can link each visit to ongoing classroom activities and the specific science lessons planned for class that day. This approach can be very enriching for the students and can create a great partnership. It requires planning, communication, and flexibility and the astronomer needs to have an interest in the specific topics that are being covered. The teacher and astronomer will need to keep in touch about what the students are doing and be prepared to reschedule if the class falls behind.

Possibilities

Integrate astronomy and environmental science

Make a school planetarium or observatory

Provide junior memberships to astronomy clubs

Have an eclipse party

Host a "Star-b-Que"

Have an annual Astronomy Day fair

Do a slide show

Organize a star party

Sponsor a camping trip to view the dark sky

2. Plan "stand-alone" visits by the astronomer

The astronomer's visits can be "extra" lessons that fit generally with the astronomy or science students are learning, but do not link directly to current lessons. Stand-alone visits can weave astronomy into the curriculum over a longer period of time, and may relate to the astronomer's particular interest or expertise. It is still essential for partners to discuss and plan, but this approach allows you to schedule the dates of visits more definitively in advance.

Most partners choose an approach somewhere between these two alternatives. They try to fit the topic and activity of the visit into the year's curriculum, while still focusing on areas of interest to the astronomer. For example, suppose a fifth-grade curriculum includes the study of the Moon. A partnership that includes an astronomer with expertise in planetary geology may decide to focus on a cratering activity, learning about the different kinds of lunar terrain, and a discussion of other worlds that resemble the Moon. A partnership that includes an active amateur astronomer may instead focus on observing and explaining the Moon's phases and a star party to look at the Moon through a telescope. Meanwhile, the teacher may have students continue charting the Moon's phases, discuss the history of lunar exploration, show a video about the Apollo 11 landings, and then encourage students to write group stories about what it would be like to live on the Moon.

Below are different ways that Project ASTRO partners have integrated the astronomer's visits into the school program, based on four or more visits:

• **Teach astronomy throughout the year** with the astronomer visiting four times or at regular intervals (such as one day each month).

• **Teach a 4-8 week astronomy unit** and have the astronomer visit four or more times during the unit.

• **Teach an astronomy unit first**. Then, after the unit is over, have a weekly (or monthly) astronomy day in your class. The astronomer can continue the visits, working with individual students or focusing on new areas of astronomy.

• **Create a lunchtime or afterschool astronomy club** for a specific grade level or all interested students. The astronomer can visit every club meeting, or at regular intervals.

• **Have students communicate** with the astronomer via electronic mail. It's a good idea to combine this with "in person" contact first.

• **Have the astronomer make visits** or be available to the teacher on an "on-call" basis. This requires advance planning, as well as a commitment to stay in touch and respond to requests.

What the Astronomer Can Do

There are many ways an astronomer can work with teachers and students, as well as a universe of possible partnership activities. Here are some ideas:

- Lead or help lead hands-on activities with students.
- Lead or arrange a field trip to a planetarium, science center, observatory or other astronomical or space science site.
- Serve as a resource person for the teacher and other school faculty.
- Help obtain, fix, and maintain equipment.
- Serve as a tutor, mentor, and role model for individual students or small groups.
- Encourage female and minority students in science.
- Invite colleagues to join you for a visit.
- Involve parents and families.
- Help teachers with curriculum and activity development.
- Assist with a science, math, and career festival in the school.
- Bring interesting artifacts and equipment to class.

More Possibilities

Do solar viewing

Have a "design an alien" contest

Monitor Sunspots

Show computer simulations

Create an astronomy display in the school library or hallway

Make a telescope

Do a school-wide auditorium program

Chart the phases of the Moon

Invite the class to the astronomer's workplace or amateur club meeting

Make a scale model of the solar system in the school or community

Make a model comet

Create messages to send to extraterrestrial beings

Set up an astronomy news bulletin board

Design a model space probe

Do a simulated mission to Mars

Work with model rockets

Use a *Starlab* portable planetarium

"Barry (our astronomer) was great with kids. Even my "sophisticated" seventh graders got involved and excited. The most frequently asked question on Tuesday morning was "Is Barry coming today?" He brought many of his own resources to our class. He supported my classroom goals as well as generating a real love and awareness of the night skies. Even though I do not have a strong technical background in astronomy, I felt like a valued partner."

–Ann Dee Clemenza, Project ASTRO Teacher

Partnering in the Classroom

Once your partnership gets underway, you'll find a way of working together that suits your skills and interests, as well as the students' needs. In some Project ASTRO partnerships, the astronomer and teacher work closely together to "team teach" the class. This means that both are equally involved in leading the class, perhaps dividing or trading off roles as the lesson moves along (see the box on team-teaching). In other Project ASTRO partnerships, the teacher may lead the main lesson, while the astronomer helps students in small groups, encouraging them to stretch their thinking or make more astute observations. Or, in some cases, especially when the astronomer is more comfortable with the students, the astronomer may lead the class through an activity, field questions, or give a brief lecture while the teacher remains actively involved managing student behavior. In general, we suggest that you start by sharing roles in the classroom, rather than having the astronomer lead the entire lesson or activity. ■

Team Teaching: Craters!

Following lessons about the Moon and its phases, I wanted to teach students about craters and crater formation. My partner astronomer, Karen, and I thought this was a great subject to team teach. Karen started the lesson by showing slides of different craters to the students. She asked the students to raise their hands and describe what they observed in the slides—and what conclusions they could draw about craters. Every now and then I jumped in to ask a follow-up question, because I wanted to encourage students to back up their conclusions with observations. During the discussion, Karen provided more information to students about how craters are formed and why astronomers study them.

Then, the students did a cratering activity from *The Universe at Your Fingertips*. In the activity, groups of students drop objects of varying sizes and from different heights into a mixture of flour and cocoa, observing and measuring the resulting craters. (The activity takes a little time to set up, and Karen was able to come before class to help me, which I appreciated a lot.) I explained the activity to the class, and divided students into their groups. Karen and I spent the rest of the class working with the student groups, helping kids make observations, and encouraging them to consider how changing certain variables affected the resulting craters. Because Karen is so familiar with the scientific process, she was able to model forming hypotheses, asking questions, and making observations with the students. She didn't tell kids the answers, but encouraged them to observe and reason. Having Karen there to work with students in groups was invaluable. The kids loved the activity and used their logical reasoning skills. We made a great team!

–Project ASTRO Teacher

What Would You Do?

Here are some typical scenarios drawn from real Project ASTRO partnerships (the names have been changed). We encourage you and your partner teacher or astronomer to discuss these scenarios together: what would you do in the same situation?

Scenario 1:

David, a research astronomer, is very interested in education. He's lectured college students before, and wants to try doing hands-on activities with students through Project ASTRO. David has young children of his own and feels comfortable around kids. He's very busy with his research and only has time for four or five classroom visits.

David's partner, Sue, teaches sixth grade. Sue is very comfortable with hands-on science, but doesn't know much about astronomy. She thinks *The Universe at Your Fingertips* will be a great resource. Sue wants her astronomer to serve as a resource person: to answer students' questions, show slides, talk about his work, help her understand astronomy better, and to work with students one-on-one. Sue is worried that David does not have the teaching skills to convey concepts to students and keep them on task (sixth graders can be tough) and she's hesitant to have him lead activities. Plus, she's worried that David may not finish activities during his visit and her class will get off schedule.

Scenario 2:

Bill is an eighth grade science teacher at a large middle school. The school, which has a very diverse student population, has a new grant to create an integrated science program. As part of this program, students work in groups doing activities and projects, and teachers do very little lecturing. Bill is very committed to this effort and believes that active learning is the best way to get students interested in science. Bill wants to focus on the solar system and have students create a scale model on the school ground (he has about 6 weeks to teach astronomy). He would like his partner astronomer to help him with astronomy concepts, to work with students in small groups during classroom visits, and to help students with projects.

Bill's partner astronomer, Valerie, is a local amateur who is a retired pharmacist and wants to get involved in a meaningful volunteer activity. Valerie has plenty of time to participate in Project ASTRO, and is very enthusiastic about sharing her love of astronomy with students. She'd love to volunteer all year. She's especially interested in Black Holes, stellar evolution, and cosmology. Over the years, she has been collecting slides and images that she is eager to share, and she has given lectures to adults that have been very well-received. Valerie is most comfortable with a lecture approach using her slides, and she'd like to help students with library research projects.

Scenario 3:

Steve is an active amateur astronomer. He's the education officer in his astronomy club and has helped schools with star parties for years. Steve has a naturally engaging way with children and adults and he's done astronomy activities with students at summer camp, county fairs, and through scouting. He's eager to learn some new activities through Project ASTRO, and hopes to work side by side with his partner teacher to develop a creative and fun program at their school. He'd love to take the students on a special nighttime star party outside of the city.

Rita, Steve's partner, is a fourth grade teacher in an inner city school. The school is besieged by problems and is known to have the lowest test scores in the district. There are very few resources available at the school (no one knows what happened to the slide projector) and students have very few experiences outside of their own community. Rita often uses her own money to buy supplies for students. She was excited to be selected for Project ASTRO so that she could bring a real scientist into the classroom to interact with students. Rita, who does not have a lot of experience with hands-on science, is very unfamiliar with astronomy. She's hoping that Steve, as a guest speaker, can lead the class during his visits so that she might learn more about astronomy at the same time. ■

6 Starting Your Partnership

Planning Guidelines

As we've said, we found that it's critical that partners meet before starting the visits to develop a focused plan. Below are some areas partners have found it useful to discuss.

• The School

How is the school organized? What are the students like? What is the school culture? Are there any school politics the astronomer should know about? Will other staff or faculty be involved? Are there any new priorities or special projects? What's the principal like? Where do visitors park? Are there specific rules school visitors must follow?

• The Students

What grade will be involved? How many students are in a class? Which students will the astronomer visit? What is the background of students (academic, language, cultural). What is their attention span? To what extent are families involved in students' school work? What sorts of things are students interested in? Are there special suggestions about working with particular students? Look at examples of student work.

• The Astronomer

How did the astronomer get into astronomy? Does he or she have areas of research or special interest? What are the astronomers' favorite aspects of astronomy? (If the astronomer specializes in astrophotography, focus on this with students. If the astronomer studies planets, spend time on the planets and how we learn about them.) What areas of astronomy is he or she less knowledgeable about? Does the astronomer have any links with amateur clubs, research organizations, or sources of materials? How could these contacts be useful? In what areas of working with kids does the astronomer need help or want to learn more?

• The Teacher

What is the teacher's science and teaching background? What is his or her experience with astronomy? What is the teacher's philosophy and teaching style? In what areas of astronomy does the teacher need help or want to learn more? How much astronomy has the teacher included in the curriculum before and how might things change as a result of the partnership?

• The Curriculum

What are science learning objectives for your grade level? What is the curriculum? How does astronomy fit into the broader science curriculum? What key concepts and processes are students expected to learn this year? What main areas of astronomy will you focus on?

• Classroom Behavior

What are the classroom (and school) rules and norms regarding behavior? How should students address the astronomer? What "classroom management" techniques does the teacher use to quiet the class or get

Attitude for a Successful Partnership

- Be flexible (it might rain, there might be a fire drill, etc.)
- Be honest
- Learn from experience, learn from mistakes
- Be open about your strengths and weaknesses
- Communicate your needs
- Don't be discouraged
- Don't expect perfection, especially the first time
- Be persistent
- Don't expect your partner to know everything
- Appreciate the astronomer's contribution and possible sacrifice (some astronomers take vacation time to do ASTRO)
- Appreciate the existing relationships between teachers and students
- Look at the big picture
- Be punctual
- Laugh

students' attention (for example, raising hands, or waiting until everyone is quiet before continuing)? What are the consequences of misbehavior in the classroom? Although it is primarily the teachers' responsibility to manage student behavior, it is important that the astronomer know what is expected of students and know a few techniques to manage discussion, noise level, and attention.

• Logistics and Scheduling

When during the year will astronomy be taught? When during the day? Will school logistics and schedules work for both partners? How often can the astronomer visit? Is anything going on in the astronomer's or teacher's life or work that may affect availability? (If the teacher wants to teach astronomy during October and November, but the astronomer plans to be out of the country observing during those months, your partnership will have problems!)

• Equipment and Materials

What audiovisual, demonstration or computer equipment is available at the school? How far in advance does it need to be ordered or reserved? What will you do if something breaks or a bulb burns out? Are there enough materials for all students? Which partner will be responsible for bringing the materials needed? What contingency plans would it be wise to have?

• Communication

What are good ways to stay in touch with each other? What are the best days and times to call? What is the best way to get a message to each other in an emergency? If more than one teacher is involved in the partnership, who will be the designated contact person?

Such planning is also useful because you'll see whether your personalities and interests "click" before making a visit. Be flexible and open to new perspectives. But if things look like they may not work out, it's better to find a new partner now. If you have a program coordinator, contact him or her at this point. Otherwise, agree to part amicably. Perhaps you can help each other find a more suitable partner.

"Although we were given time during our first workshop, we did not realize how important a firm year-long plan would be. We were so new to this that it was difficult for us to do great planning at the time. We decided to plan the first visit and take it one at a time. Looking back, it would have been better to have set dates and year-long curriculum goals (what areas would be covered at each visit, when would the star party take place, when would there be a visit to an observatory etc.)."

–Project ASTRO Teacher

Planning Checklist

❒ **Have an initial planning meeting**, preferably away from school or interruptions. At the meeting, be sure to address the areas listed above and select a few themes and activities to focus on first. Because unexpected situations can come up, be sure to have a back-up plan for each session, just in case.

❒ **Make a date for continued planning**, if needed. We suggest you try to sketch out a plan for the whole unit or semester. You can always revise the plan or make it more specific after the first visit.

❒ **Set up a time for the astronomer to observe** the classroom as an anonymous visitor before he or she begins making visits.

❒ **Introduce the astronomer** to the school principal and to any other important school personnel. The astronomer should be presented as a valued and honored visitor with expertise who is giving time to volunteer in the school.

❒ **Give the astronomer a tour** of the school (including the location of restrooms and parking spaces!).

❒ **Exchange information** about scheduling constraints or commitments. Give the astronomer a school calendar for the year.

❒ **Make a communication contract:** Who will call whom and when? How will you follow-up after visits? When and how often will you plan? How will you give each other feedback?

❒ **"Debrief" after the astronomer's observation** and subsequent visits. If you can't talk at school, make an agreement to talk by phone later.

❒ **Divide up responsibility** for any materials needed for the visits. We suggest that most materials stay at the school site, but astronomers may need some materials (such as slides) to prepare for visits. For sites with multiple teachers, you will need to make additional copies or work out a rotating system to share materials.

The First Visit

The first visit provides the opportunity for the astronomer and students to get acquainted. It is also a chance for the astronomer to get a better sense of the students' interests and prior knowledge. And, you can use the first visit to interest the students in what's to come.

Most partners have a lot of fun with the first visit. By this time, partners are usually more comfortable with each other as a result of the planning they've done. Still, the first meeting with students can be somewhat nerve-wracking for the astronomer who is new to the classroom, and for the teacher who has not had a visiting scientist in the

classroom before. Project ASTRO partners have come up with a number of first visit ideas that have helped them get off to a successful start. Of course, you will want the first meeting to fit with your style and what you plan to do in subsequent visits. Here are some ideas and suggestions from Project ASTRO partners that may spark your own thinking.

Before the Astronomer Arrives

• **Prepare the students**

Before the visit, the teacher should introduce new material thoroughly and build up the excitement about the astronomer. Emphasize that the astronomer is coming especially to see these students, that he or she knows a lot about astronomy, and is making a very special effort to come to their school. You can even have students make "Welcome to Our Astronomer" signs or cards.

• **Do the activity, "Picturing an Astronomer"** from the *Universe at Your Fingertips* before the astronomer arrives.

In this activity, students picture an astronomer in their mind and draw a picture of what they think an astronomer looks like. You can also have the students write about what they think an astronomer does. Then, students compare their different images, and discuss some of the assumptions they made. (Do they assume the astronomer is male? Do they assume the astronomer wears glasses?) Students will be extremely interested to find out what their astronomer really looks like after this activity. After the first visit, the astronomer can give out various awards for the drawings (the most life like, the most "nerdy," the funniest, etc.). You can also create a great bulletin board using these draw-

Common Concerns Partners Have

TEACHERS

Will my astronomer...

- Use appropriate vocabulary?
- Use effective teaching tools (visual aids, models)?
- Encourage girls and bilingual students?
- Learn and respect my classroom rules and routines?
- Observe student behavior?
- Fit into the crowded schedule I already have?

Will I...

- Look ignorant compared to the astronomer?
- Not understand what the astronomer is saying?
- Be asked to spend too much time on this project?

ASTRONOMERS

Will my teacher...

- Give me enough guidance?
- Want me to come to too many different classes (instead of getting to know one very well)?
- Help me to plan something that will be both of interest to the students and something I can get excited about?
- Do nothing while I have to do it all?

Will I...

- Be good enough in front of the class
- Talk over the students' heads?
- Be asked to spend too much time on this project?

Preparing to Work in Poorer Schools

Many astronomers are drawn to work with students in urban or poorer schools because they recognize the greater need that these schools and students may have. At the same time, astronomers new to the classroom may find that being in an urban school is uncomfortable. Working with poor students, or with students from minority backgrounds, can be difficult for someone who has not done it before. It takes time for students to develop trust, and the astronomer may feel self-conscious, afraid about physical safety, worried about offending someone, and in general not be sure how to connect with the students. It is important for teachers in these schools to talk explicitly about students and strategies for working with them, to emphasize the positive impact the astronomer can have, and to let the astronomer know when a student shows special interest or enthusiasm beyond the astronomer's visits.

ings, including some photographs of the real astronomer, or other astronomers.

• Have students make a list of questions

In small groups, have students come up with at least 10 questions for the astronomer. Post these questions in the classroom, and provide opportunities for the astronomer to answer some of them when he or she comes. This will also help the astronomer to see what interests students. To avoid overloading the astronomer, have each group of students or the whole class select three of their favorite questions to ask. (You may want to share the questions with the astronomer before the visit.) The astronomer can answer the questions for the class or meet with small groups. Then, keep the questions posted to refer to during the astronomy unit.

During the First Visit

• Talk about your work and interests

If you are an astronomer, share yourself with students by describing your work, how you got interested in astronomy, what you wanted to be when you were their age, what else you like to do, etc. The students will likely have a range of questions about these topics, and will appreciate that you care enough to share your personal experience with them. It's always a good idea to bring some photos or slides. One Project ASTRO astronomer started off her first slide show with a picture of her 18 month old baby, and of observatories where she has worked.

• Learn the students' names and get comfortable with each other

It's helpful to have students wear nametags for the first visit (and future visits until the astronomer learns their names), and to clarify what they should call the astronomer (other than, "hey you" or "Space Guy"). Doing an "icebreaker activity" is a great way to get acquainted and learn the children's names. Here are some ideas:

Brainstorm lists of everyday objects with astronomical names (Mars Bar, Comet Cleanser, Saturn car, etc.). Students could do this in teams with a prize to the team with the longest list.

Have students make a list of songs referring to astronomy. Have students sing or use kazoos to hum their favorite song. Play "name that tune."

Have each student write down three things about him or herself and one question about astronomy. Let each student introduce him or herself and ask their question. For added fun, the astronomer can take a Polaroid photo of each child to display at school or take home.

• Plan one manageable activity, if time allows

If there is enough time, plan to do a simple hands-on activity with students. Teachers and astronomers may want to lead the first activity together. Small group activities work well because these give the astronomer a chance to interact with students on a more personal basis. You will probably want to do an activity that ties into what students will be learning next. For example, if students will be studying the Moon, a good first activity is to have students work in groups to predict the order of the Moon's phases. Another approach is to do an attention-getting activity, like "Making a Comet in the Classroom." These activities and others can be found in *The Universe at Your Fingertips*.

Whatever you do during the first visit, try to relax and have fun. Be prepared for something not to go as planned, and be willing to be flexible. Most likely, things will be great! After the first visit, be sure that you meet with your partner or debrief on the phone that night. Discuss how the students responded, ask for feedback, and talk about what you might do differently next time. Then, make a date for the next visit. ■

"It was great having the students become more relaxed in sessions, talking about astronomy and space—from what was being done to their ideas, doubts, etc. Science became less fearsome."

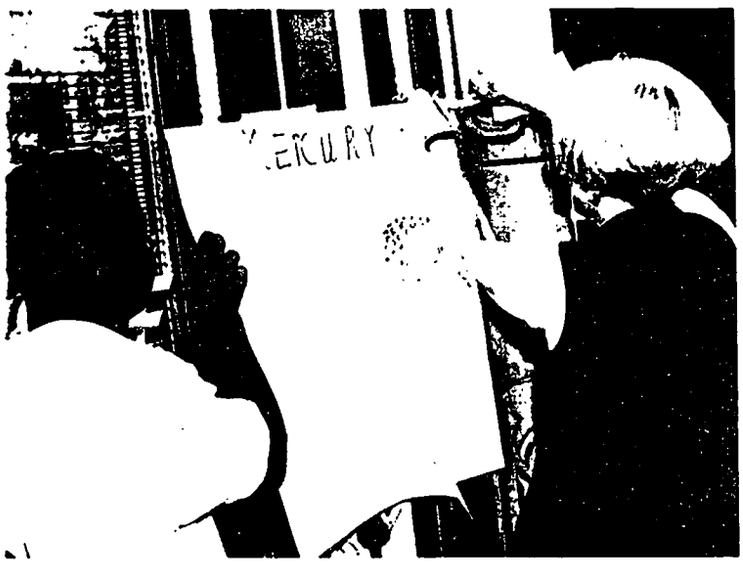
–Project ASTRO Astronomer

7 Guidelines for Teachers

We want to share with you some of the guidelines and suggestions that we've learned from Project ASTRO teachers and astronomers about the teacher's role in a Project ASTRO partnership. We hope these ideas will be helpful, and encourage you to refer back to this section as your partnership develops.

Roles and Responsibilities

Before you start your partnership, and before each visit it's a good idea to be clear about roles and responsibilities. At Project ASTRO we've learned some general lessons about the teacher's role:



• **The teacher is responsible for student behavior and classroom management.** The astronomer is not a substitute teacher, and should not be left alone to deal with the students. He or she should be able to count on the teacher for help with classroom logistics or inattentive students. Be sure to let the astronomer know about classroom rules and routines.

• **Both the teacher and astronomer are responsible for getting in touch with their partner.** "Our partnership didn't continue because I didn't hear back from my partner" is a complaint we've heard from some ASTRO participants. Avoid this pitfall by initiating contact with your partner (even if you think it's the other's turn) and returning any calls within two days (even if it's to say, "I'm swamped and will call you back later").

• **The teacher should stay engaged and involved in the classroom.** Take notes, do the activities, ask questions. This models curiosity and learning to students and helps the astronomer. For example, if it seems that students do not understand the astronomer's explanation for something, you can help the astronomer to clarify by asking the question again yourself in a different way.

• **Keep interruptions to a minimum** during the astronomer's visits (because the astronomer is only there a few times). If possible, arrange for a longer class period for the visit.

• **Keep track of time** during the visit (because astronomers can get excited and lose track).

• **Coordinate logistics,** materials, and equipment before the astronomer's visits (making copies, getting a slide projector, making sure the room is dark, etc.).

• **Arrange the details of any field trips** or activities away from school (although

astronomers were often willing to help or even take the lead.

- **Express appreciation** and thanks to the visiting astronomer. Make your astronomer feel welcome (it's great of course, to have students do this too).

- **Make plans** for the next visit, or for next year.

Tips for Teachers

We've collected some additional tips for teachers that can help make your partnership go more smoothly.

Prepare a welcome.
Select several students to greet the visiting astronomer. Tell the astronomer where and how she will be greeted.

Give your astronomer a chance to learn.
Remember when you first started teaching? It was a bit scary and you made mistakes. Maybe you lost the students' interest, or talked a bit too long. Let the astronomer have time to develop his skills and do what is interesting to him, but don't leave him floundering. You may need to strike a balance between averting a "failure" and letting your astronomer try it his or her way.

Let your astronomer use his or her interests.
Your astronomer will be more committed to you and your students if she can do something that is of particular interest to her.

Provide and request feedback.
After the visit, provide feedback to the scientist. He or she will respond to your positive reinforcement as well as constructive criticism. At the same time, ask your partner for feedback and input. He or she may have new ideas, constructive suggestions, or areas where your help is needed.

Discuss the visit with your students.
Build on their experience with follow-up activities.

Share your experience
Parents, colleagues, and school administrators benefit from hearing about scientists' visits. Publicity in the community will gain support for your efforts, and for the school.

Keep a portfolio
Keep a scrapbook with photographs, student work, curriculum outlines etc. to document your Project ASTRO effort. Take videos of the astronomer's visits and special events.

More Ideas for Teachers

- Create an "Ask the Astronomer" question box.
- Organize small group discussions with the astronomer to give quieter kids a chance to ask questions.
- Get a commitment of release days in advance for planning.
- Visit the astronomer's workplace.
- Go to an astronomy club meeting.
- Let astronomer know what will go on between visits.
- Use peer teaching (have your students teach other students).
- Invite the astronomer to an open house or back to school night.
- Leave the class with a cliff hanger to ponder or investigate (where do stars come from? What will you see tonight in the East at 7 p.m.?).

You never know which students will like astronomy
Don't assume which students will like astronomy, or which students will or won't connect with the astronomer. Many Project ASTRO teachers have found that students with behavior problems or learning difficulties have been especially turned on by astronomy.

Address the issue of women and minorities in astronomy
It's important to show students that there are female and minority astronomers. If your partner is a women or person of color, ask the astronomer to talk about his or her own experiences with science. You can also ask the visiting astronomer to talk directly about women and minorities in the field, or to help you find additional resources.

What do Students Know? Want to Know?

It's very helpful to start by finding out what students already know. To do this, you can simply ask students to tell you everything they know about a topic, say the Moon. As the students say their ideas, write the ideas on the board. Another technique is to use a "KWL Chart" (What I know. What I want to know. What I learned). Create a big chart with these headings and list the students' responses under each heading. Keep the chart up until you're done with the unit or topic, and fill in the last part.

Think interdisciplinary
Incorporate interdisciplinary activities in writing, spelling, art, social studies, reading and math (See *The Universe at Your Fingertips* for more ideas.)

Professional vs. Amateur Astronomers

It's important to keep in mind that professional and amateur astronomers have different strengths and knowledge. For example, many professional astronomers are not familiar with small telescopes or observing the constellations. Instead, they may use large telescopes (with technical support staff) to get data from instruments in space, or work with radiation that is not visible to the naked eye. Their experience offers exciting opportunities to expose students to the work of real scientists and the various ways astronomers get and analyze data from remote locations. If you are working with a professional astronomer, explore ways you can link the astronomer's research and scientific knowledge with the classroom visits. They might discuss what it is like to use large astronomical instruments or high speed computers.

Amateur astronomers will probably be more familiar with different kinds of small telescopes and identifying objects in the sky. They can serve as valuable role models for students about how we can enjoy science in our everyday lives. Many amateurs know about building or buying their own telescopes, others may be space travel or science fiction buffs, while others love hiking and camping (where the skies are dark). A good number of amateur astronomers are fascinat-

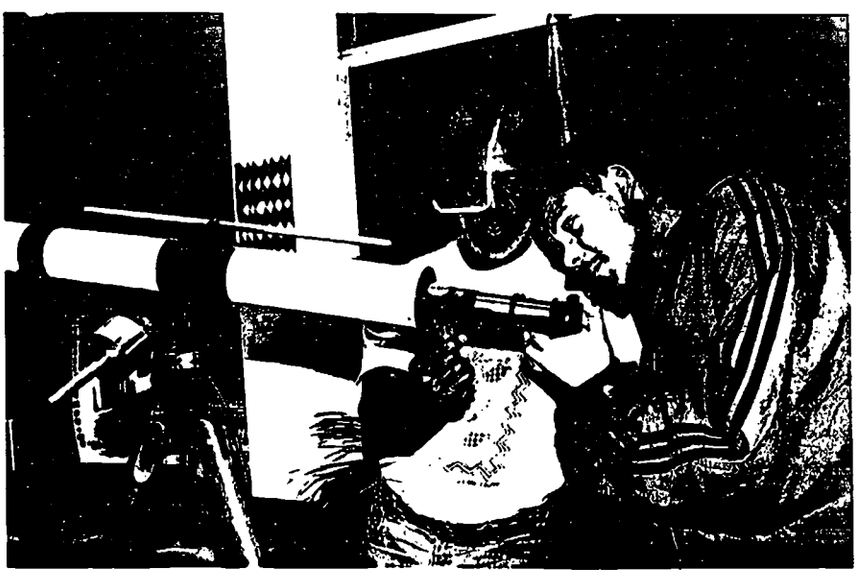
ed by cosmology (the study of the origin and large-scale evolution of the universe), read about it voraciously, and may be well-informed about theoretical developments. Both professional and amateur astronomers can make great partners and work well with students. And teachers may need to help both professional and amateur astronomers use language that is accessible to students.

Finally, keep in mind that, while your partner astronomer may know more about astronomy than you do, he or she will not know about every aspect of astronomy. Most amateur and professional astronomers focus on one or two areas of astronomy, but may be able to discuss other aspects of the field if you give them notice. ■

Interdisciplinary Teaching Ideas

Let's say you are studying the planets and have been learning about Mars. You could tie in interdisciplinary activities by having students:

- Write a story about what it would be like to be a tourist on Mars.
- Design travel brochures for a tour of Mars.
- Read and discuss science fiction about Mars written at different periods (reflecting our evolving understanding of the red planet).
- Read H.G. Wells' *War of the Worlds*.
- Imagine they are visitors from Mars and discuss what would seem most alien to them about the Earth.
- Read and discuss myths from different cultures about Mars.



8 Guidelines for Astronomers

We think you'll discover that visiting a school will be a rewarding experience. Teachers are grateful for the assistance and professional interaction, and most students will appreciate your time, care, and enthusiasm. At the same time, schools are unique cultures that can at times be frustrating for the newcomer. As workplaces for teachers, schools differ significantly from most offices. This means you'll need some special strategies to stay in touch with your teacher. Also, if you feel a bit nervous about the prospect of working with 30 active 11-year olds, you're not alone. Many people feel anxious before visiting a new classroom. You might have immediate rapport with the students, or it may take a few visits before you click with them. Bear in mind that students' reactions may have nothing to do with you, and could reflect something that happened earlier in school or at home, peer pressures, raging hormones (in early adolescence), and many other factors. Knowing and practicing some time-tested teaching techniques will help you connect with students and engage them in learning about astronomy.

Below are some tips and suggestions we've collected from Project ASTRO partners and other scientist/teacher partnership projects. We hope these tips will help you navigate the school, interact with your teachers, and work with the students. You may want to return to this section after you've done a few visits to try new ideas each time.

Don't try to cover too much

It's easy to assume that concepts and procedures which have become second nature to you can be quickly learned by others—but it simply isn't true. It takes multiple exposures, active participation... and time for new concepts to become integrated into our brains. A small amount of material presented very effectively is much better than a lot covered so hurriedly it's confusing.

(From *Preparing and Presenting Effective K-12 Science and Math Education Activities*, Sandia National Laboratories)

Roles and Responsibilities

Before you start your partnership, and before each visit, we suggest that you clarify roles and responsibilities with your partner teacher. At Project ASTRO we've learned some general lessons about the astronomer's role:

- **You are not a substitute teacher and do not need to lead the class alone.** You should count on the teacher to help you manage student activities and behavior. At the same time, it is important that astronomers learn about classroom rules and how to communicate effectively with students.

- **Both the teacher and astronomer are responsible for getting in touch with each other.** Both of you have busy schedules and it can be difficult to reach teachers during the school day. Nevertheless, your partnership will be more successful if both partners take the initiative to get in touch.

- **Prepare for visits** by practicing activities and reading any guidelines thoroughly (try the activity out on your family or a friend).

- **Request honest feedback** from the teacher (because teachers may be shy about

giving it to you). Such feedback (even if it hurts a bit) can be invaluable in helping you to become a better resource for the students.

• **Support your teacher's involvement in Project ASTRO**—let the principal know how great your partner teacher is, help your teacher attend workshops and special events, inform the community and colleagues about what the two of you are doing.

• **Keep in touch** with your teacher about your schedule.

• **Make plans** for the next visit, or for next year.

Tips for Astronomers

General Tips

Start simple, with smaller groups of students.

You don't have to know the answer to everything. Model being a scientist who finds out.

Don't assume the teacher has a strong background in astronomy or science. Be sensitive to concerns they may have about their own science preparation.

Don't overcommit or you may burn out.

You don't need to teach all of astronomy this year. Some students may have had astronomy in previous grades, others may have it in the next few years. It's best to help students understand a few focused concepts and to pique their interest in learning more.

Students are at many levels of knowledge and reasoning. Be prepared not to reach everyone.

Keep any lectures short and combine them with activities.

Monitor the safe use of equipment, to protect students and equipment.

Listen to teachers and students and be flexible about your plans, based on what you hear.

Start with an attention-getting activity.

Always have a back-up lesson or activity, just in case. It's also helpful to have some "filler" activities or questions, in case you have extra time.

"I have much more respect now for the work of teachers—it is hard work."

–Project ASTRO Astronomer

Reaching Teachers

One of the most obvious differences between teachers' lives and most astronomers' lives involves communicating with the "outside world" during the work day. In many workplaces, people have a phone in their office, a fax machine down the hall, an accessible copy machine, and a computer with e-mail. Most teachers do not have an office, let alone a phone or computer of their own to use. Their work day is focused primarily on students and staff in the school. This means that reaching each other will require some persistence and creativity. What's the reality of communication for most teachers?

Teachers may have access to a typewriter, phone, and fax but it's most likely in the main office (under the nose of the principal and office staff). Some teachers have a phone in their room, or in the science office, but can't always answer it.

Teachers may have a computer to use, but it's probably in a computer lab or at home.

Most teachers do not have access to the Internet and e-mail yet.

Most schools have few journals or astronomy books.

Teachers can talk to other teachers in their school, but have less contact with teachers in other schools.

Professional conferences are rare and special events.

–From a list by Elizabeth Roettger, Adler Planetarium, Chicago

"It's hard for kids who grow up in the inner city because when you're their age, that is the whole world to them. I was one of those children. I didn't know a whole world existed outside of my neighborhood. And I didn't know I was entitled to it either. You have to learn that from somebody else. And, once you learn that there's another world out there and you're entitled to it—that makes the difference."

–Project ASTRO Teacher

Plan a good conclusion or wrap up. Review and emphasize how much the students have learned, and provide encouragement.

Engage Students in the Process of Science

Emphasize hands-on learning.

Remember that process can be more important than just getting the right answer. When there are differences or unexpected results, explore the reasons why with students. Turn failures into science: "Why did your craters not turn out like those on the picture of the moon?" Encourage students to discover answers for themselves, or to consider that there may not be a right answer.

Students learn in different ways, so use a variety of approaches. *The Universe at Your Fingertips* contains articles about student learning and astronomy. Also, request input from your partner teacher.

Define what you are trying to accomplish. What is your purpose for this lesson?

Use age-appropriate vocabulary (you'll do better by keeping your language simple).

Take advantage of special events (a spacecraft flyby, meteor showers, eclipses, new discoveries in the news).

Develop Relationships with Students

Be yourself. Talk about your work, your family, and how you got interested in astronomy.

Validate and give positive feedback to students.

Bring things for students: special photos, individual notes (in response to questions, perhaps).

Hold contests with small astronomical prizes.

Keep in mind that not all kids will have a fascination with astronomy and space, but you can have a positive impact by showing you respect and care about students as people.

If you are less experienced with kids, you may need to work harder to learn some kid-friendly techniques and language. Be patient, and let the teacher guide you.

A Special Connection

"There was an African American girl in my class who wasn't very involved during my first visit. As I was leaving, she walked up to me after class and asked me whether there were any African American female astronauts. I told her I didn't know, and promised to find out for her. So, I called NASA and found out that, indeed, there is an African American woman astronaut named Mae Jemison, the nation's first. A medical doctor, engineer, and accomplished dancer who majored in African American history at Stanford University, Jemison flew aboard the space shuttle Endeavor during a 1992 mission. NASA sent me a picture and the next time I visited the school, I gave the picture to the student and told her more about Mae Jemison. She was very excited and told me that her grandmother had told her not to expect to find an astronaut who was a woman and African American. During class, the girl walked up to me several times, clutching the picture and asking how to pronounce Mae Jemison's name correctly so that she could show the picture to her grandmother."

–Project ASTRO Astronomer

Avoid Gender and Ethnic Stereotyping

Women and minorities are severely underrepresented in science. It is important to consciously avoid language, mindsets, and actions which disenfranchise girls and minority students. Be inclusive in your language, actively involve and respond to all students (girls and boys), and use examples and materials that include women and minorities as role models and examples. Most important, have high expectations for all students.

Support Your Teacher

Help make teachers' lives simpler, not more complex. Teachers are pulled in many directions. Strive to support your teacher without making too many extra demands on their already hectic schedules.

Invite your teacher to visit your workplace or come to an astronomy club meeting. One Project ASTRO astronomer invited his teacher to his lab where they spent an afternoon trying to devise an experiment about motion for the students to do. Even though they didn't create a successful experiment, they both felt that the time they spent working together outside of the school setting made them more effective partners.

Help your teacher find additional materials and resources. *The Universe at Your Fingertips* lists many suggestions and addresses.

Let the principal know about the great things the teacher is doing. ■

"During a scale model of the solar system activity, students became very engaged and asked many 'what if' questions—What if Mars hit the Earth? Can we go to Venus or is it too hot? Are we the only life in the Universe? How far can you see in space?"

Project ASTRO Astronomer

Get Feedback from Students

When possible, use terms and analogies that the students already know. If you use a new term, define it or ask your partner teacher to help prepare students in advance. Not sure what language is appropriate? The best test is to ask the students by posing a question such as, "How many of you know what [the term] is?" "Can anyone tell me what I mean by [X]?" Look at the children's faces and behavior. Are they fidgeting or looking bored? This may mean that they do not understand you (with the exception of eighth graders who may just look bored). Also, don't forget to involve your partner teacher. Agree that the teacher will cue you if you are talking above the students, and ask your teacher for feedback after your visit. At the same time, don't worry if all students don't understand every word you say. It's likely that there will be a range of understanding, and that your teacher can help clarify any confusion later.

How to be Effective in a Classroom

Make eye contact with the students because they love the personal contact.

Smile and feel comfortable telling amusing anecdotes because kids love a good laugh.

Organize all materials in advance because kids sometimes have a hard time waiting.

Use student volunteers to help you set up and distribute materials, samples, pictures and handouts because kids love to feel important.

Require that students raise their hands to participate because they will probably all want to talk at once.

Use a prearranged signal to get students' attention during activities (clapping, flipping light switch, etc.) because it is too hard to give good directions unless students are quiet.

Stop and wait for students to let you continue speaking if they get noisy because they have probably heard the "cold silence" before and know that it means they need to be less noisy.

Wait to give handouts to students until it is time to read or use them because if the students have the handouts while you are speaking they will be distracted.

Wait several seconds before calling on students to answer a question because the whole class needs time to think about the question before someone answers it.

Praise attentive or helpful behavior because this is the behavior you want to encourage.

Enjoy the students, their enthusiasm, and their sense of wonder because they have a fascinating perspective on the world!

–*From Sharing Science With Children: A Survival Guide for Scientists and Engineers*, Developed by the North Carolina Museum of Life and Science. Reprinted with permission of the Colorado School of Mines, Office of Special Programs and Continuing Education.

9 Involving Families, Community and the School

Project ASTRO provides many opportunities to involve families, the community, and the entire school. Linking with families and the community can serve several purposes. Students are more likely to succeed in science (and school in general) when their families are actively engaged in learning with them. Finding ways to involve families in astronomy will help support children's interest in science in and out of the classroom. (These days, most schools are trying to involve parents in their children's schooling.) And, because astronomy and space science are fascinating for many adults, they are excellent subjects to draw families to school events and to involve families in out of school activities with their children.

Linking with the community, from nearby science centers and planetaria to local businesses, will enhance your partnership activities by providing access to new resources and opportunities. Are there sites that you would like students to visit? Are there additional people to involve who can enhance the effectiveness of your partnership? Can a community connection provide materials or resources for the classroom? Are there local opportunities for teachers to develop their knowledge of astronomy? Organizations and individuals in your area may be able to meet some of these needs.

For example, a planetarium or observatory visit can be a useful addition to students learning and understanding of astronomy. Perhaps the local science center has astronomy-related activities for kids and families on the weekend. Ask an amateur astronomy club to help out with a school star party, or to help raise money for school telescopes. Find out whether research institutions provide a summer internships for teachers, or if a program can be developed. Ask local businesses to donate materials for student projects. Developing community linkages will add to the value of your Project ASTRO program. At the same time, you can use your Project ASTRO program as a vehicle to develop ongoing links between the school and needed community resources so that the connection is not just a one-time event.

Getting the School Involved

As you make links with community organizations, don't forget that sometimes involving the rest of the school can enrich your Project ASTRO program. For example:

- **Have your students** give younger students a tour of a scale model of the solar system they made, or report on an "alien being" they designed to survive on another planet.

- **Hold a brown bag lunch** for the astronomer and other faculty members. Have a mini-workshop for other teachers on a

hands-on astronomy activity, telescope use, or daytime astronomy.

• **Invite other classes** to an evening star party or a daytime observing session.

• **Hold a star party** during parents' night at the school (with the cooperation of other teachers).

• **Involve the school librarian** in doing a display of books about astronomy.

Involve Families with ASTRO Packs

ASTRO partners Frank Dibble and Sharon Regner developed a great way to involve parents in astronomy. They created "ASTRO Packs," backpacks containing materials and activities for students to do at home with family members. The students check out the backpacks for a few nights, and return them to the classroom. As students do the activities, they record their thoughts and observations in their science journals, with the help of parents. Frank and Sharon's ASTRO Packs contained the following items:

★ Two basic astronomy books

★ A Star Finder (a good star finder for children, developed by Dennis Schatz of the Pacific Science Center, can be found in the *Universe at Your Fingertips*)

★ Peanuts to share while stargazing

★ An audio cassette of *Tapes of the Night Sky* for stargazing (available from the Astronomical Society of the Pacific catalog)

★ Worksheet for students to draw his or her own constellation and write a myth to go with it

★ Star stickers to decorate a letter to the astronomer (in this case, Mr. Dibble)

★ Journal for students and parents to record their experiences with the ASTRO Pack

★ Worksheet on Native American star stories.

★ An issue of a children's science magazine. An excellent resource is *Odyssey Magazine* which is devoted to astronomy and space science (published by Cobblestone Publishing).

Linking with Outside Resources

In general, remember that students will be more engaged in science when they can do something that has meaning in the real world, such as participating in a real research project, writing an article that gets read by people, or demonstrating a science concept to families or other younger students. Kids will also be more motivated when they understand real world applications of what they are learning in school. Below are some examples of the types of connections you may want to make in your community:

• **Colleagues, especially women or minority scientists who can serve as role models**, could join you in the classroom to speak with students directly about their own experiences.

• **Colleges and universities may have students willing to work** with children, or faculty who can help provide access to research activities and resources.

• **Your local high school** may have resources you can use. Some high schools have a planetarium to visit, or more advanced equipment you can borrow.

• **NASA's research centers** may have educational programs relating to specific missions, or materials may be available to teachers through the much larger network of NASA Teacher Resource Centers. To get an updated list of NASA Teacher Resource Centers, contact NASA CORE, Lorain County JVS, 15181 Route 58 South, Oberlin, OH 44074 (216/774-1051)

• **Businesses and industries in your area can help support** your Project ASTRO

partnership through cash or in-kind donations (printing, paper, supplies).

• **Aerospace or other science-related companies** may provide you with posters, slides, and other timely materials. Some companies sponsor teacher internships during the summer. Contact the company public information office as a first step.

• **Your local media may be interested in news** about your partnerships. Send out brief press releases a week before an interesting visit or event. Good public relations is always helpful for the school, and all involved will appreciate the recognition. Don't forget the school newspaper!

Involving Families and the Community in Project ASTRO

Astronomy will be more engaging for students when you move learning activities beyond the classroom walls and invite families and others in the community to participate. Special events, regular community programs, and even homework assignments are great ways to make astronomy appeal to families and others, and to give students a chance to demonstrate what they know. Below are a few ideas.

• **Celebrate Astronomy Day** with an astronomy science fair for students and families. Astronomy Day is a national event sponsored by amateur astronomy clubs around the country. Contact your local astronomy club for the annual date.

• **Create a "Moon Room"** at a local community college or other accessible location with photographs, memorabilia, maps and books about the Apollo era. Show a lunar sample, available to educators through a training course offered by some NASA Centers.

• **Hold smaller "front yard" star parties** in the neighborhood around the school.

• **Create special evening or weekend programs** around astronomical events: eclipses, space missions, comet approaches, etc.

• **Set up an astronomy booth**, staffed by children, at local fairs and events: Girl Scouts Convention, the County Fair, festivals, etc.

• **Invite families to school star parties** (see Section 11 for more star party ideas).

• **Link up with a local scout troop** or other youth group for joint observing activities. ■

Photo by Catherine Lombard

"Project Planet Map"

Make a Scale Model of the Solar System in Your Community

Amateur astronomer Debra Scherrer and teacher Sherry Johnson at Independent School in Castro Valley, California developed a community-wide activity to help students understand the vast distances of space. They involved students and the community in creating and displaying a scale model of the solar system, called "Project Planet-Map."

Using a nine-foot weather balloon at their school to represent the Sun, students in grades 3-5 researched the sizes and distances of the planets and then created

scale models of each planet to display in various locations in the community. All 500 children in the school participated in painting the weather balloon Sun. Debra Scherrer, the astronomer, coordinated the student work, solicited donations of materials, and contacted community locations about displaying the planets, comets and asteroids.

Planets and other astronomical objects were located at the appropriate distance at a nearby middle school, a drug store, a local fire station, a grocery store, the local library, two local colleges and a shopping mall. Some locations supported the project by making astronomy displays, sponsoring a design-an-alien contest, and having astronomy related items for sale. Each display included a scale model of the planet in a plastic box, with signs, researched and written by the students, giving astronomical information about the planet, real photographs of the planet, an "alien" designed by the students, a map of the rest of the solar system sites, and signs recognizing the sponsors and student creators. Visitors to the planets got a special card that they could stamp at each planet they visited. Anyone who stamped their card at all sites received a poster of the Sun, donated by Lockheed Palo Alto Research Center.

The project cost about $800 for materials, supplies, and publicity. Funding for the project came from Project ASTRO, the PTA, the Independent School Site Council, and local businesses. Debra also received many discounts and donations, including free printing from a local printer and donated graphic design work. Getting donations and materials for the project took a great deal of Debra's time and energy. The project won an honorable mention for an Astronomy Day program from *Sky & Telescope Magazine*.

Debra and Sherry opted to do a more expensive version of this project, but it could easily be scaled down to be more affordable for other schools. Older students or several parents could help contact community locations. The informational materials could be produced less expensively, and simple rubber stamps could be used to mark visits to each planet. Debra and Sherry encased each planet in a plastic box. Instead, planets could be hung out of reach or roped off to keep curious hands away. Is this something that your students would enjoy? We guarantee it's an activity your students won't forget. ■

10 Ideas for Support and Publicity

Getting Administrator or Employer Support

Your Project ASTRO partnership will be far more likely to succeed if teachers have the support of school administrators, and astronomers have the support of their employers. We encourage you to take the time to develop the support and participation of your administrators and managers upfront and keep them informed as the visits progress.

At the School: Developing Administrator Support

Inform your principal and key administrators about Project ASTRO before you begin, and keep them informed with brief updates.

Request an initial commitment of 1-2 release days for planning and special projects (and get it in writing).

Introduce the astronomer to the principal.

Invite the principal and key administrators (superintendents, curriculum specialists) to visit your class during the astronomer's visits, or to attend star parties or special event.

Bring telescopes or do other astronomy-related activities at "back-to-school" nights. Your principal will be impressed by parents' interest in astronomy.

Seek positive public relations for your program in the community and among parents.

The Astronomer's Employer: Developing Support

Some astronomers who participate in Project ASTRO have flexible schedules or receive paid release time from their employer for school visits. Other astronomers make real sacrifices in order to visit classrooms by taking vacation days or working overtime later. The more support provided by the astronomer's employer, the more likely the partnership will be to continue. More and more, companies and institutions are recognizing the value of providing time for their staffs to do community service, but many companies still do not give time for employees to volunteer.

Project ASTRO can help provide some legitimacy to astronomers who need a few hours off to visit classrooms. Any way that the school can recognize and reward the astronomer's employer for providing time for the visits can be helpful. However, because company policies and protocols differ, teachers should be sure to talk with their astronomer before contacting his or her employer. Below are some steps you can take to develop employer support:

Notify your employer about Project ASTRO and try to get a commitment of release time for planning and visits in advance.

Enroll in your employer's volunteer program if there is one. The coordinator of the program will be impressed that you've arranged your own volunteer activity

Attend a School Board Meeting

In one Project ASTRO school, the astronomer helped develop administrator support by attending the local school board meeting with his partner teacher. Together, they borrowed a Starlab portable planetarium and invited school board members and administrators inside it for a tour of the night sky. One by one, the school board members crawled inside the inflatable dome and enjoyed a new astronomy experience. Afterwards, the astronomer made a statement to the board about Project ASTRO and the importance of supporting science education.

Put news about the good work the astronomer is doing in the company (or institution) newsletter or let the public information director know about your efforts.

Keep your employer informed about the highlights of your school visits.

Get the name of the astronomer's employer into any publicity releases about the project. Credit the company and its generosity in contributing time and resources to improve science education.

Teachers: Send appreciation letters on school letterhead to the astronomer's manager and to corporate officers (if appropriate).

Build on the initial support. If the company is supportive, could it donate equipment? Other resources? More staff? Or, help with publicity?

Getting Publicity

Getting publicity about your Project ASTRO activities is a great way to build support for the project and to involve the community. Positive publicity will enhance your community's awareness of astronomy, and the importance of science education. Publicity is also good for the school's standing in the community as well as for the astronomer's employer. And, getting publicity is always an exciting reward for students, teachers, and astronomers involved with your project. As you develop and carry out your Project ASTRO program, think about ways you can let others know what you're doing and generate positive PR.

Publicity Ideas: At School

Write about students' success in the school newspaper or parent newsletter.

Videotape Project ASTRO activities.

Take pictures and slides of your Project ASTRO program

Give a talk at professional teacher conferences.

Keep a class portfolio.

Do a display in the hall, cafeteria or library.

Publicity Ideas: In the Community

Send out press releases about your program to local papers, radio, and television stations. Think about the story you want the press to tell. Emphasize the astronomer's visits. Do this at least a week before a special event.

Call and write the reporters who cover education, science, and family issues in your local paper, radio, and TV. Send them personalized invitations and press releases about classroom visits or special events.

Contact your neighborhood newspapers or local cable channel.

Write an article for the astronomer's company newsletter, or teacher publications in your area.

Do a collaborative community project (with a science center, for example), and ask their PR department to help with publicity for your program.

Set up a booth (with student help) at a fair, expo, or other community event.

And please keep the national Project ASTRO office informed as well. ■

11 Special Events and Good Ideas

Star Party Ideas

While by no means required for a successful and rich partnership, an evening observing session, or "star party," is a fun and engaging addition to any Project ASTRO program where the expertise and equipment is available. Star parties can be done with naked eye observing, or with telescopes, as long as your site is reasonably dark enough (or can be darkened). Star parties give students the opportunity to put their observational skills to work, and to directly experience astronomy. Most students (not to mention their parents) have never looked through a telescope before, and they will enjoy learning to identify some of the constellations. Just getting students to look at and notice the sky can help them to expand their understanding and delight in astronomy.

As mentioned earlier, star parties are also great opportunities to involve families, the school, and the community. Astronomers (professional and amateur) often ask local astronomy clubs to help out so that there are enough telescopes. Some Project ASTRO star parties have drawn up to 300 people! Be sure you have enough assistance and telescopes if you are expecting a crowd (see the tips on finding an amateur club in Section 4).

Doing a Project ASTRO star party will require some advance planning. It's important to hold the star party at a convenient time in an accessible area, and to notify parents, the school, and all involved well in advance of the star party. In some cases, the school will be a good site for evening observing; in other cases, the school is not a good site due to inaccessibility or safety issues at night. If the star party is not held at school, transportation may be a problem. It's also very important to have a back-up plan—make an alternate date ahead of time in case of rain or clouds, or arrange another astronomy activity to do instead (such as a planetarium visit or an indoor hands-on project).

And remember, you can also do observing activities during the day. For example, students can observe the Moon and its phases, look at the Sun and sunspots through a safe solar filter, observe the position and colors of sunrise and sunset, and measure shadows.

Be Prepared for Your Star Party

Some Factors to Consider

Location of the star party: Where can you find an open site? Will it be at school? In a park? Outside a museum? Where is the most accessible site in your area?

Fun Star Party Ideas

Project ASTRO partners have come up with a range of ideas to make their star parties special and fun. Here are a few ideas you might want to try.

★ Do the star party as scavenger hunt. For example, ask student to find a red and a blue star, a planet, and a star cluster. Have students make star finders and tell them which objects to find before the star party.

★ Include food: Have a "star-b-que" around the campfire, a pizza party, or serve "spacy" food.

★ Have a meteor shower party. (Meteor showers come at the same time each year. Lists of the best ones can be found in many astronomy text or guide books.)

★ Do naked eye observing (a good set of guidelines for this can be found in *The Universe at Your Fingertips*).

★ Include indoors and outside astronomy activity stations along with the telescope observing.

★ Give students "ASTRO Boxes" containing activities or tasks to do during the star party. Have each student decorate a shoe or shirt box and take it to the star party. Place several activities inside (for example, have students create a constellation, count the number of stars they see, or record the phase of the moon). Students do the activities with a partner or family member dur ing the star party.

★ Camp out or have a sleep-over at the school.

★ Tell constellation myths from different cultures around a campfire. Have students create plays about the constellation myths and act them out for families or other students.

★ Hold the star party at a high school or community college. Invite older students to help.

★ Do several smaller parties throughout the year at school, or in front lawns around the neighborhood.

★ Take the students to a very dark site, away from city lights. For some students, this will be the first time they've seen real darkness.

Transportation for students and families: Will families be responsible for their own transportation? Can the school rent buses? Is public transportation available and safe? Are there any insurance issues?

Volunteers to help: Could a local amateur club help with the star party? Do any parents have telescopes and the skills to use them? Are additional parents or teachers needed to supervise students?

Permission from administrators or parents: Is permission needed from the principal? Who can authorize turning off the lights, if necessary?

Preparing the site: Will you need keys to get into the site at night? How do lights get turned off? Are there sprinklers that might go on in the middle of the star party? In most schools, the custodian will be your best ally before and during a star party.

Equipment: Will you use telescopes? Who can bring the telescopes? How should students be prepared to handle the telescopes? What rules should there be about the use of flashlights (flashlights covered with red cellophane are much less obtrusive that those that have bright beams of white light, which can ruin night vision).

Refreshments and other activities: Will you have food at the star party? What other activities can you link with the star party to make it a fun and meaningful experience? (See box)

Invitations: Will you invite other classes or the whole school to the star party? Should families attend? Should school administrators? What about calling the local paper or TV station in advance for some publicity.

Forming a School Astronomy Club

Many Project ASTRO partners have found that forming a school astronomy club is an effective way to involve students in learning science. Because the astronomy club is less structured, an astronomer may have more opportunities to explore working with students directly. The astronomy club can also give kids the chance to play an active role in deciding what they want to learn or explore. At the same time, because students join the astronomy club voluntarily, the club activities need to be fun and engaging. You will find that many of the activities and ideas contained in this manual and in *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook* can be very successfully adapted to a club setting.

How do you form an astronomy club? You need to decide in advance how many students you want in the club and how you will select them. In general, it is best to work with students who join voluntarily, rather than kids who were required to participate. The club will be easier to manage if you limit the size to 10-15 students. To select kids, you might open the club to specific grades, develop a lottery system, or require students to write an essay to join. Perhaps the club can be an extension of a classroom astronomy unit for interested students. Or, you may need to put up posters to publicize the club more widely and make it seem enticing. You will also need to decide when and how often the club will meet. Project ASTRO partners have formed astronomy clubs that meet before school, during lunch, and after school. And, finally, you need to decide how you will structure the club. Will the astronomer and teacher plan activities in advance, or will you involve students in deciding what they want to do in the club? Will the astronomer come to every meeting, or can the teacher handle some meetings alone?

In addition, you may need to talk with the school administration about finding a space, using equipment, and any funding needs. You may want to ask students to pay dues, although in many schools this could exclude some students. Alternatively, if funds are needed, you might approach the parent-teacher council, local businesses, or the astronomer's employer for some funding.

ASTRO Club at Carl Sundahl School

We used Project ASTRO activities in an after-school club, the "ASTRO Club," which meets every other Tuesday. Approximately 40 fourth through sixth graders are involved in the club. Students were invited to join based on teacher recommendation and an expressed interest in learning about astronomy. About half of the students are girls. At our school, students are already involved in a high number of after-school activities, but the ASTRO Club is a priority for most students and parents. I have taught an after-school math-science club for two years, but I had had little experience with astronomy until this year (which might be described as total immersion in astronomy!). Larry Brown, our partner astronomer, is an amateur who is extremely knowledgeable about the math and physics of astronomy. Larry loves working with the kids and getting to know them. The ASTRO Club has been a priority for him. Our club activities focused on a lunar eclipse, learning about light and color, preparing for a star party, and making a "human sundial" to be painted on our playground. Project ASTRO has provided a focus for our after-school club and a high level of interest has been generated in the school community over club activities. Next year, I want to create some new requirements for club participation, organize a parent booster group, incorporate more writing into activities, and give kids more recognition for being part of the club.

– *Gwen Guest, Project ASTRO Teacher*

Using Telecommunications and Astronomy Software

Telecommunications—particularly electronic mail and the World Wide Web—are tools you may want to use to enhance your partnership. For those teachers with access to electronic mail, this may be one way to make plans or keep in touch with your astronomer if he or she has easy access to the Internet. If your school or classroom does not currently have access to the Internet, some astronomers may be able to help you set up and use e-mail. If you have telecommunications in the classroom, you can have students communicate or share data with the astronomer via e-mail. Or, you might have students communicate with other students to share astronomy information or data. This does not, of course, replace in-person visits by your astronomer, but can add more interest and excitement to your astronomy unit.

The World Wide Web contains many astronomy-related sites and tools, in particular visual images and data (for example, you can access a map with current information about the temperature on Mars, or see the latest images from the Hubble Space Telescope). If the astronomer is familiar with the World Wide Web, he or she can help teachers learn how to access and navigate the Web. Science centers and school districts are getting increasingly involved with telecommunications and may provide workshops and assistance to teachers and astronomers interested in learning more about the Web. Both *Sky & Telescope* and *Astronomy* magazines have had articles about interesting astronomy web sites.

Telecommunications Tips

Below are some tips about using telecommunications in your Project ASTRO partnership.

(Teachers) Manage student questions: As a class select one or two questions to send the astronomer. Don't overwhelm the astronomer with questions from all students.

(Astronomers) Answer with a question: Rather than give complete or direct answers to students' questions, pose a new question or ask a "what if" question to extend students' thinking, or suggest an experiment or observation that students can do on their own.

(Teachers) Display the replies: Make hard copies of the astronomer's responses to give students something tangible to look at.

(Astronomers) If the class has access to the World Wide Web, point the students to a site where they can find information, rather than providing it yourself.

–Adapted from the Science Alliance Handbook

Astronomy Software

There is a range of astronomy software that can help students see how astronomers view the universe, review actual data and draw conclusions, understand the space program, or get a sense of scale and structure. You may want to integrate some computer activities into your Project ASTRO program. Astronomy software generally falls into one of several categories:

Planetarium software: graphic programs that display the sky from any place on any date at any time

Multimedia libraries: database programs

that store astronomy images and video clips, along with text information

Games and tutorials: programs that teach about astronomy through games, illustrated lectures, and on-line activities

Software tools: packages that allow students and teacher to use computers like scientists do—to explore new terrain and display large amounts of raw data in a usable form (e.g. image processing programs)

The Universe at Your Fingertips contains more information about specific astronomy software. However you integrate technology—whether through telecommunications or astronomy software—into your activities, consider how the use of technology can engage students in active, rather than passive, learning.

Conclusion

Teachers who care about giving students meaningful science experiences want and need expert support to convey the process and content of astronomy. Increasingly, amateur and professional astronomers recognize the importance of becoming resources to help schools and youth-serving organizations improve students' science literacy. Working together, teachers and astronomers can enhance the local curriculum and create new ways for students to learn about the science of astronomy.

As a Project ASTRO partner, you have the opportunity to make a real difference in your students' learning, as well as to affect how science is conveyed in schools and community organizations. At least one Project ASTRO volunteer has decided to change careers and become a teacher. Even if your involvement doesn't change your life that dramatically, we hope you will also be changed and enriched by participating in such a program. We applaud your efforts, large and small, and encourage you to make an ongoing commitment to bring students the wonders of astronomy. ■

How to Order *The Universe at Your Fingertips*

The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook, (edited by Andrew Fraknoi) is a comprehensive and ready-to-use collection of classroom activities, teaching ideas, and annotated resource lists. Developed through Project ASTRO, the notebook features more than 90 classroom-tested, hands-on activities for teaching many aspects of astronomy, and dozens of resource sheets listing readings, software, organizations and national projects for astronomy education. In addition, the notebook has useful articles on student learning, astronomy basics, and how to fit astronomy into the science curriculum at a variety of levels. While Project ASTRO focuses on grades 4-9, much of the material can easily be adapted to higher grades. The 813 pages are three-hole punched and ready to put into a binder.

The Universe at Your Fingertips is available through the nonprofit ASP catalog for $29.95 plus $6.00 postage and handling (California residents please add sales tax). **Send orders to Astronomical Society of the Pacific, 390 Ashton Avenue San Francisco, CA 94112 or call toll free 1-800-335-2624 to order.** (While you are ordering, ask for a free copy of the Society's illustrated catalog of educational materials on astronomy.) ■