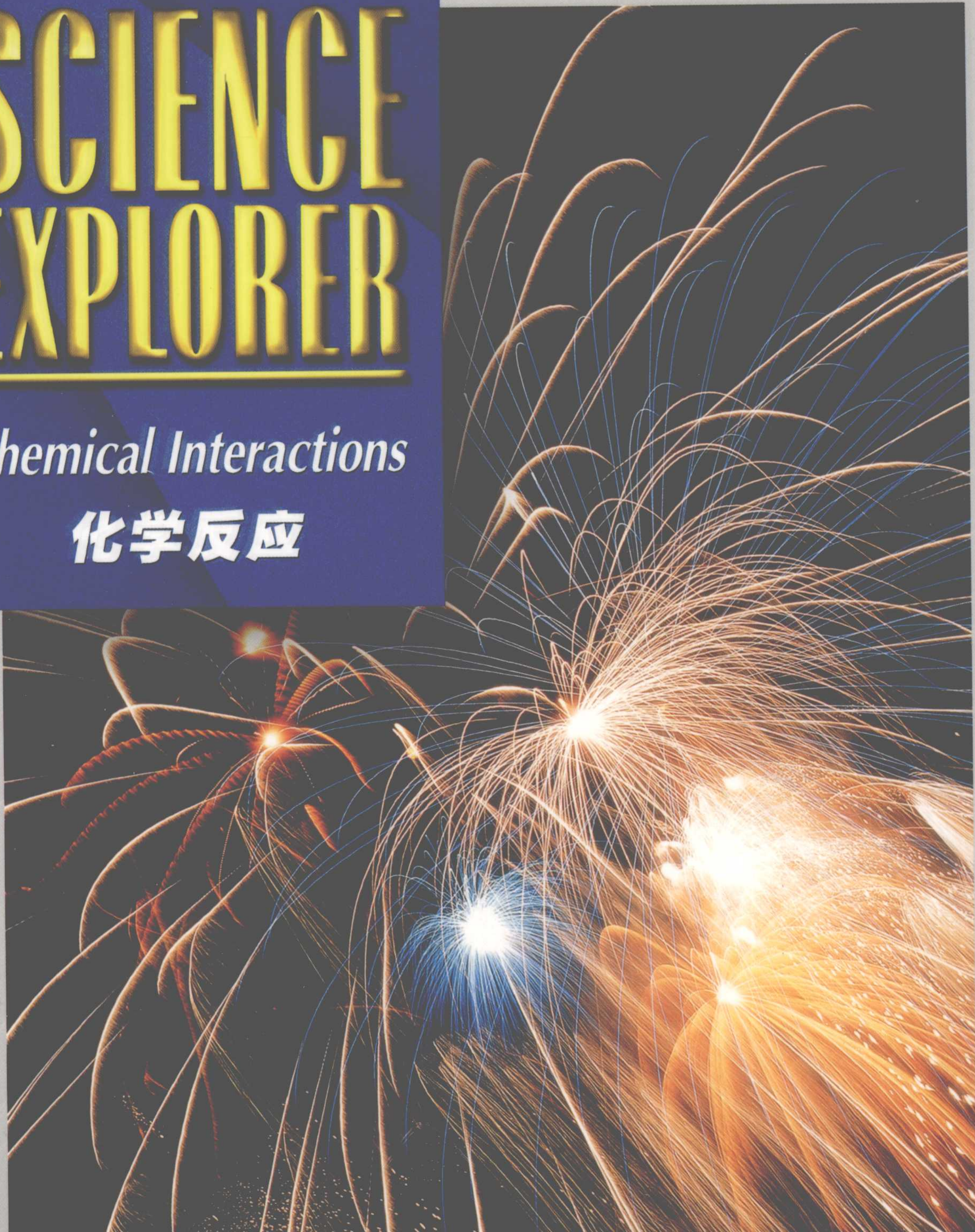
科学探索者

SCIENCE EXPLORER

Chemical Interactions

化学反应

英语版



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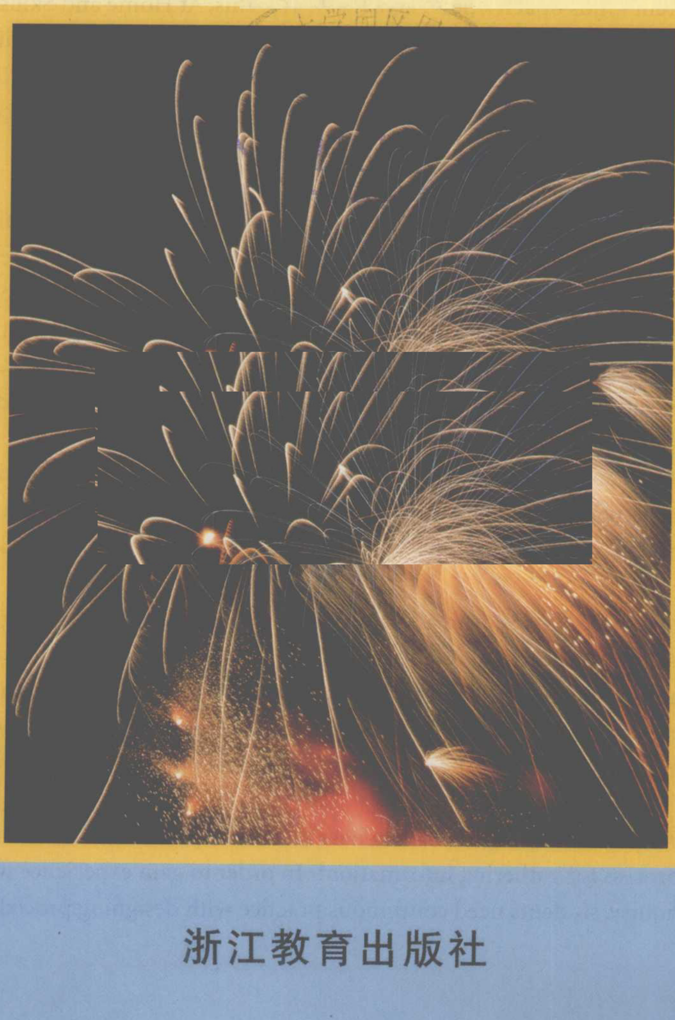
PRENTICE HALL

科学探索者

SCIENCE EXPLORER

Chemical Interactions

化学反应



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Preface to *Science Explorer*

Welcome to *Science Explorer.* As the program lead author, one which is used by more students than any other in the United States, I know you will find this text engaging and fascinating.

Every aspect of *Science Explorer* is designed to motivate students to think about the science they are learning. This is, by definition, an inquiry approach to teaching and learning science. Why is inquiry so important? In today's world, in which nations are both competing and cooperating with one another, individuals and nations will perform well are those who are able to think scientifically, to identify critical questions to study, to carry out complicated procedures to eliminate all possibilities except the one under study, to discuss, share and argue with colleagues, and to adjust what you know based on that social interaction. This is the precise focus of *Science Explorer.*

Science Explorer is designed around numerous hands-on activities that stimulate students to think like scientists. Different kinds of activities — Discover, Try This, At Home and Skills Activities — involve students in relatively short term investigations that focus on individual inquiry skills like inferring, graphing and classifying. Other activities — Labs, Chapter Projects, and Tech and Design — allow students to do inquiry in greater depth and for greater periods of time. This combination of ways to approach inquiry is just what is envisioned by many international reports.

The text in *Science Explorer* is designed to engage students intellectually. It is animated and focused on teaching important content. All of the text has undergone the most detailed of reviews to ensure accuracy and suitability for students. Graphics of various sorts are an integral part of the program because they actively invite students to engage with the text by asking questions that require thoughtful analysis. I invite you to select a section randomly from any of the books and read it. I know you will be struck by the captivating writing style and the way that it reaches out to grab students' interest.

Since inquiry is such an important aspect of the program, let me share some quick questions that I used when designing activities for *Science Explorer.* I think you will find them useful when you are teaching the program. To make sure you are getting students involved in inquiry, ask yourself:

1. *Who asks the question?* That is, who asks the question that focuses the investigation (e.g., "What effect does the tilt of the earth have on seasons?" or "What effect does pH have on litmus paper?" or "Which antacid best neutralizes acid?")? Is it the student, the teacher or the book? In most curricula, these are an element given in the materials. However, as a teacher you need to plan activities that, at least on a periodic basis, allow students to pursue their own questions.

2. *Who designs the procedures?* I am speaking here of activity procedures for an investigation. Who designs this process for gathering information? In order to gain experience with the logic underlying inquiry, students need continuous practice with designing procedures. Some labs,

where the primary target is content acquisition, designate procedures. But others should ask students to do so.

3. *Who decides what data to collect?* Here, the focus is on the data itself. What data is important and who determines that? To answer this question, students must have a deep understanding of what they are trying to accomplish.

4. *Who formulates explanations based upon the data?* Do the text materials or the teacher give the answers? Or do questions posed at the end of activities make students think about what they are doing and then analyze and draw conclusions based on their data? The bottom line — are you and the curriculum making students think?

5. *Who communicates and justifies the results?* Do activities push students not only to communicate, but to justify their answers? Are activities thoughtfully designed and interesting so that students want to share their results and argue about conclusions?

6. *What kind of classroom climate is set up so that students can wrestle with the difficult questions posed during a good inquiry?* Setting up an intellectually positive climate that stimulates students to think is the responsibility of the teacher. Do students know that they are expected to think and grapple with data? Or is there a sense among them that they will pretend to learn if the teacher pretends to teach?

I think you will find that *Science Explorer* promotes good results related to all six of these questions. I know your students will enjoy the program; I am also confident that you will learn to be a better science teacher with the program.

Michael Padilla
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培养创新能力的好书

朱清时

(中国科学技术大学校长　中国科学院院士)

20世纪是人类历史上知识“大爆炸”的时代。例如，在这个世纪之初，人类对“光合作用”的了解，只限于叶绿素利用太阳能使二氧化碳与水反应生成碳水化合物和氧气这个概念，在这个世纪之末，我们已经厘清了光合作用所包含的大量复杂的化学反应，以及促进这些反应的各种酶，还发现了大部分的酶是如何与遗传基因相互对应的。要把现代关于光合作用的知识叙述一遍，需要写一本数百页的厚书。由此可见，人类关于光合作用的知识量在这一百年中增加了千倍以上。其实，科学技术的各个领域也都是如此。

积累的知识越多，人类文明越发达；然而，为了到达知识的前沿，学习的负担也就越重。传统的教学方法是以知识传授为主，追求知识的连贯、系统和完整，因此不得不以老师为中心，因为只有老师知道怎样的知识是完整、连贯和系统的。这样一来就容易变成填鸭式的灌输式教育，使学生对自然科学的兴趣、爱好以及他的创新能力都得不到发展。这样的教育不能满足人类社会发展的要求。

自20世纪中叶开始，一些科技发达的国家普遍进行了教学改革，摸索出了新的把培养学生的兴趣、爱好以及创新能力放在首位的教学方法。美国培生教育集团公司出版的《科学探索者》系列教材，就是这种创新能力教学的杰出代表。这套系列教材是针对21世纪人才培养计划编写的，已被美国和其他二十多个科技发达国家的学校广泛采用。它不仅涵盖自然科学各个领域的知识，而且以新的观念和方法训练读者的创新能力。读者在阅读它时，会被它引导着像科学家那样思考、做观察和做实验。这套系列教材既有科学性，又有趣味性和操作性，不仅适用于新课标的课堂辅助教学，也是一套极佳的科普读物。

几年前，浙江教育出版社与培生教育集团公司合作推出了《科学探索者》系列教材的中文版，非常受欢迎。现在他们又推出英文版，使读者不仅可以原汁原味地阅读它，还可以在学习科学的同时练习英文。希望英文版《科学探索者》系列教材与中文版一样广受喜爱科学的学子们的欢迎。

以上是为序。

双语教学的一种宝贵教学资源

张志远

(全国双语教学研究会会长　中央教育科学研究所教授)

Science Explorer(《科学探索者》)是根据美国《国家科学教育标准》为美国中学生编写的科学教材。这套丛书不仅内容丰富、图文并茂，而且在引领学生探究、启迪学生心智方面也有独到之处。因此，这套语言地道、通俗易懂的英文科学教材，为我国中学汉英双语教育实验提供了丰富的教育资源。

1985年，美国制订了《2061计划》，对中小学学生的科学素养教育提出了一系列建议。在此基础上，1996年制订的《国家科学教育标准》提出了“学生是研究者，学生似科学家”的理念。这个标准对许多国家的科学教育标准的制订产生了巨大的影响。

从《科学探索者》的编写思路和内容，我们可以看出，它与我国《初中科学课程标准》颇有相通之处。该丛书倡导探究性学习，要求学生像科学家那样思考、观察和实验，把重点放在培养科学探索的兴趣、方法和能力上。丛书内容的综合性、跨学科性和方法的科学性无疑为我国中学科学教育提供了极好的教学资源。

总之，丛书的撰写既保持了科学作品的严密性，又兼顾了面向中学生的普及性。除特定的科学术语外，所使用的词汇都是常用词汇，对于英语作为外语学习的学生来说不难接受。此外，丛书所选素材虽以美国为主，但也体现了跨文化的包容性，注意吸纳其他国家和民族的科学财富，凝聚了人类智慧的结晶，如书中关于秦始皇统一度量衡对人类发展的影响和中国养蚕业“蚕花娘娘”的传说，都无形中增添了几分人文色彩与和谐温馨的氛围，读者定会为之吸引，为之倾心。

有鉴于此，该套丛书不失为我国中学双语教学的宝贵资源。

PRENTICE HALL SCIENCE EXPLORER

Chemical Interactions

Program Resources

Student Edition
Annotated Teacher's Edition
Teaching Resources Book with Color Transparencies
Chemical Interactions Materials Kits

Program Components

Integrated Science Laboratory Manual
Integrated Science Laboratory Manual, Teacher's Edition
Inquiry Skills Activity Book
Student-Centered Science Activity Books
Program Planning Guide
Guided Reading English Audiotapes
Guided Reading Spanish Audiotapes and Summaries
Product Testing Activities by Consumer Reports™
Event-Based Science Series (NSF funded)
Prentice Hall Interdisciplinary Explorations
Cobblestone, Odyssey, Calliope, and *Faces* Magazines

Media/Technology

Science Explorer Interactive Student Tutorial CD-ROMs
Odyssey of Discovery CD-ROMs
Resource Pro® (Teaching Resources on CD-ROM)
Assessment Resources CD-ROM with Dial-A-Test®
Internet site at www. science-explorer. phschool. com
Life, Earth, and Physical Science Videodiscs
Life, Earth, and Physical Science Videotapes

Science Explorer Student Editions

From Bacteria to Plants
Animals
Cells and Heredity
Human Biology and Health
Environmental Science
Inside Earth
Earth's Changing Surface
Earth's Waters
Weather and Climate
Astronomy
Chemical Building Blocks
Chemical Interactions
Motion, Forces, and Energy
Electricity and Magnetism
Sound and Light
The Nature of Science and Technology

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Cover: The chemical reactions of fireworks fill a night sky with color and beauty.

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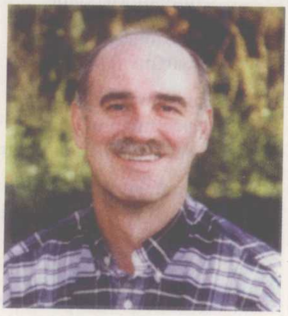

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Michael Padilla is a leader in middle school science education. He has served as an editor and elected officer for the National Science Teachers Association. He has been principal investigator of several National Science Foundation and Eisenhower grants and served as a writer of the National Science Education Standards.

As lead author of *Science Explorer*, Mike has inspired the team in developing a program that meets the needs of middle grades students, promotes science inquiry, and is aligned with the National Science Education Standards.

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Science Explorer was created in collaboration with the College of Engineering at Tufts University. Tufts has an extensive engineering outreach program that uses engineering design and construction to excite and motivate students and teachers in science and technology education.

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PRENTICE HALL SCIENCE EXPLORER

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Chemical Interactions

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In-depth practice of inquiry skills

Real-World Lab

Everyday application of science concepts

Interdisciplinary Activities

Science and History

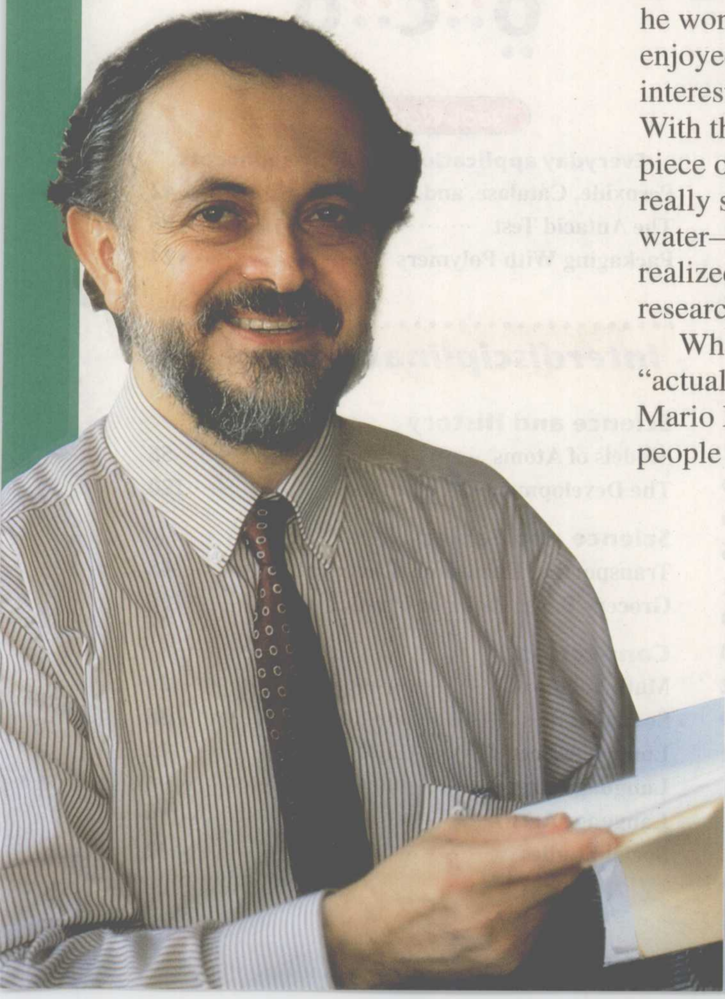
Science and Society

Connection

SAVING THE OZONE LAYER

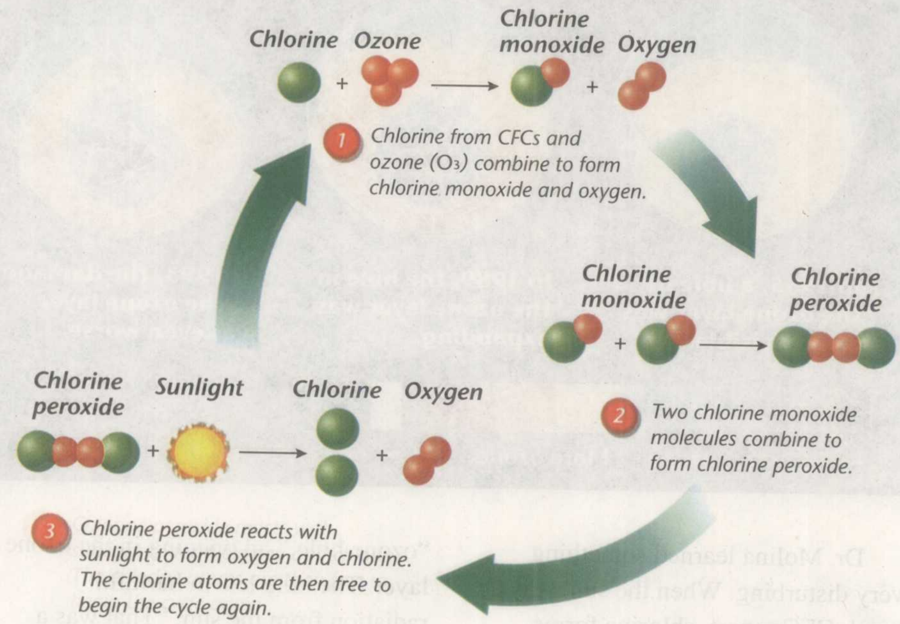
As a child growing up in Mexico, long before he won a Nobel Prize in chemistry, Mario Molina enjoyed playing with science. "I was always interested in chemistry sets or toy microscopes. With the microscope in front of me, I'd take a piece of lettuce, put it in water, and let it rot and really stink. To see the life teeming in a drop of water—that for me was fascinating. Even then I realized it would be great if I could become a research scientist."

What Mario wanted to do, he decided, was "actually use science for things that affect society." Mario Molina began by looking at the chemicals people put into the air.



Dr. Mario Molina Born in Mexico City, chemist Mario Molina is now a Professor of Earth, Atmospheric, and Planetary Sciences at the Massachusetts Institute of Technology in Cambridge, Massachusetts. In 1995, Professor Molina, Sherwood Rowland, and Paul Crutzen won the Nobel Prize in Chemistry for their work on CFCs and the ozone layer.

Cycle of Ozone Destruction



Asking Simple Questions

In the early 1970s, one of Dr. Molina's co-workers, Sherwood Rowland, heard about a group of compounds called chlorofluorocarbons, or CFCs. CFCs were used in air conditioners, refrigerators, and aerosol spray cans, but leaked into the air. "It is something that is not natural, but is now in the atmosphere all over the planet." What happens to these compounds in the air, Rowland and Molina wondered, and what do they do to the air?

"We didn't know ahead of time if CFCs were doing damage or not," Dr. Molina explains. "So what we did was study what was going on. We learned that CFCs aren't changed much down near Earth. But we expected that if they got high enough in the atmosphere, solar radiation would destroy them."

Radiation is how energy from the sun reaches Earth. Ultraviolet (UV) rays, a form of radiation, break compounds apart and change them. "Above a certain altitude, everything falls apart. We had to learn how high CFCs went and how long it took them to get there. Then we asked: What does it mean that CFCs are up there?"

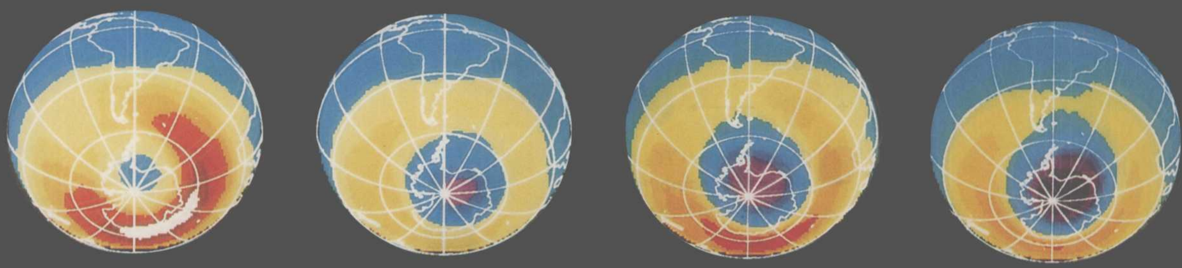
A Protective Shield in the Sky

In his laboratory, Dr. Molina studied how ultraviolet light changes CFCs. "It became clear that these molecules would be destroyed by UV rays in the stratosphere—the upper atmosphere, where the ozone layer is. At the time, I didn't even know what the ozone layer was."

But Mario Molina learned fast. The ozone layer is a thin layer of the atmosphere that contains ozone, a form of oxygen. The ozone blocks out UV rays from the sun. UV rays would be dangerous to living things if they reached Earth's surface.

In a 1987 international treaty, the United States and other industrial nations agreed to reduce the use of CFCs in spray cans and other products.

Changes in the ozone layer over Antarctica, 1979 to 1993



In 1979, thinning of the ozone layer was visible in satellite images.

In 1985, a hole in the ozone layer was clearly visible.

In 1989, the hole in the ozone layer was expanding.

In 1993, the damage to the ozone layer was even worse.

These images of the South Pole, taken by satellite between 1979 and 1993, show a hole developing in the ozone layer of the atmosphere. The changing size and color of the image over the pole represent how quickly the hole increased.

Dr. Molina learned something very disturbing. When the sun's rays break CFCs apart, chlorine forms. A chain of chemical changes that destroys ozone then begins. "Very small amounts of CFCs can have very big effects on ozone."

A Scary Prediction Comes True

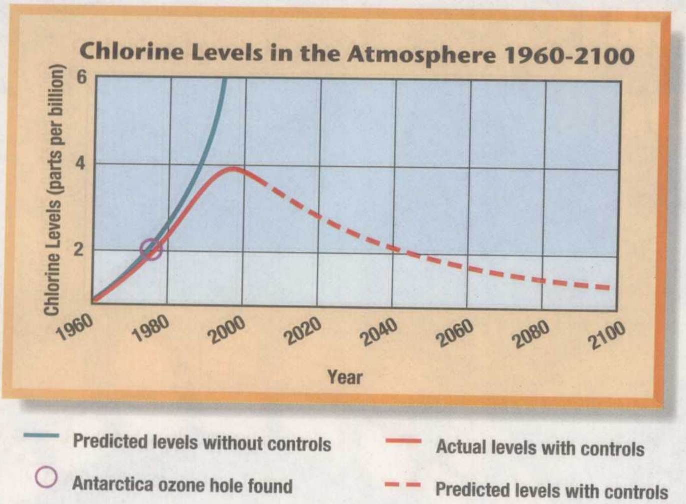
Mario Molina and his co-workers made a frightening prediction. If CFCs can reach the stratosphere, they will eventually damage the protective ozone layer. Other scientists thought Mario Molina was wrong or exaggerating. But more and more evidence came in. Researchers sent balloons up into the stratosphere with scientific instruments to measure chlorine formed by CFCs. They found that CFCs were in the stratosphere and that the sun's rays were breaking them down.

Was the ozone layer being hurt? Yes. Over Antarctica, there was an "ozone hole," an opening in the ozone layer. The hole lets in harmful radiation from the sun. "That was a surprise to us and to everybody. It was a very large effect that we hadn't predicted. Some scientists thought the ozone hole was natural, but we thought it was caused by CFCs. We checked it out by doing experiments from Antarctica. In a couple of years it became very clear that this hole was a result of the CFCs."

Scientist and Speaker

Dr. Molina now had to convince people to stop making and using CFCs. "We were lucky that the effect

Shown here is the ER-2 aircraft, which was used to measure gases in the ozone hole over Antarctica. ▶



The graph shows that the level of chlorine in the atmosphere would have increased rapidly if controls on CFCs had not been passed. With controls in place, the amount of chlorine in the atmosphere should gradually decrease to levels in the light blue region of the graph. The ozone hole should then close.

over Antarctica was so large. That made it easy to measure and test. But similar effects exist everywhere. As scientists we had to inform the public and the government. If you're convinced that you're right and that something dangerous is going to happen, you need to risk speaking out."

Mario Molina went to the U.S. Senate and to other governments. He was able to show how UV radiation was causing damage. "There was damage to some crops, damage to growing fish, damage that we can already see and measure today."

Finally, the world listened. Through the United Nations, an agreement was signed by most industrial nations to stop using CFCs by the year 2000.

Work Still to Do

"Everybody has to work together," chemist Molina says. He has done more than his share. He gave $200,000 of his Nobel Prize money to help train scientists from Latin America and other developing countries. "There is a need to understand our planet, and we need very good minds to work on these problems. There are big challenges out there," he says with a confident smile, "but fortunately science is fascinating."

In Your Journal

Mario Molina particularly wants to know how chemicals made by people get into the atmosphere and change it. Take a walk in your neighborhood. Make a list of ways you can observe—or think of—that people put chemicals into the air. Remember that smoke is a mixture of chemicals.