An Open Letter to Congress on Near Earth Objects

July 8, 2003

United States Senate

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Hon. Chris Cox, Chair
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Re: The Imperative to Address the Impact Threat From Near Earth Objects (NEOs)

Dear Members of Congress:

We write to you today as concerned citizens, convinced that the time has come for our nation to address comprehensively the impact threat from asteroids and comets. A growing body of scientific evidence shows that some of these celestial bodies, also known as Near Earth Objects (NEOs), pose a potentially devastating threat of collision with Earth, capable of causing widespread destruction and loss of life. The largest such impacts can not only threaten the survival of our nation, but even that of civilization itself.

Although we are genuinely concerned about the NEO threat, none of us is an alarmist. We know of no Near Earth Object currently on a collision course with Earth, but science's limited knowledge of the NEO population cannot rule out that possibility. Based on current information, a *crisis* response to these potential threats is not warranted. That being said, however, based upon evidence of past impacts and recent asteroid observations as well as the possible consequences from just one relatively "small" NEO impact, "business as usual" regarding this threat is simply no longer a responsible or sensible course of action.

Studies indicate that, with the commitment of modest resources, NEO impacts can likely be predicted and, with adequate warning, steps taken to prevent them. Thanks to scientific advances and increased awareness, we now have a historic opportunity to deal comprehensively and effectively with the NEO threat. Doing so, however, will require determined and coordinated action by Congress, the Executive Branch, and the private sector to direct effective use of our nation's substantial scientific and technological capability.

U.S. and international academic conferences, as well as Congressional hearings, have served to illuminate some aspects of the NEO impact hazard. Here, we build upon this background and outline a recommended course of action for Congress.

To address this potential threat, we strongly urge that each of you take steps within your respective committee jurisdictions to implement immediately the following recommendations (each is discussed in more detail in the enclosure):

1. **NEO Detection:** Expand and enhance this nation's capability to detect and to determine the orbits and physical characteristics of NEOs.

2. **NEO Exploration:** Expand robotic exploration of asteroids and Earth-approaching comets. Obtain crucial follow up information on NEOs (required to develop an effective deflection capability) by directing that U.S. astronauts again leave low-Earth orbit . . . this time to protect life on Earth.

3. **NEO Contingency and Response Planning:** Initiate comprehensive contingency and response planning for deflecting any NEO found to pose a potential threat to Earth. In parallel, plan to meet the disaster relief needs created by an impending or actual NEO impact. U.S. government/private sector planning should invite international cooperation in addressing the problems of NEO detection, potential hazards and actual impacts.

Overview of Confirmed NEO Impacts and Recently Detected NEOs

Sixty-five million years ago, a trillion-ton comet or asteroid only about six miles across struck what is now Chicxulub on Mexico's Yucatan Peninsula. That impact resulted in the extinction of at least 75% of Earth's species, including the dinosaurs.

Thirty-five million years ago, a comet or asteroid only approximately 3 miles in diameter struck Earth in Chesapeake Bay, about 120 miles southeast of Washington, D.C. That impact created a crater some 50 miles wide, changed the courses of many modern rivers and caused changes in ground-water aquifers that are still evident today.

Fifty thousand years ago, an asteroid just 150 feet in diameter, weighing approximately 300,000 tons, and traveling at 40,000 miles per hour struck Earth in what is today Arizona. Today, the crater from that impact, even after weathering, is still nearly a mile wide and 570 feet deep.

About a hundred years ago, on June 30, 1908, an object from space appeared in the morning sky over western China. It plunged through the atmosphere, glowing at a temperature of over 5,000 degrees F. Streaking over central Russia, the object's passage produced a deafening roar, preceded by a supersonic blast wave that leveled trees and houses in its path. As reported in the newspaper *Sibir,* this impact occurred "early in the ninth hour of the morning." Near the Stony Tunguska River, the object exploded in mid-air with an energy greater than a 10-megaton nuclear blast. The explosion devastated a region some 40 miles across, two-thirds the size of Rhode Island. Only a few people were killed in this sparsely populated region, but the story would have been very different if the object had hit a few hours later over Europe instead of the Siberian forest. The death toll in major cities such as St. Petersburg, Helsinki, Stockholm or Oslo might have reached 500,000.

In 1947, also in Russia, in the Sikhote-Alin Mountains, northeast of Vladivostok, a small meteor traveling at 31,000 miles per hour struck Earth's atmosphere, creating a fireball witnesses said was brighter than the sun. One of the fragments left an impact crater 85 feet across and 20 feet deep.

In 1994, the world witnessed the devastating effects that a large NEO impact could inflict on Earth. Astronomers who had observed the breakup of comet Shoemaker-Levy 9 then tracked its headlong crash into Jupiter, where it generated an explosion with an energy equivalent to a billion megatons of TNT. The resulting dust cloud in Jupiter's atmosphere swelled larger than our own Earth; a similar impact here would have destroyed our civilization and devastated life on this planet. Shoemaker-Levy 9 *was discovered just sixteen months before it hit Jupiter*, and its spectacular demise was a shot across our bow... a reminder that comets also can strike Earth. Comets, though less frequent visitors to Earth's vicinity than asteroids, strike with much greater kinetic energy, and comprise a small but significant part of the impact threat to Earth.

On January 7, 2002, the asteroid 2001 YB5 missed our planet by a little more than twice the distance to the Moon. If this 300-yard-wide, stadium-sized object, discovered *only 12 days before* its closest approach, had hit the Earth's continental landmasses, it would have destroyed nearly everyone and everything in an area about the size of New England. An ocean impact would also have spawned huge tsunamis, with the potential for damage to coastal areas beyond anything in historical experience.

The modest search efforts sponsored by the National Aeronautics and Space Administration (NASA) and the Department of Defense have detected a steady stream of close encounters. **On June 14, 2002,** asteroid 2002 MN, an object about 100 yards in diameter, passed within just 75,000 miles of Earth at a speed of over 23,000 miles per hour. 2002 MN was detected by astronomers at the Lincoln Near Earth Asteroid Research (LINEAR) search facility in New Mexico *three days after* its closest approach to Earth. Had this object struck Earth, it would have exploded with energy about equal to that of the 1908 Siberian impact near Tunguska.

On July 5, 2002, the LINEAR astronomers discovered another object, designated 2002 NT7, estimated to be over a mile in diameter. And in **November 2002,** astronomers discovered 2002 VU94, an NEO estimated to be over two miles across. While both objects pose no danger to Earth in the coming centuries, their recent discovery and large size emphasize the fact that many large NEOs *remain undiscovered.*

Scientists have realized for some time that Earth travels amid a "sea" of similar objects, large and small. NASA stated last year in Congressional testimony that we have detected only a little more than half of all NEOs larger than a kilometer in diameter. Prudence dictates that more be done to identify NEOs, and to obtain the scientific information necessary to divert any sizable NEO found to be on a collision course with Earth.

The NEO Threat

The latest NEO close approaches are typical of the two dozen such encounters known to have occurred in the 20th Century. These are only a small fraction of the actual number that have occurred; most have gone completely *undetected.* Such approaches are commonplace in our part of the solar system. The late planetary geologist Eugene Shoemaker put it succinctly: "Earth exists in an asteroid swarm."

We know that since 1937, at least 22 asteroids have approached Earth more closely than did 2001 YB5, which missed by just twice the distance to the Moon. Five of those objects were larger than 100 yards in diameter. According to NASA, there may be as many as 100,000 NEOs with diameters of 100 yards or larger. Of those asteroids larger than 150 yards in diameter, about 250 are today *estimated* to be potentially hazardous. The United States has very *limited capability* to detect these smaller NEOs, which can nevertheless inflict substantial damage upon striking Earth. There is a significant probability (20%) of such an object colliding with the Earth during the next century.

Although the annual probability of a large NEO impact on Earth is relatively small, the results of such a collision would be catastrophic. The physics of Earth's surface and atmosphere impose natural upper limits on the destructive capacity of natural disasters, such as earthquakes, landslides, and storms. By contrast, the energy released by an NEO impact is limited only by the object's mass and velocity. Given our understanding of the devastating consequences to our planet and its people from such an event, (as well as the smaller-scale but still-damaging effects from smaller NEO impacts), our nation should act comprehensively and aggressively to address this threat. America's efforts to predict, and then to avoid or mitigate such a threat, should be at least commensurate with our national efforts to deal with more familiar terrestrial hazards.

If space research has taught us anything, it is the certainty that an asteroid or comet **will** hit Earth again. Impacts are common events in Earth's history: scientists have found more than 150 large impact craters on our planet's surface. Were it not for Earth's oceans and geological forces such as erosion and plate tectonics, the planet's impact scars would be as plain as those visible on the Moon.

Potential Misinterpretation of NEO Impacts

Even small NEO impacts in the atmosphere, on the surface, or at sea create explosions that could exacerbate existing political tensions and escalate into major international confrontations. For example, an atmospheric impact in 2002 produced a large, highly visible burst of light in the sky during the height of war tensions between nuclear-armed countries India and Pakistan. That high-altitude explosion happened to occur over the Mediterranean, just a few thousand miles from their disputed border region. Had that NEO impact occurred less than three hours earlier, it would have detonated over southern Asia, where its misinterpretation as a surprise attack could have triggered a deadly nuclear exchange. With military and diplomatic tensions at their peak in other areas of conflict in the world, the potential for a mistake is even greater today.

Conclusion

For the first time in human history, we have the potential to protect ourselves from a catastrophe of truly cosmic proportions. All of us remember vividly the effect on our nation of terrorist strikes using subsonic aircraft turned into flying bombs: thousands of our citizens dead, and our economy badly shaken. Consider the ramifications of an impact from a relatively small NEO: more than a million times more massive than an aircraft, and traveling at more than thirty times the speed of sound. If such an object were to strike a city like New York, millions would die. In addition to the staggering loss of life, the effects on the national and global economy would be devastating. Recovery would take decades.

We cannot rely on statistics alone to protect us from catastrophe; such a strategy is like refusing to buy fire insurance because blazes are infrequent. Our country simply cannot afford to wait for the first modern occurrence of a devastating NEO impact before taking steps to adequately address this threat.

We may not have the luxury of a second chance, for time is not necessarily on our side. **If we do not act now, and we subsequently learn too late of an impending collision against which we cannot defend, it will not matter who should have moved to prevent the catastrophe . . . only that they failed to do so when they had the opportunity to prevent it.**

Our nation, our families, and others around the globe deserve our best efforts to protect against the NEO impact threat. We urge the Congress to call on this nation's ready supply of talents and energies to responsibly address this threat. Our international partners also should be called upon to help meet this challenge, but the United States has a compelling responsibility to lead the way. Preventing an NEO impact is a vital mission for our nation's space program and for the American people. For the first time since Apollo, our astronauts should once again leave low-Earth orbit and journey into deep space, this time to protect life on our home planet.

We strongly recommend your prompt attention and *action* to address this too-long-ignored threat to the security of America and to the world. The accompanying recommendations are prudent and concrete steps each of you can now take to safeguard our nation. Your timely and effective response can protect the people of the United States and the world from the real threat posed by Near Earth Objects.

Sincerely,

Dr. Harrison H. Schmitt
Former Astronaut, U.S. Senator
Planetary Geologist

Dr. Carolyn S. Shoemaker
Lowell Observatory

David H. Levy
Jarnac Observatory, Inc.

Dr. John Lewis
Professor of Planetary Sciences
University of Arizona

Dr. Neil D. Tyson
Director, Hayden Planetarium
New York, New York

Dr. Freeman Dyson
Professor Emeritus, Institute
for Advanced Studies
Princeton University

Dr. Richard P. Hallion
Aerospace Historian

Dr. Thomas D. Jones
Former Space Shuttle Astronaut
Missions STS-59, 68, 80 & 98

Bruce Joel Rubin
Screenwriter

Dr. Lucy Ann McFadden
Planetary Scientist
University of Maryland

Erik C. Jones
Amateur Astronomer

Marc Schlather
President, ProSpace

William E. Burrows
Author, NYU Professor
and Space Historian

Enclosure: NEO Detection, Impact Prevention and Mitigation Recommendations

cc: President George W. Bush
Vice President Richard B. Cheney
Hon. Kofi Annan, Secretary General, The United Nations
Hon. Colin L. Powell, Secretary of State
Hon. Donald H. Rumsfeld, Secretary of Defense
Hon. Tom Ridge, Secretary of Homeland Security
Hon. Sean O'Keefe, Administrator, NASA

United States Senate:

Jim Morhard, Staff Director, **Appropriations Committee**
Terrence Sauvain, Minority Staff Director
Jeanne Bumpus, Staff Director, **Commerce, Science and Trans. Committee**
Kevin Kayes, Minority Staff Director
Floyd DesChamps, Maj. Sr. Staff Mem., **Science, Technology and Space Subcommittee**
Jean Toal Eisen, Minority Staff Director
Judy Ansley, Staff Director, **Armed Services Committee**
Richard DeBobes, Minority Staff Director
Ken Myers, Staff Director, **Foreign Relations Committee**
Antony Blinken, Minority Staff Director
Michael Bopp, Staff Director, **Governmental Affairs Committee**
Joyce Rechtschaffen, Minority Staff Director

U. S. House of Representatives:

James Dyer, Staff Director, **Appropriations Committee**
Scott Lilly, Minority Staff Director
David Goldston, Chief of Staff, **Science Committee**
Robert Palmer, Minority Staff Director
Bill Adkins, Staff Director, **Space and Aeronautics Subcommittee**
Richard Obermann, Minority Professional Staff Member
Robert Rangel, Staff Director, **Armed Services Committee**
Jim Schweiter, Minority Staff Director
Tom Mooney, **International Relations Committee**
Robert King, Minority Staff Director
Uttam Dhillon, Staff Director, **Select Committee on Homeland Security**
Steve Cash, Minority Staff Director
National Academy of Sciences
National Academy of Engineering
American Institute of Aeronautics and Astronautics
American Astronomical Society (Division for Planetary Sciences)
Association of Space Explorers
American Geophysical Union
Defense Advanced Research Projects Agency
Minor Planet Center
National Space Science and Technology Institute
The B612 Foundation
The National Space Society
The Planetary Society
Space Foundation
Space Frontier Foundation
Smithsonian Institution

Point of Contact: To respond to this letter, request additional information about it or contact signatories, please refer to www.CongressNEOaction.org or call or fax Dr. T. D. Jones at tel. no. (703) 242-9256 or fax no. (703) 242-8935]

NEO Detection, Impact Prevention and Mitigation Recommendations

After assessing the nature and scope of the NEO impact threat, and in consultation with many leading authorities on space issues, we are recommending three steps to deal with the problem. The first will increase our nation's ability to detect an NEO impact in time, the second will lay the groundwork for deflecting such an object, and the third will help mitigate the consequences of an actual NEO impact. Such steps would entail a relatively modest commitment of resources, an investment warranted by the potential consequences of misjudging the NEO impact threat to Earth.

Recommendation #1:
Immediately Increase the Scope of and Funding for NEO Detection

The United States is currently engaged in a search for all NEOs greater than 0.62 miles (a kilometer) in diameter. The effort is producing results, but only a few dozen researchers are funded to conduct this basic survey. Resources committed to this work have been very modest and not commensurate with the potential threat; thus, additional investment in search programs is both appropriate and prudent. A dramatic improvement in the rate at which asteroids and comets are discovered would likely result if the United States were to increase the current level of funding, now at about $3.5 million per year, to at least $20 million annually.

We recommend that Congress take the following measures to enhance the search for NEOs:

- **Increase search activities for detection of NEOs 0.62 miles (1 kilometer) in diameter and larger.** Researchers estimate that only one-half of such NEOs have been located. The pace of identification should be accelerated. Support for Southern Hemisphere search activities may further increase the discovery rate and should be expanded. Even when NASA achieves its current goal of identifying 90% of large NEOs, the undiscovered remainder will, of course, still pose a potential hazard. Congress should direct NASA to pursue the search for all such objects to statistical completion.

- **Expand the search effort to include detection and tracking of NEOs smaller than 0.62 miles (1 kilometer).** NEOs such as 2002 MN (about a hundred yards across) are not currently the target of any formal search program. Rather, they are discovered as by-products of the search for larger objects. Because an impact of even a relatively small NEO could still destroy a major city, the United States should establish the goal of predicting any close approach to Earth by any asteroid larger than 200 yards in diameter.

- **Increase funding for the Minor Planet Center (MPC) to $1 million annually.** The MPC is responsible for the collection, computation and dissemination of the characteristics and orbits of asteroids and comets. As the central international clearinghouse for tracking NEOs, it should be funded at a level more commensurate with its important role in understanding and addressing the NEO threat.

- **Provide funding for more and better instrumentation and additional follow-up observations.** In addition to maintaining existing optical and radar search programs, NASA should be given the added resources and mandate to enhance the instrumentation dedicated to NEO detection and to respond to NEO discoveries with more detailed

observations. Such radar and spectroscopic observations are vital to refine asteroid orbits and determine an NEO's general composition.

Recommendation #2:
Expand Current NEO Exploration Programs

Given the real probability of an asteroid or comet impact, our nation must understand NEO characteristics well enough to develop practical methods to deflect them. Without adequate knowledge of the composition and mechanical properties of such objects, developing diversion strategies will be problematic at best and fatally ineffective at worst.

Therefore, we recommend that the United States take the following action:

- **Mount additional near-term robotic missions to selected asteroids and Earth-approaching comets.** By visiting NEOs in our own "neighborhood," we can determine their composition, measure their structural and mechanical properties, and provide the knowledge essential to preventing impacts on Earth by similar objects.

- **Begin planning now to send explorers to nearby asteroids and Earth-approaching comets.** Developing the capability to send astronauts to NEOs (on round-trips lasting just a few months) is the next logical human spaceflight goal for the United States. Such expeditions will help provide protection to Earth, serve as an insurance policy against future NEO impacts and, in the process, expand our ability to understand and use the vast and beneficial resources of space. Ideally, these voyages should immediately follow the completion of the International Space Station; planning for them should start now.

Our nation should once again send its astronauts beyond low-Earth orbit . . . this time to protect our planetary home.

Recommendation #3:
Develop NEO Contingency and Response Plans

Just as the federal government plans appropriate responses to disasters such as hurricanes and earthquakes, it should prepare contingency plans for dealing with an NEO impact. The government should begin planning now to deflect any NEO found to pose a potential threat to Earth. It should also plan to meet emergency response and disaster relief needs created by an impending or actual NEO impact. This government/private sector planning should include international coordination to address the issues of NEO detection, potential hazards and actual impacts.

To guide essential contingency planning, we recommend the following:

- **Establish an Interagency NEO Task Force to address the NEO Impact Threat:** This Task Force should be composed of senior representatives from appropriate government agencies: Department Of Homeland Security; Department of Defense; Department of State; Department of Energy; NASA; Federal Emergency Management Agency; National Science Foundation; Office of Science and Technology Policy; and the National Research Council. The Task Force should also include appropriate

representatives from industry and academia. It should be assigned responsibilities for guiding NEO impact contingency planning through an NEO Impact Response Center (see below), including identification, monitoring and analysis, international coordination of NEO search efforts, impact response and mitigation, and deflection strategies and technology.

- **Establish an NEO Impact Response Center:** This Center should be assigned responsibilities to -- (1) collate accurate information from all available sources on the threat potential of any potentially hazardous NEOs; (2) distribute such information and analysis to public agencies, both in the United States and overseas; (3) develop and implement contingency plans, to include the actions required to deflect an NEO if that becomes necessary; and (4) ensure that an unexpected impact is not misinterpreted as an attack on any country.

  The Center should collect astronomical and technical data about NEOs provided by existing research and search efforts. More importantly, it should verify this information and provide authoritative analysis to the President (and Secretary of Homeland Security), and the relevant committees of the Congress in the event of a projected NEO impact. The Center would enable U.S. civil and military authorities to develop the appropriate responses to an impact prediction and disseminate impact information worldwide.

THE SIGNERS: BIOGRAPHICAL INFORMATION

HARRISON SCHMITT is a geologist, former astronaut, and U.S. Senator. He holds a Doctorate in Geology from Harvard University. He served as Lunar Module pilot on the Apollo 17 mission in 1972, and was the first scientist to walk on the Moon. Jack represented New Mexico in the Senate from 1977-1982. He consults, speaks, and writes on policy issues of the future, space, and the science of the Moon.

CAROLYN SHOEMAKER has discovered more comets than any other living astronomer. Her tally includes 32 comets and more than 300 asteroids, including the co-discovery of comet Shoemaker-Levy 9, which collided with Jupiter in 1994. Dr. Shoemaker, who earned her doctorate in astronomy from Northern Arizona University, is especially interested in the discovery of asteroids and comets and investigation of ancient impact structures.

DAVID LEVY is an accomplished astronomer and writer. He has discovered 21 comets, 8 with his own observatory in southern Arizona. With Gene and Carolyn Shoemaker, he discovered Shoemaker-Levy 9, which broke apart and collided with Jupiter in 1994, causing the largest explosion in recorded history. David Levy is also the science editor for Parade Magazine, an Emmy-winning television writer, and has published 29 books on science and astronomy.

JOHN LEWIS is a professor of planetary science at the University of Arizona's Lunar and Planetary Laboratory. His interests in the chemistry and formation of the solar system and the economic development of space have made him a leading proponent of turning potentially hazardous near Earth objects into attractive space resources. An expert on the composition and chemistry of asteroids and comets, Dr. Lewis has written such popular science books as *Rain of Iron and Ice* and *Mining the Sky*.

NEIL DEGRASSE TYSON is an astrophysicist and director of the Hayden Planetarium in New York City. He is a graduate of Harvard and holds a doctorate in astrophysics from Columbia University. His research interests include star formation, exploding stars, dwarf galaxies, and the structure of our Milky Way galaxy. A popular educator, Dr. Tyson is also a visiting research scientist and lecturer at Princeton University; his books and television appearances continue to stimulate the public's fascination with space science.

FREEMAN DYSON is a mathematical physicist and professor emeritus of physics at the Institute for Advanced Study in Princeton, N.J. His research has been spread over many fields, pure mathematics, atomic physics, astrophysics, statistical mechanics, and the origin of life. He has written extensively on the subjects of space exploration and the challenges of modern technology, and is the 2000 recipient of the Templeton Prize for Progress in Religion.

RICHARD HALLION is the U.S. Air Force Historian, responsible for directing the worldwide Air Force historical and museum programs. He is the former Charles A. Lindbergh Professor of Aerospace History, Smithsonian Institution, 1990-1991. Dr. Hallion is the author of 15 books relating to aerospace history, and teaches and lectures widely.

THOMAS JONES is a planetary scientist and veteran astronaut. A Distinguished Graduate of the Air Force Academy, Tom has piloted strategic bombers, and served the CIA and NASA as an engineer and scientist. He holds a doctorate in Planetary Science from the University of Arizona. On his last shuttle mission, he helped install the *Destiny* science lab at the International Space Station. Dr. Jones is now an independent consultant, author, and speaker.

BRUCE RUBIN is an Academy Award-winning screenwriter (for his original screenplay, *Ghost*). He also co-wrote (with Michael Tolkin) the film *Deep Impact*, a dramatic story of humanity's reactions when a comet is discovered on a collision course with Earth. Through his extensive research for *Deep Impact*, Mr. Rubin became convinced of the enormous importance of an adequate response to the NEO hazard, and has become an outspoken advocate of concerted action to deal with what he perceives as a real threat to the planet and our species.

LUCY MCFADDEN is a planetary scientist at the University of Maryland College Park. Her research interests include the study of the composition of asteroids and comets and their relationship to solar system evolution. Dr. McFadden was a member of the science team for the Near Earth Asteroid Rendezvous mission, NEAR, the first spacecraft to orbit and land on an asteroid. She is Co-Investigator on NASA's upcoming small body Discovery missions, Deep Impact and Dawn.

CHRIS JONES is an amateur astronomer and a new high school graduate in Fairfax, Virginia, where he was president of his senior class. His interest in astronomy began at age six and has grown steadily; he recently earned an astronomy high achievement award. A Tae Kwon Do black belt and an all-star soccer player, he currently scans the skies using an 8" reflecting telescope. His growing awareness of the potential threat posed by Near Earth Objects has convinced him of the need for aggressive government action to address that threat.

MARC SCHLATHER is President of ProSpace, a grassroots space policy organization. ProSpace is devoted to enabling the next generation of space explorers by opening wider access to the space frontier. Its members work to accomplish those goals by communicating with the Congress and Executive branch on a regular basis about new ideas and solutions for space. Mr. Schlather also serves as Executive Director of the Space Roundtable at the United States Senate, which is chaired by ten members of that body.

WILLIAM E. BURROWS is Professor of Journalism and Mass Communications at New York University. He directs NYU's Science and Environmental Reporting program. A noted space historian and policy expert, he writes frequently on air, space, and national security. Mr. Burrows is the author of *Deep Black: Space Espionage and National Security,* and *This New Ocean: The Story of the First Space Age.*