Chairman Kerry, Ranking Member Ensign, and distinguished Members of the Committee. Thank you for holding this important hearing and for recognizing the importance of science and scientific achievement to America's health and vitality. It is my honor and pleasure to participate in this inquiry into the critical role that science plays in the life of our nation and the world.

My name is George Smoot and I am a Senior Scientist at Lawrence Berkeley National Laboratory and a Professor of Physics at the University of California Berkeley. I am perhaps unique in having received roughly comparable and vital support from the Nation’s three primary physical science agencies: DOE, NASA and NSF. As a scientist at Berkeley Lab and a professor at UC Berkeley, I benefit from the great advantages provided by a world-class national laboratory and one of the world’s great research universities. Both play critical roles in promoting America’s and the world’s scientific advancement through internationally recognized research, rigorous education of future scientists, and unique scientific tools and resources. Both have also played critical roles in my career as an astrophysicist, and in my work that led to the 2006 Nobel Prize in Physics, which I shared with my distinguished colleague and fellow witness here today, John Mather.

I was awarded the Nobel Prize for my role in discovering experimental evidence for the “Big Bang,” the primeval explosion that began the universe. This evidence was a map of the infant universe that revealed a pattern of minuscule temperature variations -- "hot" and “cold" regions with temperature differences of a hundred-thousandth of a degree. These temperature variations, created when the universe was smaller than the smallest dot on a TV screen, are thought to be the primordial "seeds" that grew into the universe of galaxies and galaxy clusters we see today. The "map" of the universe that we created was produced in 1992 from data gathered by NASA's Cosmic Background Explorer (COBE) satellite.

It was exciting work. It was an exciting time. It was a time that ushered in what some call the Golden Age of Cosmology. Since our COBE results, more amazing discoveries have been made. We continue to make maps of the universe with increasing accuracy, revealing more than we ever imagined. We now know that there is something that makes up roughly three quarters of our universe about which we have no clue as to what it is. We call it Dark Energy for lack of a better name, and it is driving the universe to expand at an accelerating speed, contrary to the expected force of gravity slowing the expansion down and ultimately pulling the universe back in on itself.

New maps also reveal the existence of Dark Matter. Although it is estimated to make up a fifth of the universe, we also don’t know what it is. Perhaps this unknown matter will someday be viewed through particle physics experiments, or be revealed through even more accurate maps of the universe. What we are sure of is that there will be new discoveries that continue to surprise us, yet will lead us closer to a fuller understanding of the universe and the properties of matter and energy and space and time.

The discoveries that John and I made, as well as those made by others, are not the result of singular endeavors. They rest on the shoulders of many individuals and are made possible by funding from more than one federal agency. It certainly took a large group of committed scientists, theorists, technicians, and engineers to uncover the secrets of the infant universe.. And, it took significant federal funding.

America’s innovation stems from the creativity that institutions like Berkeley Lab, UC Berkeley, U Mass, Stanford and Goddard Space Flight Center encourage and nurture in their students, researchers and professors. It stems from the intellectual freedom that only inquiry at the most basic and theoretical level of science provides. It stems from the commitment of federal investment in the education of our children, the research of our investigators, and the development and maintenance of our scientific infrastructure. Science is an organic enterprise and does not exist in a vacuum. Science flows from its environment and is nurtured by steady funding and new young educated minds. If adequately supported these ingredients incubate and grow. They lay the foundation, the seeds, for the next generation of discoveries and innovations.

My early work as a post-doctoral physicist at Berkeley Lab was funded through the United States Department of Energy’s Office of Science. I had the very great fortune of working with legendary scientists. Nobelists like Luis Alvarez encouraged me to “think big” and then gave me the space and freedom to do so. It was the funding from DOE that provided the foundation that allowed my work to progress. It enabled me to build my expertise and to organize the necessary team to tackle the hardest questions.

One point that I hope to leave with you today is that the U.S. Department of Energy is the major funder of the physical sciences in the United States. What does that mean? It means that DOE is the largest investor in the development and maintenance of our nation’s scientific resources, both human and infrastructure, in the research fields of chemistry, astronomy, all forms of physics, material sciences, and more. From its national scientific user facilities, such as
synchrotron light sources, electron microscopes and particle accelerators, to programmatic research funding at its national labs and at research universities, DOE is supporting the underpinnings of American innovation.

The Department of Energy has also played a unique and critical role in training America's scientists and engineers for more than 50 years. I am an example of this support, as are many scientists of my generation. These scientists and engineers have made major contributions to the United State's economic and scientific pre-eminence. The nation's grand challenges, such as our current and future energy and environmental needs, will only be solved through scientific and technological innovation developed by a highly skilled workforce. The DOE's Workforce Development for Teachers and Scientists program is a catalyst for the training of the next generation of scientists. Through this program DOE national laboratories provide a wide range of educational opportunities for more than 280,000 educators and students on an annual basis. It is particularly important that we continue to extend and expand such opportunities to our students and, critically, to our teachers of science, technology, engineering, and mathematics. The entire science education infrastructure from K-12 through undergraduate students, and graduate students to postdoctoral scholars is the pipeline of future scientists and technologists. The educators, mentors and role models are the pumps that bring them along, prepare and excite them for their challenging and rewarding work.

However, as I intimated earlier, research and scientific training is underwritten by more than just funding from DOE. In my case, I have been honored to receive funding from the National Science Foundation and, of course, from NASA. Each agency played a crucial role in my development as a scientist and in the development of the programs on which I worked.

My group has received substantial funding from the NSF over many years that included support for graduate students and postdoctoral scholars, as well as access to NSF sites and facilities, such as the South Pole station. In fact, NSF funds probably exceeded or matched DOE funding of my work over the years.

In the mix of federal support for my research, DOE funding served two incredibly important roles: (1) stability and longer-term risk, and (2) development of novel instrumentation later used on NASA platforms (aircraft, balloons, satellites) and at NSF sites. DOE provided steady and reliable program funding that allowed development of new concepts, instrumentation and ultimately fields. NSF and NASA funding was in general for specific projects or relatively short, and well-defined, research objectives (often prototyped with DOE funds). The NSF could be counted on to be interested in funding specific observations or developing new approaches that were linked to their program disciplines. Like DOE, NSF also liked to involve graduate students and undergraduates in research and often provided modest additional funds for that purpose. This activity helped funnel a number of bright young students on into graduate school and PhD programs.

A very critical result of NSF funding was the creation of the Center for Particle Astrophysics. This center revolutionized the approach to the field. Now essentially every major first-rate university has a cosmology center modeled after it. The Center brought together a number of groups and institutions to push forward our understanding of Dark Matter and the accelerating universe, leading to the realization that Dark Energy makes up the majority of the Universe. The vibrancy of the combined programs of science and people, in addition to education and outreach programs, had a profound effect of productivity and creativity. It impressed all who saw it. Because of its success, the NSF has continued and expanded their center programs.

This illustrates my second point that I hope you will take to heart and leave here today remembering. America's scientific leadership and capacity for innovation stem broadly from the federal government's investment in a rich portfolio of research. Therefore, it is critical that all federal funding of research be increased.

The scientific community is very pleased to see both the Administration's and the Congress' commitment to doubling the budgets of the NSF, the DOE Office of Science and of NIST. However, NASA's science budget, the NIH and DOD's scientific programs play important roles as well and should not be overlooked. Passage last week of Senate Bill 761, the America COMPETES Act, was a vital development and your work on this milestone legislation is recognized by all of us interested in American science. However, more must be done to raise the level of research funding significantly higher, and for all federal research agencies.

The third and final point that I want to leave you with, is that Congress and the Administration must stay vigilant in your commitment to long term, basic science that has no obvious immediate commercial application. Without this foundational research the really big, transformational discoveries and leaps in understanding will not occur. Basic science is the beginning of the innovation pipeline that leads to revolutionary technologies.

Take the prospects for advancements in energy research. Although progress in the effectiveness and cost efficiency of existing technologies, such as current methods of ethanol production and silicon-based photovoltaic cells, will happen, many believe that their learning curves are flattening out and that improvements will not get us to a place where significant inroads are made in carbon emission reductions or energy independence.

However, some of the most promising avenues for developing new, clean and revolutionary energy technologies are solutions rooted in fundamental basic science. For example, the DOE Office of Science is funding new bioenergy research centers that will investigate all of the scientific aspects of developing new cleaner fuels from biomass. We have known for a long time that we could produce liquid fuel from biomass; the problem has been that it is prohibitively expensive; we had to put the biomass in acid baths to free up the chemicals and then treat the resulting liquid, consuming a lot of energy while doing it. The research challenge is to find, and perhaps design and synthesize, new biological organisms and enzymes that will make the conversion process cheap enough to compete against the cost of gasoline. The new tools developed with the support of the Office of Science in genomics, computer modeling and synthetic biology put this within our reach, but much more work needs to be done.
In another example, the Office of Science is funding advanced research in nanotechnologies which offer the best hope for developing new energy storage systems that will be critical for making solar and wind economically attractive alternatives. Why is new nanotechnology so important for the future growth of solar and wind energy? These resources are available only while the sun shines or the wind blows, and that may be at times when they are not needed. Inexpensive ways to store that energy would make them useful resources all of the time. And why is nanotechnology so important to developing new energy storage systems? Our future success in energy storage depends on being able to build batteries that will be able to hold much higher charges, and be discharged much more rapidly, than present ones do; the way to achieve these advances is through advanced nanotechnology research – again, fundamental basic science.

In conclusion, I applaud the renewed focus that the Senate, the House and the Administration have placed on the need to maintain America’s international competitiveness through nurturing innovation. Innovation, like science, is organic. No one knows where the next big “breakthrough” will occur and where it will lead us. No one can guess who will be the next young “Einstein” or “Edison” that takes the world in new directions. Therefore, it is critical that every child, every student, every researcher and every creative idea have the potential to blossom. You, as the stewards of our government, have the power of the purse and the legislative pen that can ensure America continues to invest in a broad portfolio of scientific endeavors, more aggressively invests in math and science education, provides the updated scientific infrastructure needed for 21st Century science, and encourages a research environment that embraces risks and awards creativity.

In times of crisis the nation mobilizes its science enterprise. Whether in response to hostile outside threats, challenges to our preeminence, such as in the case of Sputnik, or as with today’s energy-based climate and economic security concerns, the nation turns to scientific and technological solutions. For future crises it is critical that the country keep a broad, vital and strong science infrastructure.

Even without the grand challenges to address, science impacts everyday life and makes our world a better place. It is clear to all that the economic prosperity, personal health, and world leadership of the country and its population rests upon the products of basic scientific research and the vitality of our science enterprise. The country’s place in the world will directly reflect the level of its science. Any country that wishes to be a world leader must be a world leader in science.

Thank you, again, for the opportunity to provide testimony on this important topic.