I am very happy to have been asked to address the graduates of the Physics and Astronomy Department at UCLA on the day of their Commencement. Commencement is a special time for the graduates and their parents, family and friends. Indeed, I would hazard to say that Commencement is probably one of the happiest days that all of you will have in your life. So, enjoy it! And please graduates give a big round of applause to your parents, family and friends for all their support and love through the years.

Thinking about what to say today, I decided it would be most useful if I spent some time reflecting on what kind of future you will face. Although all of you have followed similar paths to get to this day, your lives are likely to diverge in the future. A majority of you will continue to pursue a career in Physics or Astronomy, but many of you are already embarking on quite different paths. No matter what the next phase of your life-journey turns out to be, you are all very fortunate to have gotten a degree from the Department of Physics and Astronomy at UCLA. Although it is an old cliché, it is nevertheless true that if you were trained as a physicist or an astronomer you can do anything you put your mind to in life!

Let me begin by talking about the near term future. If you plan to continue your career in physics or astronomy you are very lucky because new facilities have just come, or will soon be coming, on line that promise to open up entirely new perspectives on the universe. The Large Hadron Collider at CERN which is now running very well, albeit at a reduced energy, is poised to discover the origin of electroweak symmetry breaking, responsible for giving mass to the elementary constituents of matter, the quarks and leptons. Will the LHC find the Higgs boson? Is there supersymmetry? Are there hidden dimensions of space? Time will tell and, indeed, you may well be part of these discoveries!

In a totally different area of research, the new X-ray free electron laser facility at the SLAC National Lab, whose existence is due to the genius of one of our own faculty members, Claudio Pellegrini, has also just started operations and will provide femtosecond beams of radiation of an intensity a billion times more than has ever been achieved before, thus allowing the real time study of chemical reactions and the probing of materials in entirely new regimes. This is a new frontier and nobody really knows what we will learn? Can we get to attosecond pulses and probe even further?

Yet in another area, the astronomers can look forward to first light from a 30-meter telescope at the end of this decade. With an order of magnitude more seeing power than the Keck telescopes the TMT will allow us a more in depth study of the early universe, as well as help us discover and study earth-like planets in our galaxy. Nobody really knows what we will find as we probe the cosmos further, but I hope that these studies will throw
more light on the mysterious dark energy that drives the acceleration of the universe’s expansion in time.

While it is easier for me to imagine what will happen in the near term in physics and astronomy, I am equally certain that those of you who are now choosing a different path to pursue than being a professional physicist or astronomer will find equally exciting opportunities in whatever field you choose to participate in. Indeed perhaps the most useful piece of advice that I can give all of you is to simply pursue your passion. If you do so, you will do what excites you, and that will make you happy and this is most likely to make you successful.

I want to spend a bit more time talking to you about the longer term future. When I think about that, I wonder if we have exposed you enough to what you will really need to know to prosper in 2030 or 2050, given the complexity of the world that you will have to live in then. There is a very book, written about 30-years ago, entitled No Limits to Learning: Bridging the Human Gap (Pergamon Press, New York, 1979) by James Bodkin, Mahdi Elmandjra and Mircea Malitza which focuses on the educational challenges posed by our increasingly interconnected world. In their book, the authors emphasize the importance of learning being both anticipatory and participatory. In their view, it is crucial to prepare students to be problem solvers, since they will have to face and deal with many unforeseen challenges in the future for which there is no direct training. Hence learning must be anticipatory. All of you have been taken down this path in the Department and have emerged brilliantly on the other side. You are problem solvers, without a doubt!

However, I am less sure that your learning has been participatory in equal measure. The authors of No Limits to Learning also emphasized the need for educational systems to help students to engage in society. In their view, in today’s complex world, one cannot really afford to have citizens sit aloof on the sidelines. Hence effective learning must also encourage participation. Here, I believe we have not been as successful in the Department, but you will need to acquire these participatory skills as you move along in your career!

It is unquestionable that our world is undergoing rapid change and that you will have to adapt to, and hopefully shape, some of the changes that will occur in the next half century. Although changes will occur in essentially all areas of human endeavor, I would like to focus here on the crucial changes which will be needed in four areas which are particularly critical to our future: Ethics; Environment; Energy; and Economics. Let me comment briefly on each of them in turn.

Of the four Es, Ethics stands apart as it is the foundation of our value system. In the last 50-years we have begun to develop new ethical mores to help codify the behavior of mankind in a world dominated by change. This new ethics has arisen in part from the need to address the relationship that humans have with the planet they inhabit, and in part because of the realization that the generation of humans living today have an increased responsibility to ensure the well being of future generations. We must arrive at a new
global ethics consonant with the world of today. In this new ethics, it seems to me, that two fundamental tenets stand clearly above others:

I. We must learn to live in peace among ourselves as well as in harmony with nature.

II. Our society must be prepared to assign to the future at least as high priority as it does to the present.

As you begin your life after UCLA, I hope you will be guided by these core values.

Let me turn to the second E, Environment. I believe the global threats facing mankind are most clearly perceived in connection with the environment. Although climate change due to the increase in GHG is perhaps the best known of these threats, there are many others dangers afoot which are as important but less in the public’s eye, ranging from deforestation and the depletion of aquifers, to a systemic loss of biodiversity. A common thread that unites these environmental problems is that any attempts at mitigation necessitate concerted global action.

Although there is considerable willingness in many quarters to address the challenge posed by carbon pollution, there is still considerable disagreement on how to do this effectively in most countries across the globe, including the United States. Debates on whether to impose a carbon tax, or whether to institute a cap and trade system continue to rage, fueled in part by uncertainty on what will be the actual mix of alternative energy sources which will eventually replace fossil fuels. This is a problem which you are eminently suited to contribute to, and is an issue that you will, most probably, be called to resolve.

Academia has been one of the real agents of change on environmental issues and in all For example, much of our present understanding of the anthropogenic factors which drive climate change has come from universities. Furthermore, although climate change is a global phenomenon, both mitigation and adaptation strategies to address consequences of climate change require a better understanding of what is happening at the regional level and what needs to be done locally. The science and policy ideas needed for the success of these efforts are, again, mostly being pursued by small groups of academics scattered across the globe, but linked intellectually. Many of them have a degree in physics, as you now also have. So, perhaps, this may be an interesting path that some of you will follow in the future.

There is a deep interrelation between Environment and Energy, the third big E. As with the environment, academia is also playing a big role. In essentially all universities, myriads of faculty members are very actively and broadly engaged in energy research. To develop renewable, low carbon, energy alternatives to fossil fuels requires new science and engineering breakthroughs, particular in materials, and these will come mostly from the world’s research universities. Obviously, this is another area that many of you can, and will, contribute in the future. But science and engineering are not all that is required to move the world along a sustainable energy path. One needs also to
understand what policy measures need to be implemented (fiscal and economic incentives, regulatory legislation, etc) to make sustainability an integral component of society across the globe. Again, ideas on how best to proceed on the policy side are being developed by social scientists, economists and law professors across universities around the world. So, here again, for some of you that may be so inclined, there are opportunities and challenges waiting for you.

This brings me to consider the last of the 4Es: Economics. This is a hot topic in view of the global economic meltdown, but it is clear that it is also an absolutely central topic to address in the context of sustainability. Simply put, it is not possible to arrive at a sustainable society unless we change our view of the relationship between the economy and our environment. Lester Brown in his wonderful book *Eco-Economy: Building an Economy for the Earth* (W. W. Norton & Company Inc., New York, 2001) puts it succinctly when he says “the issue now is … whether the environment is part of the economy or the economy is part of the environment”. Unless we can restructure the global economy so that it truly leads to economic development which is sustainable we will undermine our delicate environment on earth and irreversibly deplete its resources, leading to catastrophic consequences.

Herman Daly, one of the pioneers of the new field of ecological economics, argues that the limiting factor in economic development is not anymore human capital but natural capital, the products and services provided by the earth ecosystems. In a sustainable economy these costs should be part of the economic equation and not be considered externalities. One of the great challenges facing mankind is to really begin restructuring the world economy so that it properly takes into account the environmental impacts of human activity.

Unfortunately, and rather remarkably, economists have been loath to tackle these issues. For instance, while there is considerable faculty enthusiasm in universities to tackle a host of environmental and energy issues, with some notable exceptions, many of the leading economists on universities faculties are not eager to think through the steps needed to restructure the economy onto an environment sustainable path. In my view, this is a real pity. However, it offers opportunities to others – perhaps even for some of you! - to think through how to reshape the present economic system into one where natural capital is given a real economic value.

Let me conclude. Although I have ranged far and wide, from the possibility of discovering extra dimension of space at the LHC, to some of the steps needed to build a new economics for a sustainable world, I hope my message to you is clear. You are standing at the threshold of a world full of opportunities and challenges. The Department and UCLA have prepared you well to face this world. You all have the innate ability to succeed and make a difference. So, go forward with confidence and makes us all proud! I wish you all the best of luck for the future.