My Sisyphean Boulder

King Address 2014

By

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President Keefe, Provost Berry, Deans, Colleagues and Friends,

It has become customary to express thanks at the beginning of this address, and while I will follow that custom, I must admit that I am uneasy naming individuals when so many of you have touched my life in special ways at different times over the years. I will instead be vague and express my sincere gratitude for so many thoughtful conversations shared in so many ways, but especially to those of you who have shared those conversations with me over lunches, dinners, cups of coffee, or glasses of wine. To some, I thank you for the beautiful gifts made with your hands and those straight from your heart, since it has always amazed me how they came at the right time. To my long-time special friend, thank you for letting me teach your daughter, because that said so very much to me, and it was indeed an honor. And, to everyone who has worked with me over the years, I thank you for your kindness, your patience, and most of all for teaching me so many things. Finally, I would be remiss not to thank the three most important men in my life: my husband Steve who has such an incredible sense of humor and who has totally perfected the ability to appear to be listening and my two sons, Alex and Emery, who have truly taught me the meaning of unconditional love. Now my story…

A year or so ago I read, or heard, several references to the same Greek myth all within a very short period of time – in Brian Green's book *The Fabric of the Cosmos*, in a Maureen Dowd column in the *New York Times*, and by a colleague discussing a UD task. The myth was that of Sisyphus as he suffered the punishment of spending eternity pushing a boulder to the

top of a hill, only to have it roll down the hill, and be faced with the same task again, and again, and again.

What struck me as I reread the myth was how so much of my own life has been spent doing things which are very cyclical, from my early years on a dairy and tobacco farm in southern Ohio, to my years as a professor at UD. Each year the crops can be bountiful and the students can be incredible, but the former are picked and the latter graduate, and then you start all over again. One never knows as a new year begins whether the right amount of rain will fall or whether the students will live up to their true potential, but even a bad year will end, and again there will be a new start at the bottom of the hill the next year.

My UD Sisyphean boulder is ever changing as it is made up of lumps of clay that start as unique but fairly unformed masses that fall off *about* four years later. Each year I have a chance to try to mold these students to appreciate the beauty of the natural world. I work with some in a very one-to-one way, as we do research during January and the summer months, and I would like to give you an idea of what we do as we wander off together by showing three slides covering this research.

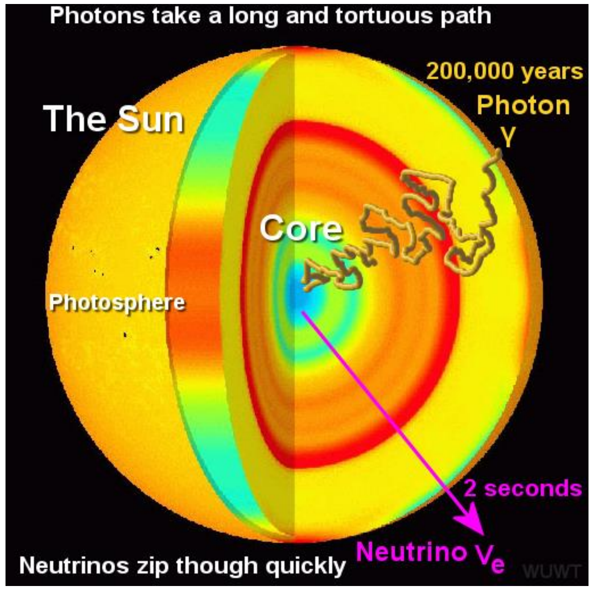
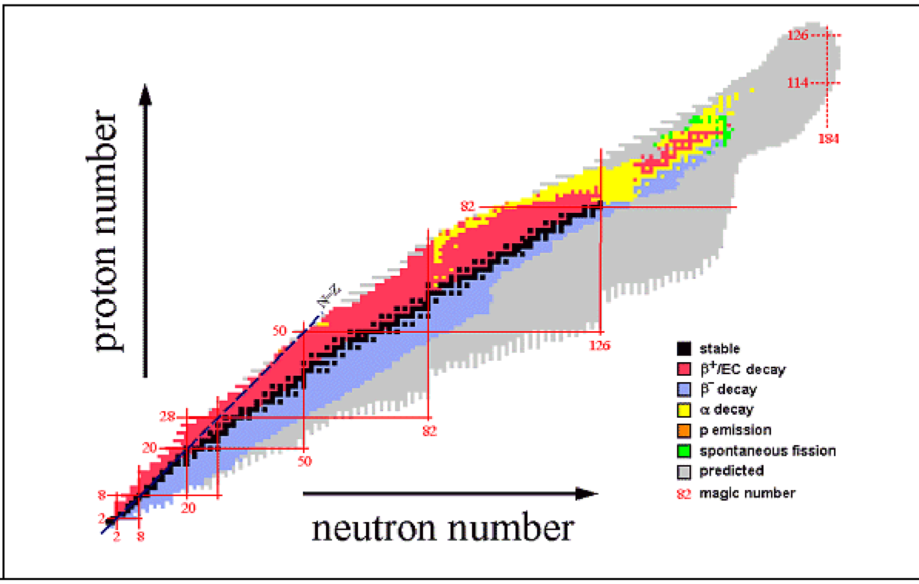


Figure 1. Neutrinos propagate from the Sun's core to the Earth in a very short period of time giving us a window to the fusion reactions in the core. (Original source not clear; multiple web addresses.)

The first slide is related to neutrino physics and shows a picture of the core of the sun. A neutrino is a fundamental particle, and it is the only particle that can propagate quickly (about 8 minutes) from its production in nuclear fusion reactions at the core of the sun to the Earth. The study of these solar neutrinos gives us a window to the energy-production mechanisms in the center of stars. In my first few years at UD, my students and I completed measurements trying to understand the very detailed nuclear properties of the detectors used to detect these elusive particles – information that must be known before the instruments can be used. In recent years, our measurements have become of interest again to neutrino physicists, as some of the nuclei we have studied have become important in experiments that investigate fundamental properties of the weak nuclear force and may lead to a determination of the mass of the neutrino.

The second area of research – the nuclear structure studies of the nuclei with 84 neutrons and nuclei with 52 protons – was the focus of our investigations for well over a decade, with measurements made both at the University of Kentucky and at the Paul Scherrer Institute in Switzerland to look at the behavior of nuclear excitations across a chain of nuclei with either a fixed number of neutrons or protons, respectively.



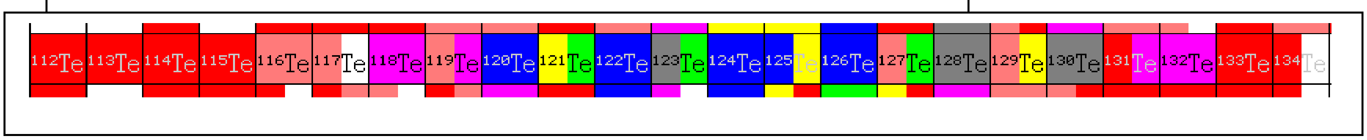


Figure 2. The chart of the nuclides is shown on the left and a blowup of the Te region is shown below. Source: http://fys246.nuclear.lu.se/topics.asp

Shown is the chart of all the nuclei that have been observed. If one wants to study what happens as the number of neutrons changes in a nucleus, then one moves horizontally across the chart; one moves vertically to investigate nuclei with changing numbers of protons but fixed neutron number. The smaller picture is an enlargement showing the tellurium nuclei, which were the focus of our investigation of the systematics of excitations in nuclei with 52 protons.

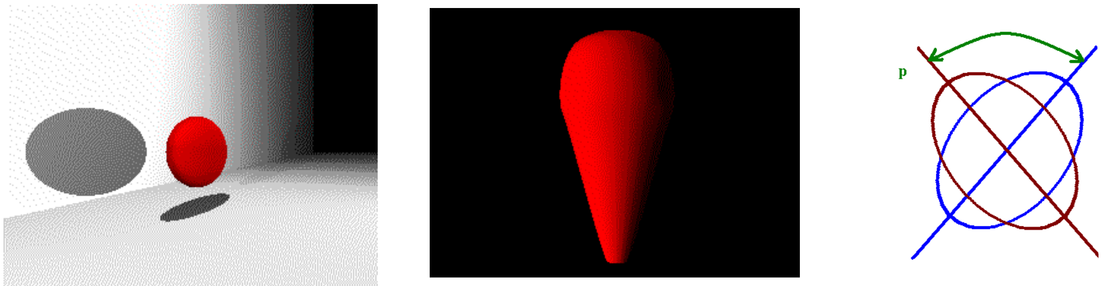


Figure 3. Coherent collective quadrupole oscillations and octupole oscillations of nuclear matter, respectively, are shown in the left and center figure. The right figure shows a scissors mode of excitation where the neutrons and protons oscillate out-of-phase. Source: Shared among nuclear structure physicists – obtained from Professor Steven W. Yates.

You can see three types of these collective excitations modeled in Fig. 3. The two left-most panels are examples of motion where the neutrons and protons in the nucleus oscillate together, or in phase. One of the main goals of our study was to look for similar excitations in which the neutrons oscillate out-of-phase with respect to the protons much like the blades of a pair of scissors in motion, with the neutrons being one blade and the protons the other. A schematic of such an excitation is shown in the right-most panel of Fig. 3. Evidence was found for these scissors-like excitations, and this extensive investigation resulted in a tremendous amount of new information on the nuclei studied that helps us better understand the strong nuclear force.

In the last few years, our research has moved more into the area of applied nuclear physics, as our investigations have focused on the study of neutron reactions for fission reactor applications. On the slide you can see a picture of a next generation sodium-cooled reactor – a reactor which is scheduled to come online in 2030 or so. These next-generation reactors are designed to consume a larger percentage of nuclear fuel relative to today's reactors, leaving less radioactive waste and generating electricity more efficiently. Neutron

reaction and scattering probabilities, called "cross sections", are needed from materials used in building the reactors and their surrounding structures and of the sodium coolant in the core; these probabilities are necessary for determining critical operating conditions in the reactor core and structural integrity limits of the surrounding materials.

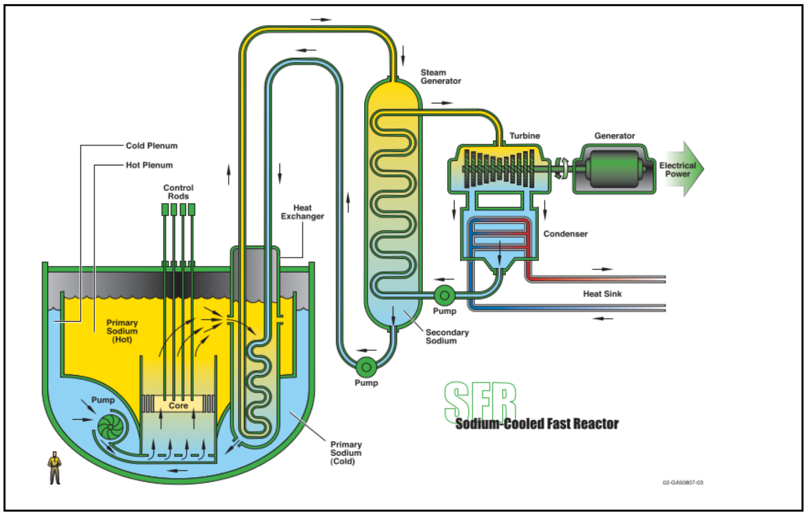
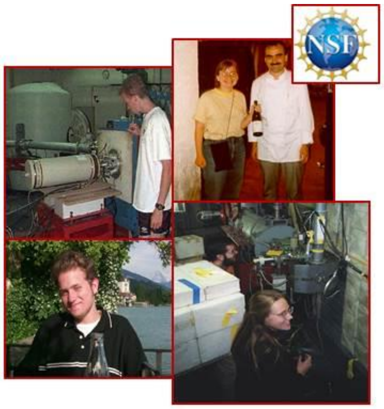


Figure 4. A schematic of a sodium-cooled fast reactor. Neutron scattering information is needed for both structural materials and Na coolant. Source: http://www.ne.doe.gov/genIV/documents/gen_iv_roadmap.pdf

And my final slide shows the list of students who have participated in the experiments and data analyses associated with all these studies. For years I have included this list in the institutional impact statement of grant proposals, and I have known my research students were important for funding. Some things have happened in the last few years, however, that have made me realize just how valuable this list really is, and I share these because I think everyone who teaches our students can come up with their own list – one which may, in fact, be better than mine.



National Science Foundation Funded Students: Eric Meier (MD - UT Southwestern); Christopher Bennett (MD - Tulane); Suzy Maska (MS Physics, UNC, MD – UT San Antonio); Carl Lundstedt (Ph.D Physics - U of Neb); William Faulkner (Navy Nuclear Engineer, MBA - U. of Chicago); Chris Davoren (Software Developer); Stephen Etzkorn (Ph.D Physics – Ohio State U.); Peter Burkett (MS Geophysics – Penn State); Corey Collard (Ph.D. Nuclear Engineering – U of Mich.); Garrish Alexander (MD - UT Houston); Meghan Walbran (MS Physics Education – U. of Hartford); Beth Sklaney (MS Physics – Syracuse); Chris Aubin (Ph.D. Physics – Wash. U.); Patrick Roddy (Ph.D. Physics – UTD); Matt Burns (MS Physics - UTD); J.C. Boehringer (HS Physics Teacher); Jeff Ellis

Department of Energy Funded Students: Peter McDonough (Ph.D. Candidate in EE - TX Tech); Luke Kersting (Ph.D. Candidate in Nuclear Eng. - U. of WI); Collin Lueck (MD Candidate – USC); Anthony Sigillito (PH.D. Candidate in EE – Princeton); Jessie Girgis (Grad Candidate); Laura Downes (MD Candidate – U. of KY); Jeff Schniederjan (Actuary); Brett Combs (Compass Minerals); Leslie Sidwell (H.S. Teacher – Red Oak ISD), Samuel Henderson (UD Junior), Aaron French (UD Junior), Zach Santonil (UD Senior).

Last year I gave a talk at the University of Notre Dame, and when I put up a similar slide to acknowledge those who had helped in the research, there was a collective gasp from a room full of nuclear scientists. The director of the lab where I do most of my measurements has used the list at international meetings to emphasize what is accomplished at the lab. But the biggest eye-opener for me is best conveyed by the following. The cliché that we learn the most by our mistakes certainly applies here.

Last year I had the unfortunate responsibility of having to report a grant budget issue to my Department of Energy liaison, who is also an experimentalist at a national lab. It was not an over expenditure, but it was something that affects my budget this year. I wrote to him as soon as I learned of my error and was rather surprised at how quickly he called me. What he said during the ensuing conversation told me that my list was more important than

even I had previously appreciated. His words were, "Sally, I cannot send you the missing money, but is there some equipment or something I can send to free up money elsewhere in your budget? It is very important to us that your students do not lose funding." So, it is not the neutron scattering cross sections on sodium and iron or the scissors-like excitations in the tellurium isotopes; rather, even for federal funding agencies, what is most important are the Leslies and the Lukes and the Bretts and the Samuels. In the last year as the Scholarship and Fellowship Advisor, I have seen how our students react when you support them for prestigious awards. Encourage your students to achieve, celebrate their accomplishments, make your own lists, and then reap the rewards for you, for the University, and most importantly for them. I believe there is so much potential in everyone's list.

Ah, but now back to my metaphor…

If you have ever hoed a seemingly endless row of tobacco in the hot summer sun, or milked a cow on a cold winter's morning, or certainly if you have ever mentored an undergraduate for ten weeks in the summer, then you know these tasks can become Sisyphean in the truest sense. But as I sat at graduation last year and watched students walk across the stage to receive their diplomas, I thought about how some of the pieces of clay had fallen off my boulder as works of art, although certainly not in their final form. I thought about how these students have a commonality because they all have experienced the core curriculum, but they are also different because they have been touched in different ways by each other, by different majors, and by differences in their interactions with us. There are those who celebrate this commonality, and I too appreciate it much more than you may

realize, but I am, in fact, someone who celebrates the differences, because it is the differences I believe that make a university a university and that make life interesting.

But there was something else I realized as I sat there at graduation thinking of this metaphor. At UD, it is not my Sisyphean boulder to carry alone; rather it is a rock whose weight is shared by everyone in this room, and the efforts put forth carrying it each year are certainly not futile. And with that realization, the cyclical task of educating our students lost any form of punishment, and the boulder became considerably lighter. More importantly the task became in the truest sense an honor. Thank you for helping carry the load, and thank you also for this honor.