49th Annual

ONCE UPON A CHRISTMAS CHEERY IN THE LAB OF SHAKHASHIRI

NOVEMBER 25, 2018

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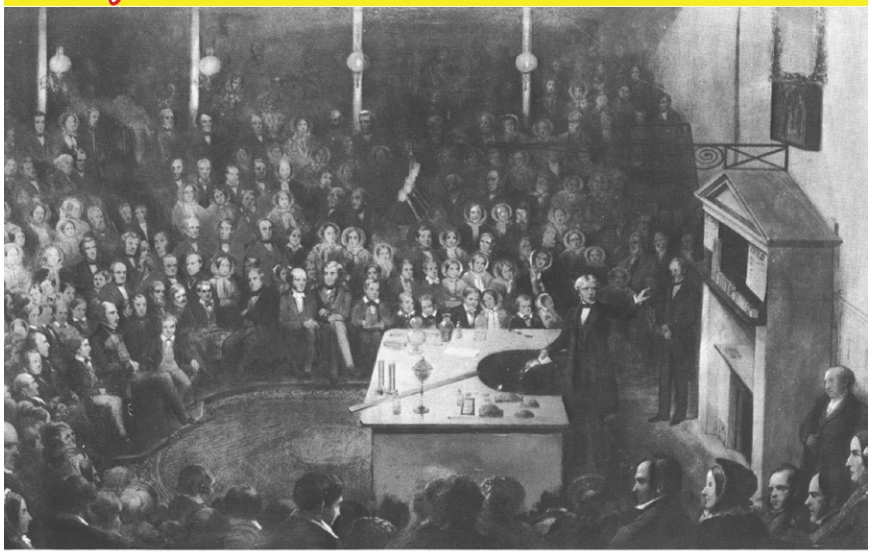
ORIGIN of the Christmas Lecture



Michael Faraday, the noted English physicist and chemist, lived from 1791 to 1867. He was a gifted lecturer who began giving his Christmas Lectures for children and their families at the Royal Institution of Great Britain in the 1840s. Faraday loved simplicity, and he had a strong sense of the dramatic. His audience entered wholeheartedly into the world of science with his guidance. His ideas were still considered very unorthodox at that time, and children, who had not yet adopted conventional ideas, would react enthusiastically to the ones he presented. Eventually, the lectures became very popular, and even the Prince of Wales attended and learned about the mysteries of electricity. Faraday sought to awaken the sense of wonder in his listeners. He knew that once a person could be made to wonder about the world, it was only a short step to studying it. He strove to point out that if you looked closely at the most ordinary thing, such as the force of gravity, it ceased to be ordinary and became somehow miraculous. Throughout the 19 annual Christmas Lectures that he presented, Faraday did all he could to urge his listeners to see and judge for themselves, to experiment, and to question nature directly whenever anyone discovered something out of the ordinary.

Once Upon a Christmas Cheery In the Lab of Shakhashiri

In December of 1970, near the end of my first semester on the faculty of UW-Madison, I presented the first ONCE UPON A CHRISTMAS CHEERY IN THE LAB OF SHAKHASHIRI in my freshman chemistry class. Colorful displays of exciting chemical transformations were used and the audience was thrilled. Word spread that the Christmas Lecture was a fun event and the following year the lecture hall overflowed with students and their friends. In 1972 the Christmas Lecture was given in two evening sessions and opened to the public. In 1973 Wisconsin Public Television offered to videotape the program for broadcast during the week of Christmas. Thus began an uninterrupted collaboration with UW-Extension to bring science to audiences throughout Wisconsin, and on PBS stations.

Since then, variations of this program have played to packed houses at the National Academy of Sciences and the Smithsonian's Air and Space Museum in Washington, the halls of the US Congress, Boston's Museum of Science, elsewhere across the country and around the world. The goal of the Christmas Lecture has remained the same over the years: *connectivity with the audience*. My ultimate purpose is to trigger cerebral and emotional engagement to heighten the audience's joy in learning and to celebrate the role of science in society.

It is my good fortune to mark this 49th anniversary with appreciation for the wide interest and support that all my work enjoys locally and globally.

>> Bassam Z. Shakhashiri

I expect to pass through the world but once.
Any good therefore that I can do, or any kindness
that I can show to any fellow creature, let me do it now.
Let me not defer or neglect it,
for I shall not pass this way again.

>> Attributed to Etienne de Grellet du Mabiller (1773-1855)

Fostering COMMUNITY APPRECIATION OF SCIENCE

Science literacy enlightens and enables people to make informed choices, to be skeptical, and to reject shams, quackery, unproven conjecture, and to avoid being bamboozled into making foolish decisions where matters of science and technology are concerned. Science literacy is for everyone—scientists, artists, humanists, all professionals, the general public, youth and adults alike.

>> Bassam Z. Shakhashiri

"Public sentiment is everything. With public sentiment, nothing can fail; without it nothing can succeed."

>> Abraham Lincoln

Bassam Z. Shakhashiri

is professor of chemistry at the University of Wisconsin-Madison and since 2001, the first holder of the William T. Evjue Distinguished Chair for the Wisconsin Idea. He has given over 1500 invited lectures and presentations around the world. He is the recipient of 7 honorary doctoral degrees and over 35 awards from the American Association for the Advancement of Science, Madison Metropolitan School District, American Chemical Society (ACS), National Science Board, Council of Scientific Society Presidents and more. He is the recipient of the 2018 ACS Grady-Stack Award for Interpreting Chemistry for the Public.

In 1977 Bassam became founding chair of the UW System Undergraduate Teaching Improvement Council, now called the Office of Professional and Instructional Development. In 1983 he founded the Institute for Chemical Education (ICE) and served as its first director. From 1984-90 he served as NSF Assistant Director for Science and Engineering Education. In 2002 he founded the Wisconsin Initiative for Science Literacy (WISL) and continues to serve as its director. He served as the 2012 President of the American Chemical Society.

Bassam has been featured in newspapers, magazines, national and local radio and television, and appears as a regular guest on the Ideas Network of Wisconsin Public Radio. He and his wife June live in Madison. Their daughter Elizabeth, a 2007 alumnus of UW-Madison, graduated in 2010 from the University of Michigan Law School and lives in Chicago with her husband Bob and their daughter Violet.

JOIN IN SUSTAINING OUR SCIENCE OUTREACH AND MAKE YOUR GIFT TO WISL TODAY

The dual mission of WISL is to promote literacy in science, mathematics and technology among the general public and to attract future generations to careers in research, teaching and public service. WISL programs are supported by UW-Madison and by private donations. You may mail your tax-deductible contribution to the address below or contribute online at GO.WISC.EDU/SUPPORTSCIFUN

THE SHAKHASHIRI SCIENCE EDUCATION FUND AT UW FOUNDATION
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~ Your Gift is Much Appreciated ~

Science & Society

Today our biggest challenge is to help sustain Earth and its people in the face of:

- Population Growth
- Finite Resources
- Malnutrition
- Spreading Disease
- Deadly Violence
- War
- Climate Change
- And the denial of basic human rights, *especially the right to benefit from scientific and technological progress.*

We advance chemistry through research, education, and innovation. Basic research in science greatly increases our understanding of nature, triggers creative waves of invention and innovation, and prompts technological breakthroughs that can serve society well in the future. Solutions to the world's problems demand thinking "outside the box" and encouraging radical innovation, both coupled with transformative changes in education.

Proficiency or technical skill alone does not ensure responsibility and stewardship. In a free and civil society, people must be virtuous as well as skilled.

We must aim to effect comprehensive, fundamental, and systemic change in our own attitudes and in our behavior as scientists and as responsible citizens. Purposeful communication of the critical role of science and technology in society can help alter attitudes of the general public and can also foster collaboration among people across geographic boundaries to work together to solve global grand challenges. We have the talent and the capacity to succeed, but as scientist-citizens we must also help develop the will to take action.

Science and society have what is essentially a social contract that enables great intellectual achievements but comes with mutual expectations of benefiting the human condition and protecting our planet.

>> Bassam Z. Shakhashiri

GLOBAL WARMING IS UNEQUIVOCAL

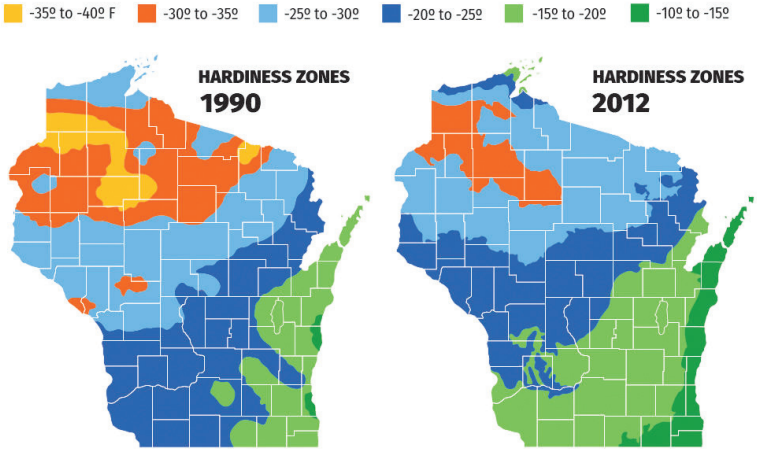
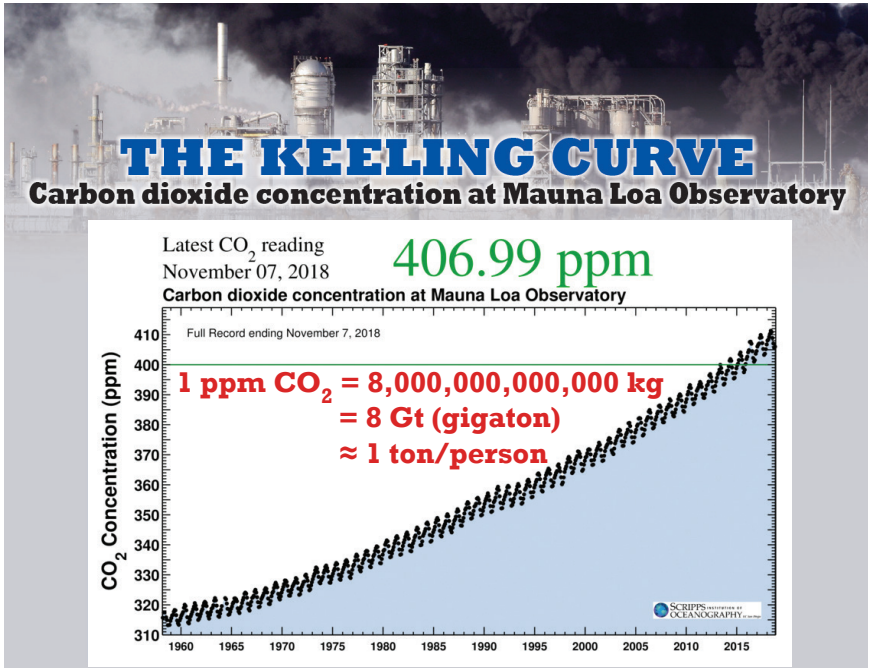


Illustration by Brandon Raygo, The Capital Times / Data Source: U.S. Dept. of Agriculture, PRISM Climate Group, Oregon State University

The zone color key shows the lowest observed winter temperatures in that area.



This graph plots the ongoing change in concentration of carbon dioxide in Earth's atmosphere, beginning in 1958. It is based on continuous measurements taken at the Mauna Loa Observatory in Hawaii that began under the supervision of Charles David Keeling.

INDIUM

This is the 49th annual presentation of *Once Upon a Christmas Cheery in the Lab of Shakhashiri*. To mark this occasion, we feature the element whose atomic number is 49, namely indium.

Pure indium is a soft, silvery metal. It's not found pure in nature, only in compounds with other elements. It's a fairly rare element, making up less than 1 part per million of the Earth's crust, about the same as silver.

The element was discovered by accident in 1863 by two German chemists, Ferdinand Reich and Hieronymous Theodor Richter. They were attempting to extract a different element, thallium, from an ore found near their laboratory. They tested their extract by heating it to see what color of light it emitted. Their extract emitted a deep indigo color, which thallium does not do, so they knew what they had was not thallium, but instead an unknown element. Because it emitted indigo colored light, they named their new element indium.

Despite indium's scarcity, its use has increased rapidly over the past 20 years. One reason for this is the increasing demand for display panels on electronic devices: smartphones, computers, and televisions. Approximately 70% of all indium is used to make indium tin oxide (ITO) film. As a film, ITO is transparent, colorless, and a good conductor of electricity. The touch-screen devices you've used very likely had ITO film in them.

Indium is also used in some light-emitting diodes (LEDs). Two compounds used in LEDs contain indium and gallium, one with nitrogen and the other with phosphorus. These compounds are called InGaN and InGaP, respectively. InGaN is used in LEDs that produce green, blue, or white light. LEDs that contain InGaP produce red, orange, or yellow. On your way to this year's celebration, you probably passed several traffic or street lights that contain LEDs. And this time of year, many decorative holiday lights also contain LEDs. Many cell phones, as well as televisions and computer monitors, have liquid crystal display (LCD) screens, which rely on ITO films, too. If you brought your smartphone today, thank you for bringing a little bit of indium along to join in the celebration!

Indium is also a frequent addition to shiny, metallic dental amalgam fillings. Dental amalgams contain mercury, which can be toxic if it's swallowed or inhaled. Indium helps keep mercury in the filling, preventing it from being toxic.

One of the more uncommon applications of indium is in nuclear reactors. The rate of the reaction in a nuclear reactor is adjusted with control rods that are raised or lowered into the reactor. Some of these control rods are made of an alloy (a mixture of metals) that contains silver, cadmium, and indium.

GUESTS

Rodney Schreiner

Senior Scientist Emeritus at UW-Madison, he has presented science shows in a wide variety of locations, including the Epcot Center, and has collaborated on 48 Christmas Lectures.

Bucky Badger

He has participated in many of Bassam's Christmas Lectures and public events, and he always obeys the safety rules!

Michael Leckrone

Professor of Music and Director of Bands at UW-Madison, he has delighted audiences for 50 years in a wide variety of venues.

Pro Arte Quartet

UW-Madison Professor of Music David Perry and Artist-in-Residence Suzanne Beia, violin; Professor Sally Chisholm, viola; and Professor Parry Karp, cello. Founded in 1912, it is one of the world's most distinguished string quartets.

Paul Rowe

Professor of Voice at the UW-Madison School of Music, he has performed with many of the leading musical organizations, including the Boston Symphony Orchestra, American Ballet Theater, and Musica Sacra.

Julia Nepper

A science writer at Promega Corporation. In 2017, at age 23, she received her Ph.D. in biophysics from UW-Madison.

Acknowledgements

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is made possible through
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University of Wisconsin-Madison

Department of Chemistry

Wisconsin Public Television

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December 15 at 6:30 a.m.
December 16 at 7:00 a.m.
December 17 at 9:00 a.m.
December 18 at 4:00 p.m.
December 19 at 4:30 p.m.
December 21 at 6:30 a.m.
December 22 at 6:30 a.m.
December 23 at 8:00 a.m.
December 24 at 11:00 a.m.
December 25 at Noon

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