

A TIME FOR PHYSICS FIRST

ACADEMY FOR TEACHERS - INQUIRY AND MODELING EXPERIENCES FOR PHYSICS FIRST

LEADERSHIP IN FRESHMAN PHYSICS, 2009-14

A TIME for PHYSICS FIRST

NEWSLETTER: Vol 4, No. 1, April 2010

FINGERPRINTS AT THE CROSSROADS BETWEEN MATHEMATICS, PHYSICS AND ENGINEERING

Dorina Mitrea, Department of Mathematics, MU



A fundamental trend in modern scientific endeavors is the effort to blur the boundaries not only between the subareas of a given field but also between scientific fields themselves. For example, we have all come to accept the idea that physics and biology can work in tandem and advance our understanding of these fields in ways that were hard to imagine even a few decades ago. Also, while traditionally it was mathematics which served as a tool for developing sophisticated physical theories, such as quantum mechanics and general relativity, it is intriguing to realize that ideas, methods and even terminology originally arising in physics are now making their way into mainstream mathematics more frequently than ever before, thus strengthening and enriching the ties between these two old, fundamental fields of science.

A more recent example in this regard is the historical development of wavelet theory, now a well-established branch of mathematics. In the 1970s Jean Morlet, a geologist by training, worked with Alex Grossmann, a physicist, to solve signal processing problems for oil prospection. They used the French word *ondelette*, meaning "small wave," transferred to English by translating "onde" into "wave," which resulted in the currently used term "wavelet."

In geophysical explorations, aimed at detecting oil deposits, one approach was to use "devices" which broadcast ground penetrating waves whose reflection off various layers of earth, having different physical characteristics, bares the signature of theses layers, thus allowing for a fairly accurate representation of the structure of the earth. This is an example of a non-destructive, non-intrusive method in which the inter-

TABLE OF CONTENTS	
Fingerprints at the Crossroads between Mathematics, Physics and Engineering	1
Highlights of the June 2010 Summer Academy	3
Schools Participating in Summer 2010	3
Introducing our Coaches and Mentors	4
Our Core Partner Districts... ..	8
Brain Benders	9

nal nature of an object is understood without having to physically sample it. From the mathematical point of view, a "signal" can be thought of as a function visualized by its graph. Hence, in the aforementioned experiment, one is forced to be able to recognize patterns in the makeup of a function. Ultimately, this comes down to the ability of identifying certain essential "building blocks" which are common for the class of functions one encounters, much as simple Lego building blocks are used to create complex structures. This is not unlike the insight of Joseph Fourier, a French mathematician and physicist, who in his studies about the heat transfer at the beginning of the 19th century, has succeeded in representing the graphs of fairly arbitrary classes of functions as a superposition of sine and cosine curves with appropriate amplitudes. This has led him to consider what has now become to be known as the Fourier Transform, which is a fundamental tool of modern mathematics. Nonetheless, one drawback of employing sines and cosines is that such curves are not localized, but keep on oscillating with the same amplitudes indefinitely. What Morlet and Grossmann needed were "bulding blocks" which can replace the sines and co-

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sines and which have much better localization (or decay) properties. They partly succeeded in this regard and their efforts were refined and further developed by mathematicians such as Ronald Coifman, Ingrid Daubechies, Stéphane Mallat, Yves Meyer, and many others, into a robust mathematical field, the theory of wavelets.

Wavelets have found applications in many other branches of physics and engineering, such as image compression, denoising, data storing (such as FBI fingerprint database), medical imaging, scattering, etc. To understand how wavelets can be used in image processing, one should consider the fact that a rectangular image consists of pixels while the color of each pixel is associated with a certain number. Hence, ultimately, a picture can be identified with the graph of a function which at each point (corresponding to a pixel) associates the numerical value of that pixel. By decomposing such a function into wavelet building blocks and retaining only the blocks which

have large coefficients, one can economically store the image while retaining only a fraction of the volume of data encoded in the original picture. This can be done with remarkable accuracy: retaining only 25% of the original data still yields an image which renders a remarkably accurate representation of the original as far as the human eye is concerned. Furthermore, given that the wavelets have universal character (are independent of the function analyzed) it is possible to electronically send the numerical values of the coefficients and have the picture reassembled at the receiving end with great accuracy and great speed. The implications for high volume data storing and transmission, such as FBI fingerprint database or in the military, are obvious. Imagine this scenario: a drone plane taking pictures flying high up, even on a cloudy day, can be equipped with a program which enhances the images (denoising), compresses them (as described before), sends them in real time to headquarters where they are reviewed and the decision is taken.

Wavelets have also found applications in computer animated films, human vision, data mining, modem design, astronomy, radar and earthquake prediction, and the list goes on. There is abundant literature on this subject. We refer the reader interested in more details on some of these topics to the easily accessible links listed below and the references therein.

Wavelet theory is a fascinating area, both for scientists as well as for the non-specialists, whose impact on our daily life was hard to predict in its infant stages. The historical development of wavelets underscores the importance of fostering collaboration between scientists working in different fields in the pursuit of the ultimate goal of finding solutions to real life problems and understanding the nature of our universe.

<http://www.ams.org/notices/199511/brislawn.pdf>

<http://www.ams.org/notices/199909/rev-jerison.pdf>

<http://www.beyonddiscovery.org/content/view.txt.asp?a=1952>



Above: How many animals can you find in this optical illusion?

Left: Thirty six Missouri school districts are core partners in the A TIME for Physics First program. Districts are sending between one and seven teachers to the program. The distribution across the state is shown in the map. Thirty six 9th grade science teachers will start in summer 2010. The rest will start in summer 2011.

HIGHLIGHTS OF THE JUNE 2010 SUMMER ACADEMY

Meera Chandrasekhar, Physics and Astronomy, MU

We hope the April 17 pre-academy meeting served to whet your appetite for the summer academy! Here's a short list of what we'll be doing this summer:

Content: We'll be covering four physics units: Electricity, Uniform Motion, (Uniform) Accelerated Motion, and Forces & Newton's Laws. The Curriculum Revision Team has been hard at work editing and worrying over the labs, practice problems and readings. A lot of thought is going into the content, the presentation and the supporting materials, such as student misconceptions, objectives for each unit, etc.

Leadership: The Research and Leadership Team have been putting together a thoughtful package of materials and activities, some of which are tailored by your responses to questions in your applications and during the pre-Academy meeting.

Math Teacher Academy: Building math teachers have been invited to attend the academy with Fellows for a week (June 14-18). They will spend half their time working with Fellows in the classes, and the other half in discussions with each other and the Math faculty member.

Administrator Academy: Building or district administrators have been invited to attend the academy for two days (June 17-18). They will spend time with Fellows, discuss leadership, and confer on ways to support 9th grade physics in their schools.

Vendor Fair: Several vendors of science equipment have been invited to be present during a lunch-time

fair on June 18. Fellows and their administrators will have a chance to discuss equipment and materials with representatives. Several have offered discounts to the project and to schools within the project.

PLC Training: The Heart of Missouri Regional Professional Development Center will conduct training on getting the most out of Professional Learning Communities. Following the training, PLC groups will have time during the academy to get together in preparation for their academic year discussions.

Classes: Classes will meet from 8:30 am to 4:30 pm Mon, Tue, Wed, Thu and 8:30 to 3 on Fridays, with an hour-long break for lunch. The MTWR classes will focus on physics content and pedagogy, while Friday classes will focus on leadership. Included in the schedule are sessions on PLC training, training to use the interactive website, pre- and post tests, and a guest speaker. Help with homework will be available in the evenings (schedule to be announced).

Observatory: The Laws Observatory on the fifth floor of the Physics Building will be open on Wednesday evenings, weather permitting. Members of the Central Missouri Astronomical Association will assist with viewings.

Meals and Recreation: A few lunches during the academy will be catered; several campus eateries will be open in the summer, as well as restaurants in town. The Recreation Center and swimming pool on campus are open in the summer, subscription is required. We'll have

more specific information for Fellows on June 7.

Guest Speaker: Prof. Paul Miceli from the Physics Department at MU will speak on resistance and superconductivity, and will include some intriguing demonstrations.

The Physics First staff is looking forward to working with all of you this summer. Be prepared for an intense, supportive and fun time!

SCHOOLS PARTICIPATING IN SUMMER 2010

Camdenton High School - Horizons

Camdenton High School

Sparta High School

Hillcrest High School

Kickapoo High School

Glendale High School

Bailey Alternative High School

Marceline High School

Winnetonka High School

Trenton High School

West Jr. High School

Simonsen 9th Grade Center

Kingston High School

Kirkwood High School

Mehlville High School

Hancock High School

Hazelwood Central High

Hazelwood East High

Kirksville High School

La Plata High School

Moberly High School

Cooper County High

New Franklin High School

Southern Boone Co. High School

INTRODUCING OUR COACHES AND MENTORS

ATIME for Physics First has a team of coaches and mentors whose task is to provide support for Physics First Fellows. Coaches work with Cohort 1 participants (starting summer 2010) and Mentors work with Cohort 2 participants (starting summer 2011). Coaches and mentors will attend the summer academies with their mentees, and will provide support throughout the academic year. Coaches will visit their mentees 8 times during the academic year, while Mentors will provide support online through the project's interactive website.

Jack Wiegers, Dennis Nickelson and Becky Baker will be coaches. Majed Dweik, James Gage, Dale Orr and Glenn Owens will be coaches and mentors. Joan Twillman and Linda Kralina will be mentors only. Below are short biographies.

BECKY BAKER, COACH

Becky Baker has been a member of the Department of Physics, Astronomy and Materials Science at Missouri State University in Springfield, Missouri since 1990. She has been on leave for the last three years serving as the Director of the Missouri Virtual School (MVS) at Missouri State University. Throughout its twelve year history, MVS served over 3,000 high school students and 112 school districts across Missouri using a variety of distance education formats delivered synchronously. During its history she taught distance education classes in chemistry, physics, general science, astronomy and college algebra. Previous to her time at Missouri State she taught high school at St. Francis Borgia in Washington,

MO, Republic High School in Republic, and Hillcrest High School in Springfield. When she rejoins the department this fall she will be teaching the two introductory trig-based physics classes and the beginning astronomy class as well as serving as a coach for the Physics First program. Her teachers come from three school districts - Springfield, Camdenton and Sparta.



Outside of class Becky enjoys a number of activities. Currently she is in the process of starting a long-term project on the interior of her home that includes painting walls, woodwork and pulling carpet up to expose the hardwood floors underneath – discovered in the aftermath of a small fire. In addition to working on the house, she enjoys antiquing, flying kites and exploring old trails in a jeep while geocaching. She would also like to do more traveling across the United States and Canada. Her favorite trip so far was in 2004 to Colorado and Utah spending time in the mountains, exploring the Canyonland and

Arches National Parks and, among other things, seeing dinosaur prints for the first time.

Becky lives in Springfield with two pets – a cat named Sadie and a dog named Biscuits – both of whom are sure they are the “top dog.” Biscuit is an escape artist and is constantly looking for new ways of getting outside to chase the other cats out of the yard. Sadie prefers to lounge around the house and be pampered whenever she wants.

MAJED DWEIK, PHD.

Dr. Dweik is an assistant professor in the department of Life and Physical Sciences at Lincoln University. He is an instructor for several physics classes including General Physics for Engineers, Thermodynamics and Nanotechnology.

He is currently working on several funded projects. Students from different levels, including K-12 students, participate in a hands-on-experimental project to learn about nanotechnology. The approach used is based on four types of experiments: fundamentals of nanotechnology, fabrication of nanomaterials, characterization of nanomaterials and applications



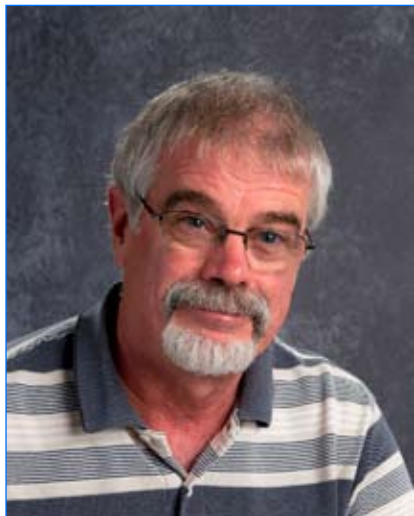
of nanotechnology. Participating students from physics and other sciences use skills learned from science and math classes to perform experiments. These students will later go on to more advanced applied research, such as implantable nanobiosensor development.

Dr. Dweik is currently a Councilor-at-Large for the Institute of Biological Engineering (IBE) and member of American Association of Physics Teachers (AAPT), The Institute of Electrical and Electronics Engineers (IEEE), Alpha Epsilon honor society and Sigma Xi Chapter of the University of Missouri-Columbia. Dr. Dweik was a nominee for 2009 Governor's Award.

JIM GAGE, COACH AND MENTOR

My interest in being a coach for this project is two fold. Firstly, I wish to share the experiences and knowledge given to me over by 35+ years as a mechanical engineer and teacher. Secondly, I hope to assist in reversing the decline in American students' educational standing worldwide in science and mathematics.

I live in Kirksville, Mo. For 14 years I have had the pleasure of working as the Director of Engineering for Kraft Food Inc., North American Division. During that tenure, the department had a staff of 12 professional architects, engineers and packaging machine designers. We were responsible for capital improvements, new product support and major physical plant improvements for 114 manufacturing plants throughout North America. I left Kraft to open an engineering and project management consulting firm in the Chicago area. For the next 10 years the firm was responsible for numerous mechani-



cal system design projects for high-rise construction in Chicago. The firm also developed a reputation for forensic studies of mechanical system design problems and failures. Upon retirement, I obtained a Missouri teacher certificate to pursue my interest in sharing my experiences and knowledge. I have spent the last 5 years at Schuyler School District teaching dual credit science and math courses, as well as secondary math and science.

I have a BS Engineering, SUNY Maritime College; MS Engineering Manhattan College; 36 credits toward MS Education, DePaul University. I am a Licensed Foster Parent, Behavioral Adolescent Boys; Collector Rare Orchids; and Adjunct Instructor of the Local Community Colleges.

LINDA KRALINA, MENTOR

Dr. Linda M. Kralina has taught college physics classes as well as various high school science classes for several years, including general science, chemistry, organic and AP chemistry, and advanced and AP Physics. She currently teaches the Life & General Science Methods classes for pre-service teachers at University of Missouri-St. Louis.

Active in her profession, Dr. Kralina has served as Convention

Chair for the national convention for NSTA in St. Louis, the Missouri State STOM convention, chaired the World Year of Physics celebration in partnership with the St. Louis Science Center and SLAPT, and chaired the Hospitality Committee for NSTA 2007 when it was moved to St. Louis from New Orleans. She has presented at numerous conferences and conventions.



During her high school teaching career, she has sponsored several extracurricular science clubs, including Suzy Science and the Whiz Kids, costumed teenagers who performed science demonstrations for over twenty elementary schools, numerous PTAs, and American Chemical Society celebrations. Other clubs include JETS, Battle of the Burets, TEAMS, STARS, FIRST Robotics, Science Olympiad, Name the Orbiter and Science Fair. Her students have won many awards at the local, state and national levels. Her dissertation focused on the impact of extracurricular science clubs to increase student interest in science and teaching.

Dr. Kralina has received many awards during her career, including the prestigious Presidential Award for Excellence in Math and Science

Teaching, the National Thanks to Teachers Award, Monsanto Science Teacher Award, Missouri Outstanding Science Teacher Award, American Chemical Society Teaching Award, National Tandy Technology Teacher Award, and UMSL Distinguished Alumni Award.

DENNIS NICKELSON, COACH

Dennis Nickelson is an Assistant Professor of Mathematics and Physics at William Woods University in Fulton. He obtained his B.S.E. in chemistry and physics from Central Missouri State University (University of Central Missouri), a M.Ed. from Lincoln University, and an Ed.S. and Ph.D. from the University of Missouri, Columbia. He was elected to the school board of Jefferson City Public Schools in Spring 2010.



A retired physics teacher and science chair from Jefferson City High School, Dr. Nickelson has 30 years experience teaching in Missouri public schools. He spent five summers on the faculty of the Missouri Scholars Academy. He served as the Central Missouri Science Olympiad Director for eleven years. He has been an adjunct professor for Lincoln University, Linn Technical State College, Columbia Col-

lege, and University of Missouri, Columbia. He is also the chemistry and physics teacher for the Missouri Distance Learning High School after authoring the courses.

Dr. Nickelson has served as senior staff on several professional development projects for Columbia Public Schools, the Missouri Constructing Physics Understanding in a Computer Enhanced Environment, and Making Science Accessible Through Inquiry and Literacy for the St. Louis Public Schools (COPi). He served as a coach mentor and a peer teacher in the A TIME for Physics First Project funded by Mo-DESE (2005-08).

DALE ORR, COACH AND MENTOR

Dale is a retired teacher from the North Kansas City School District where he taught for twenty five years. While teaching in the district he co-sponsored the science Olympiad team at Winnetonka High School for almost twenty years and Oak Park High School for one year. Prior to teaching in the North Kansas City District, he taught in the Smithville School District for seven and a half years. As a teacher/student advocate, Dale served on North Kansas City NEA's execu-



tive board and as their president for four years.

Dale is currently training for his second half-marathon and enjoys spending time with his wife, three adult children and two grandchildren.

GLENN OWENS, COACH AND MENTOR.

Here's my story: I am a retired science/art teacher, with a Master's in curriculum design. Just after I retired from teaching, I became a coach mentor during the earlier phase of Physics First. The PF program was a good thing for me. It allowed me to slowly phase out of the classroom and made it possible for me to work with lots of physics teachers from all parts of the state of Missouri.



On the personal side, I live in south St. Louis city with my wife, who has a stained-glass business, and we are building an addition onto our home. During breaks from remodeling, I am writing a novel, maybe three, about spies, cars, international politics and true love. I have three adult children, all of whom are successful and happy in their endeavors. I have wide ranging interests: construction, electric-

ity, mechanics, painting, stained glass, model railroading, photography, writing, bicycling, swimming, gardening and other things that happen to pique my interests (can you tell that I have ADD?). I always worked during summer breaks, doing everything from construction to working in science labs. I retired, after 22 years, as an intelligence officer in the US Navy Reserves. All-in-all, life is good.

JOAN TWILLMAN, MENTOR

Joan Twillman earned a Bachelor's degree in Chemistry from UMSL and a M.Ed. from National Louis University. For 24 years, she taught science in the City of St. Charles School District in classes that included Physical Science, Chemistry, Science Research, and Forensic Science. Joan sincerely enjoyed being the sponsor for a science club whose mission was to "have more fun than any other team while competing honorably" in Science Olympiad, WYSE, Envirothon, Battle of the Burets, Science Fair, Junior Science, Engineering, and Humanities Symposium, and other events, ranging from the local to international level.

She has published articles in "The Science Teacher" and "The Forensics Teacher," and has presented workshops at the local, state and national level. Last year she received the Monsanto Science Teaching Award and in 2007 she was named Outstanding High School Teacher by the Science Teachers of Missouri.

Although "retired," Joan is the St. Louis Regional C- Division Director of the Science Olympiad. Among other things, she volunteers as a Master Naturalist assisting with controlled burns, cleaning a cave, facilitating educational opportuni-

ties for teachers and students, and working to schedule field trips and speakers for adult learners. She also helps with the Forensic Science Educational Programs at Saint Louis University, and enjoys mentoring individual students with research projects in a wide variety of fields. A strong belief that science is fun, interesting, and quite important for the continued social and economic success of the U.S. drives her enthusiasm for physics.



Hobbies include science in almost any form, reading, going places, and enjoying the rivers of Missouri. Joan is an avid kayaker who registered this year as one half of a Women's Tandem team in the MR-340, an 88 hour kayak and canoe race from Kansas City to St. Charles, which will be held this summer. The team name? "Science Is Fun."

Joan and her husband Ron are longtime residents of St. Charles, MO where they live in, and work on a century-old house. They have three grown sons and one granddaughter.

JACK WIEGERS, COACH

In the early 1950s, while I was in college, I started teaching part time. Every September since has found me in a classroom. I have taught in Europe and Central America and at the elementary through graduate level. From 1970 to early

1990s, I worked in the School District of University City where I taught mathematics, earth science, physics and physical science. In the late 1980s, I became a co-principal investigator for a NSF-funded professional development program for University City elementary teachers. In 1992, I became a staff officer at the National Academy of Sciences for the working group developing the National Science Education Standards.

Since 1991, I have been teaching at Washington University, St. Louis, MO in the Science Outreach Program that works with school districts and teachers. During these last nineteen years, I have team-taught courses with and for many remarkable elementary, middle and high school teachers who have enriched my life. I have participated in national and local NSF funded projects—sometimes as participant and sometimes as part of the staff. In the last three years, I and my teaching partner, Patrick Gibbons, professor of physics, have worked with all the 9th grade science teachers in the Hazelwood School District to implement A TIME for Physics First program.

I have done graduate work in physics, philosophy, and divinity and extensive work with the Psychoanalytic Foundation in St. Louis. From this work, for a long time my interest has been in understanding research about the nature of knowledge and inquiry learning/teaching and helping teachers and myself use this work in our teaching science. I am looking forward to sharing with others who are interested in coaching, mentoring and the teaching of physics.

OUR CORE PARTNER DISTRICTS...

DOES K-14 MEAN YOU HAVE A COMMUNITY COLLEGE?

ELIZABETH DYER

One of the first questions people ask about Kingston K-14 is, "What is the meaning of K-14?" It doesn't fit the standard R or C code. In 1956, 14 rural K-8 school districts consolidated to form Kingston K-14 district. The first high school graduating class occurred in 1999.

Kingston remains a small, rural school district. We are located between Potosi and DeSoto, about 58 miles south-west of the Arch in St. Louis. The high school has 284 students, including community school students who have returned to school after a break in their education. There are 22 high school teachers. Next year, we will enroll our entire new Freshman class of 55 students in Physics First, plus any returning sophomores back for another round.

Kingston's mascot is the Cougar. Since we do not have a football field, our largest sports team is Power Lifting, but the track, basketball, volleyball, baseball and softball teams are growing. We are an A+ School and participate in the High Schools That Work program. Due to hard work from all students and staff, we received DESE's Distinction in Performance for Improved Achievement Award for 2008/2009. We continue to stress high rigor in all our classes so that our students will be ready for continuing education and successful careers.

MCDONALD COUNTY R-1

SHERYL MADDEN

McDonald County is located in the southwest corner of the state. Major industries in the area other than the school district, include Tyson Food, Inc. and Simmons Industries, Inc. which are chicken processing plants as well as many chicken and turkey farms and cattle ranches. Tourism is another industry for the county with several creeks and rivers offering canoe trips, camping and fishing. McDonald County has six communities with six Jr. High Schools that feed into the centralized McDonald County High School. The high school serves approximately 1100 students in grades 9-12. The two Physics First teachers will serve 200-250 students. We are proud to say McDonald County R-1 received the award of Distinction in Performance in the state of Missouri.

PHYSICS FOR ALL STUDENTS IN COLUMBIA

SARA TORRES

Columbia Public Schools implemented freshman physics for ALL students in 2006. All three junior highs and our alternative school offer the course. Since 2006, we have developed a honors freshman physics course and a physics/engineering course.

During our implementation of freshman physics, it was necessary to provide additional professional

development beyond what a grant provides. The district had all of the teachers who were involved in implementing freshmen physics meet throughout the year for daylong collaboration. This provided the opportunity for teachers to discuss the challenges, surprises, and strengths of implementing the curriculum.

SPRINGFIELD PUBLIC SCHOOLS

ANNE WALLENMEYER

SPRINGFIELD PUBLIC SCHOOLS EXISTS FOR THE ACADEMIC EXCELLENCE OF ALL STUDENTS.

Welcome to Springfield Public Schools located in Springfield, Missouri.

Established in 1867, Springfield Public Schools is today the largest, fully accredited school district in Missouri with 23,972 students, 36 elementary schools, an intermediate school (grades 5-6), nine middle schools, five high schools, an alternative high school, a gifted school, and an early childhood center. Beyond that, more than a dozen choice programs are available to meet the diverse needs of many students.

Each of our schools and programs align with our three primary district goals of improving student achievement, improving the graduation rate, and ensuring effective and efficient use of resources.

For more information, go to our Web site <http://www.springfield-publicschools.org>.

The newsletter will publish profiles on Core Partner Districts on a regular basis. We invite Physics First Fellows, math teachers and administrators to a stories about your district. You may email submissions to the editors, or use the newsletter article submission form on the website.

BRAIN BENDERS

Dorina Kosztin, University of Missouri

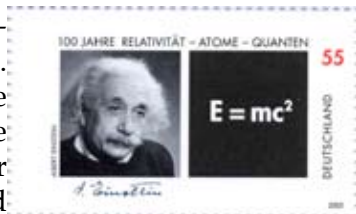


CUTTING ICE

A single ice cube is floating in a glass of water. You hold a piece of string about four inches long. Problem: without touching the ice with your fingers, lift the cube out of the glass using the string.

VANISHING STAMP

Place a postage stamp face up on a table. Set a glass of water on the stamp. When looking from above or from the side, you can see the stamp. Cover the glass with a saucer that has a diameter bigger than the glass. Walk around the glass, peering into it from any angle you want: the stamp is now completely invisible! WHY??



COLORFUL CEILINGS

Place a pocket mirror in a bowl of water so it is at an angle of about 30 degrees to the surface of the water. Darken the room and shine a flashlight toward the mirror. What do you see, and why?

From "Entertaining science experiments with everyday objects" by Martin Gardner.

Answers to December 2009 Brain Benders

1	V E	LO	C I	TY		
2	TH	E R	MA	L		
3	RA	D I	AN	T		
4	S O	UN	D			
5	C O	N S	ER	VA	TI	O N
6	NU	C L	EA	R		
7	WO	R K				
8	K I	NE	TI	C		
9	T E	MP	E R	AT	U R	E
10	C H	EM	I C	AL		
11	C R	EA	TE	D		
12	DE	S T	R O	YE	D	

FAST FACTS:

Grant period: September 1, 2009 - August 31, 2014
 Funding Agency: National Science Foundation
 First summer academy: June 7-July 2, 2010
 Pre-Academy Meeting: April 17, 2010
 Target Participants: Ninth grade science teachers in Missouri school districts
 Contact:

Sarah Hill
 Department of Physics and Astronomy
 University of Missouri
 Columbia, MO 65211
 Telephone: (573)-882-7997
 FAX: (573)-882-4195
 Email: hillsar@missouri.edu

Further information: Please refer to the project website, www.physicsfirstmo.org

EDITORIAL BOARD:

Sarah Hill hillsar@missouri.edu
 Meera Chandrasekhar meerac@missouri.edu
 Sara Torres storres@columbia.k12.mo.us

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 Department of Physics and Astronomy
 University of Missouri, Columbia MO 65211

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Pre-Academy meeting, April 17, 2010. Physics Building, MU

From:

A TIME for Physics First
223 Physics Building
University of Missouri
Columbia MO 65211