

STEM Society Meeting, April 12, 2016

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Last Edit: 5/1/2016

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1 About the STEM Society and the STEM Society Website

STEM is an abbreviation for Science, Technology, Engineering and Mathematics. The acronym STEM is commonly associated with K-12 education, but our use of the term is only slightly bound to this meaning. There are over one hundred people on the mailing list, although a much smaller group attends any one meeting. We meet on the second Tuesday of each month at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The meetings are open to all. The start time is 6PM. We make presentations, have discussions, and have demonstration experiments. These relate to Science, the History of Science, Mathematics, Engineering, Philosophy and Technology at all levels. The topics have ranged from a technical discussion of the Mathematics of General Relativity to scientific experiments for young students.

These meeting notes contain links to many other documents, which may be viewed or downloaded by clicking the link. A partial list of documents can be reached by clicking the heading **Documents**. The meeting notes may also be viewed in an archive file (archive.pdf), which is in the list of documents. Many of the documents are PDF files. They may be viewed or downloaded to the computer by clicking, provided Adobe Reader, or another program capable of reading PDF files, is present. There are many more documents available at the site than are listed under **Documents** because the documents.htm file is not at all up to date. The last time I checked, about March 2014, there were about 350 document files on the site. We are in the process of creating better techniques for finding documents and authors. The first meeting of the STEM Society was in November of 2006. For several years we used the content management program called Joomla. It had a fancy looking interface, but was hard to use. It overran the space somehow at our internet provider Bluehost. So we now have a very simple HTML site. It is not so slick looking as Joomla, but is very easy to maintain and modify.

The web site is:

<http://www.stem2.org/>

Direct to the documents list:

<http://www.stem2.org/je/documents.htm>

Direct to the archive file:

<http://www.stem2.org/je/archive.pdf>

2 The April 12, 2016 Meeting Announcement

The April meeting of the STEM Society will take place on the second Tuesday of the month, April 12, 2016, at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The starting time is 6PM. Also look at our website for past meeting notes:

The web site is:

<http://www.stem2.org/>

Questions, Topics and possible Discussions:

(a) What is the connection between the Black and Veach Engineering Company, two female mathematics professors, a great world famous mathematician of the 20th century, and the early 20th century histories of Kansas University, Nebraska University, and Princeton University?

(b) What is the Mpemba Effect in Thermodynamics and what is the connection with Africa, with very early philosophers and scientists, and with generations of high school Physics students?

(c) What is a topological knot, what does chiral (rhymes with π as pronounced in English speaking countries) mean, and what is the connection with Chemistry and DNA?

(d) What is a Spherical Harmonic, and what is its connection with Legendre Polynomials?

(e) How do you design gears that transmit uniform angular velocity? How do you make such gears with a laser cutter? What is the connection with the first American student to be given a PhD in Physics. What is this student famous for?

(f) As always, attendees are free to bring, and should bring additional topics, things, ideas, and presentations. We need more presentations from our very

diverse and experienced fellowship.

3 Rich Kaufman: Fracking, Cornell University, and the Marcellus Shale

Rich explained Hydraulic Fracturing of shale to obtain methane, and its dangers. The Marcellus shale underlies several of the eastern states including parts of New York and Cornell University, which especially concerns Rich, who is a graduate of Cornell, and is concerned about preserving this beautiful Finger Lakes region of New York.

Drilling is guided initially vertically, but then changes to a horizontal direction. So the shale lies very deep and is reached first by drilling vertically. When the proper depth is reached the drilling turns 90 degrees and goes horizontally. An extremely high pressure liquid is pumped into the pipe from above with high pressure compressors fracturing the rock and allowing gas to escape from the rock back up the pipe. There are several threats to the environment posed by these operations.

We viewed a map of the Cornell campus and discussed several items about Cornell.

Cornell is a private Ivy League University but actually receives public support too. But this support goes primarily to the Agricultural part of the University. Cornell is a land grant university and received public land through the Morrill act of the 1860's. But Kansas University is actually not a Land Grant University. And the University of Missouri is not one either, a fact I did not know before our discussion.

4 Hot Water Freezes Faster Than Cold Water

This is a claim that has been around forever. One author says that even some of the ancients made the assertion that hot water freezes faster than cold. Some have claimed that the experiment was conducted first by an African high school student named Mpemba, and he was the first to observe this paradoxical outcome.

Freezing of a liquid like water, is a complex process involving radiation, convection, the type of environment, the type of container, the fact that water does not have a uniform temperature as it cools, the fact that freezing is not well defined, because ice usually forms at the top of a water surface due to the density of ice being of lower value than the liquid water, and that water does not freeze in an instant, and there is a general vagueness in defining the experiment, often poor measurement, and so on. Some consider the whole topic belonging to pseudoscience. Many papers have been published over the years, and none have been very convincing one way or another, as far as I know. The paradox is most evident if one assumes that cooling water at any specific time has a constant uniform temperature throughout the volume of water, a fact that is definitely not true. This reminds us a little of the controversy over "Fusion in a Jar," which some researchers still continue to pursue to this day. This reminds us that science is hard, and the idea that there are certain simple steps, called "the scientific method," which if followed always lead to truth, is a chimera.

The reason that I introduced the topic was seeing a journal of high school science at Linda Hall library on this topic, and thought it might generate some interest.

I collected a little information and put it in a preliminary document called **Freezing Water: Hot vs Cold**, which contains a few references, and is very incomplete. I doubt I will pursue it any further.

<http://www.stem2.org/je/cooling.pdf>

5 The First American PhD in Physics

J. Willard Gibbs was received the first PhD in physics given at an American University (Yale). He wrote a thesis on **Spur Gears**. He created Vector Analysis, and founded much of Statistical Mechanics, and was one of the greatest physicists of all time.

We did not have time to discuss the theory of involute gears, which allow uniform angular velocity to be transmitted.

6 Knot Theory

We discussed the mathematical theory of knots, and its application to chemistry, DNA, and chirality (chiral is pronounced $k\bar{i}ral$, which means handedness). For some **Knot Theory** references see:

<http://www.stem2.org/je/knots.pdf>

7 Spherical Harmonics and Legendre Polynomials

We discussed some of the material contained in the following document:

<http://www.stem2.org/je/legendre.pdf>

8 Solomon Lefschetz, Wealthy Babcock, Florence Black, and Black & Veatch

The great Mathematician Solomon Lefschetz, Professors Wealthy Babcock, and Florence Black of the University of Kansas, and the engineering company Black & Veatch have some interesting connections, which are explored below.

For possible updates or corrections to this material see

<http://www.stem2.org/je/lefschetz.pdf>

8.1 Solomon Lefschetz

Solomon Lefschetz was born in Moscow in September 3, 1884 and died on October 5, 1972 in Princeton New Jersey. He was one of the most famous mathematicians of the 20th century. His family moved to Paris shortly after his birth, so he was educated in France, and thus French was his first language. He graduated from the École Central in Paris as an engineer. Shortly after graduation he emigrated to the United States in 1905 and worked there for the Baldwin Locomotive Works, and then from 1907 to 1910 at Westinghouse in Pittsburgh. He lost both of his hands there in an accident when they were blown off, or burned off, in a transformer explosion. So he turned to

Mathematics, and obtained a Ph.D. from Clark University located in Worcester, Mass. in 1911, with a thesis in Algebraic Geometry. Then he found a position teaching at the University of Nebraska, which lasted from 1911 to 1913, and then he found a better position at the University of Kansas. He spent 10 years there from 1913 to 1923. His experiences in Nebraska and Kansas are outlined in an article, called **Reminiscences of a Mathematical Immigrant in the United States**, which he wrote for the American Mathematical Monthly in 1970, which is quite interesting, outlining the poor preparation of the students in these schools at the time since in state schools such as these, all high school graduates of the particular state were guaranteed admission. The quality of the students increased somewhat as many of the students flunked out. As one having attended the University of Nebraska, I can attest that the goal of the faculty at these schools was to flunk as many of these students as possible, which made for quite a bit of pressure at these schools, in the freshman year, on the students to avoid this fait.

But Lefschetz enjoyed his time in the midwest, being able to accomplish much research, and to publish many papers. So he received an offer to join the faculty at Princeton in 1924, which he accepted and he stayed until 1953. He founded much of Algebraic Topology, and introduced Topology to the field of Algebraic Geometry. Both of these subjects are very difficult areas in mathematics. He was editor of the prestigious **Annals of Mathematics** from 1928 - 1958, won several prizes, was president of The American Mathematical Society for a couple of years, and head of the Princeton Mathematics Department for a long period, while Princeton was considered the top mathematics department in the United States. During the Second World War he became interested in the Area of Nonlinear Differential Equations, and made contributions that revolutionized this field. He was made a Fellow of the Royal Society.

For more about Lefschitz see the Wikipedia article on him, the biography published by the University of St Andrews, and an interesting chapter of the popular book by Sylvia Nassar about John Nash called "A Beautiful Mind," which in chapter 4, discusses Lefschetz as head of the Mathematics Department at Princeton. This book was made into a popular movie. See the bibliography.

8.2 Wealthy Babcock

Wealthy Babcock was a professor of Mathematics at the University of Kansas. She grew up in northern Kansas on a farm. She was born on November 18, 1895 and died April 10, 1990. She and Florence Black both received the Ph.D. in 1926. Babcock's thesis was on Projective Geometry. She Retired from Kansas University in 1966. She taught courses such as Advanced Calculus. Kansas University had for a long time departmental libraries. Besides her heavy teaching load she managed the departmental mathematics library from the 1930's to her retirement. The library was located at 207 Strong Hall and existed from 1926 to 1989. It was named the Wealthy Babcock Mathematics Library in her honor. In the 1985 interview Babcock named a couple of her outstanding students: Conyers Herring and — Bell (also mentioned by Lefschetz). She talks about Solomon Lefschetz in her interview and how he became a world famous mathematician and she said he was very amusing, and very nice to her. When Babcock had her orals, Lefschetz returned to Kansas from Princeton to participate. She has a story about her umbrella which she stored in the mathematics office so that she and Miss Black could find it when there was a sudden rain storm. She relates how Lefschetz had "stolen" the umbrella giving it to some female student during a rain storm. At Kansas at the time one could not graduate without demonstrating the ability to swim 50 feet. Babcock did not know how to swim, and had difficulty with this, although later became a better swimmer.

Babcock and Florence Black were both very interested in athletics and in travelling. When they obtained their Ph.D.'s in 1926 for example they bought a Ford and drove to La Jolla California. This was not easy in 1926, there being few paved roads. Babcock and Black loved horses and had a farm at 23rd and Louisiana where they kept their horses.

Just a few months ago I found a mathematics book at a thrift store with Babcock's name in it. I don't remember meeting Babcock when I was a graduate student in the Kansas mathematics department from 1968 to 1973. She had retired by then, but was still around, so I probably did see her, but did not know who she was.

8.3 Florence Black

Florence Black was a professor of mathematics at Kansas University from 1926 to her retirement. She was known as "Blackie." Each year a teach-

ing award is given at Kansas University called the Florence Black Teaching Award, which was named in her honor at the time of her retirement.

Florence was the younger sister of the founder of the Black and Veatch Engineering Company. Florence and Wealthy spent a lot of time together riding horses and taking car trips. Florence taught many of the same courses as Wealthy Babcock. Florence received the Ph.D. at the same time as Babcock in 1926.

From the internet:

Biography:

Florence Black (Nov 22, 1889-Sept 13, 1974), affectionately known as "Blackie", served for years as an outstanding, rigorous Mathematics Professor at the University of Kansas. Extremely active in University life, she was an ultimate fan of KU Athletics.

Miss Black received her AB degree in 1913 from KU, and then went into secondary education. She taught at Anthony (KS) High School from 1912-1915 and at Wichita High School from 1915-1918. At that time, she returned to KU as an Instructor of Mathematics, earning her MA in 1921 and her PhD in 1926. She taught at the school for 42 years before retiring from active teaching in 1960. During that time, she taught many mathematics and engineering students analytic geometry, calculus, and differential equations. She was described as "sympathetic and patient with those who were trying to learn, but demanding with those who were careless and lazy." In honor of her work, the Florence Black Teaching Award in Mathematics was established upon her retirement. Perhaps the most telling statement of her teaching style came from Chancellor Mallott: She always impressed me because she seemed to be interested in teaching students, rather than peddling a discipline.

The University greatly benefitted by Professor Blacks devoted enthusiasm and dedication to extracurricular activities. She served as a member on the Committee on Scholarships for 20 years, the College Faculty Secretary for 19 years, Treasurer of the University Chapter of Sigma Xi (an international honor society for engineering and science) for 12 years, and Treasurer of the Womens Faculty Club from 1930 to the 1970s, when the club disbanded. Professor Black was the faculty adviser of the Jay Jaynes, the KU womens pep club, from its founding until 1952. She loved the outdoors, swimming, tennis (she and her sister won the high school tennis doubles championship), horseback riding, camping, and was well known by the students for this energy, as the campus was much smaller then. Students, mathematics or not, all knew her for her car, Algebraic Analytic, or Algie Ann, for short. She famously es-

caped a shipwreck on a trip to Alaska in 1939, and visited Tanzania, Uganda, and Kenya in her lifetime.

Florence Black held a phenomenal record of attendance at KU football and basketball games. Attending with her best friend and fellow Mathematics Professor Wealthy Babcock, Miss Black did not miss one single basketball game from 1918 to 1973 and missed no football games until it became too cold for her. She and Wealthy could be found every Saturday morning at the team football meetings, reviewing film. Legendary KU Football Coach Don Fambrough once said, "Every coach deserves to have at least one fan like Florence Black."

8.4 The Black and Veatch Engineering Company

Ernest Bateman Black 1882-1949 was the founder of Black and Veatch Company along with Nathan Thomas Veatch. Ernest Bateman Black and Nathan Thomas Veatch were engineering students at Kansas University. They started their company in 1915 with 12 employees, they were supported originally with power and water government contracts. Black and Veatch worked on Sandia and Los Alamos projects over the years.

Mike Wolf and Diane Query, my coworkers at Allied-Signal, both worked at Black and Veatch. Mike worked on a Sandia Solar Energy Project involving a field of mirrors focusing sunlight on an elevated boiler. Black and Veatch now in 2016, has 10,000 employees in 50 offices around the world. From a company history obtained from the internet:

History of Black and Veatch

Black and Veatch was founded in 1915 as a two-person partnership between former University of Kansas School of Engineering graduates Ernest Bateman (E.B.) Black and Nathan Thomas (N.T.) Veatch. The company began with 12 employees and an office in Kansas City, Missouri. It landed two large contracts, one in power and one in water, in its first year. The company's strong ties with government work began in 1917, as the United States Government War Department asked Black and Veatch to supervise construction of military training camps during World War I.

In the early years, the company mostly focused on water and power projects throughout the Midwest. In 1928, Black and Veatch designed and constructed 250 miles of roadways for Jackson County, Missouri. During that time, N.T.

Veatch formed a strong friendship with Harry Truman that lasted through Trumans presidency. Following World War II, Black and Veatch became involved with the work at the United States Atomic Energy Commission at Los Alamos, New Mexico ...

8.5 Bibliography

Lefschetz published many books, a few are listed here.

[1] Babcock Wealthy, **1985 Interview**, Professor Tom Lewin babcockwealthy.pdf

[2] Lefschetz Solomon, **Reminiscences of a Mathematical Immigrant in the United States**, American Mathematical Monthly, Vol. 77, 1970, pp. 344-350. <http://www.ams.org/samplings/math-history/hmath1-lefschetz14.pdf>

[3] Wikipedia (Solomon Lefschetz).

[4] **Lefschetz Biography**, University of St Andrews. <http://www-groups.dcs.st-and.ac.uk/history/Biographies/Lefschetz.html>

[5] Lefschetz Solomon, **Differential Equations: Geometric Theory**

[6] Lefschetz Solomon, **Algebraic Topology** American Mathematical Society, 1942.

[7] Lefschetz Solomon, **Algebraic Geometry**, 1953, 2nd edition 1964, Princeton.

[8] Nasar Sylvia, **A Beautiful Mind**, Touchstone. 1998, *See Chapter 4, School of Genius, Princeton Fall 1948, which contains interesting material about Solomon Lefschetz.*