STEM Society Meeting, January 12, 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 January 12, 2016 Meeting Announcement

The January meeting of the STEM Society will take place on the second Tuesday of the month, January 12, 2016, at the Trailside Center at 99th and Holmes in Kansas City, Missouri. The starting time is 6PM.

Questions, Topics and possible Discussions:

(a) We can look at some of the topics we did not get to fully last meeting, including Dirac, and Historical Adventures in Arithmetic.

(b) Tom Grant will present the elements of Nuclear Reactor Engineering.

(c) 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 Tom Grant: A History of Nuclear Weapons

Tom Grant has a quite distinguished career in several areas. At one time he was an army officer stationed in the Pentagon, where one of his his assignment was checking on the condition of nuclear weapons at various sites around the world, so he has quite a bit of knowledge of such gadgets. Tom had several handouts including the following:

- A nine page document, **Nuclear Weapons Technology and Politics**, by Thomas J. Grant, 1977.
- Two Books, titled **Nuclides and Isotopes**
- A nice color 8.5 by 11 Periodic Table of the Elements.
- a large chart, maybe 4 ft by 10 ft, outlining various nuclear reactions and chains with energies and so on.

A considerable amount of time was spent going over the **Nuclear Weapons Technology and Politics** document. This document covers notable developments and occurrences in this area from 1932 to 1976. Then Tom went over such developments from then, up to the present time. He talked about the loss of nuclear weapons by various accidents and plane crashes both by the U.S. and the Soviet Union. There have been about 50 such losses by the U.S. and many more by the Soviet Union. Many have never been found, having fallen into oceans and such. Recently there has been a weapon found

in the ocean near Savannah Georgia by amateur divers. Tom also went over the technology of PET scans Positron Emission Tomography. Last month Tom gave an ad hoc talk on Nuclear Reactors, including the saga of missing radioactive material that had originated in Africa. It turned out that there was no missing material at all; an explanation turned out to be that there had been natural fission occurring in Africa many many years ago. One of the articles written about this was published in Scientific American in 1976:

[1] Cowan George, **Natural Fission Reactor**, Scientific American, Volume 235, issue 1, July 1, 1976.

There have been other articles written about this since. See the Wikipedia article **Natural Nuclear Fission Reactor**. Some people still believe that nuclear reactions were created by man, and that if scientists had been prevented from working on nuclear reactions, nuclear bombs would not exist. However, these reactions are not artificial but in fact power the sun, and produced the atomic elements. Hence the control of nuclear weapons depends largely on politics, not on the control, or secrecy of scientific knowledge.

There was an article on Tuesday January 12th, on new production of nuclear weapons, published in the New York Times, and republished in many other newspapers, including the Kansas City Star.

4 Review by Rich Kaufman: The Manga Guide to Relativity

Rich found parts of this book interesting.

This book is available from the Johnson County Library.

[1] Hideo Nitta, **The Mango Guide to Relativity**, Ohmsha Ltd. of Tokyo, Japan, 2009. *This a graphic book, that is, a comic book, interspersed with a few traditional elementary mathematical sections.*

5 Jim Emery Review of A Biography of Paul Dirac

[1] Farmelo, Graham, **The Strangest Man: the Hidden Life of Paul Dirac, Mystic of the Atom**, 092715 kcmo, LHL Books (QC16.D57 F37 2009)

This book can be found in the Linda Hall Library, or in the Kansas City Missouri public Library.
Also see:

[2] Dirac Paul A. M., **The Principles of Quantum Mechanics**, 4th Edition, 1957 edition, reprinted 1993, Oxford University Press.

My complete review document may be downloaded as:

`http://www.stem2.org/je/dirac.pdf`

Contents of the Document

6 Historical Adventures in Arithmetic: Casting Out Nines

What is the number 352648 mod(9) (that is, what is the remainder upon division by 9)? If a number is divisible by 9, then the number mod 9 is zero, because the remainder is zero. For the same reason if $n = n_1 + n_2$ and n_2 is dividable by 9, then

$$n\text{mod } 9 = n_1\text{mod } 9.$$

We have

$$352648 = 3(100000) + 5(10000) + 2(1000) + 6(100) + 4(10) + 8.$$

So we can rewrite it as

$$(352648 = 3(99999+1)+5(9999+1)+2(999+1)+6(99+1)+4(9+1)+8)\text{mod } 9$$

$$= (3+5+2+6+4+8+(3*99999+5*9999+2*999+6*99+4*9))\text{mod } 9$$

$$= ((3+5+2)+6+4+8)\text{mod } 9$$

$$= (1+6+4+8)\text{mod } 9$$

$$= ((1+6+4)+8)\text{mod } 9$$

$$= (2+8)\text{mod } 9$$

$$= ((2+8))\text{mod } 9$$

$$= 1\text{mod } 9$$

Indeed

$$352648 - 9 * 39183 = 1$$

This discussion has demonstrated the validity of the following:

Proposition. If n is an integer, then

$$n \bmod 9 = s \bmod 9,$$

where s is the sum of the digits of n.

So as in the previous example, if $n = 352648$, the sum of the digits is $3+5+2+6+4+8$, and one can evaluate this mod 9 by adding digits from the left until the sum exceeds 9, then subtract 9 and keep the remainder, (that is cast out nines), and continue in this way to the end of the summing.

If an arithmetical calculation is correct in ordinary arithmetic, then it is correct mod 9 also, which by the above procedure is simple and can be done in your head, with a little practice. This can be used to check calculations. This was taught in the schools back when calculations were done by hand, rather than by machines (before adding machines, cash registers, or computers). I suppose this could be done very rapidly with the skill that comes with practice. So if you were calculating a product of two large numbers, you could replace the two large numbers by their mod 9 values, multiply then together, mod 9, and check for agreement with the mod 9 value of the product.

Here is a Python Program Illustrating The Checking of a Multiplication of two relatively large integers by the *Casting Out Nines* technique.

```
# casting9.py checking a product by using mod 9 arithmetic
a=5197328623418
b=109852876129
c=a*b
print " a= ", a
print " b= " , b
print " c= a*b=", c
ad9=a/9
am9=a-ad9*9
print " a (mod 9)= ", am9
bd9=b/9
bm9=b-bd9*9
print " b (mod 9)= ", bm9
p=am9*bm9
print " p=  a (mod 9) times b (mod 9)= ", p
pd9=p/9
```

```
pm9=p-pd9*9
print " p (mod 9)= ", pm9
cd9=c/9
cm9=c-cd9*9
print " c (mod 9)= ",cm9
```

Output of program casting9.py

```
 a=  5197328623418
 b=  109852876129
 c= a*b= 570941497470043642588922
 a (mod 9)=  5
 b (mod 9)=  4
 p=  a (mod 9) times b (mod 9)=  20
 p (mod 9)=  2
 c (mod 9)=  2
```

The two (mod 9) computations agree. If they did not agree, then the product of $c = a * b$ must be incorrect. But even though they do agree, c could still be incorrect, for example if we added 81 to c, $c + 81$ is not equal to $a * b$, although $c + 81$ (mod 9) is 2. The probability of a false positive here is about 1 in 9. There is also a (mod 11) test.

Notice that most people do not have a readily available method to calculate the above product by machine. The computer language **Python** does have the ability to compute with very large integers.

7 Bibliography

[1] Larson Harold D., Arithmetic for Colleges, Macmillan, revised edition 1958. *This book was found in a thrift store and originally belonged to Wealthy Babcock, a long time Kansas University Professor of mathematics, for whom the old Mathematics Departmental Library was named, because she had headed the library for many years. This library was located in Strong Hall. In the past most departments in the University had all the books belonging to the*

general University collection, which were in the subject area of the department, located in a departmental library in the building where the department was located.

[2] Emery James D, **Scientific Programming in Python**, 4/8/14, *www.stem2.org/je/python.pdf.*