STEM Society Meeting, December 13, 2016

James Emery

Last Edit: 12/28/2016

Contents

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 December 13, 2016 Meeting Announcement

The December meeting of the STEM Society will take place on the second Tuesday of the month, December 13, 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/`

Possible Topics and Discussions:

(a) Ken Schmitz will make some brief additional remarks about his presentation on the "Fate of Mankind" given at our October meeting.

(b) Jim Emery will discuss some of the following topics, depending on what he prepares between now and the December 13th meeting. These topics are the following: (1) A book review of "Stuff Matters" by Mark Miodownik, which is about Materials Science, told in a very pleasing literary style. (2) Some material from a book I have been writing called "Computational Mathematics." (3) Cécile Lagandré a while back sent me some information about the Fibonacci Spiral, and the Museum of Mathematics in New York City, and about the material put on the internet by Violet Hart, the daughter of the mathematician George Hart, who runs the museum. I would like to discuss this spiral, and how one can construct a program to draw such a spiral. (4) Perhaps a discussion of light scattering and about the interesting

English scientist George Gabriel Stokes (Aug 13, 1819 - Feb 1, 1903) who was a physicist and mathematician, who made many contributions to mathematics and physics. He discovered a type of light scattering now called Stokes scattering. (5) I came across a very interesting Wikipedia article about the construction of the first nuclear reactor at the University of Chicago in 1942. And I would like to present at least a few remarks on this.

(c) As always, attendees are free to bring, and should bring additional topics, things, ideas, and presentations, which, subject to time constraints, can be presented. You should let me know at the meeting if you have material to present.

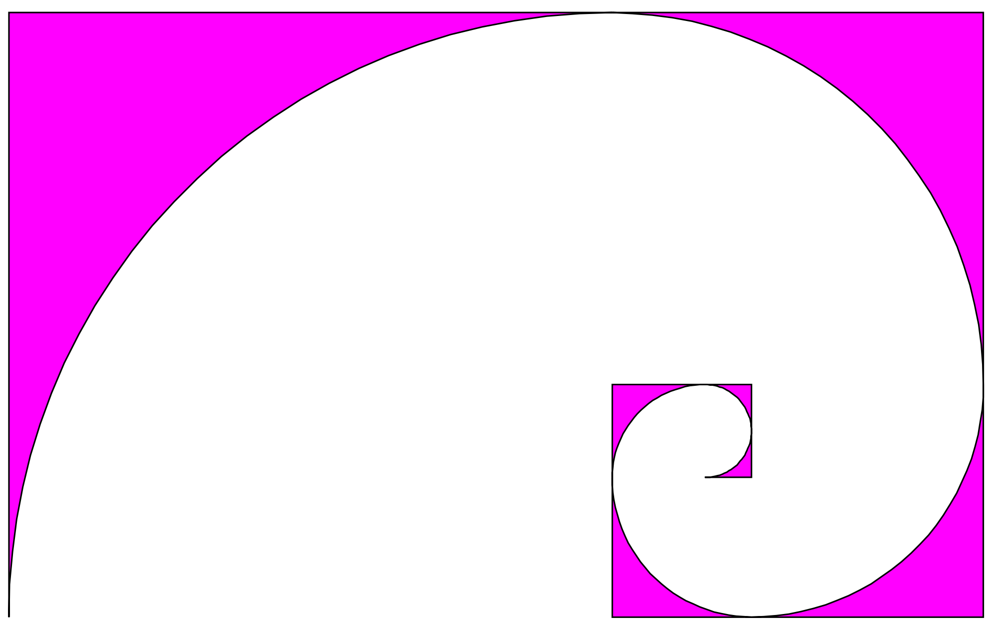

Figure 1: **The Fibonacci Spiral.** The Fibonacci spiral is created by constructing a sequence of squares with a side having length equal to a sequential Fibonacci number. A circular arc is drawn in a corner of the square so the nth arc has radius equal to the nth Fibonacci number. The arc is rotated by positive angle $\pi/2$ as each new Fibonacci number is encountered. For example in this figure, there are seven arcs with radii corresponding to the Fibonacci numbers 1,1,2,3,5,8, and 13. This generates a spiral with continuous tangent.

3 National Museum of Mathematics

National Museum of Mathematics
11 E 26th St, New York City, NY 10010-1402
+1 212-542-0566

The fabulous Vi Hart (Violet Hart, father George Hart) explains the Fibonacci spiral;

https://www.youtube.com/watch?v=ahXIMUkSXX0

4 How to Draw a Fibonacci Spiral With a Computer Program

The Fortran Program called ***fibspiralfill.ftn*** **draws a Fibonacci Spiral**. Here is a listing of that program:

```
c fibspiralfill.ftn draws fibonacci spiral with filled corners 12/19/16
c type fpsvars to access fortran power station libraries
c to compile and run and view p.ps file of spiral type:
c the following commands, which can be stored as doit.bat:
c
c fl32 fibspiralfill.ftn
c fibspiralfill
c pltmerge p.eg q.eg
c eg2ps q.eg p.ps
c
c rem gsv p.ps (gsv need be run only once if we leave ghostview open,
c because a new version of p.ps will be automatically opened by ghostview).
c
      implicit real*8(a-h,o-z)
c     character rgb*30
c      dimension prj(3),ci(4),pa(3,4)
c      dimension sp(3),cp(3),ep(3)
c      dimension p1(2), p2(2)
       dimension u1(2), u2(2),ut(2),c(2),ac(2)
       integer f,fprev,count
       nf=1
       open(nf,file='p.eg',status='unknown')
       one=1.
       zero=0.
       pi=4.*atan(one)
c
       narcs=7
       fprev=0
       f=1
       c(1)=0.
       c(2)=0.
```

```
       count=1
       xmn=c(1)
       xmx=c(1)
       ymn=c(2)
       ymx=c(2)
       u1(1)=1.
       u1(2)=0.
       call rot2dv90(u1,u2)
c
       npts=30
       do i=1,narcs
        write(*,*)' f = ',f
        x=c(1)
y=c(2)
x1=x
y1=y
c       call xmove(nf,x,y)
if(x .lt. xmn)xmn=x
if(x .gt.xmx)xmx=x
if(y .lt. ymn)ymn=y
if(y .gt. ymx)ymx=y
x=x+f*u1(1)
y=y+f*u1(2)
x2=x
y2=y
c call xdraw(nf,x,y)
if(x .lt. xmn)xmn=x
if(x .gt. xmx)xmx=x
if(y .lt. ymn)ymn=y
if(y .gt. ymx)ymx=y
x=x+f*u2(1)
y=y+f*u2(2)
x3=x
y3=y
c        call xdraw(nf,x,y)
if(x .lt. xmn)xmn=x
if(x .gt.xmx)xmx=x
if(y .lt. ymn)ymn=y
if(y .gt. ymx)ymx=y
if(count .eq. 1)then
 a1=-pi/2
 a2=0.
endif
if(count .eq. 2)then
 a1=0.
 a2=pi/2.
endif
if(count .eq. 3)then
 a1=pi/2
 a2=pi
endif
if(count .eq. 4)then
 a1=pi
 a2=3.*pi/2.
endif
ac(1)=c(1)+f*u2(1)
ac(2)=c(2)+f*u2(2)
```

```
r=f
xc=ac(1)
yc=ac(2)
c       call xdarc(nf,xc,yc,r,a1,a2,npts)
c
         call xmove(nf,x1,y1)
 call xdraw(nf,x2,y2)
         call xdraw(nf,x3,y3)
c        fill corner
 do j=2,npts
  a=(j-1)*(a1-a2)/(npts-1) + a2
  xx=xc+r*cos(a)
  yy=yc+r*sin(a)
  call xdraw(nf,xx,yy)
 enddo
         write(nf,'(a)')'p gsave'
         write(nf,'(a)')'p 1 0 1 setrgbcolor'
         write(nf,'(a)')'p fill'
         write(nf,'(a)')'p grestore'
         write(nf,'(a)')'p stroke'
c(1)=x
c(2)=y
tmp=f
f=f+fp
        fp=tmp
call rot2dv90(u1,ut)
u1(1)=ut(1)
u1(2)=ut(2)
call rot2dv90(u2,ut)
u2(1)=ut(1)
u2(2)=ut(2)
        count=count+1
        if(count .gt. 4)count=1
       enddo
      end
c
c+ rot2dv90 rotate a 2 dimensional vector 90 degrees
       subroutine rot2dv90(u,v)
c input
c  u- a two dimensional vector
c output
c  v- a two dimensional vector rotated 90 degrees
      implicit real*8(a-h,o-z)
      dimension u(2),v(2)
      c=0.
      s=1.
      v(1)=c*u(1)-s*u(2)
      v(2)=s*u(1)+c*u(2)
      return
      end
c

c+ lenstr   nonblank length of string
      function lenstr(s)
c  length of the substring of s obtained by deleting all
c  trailing blanks from s.  thus the length of a string
c  containing only blanks will be 0.
```

```
      character   s*(*)
      lenstr=0
      n=len(s)
      do 10 i=n,1,-1
      if(s(i:i) .ne. ' ')then
         lenstr=i
         return
      endif
10    continue
      return
      end
c+ str    floating point number to string
      subroutine str(x,s)
      implicit real*8(a-h,o-z)
      character s*25,c*25,b*25,e*25
       zero=0.
      if(x.eq.zero)then
         s='0'
         return
      endif
      write(c,'(g11.4)')x
      read(c,'(a25)')b
      l=lenstr(b)
      do 10 i=1,l
      n1=i
      if(b(i:i).ne.' ')go to 20
 10   continue
 20   continue
       if(b(n1:n1).eq.'0')n1=n1+1
       b=b(n1:l)
       l=l+1-n1
       k=index(b,'E')
       if(k.gt.0)e=b(k:l)
       if(k.gt.0)then
         s=b(1:(k-1))
         k1=index(b,'E+0')
         if(k1.gt.0)then
          e='E'//b((k1+3):l)
         else
          k1=index(b,'E+')
          if(k1.gt.0)e='E'//b((k1+2):l)
         endif
         k1=index(b,'E-0')
         if(k1.gt.0)e='E-'//b((k1+3):l)
         l=k-1
       else
          s=b
       endif
       j=index(s,'.')
       n2=l
      if(j.ne.0)then
              do 30 i=1,l
               n2=l+1-i
               if(s(n2:n2).ne.'0')go to 40
30             continue
       endif
40             continue
```

```
        s=s(1:n2)
        if(s(n2:n2).eq.'.')then
           s=s(1:(n2-1))
           n2=n2-1
         endif
        if(k.gt.0)s=s(1:n2)//e
      return
      end

c+ xdraw  draw parameters to external plot file
      subroutine xdraw(nfile,x,y)
      implicit real*8(a-h,o-z)
      character s*25,t*80
      t='d'
      n=2
      call str(x,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      call str(y,s)
      l=lenstr(s)
      t(n:80)=s
      write(nfile,'(a)')t(1:(n+l-1))
      return
      end
c
c+ xmove  move parameters to external plot file
      subroutine xmove(nfile,x,y)
      implicit real*8(a-h,o-z)
      character s*25,t*80
      t='m'
      n=2
      call str(x,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      call str(y,s)
      l=lenstr(s)
      t(n:80)=s
      write(nfile,'(a)')t(1:(n+l-1))
      return
      end
c

c+ xdarc  arc into external plot file
      subroutine xdarc(nfile,xc,yc,r,a1,a2,npts)
      implicit real*8(a-h,o-z)
c nfile-unit number for output file
c xc,yc-arc center
c     r-arc radius
c a1,a2-start and end angles
c  npts-number of points in arc
      character s*25,t*80
      t='a'
      n=2
      call str(xc,s)
      l=lenstr(s)
```

```
      t(n:80)=s
      n=n+l+1
      call str(yc,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      call str(r,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      call str(a1,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      call str(a2,s)
      l=lenstr(s)
      t(n:80)=s
      n=n+l+1
      an=npts
      call str(an,s)
      l=lenstr(s)
      t(n:80)=s
      write(nfile,'(a)')t(1:(n+l-1))
      return
      end
```

When compiled and run the program produces the eg file q.eg (an Emery graphics file). The first part of this file fills the first arc

```
v-1 1 -1 1
w-15.525 6.525 -7.525 14.525
m0 0
d1 0
d1 1
d.9985 .9459
d.9941 .8919
d.9868 .8382
d.9766 .785
d.9635 .7325
d.9477 .6807
d.929 .6299
d.9076 .5801
d.8835 .5316
d.8569 .4844
d.8277 .4388
d.7961 .3948
d.7622 .3526
d.726 .3123
d.6877 .274
d.6474 .2378
d.6052 .2039
d.5612 .1723
d.5156 .1431
d.4684 .1165
d.4199 .9242E-1
d.3701 .7102E-1
```

```
d.3193 .5235E-1
d.2675 .3645E-1
d.215 .2338E-1
d.1618 .1317E-1
d.1081 .5862E-2
d.5414E-1 .1467E-2
d.6123E-16 0
p gsave
p 1 0 1 setrgbcolor
p fill
p grestore
p stroke
```

The commands starting with "p" are Postscript commands passed on to the Postscript file.

This is repeated similarly for the rest of the arcs making up the spiral.

The emery graphics file q.eg is converted to postscript with the program **eg2ps.c** as follows:

```
eg2ps q.eg p.ps
```

5 Book Review: *Stuff Matters*, by Mark Miodownik

Introduction. A teenage boy is slashed in the back with a razor blade while refusing to surrender his money while waiting for a train in the London Underground. As he tries to get home with the blood dripping down his back from his 13 cm cut, he starts wondering why the razor blade was so hard and sharp and cut easily through his leather jacket and clothes through several layers of skin, while other steel objects like paper staples are so easily bent. Mark Miodownik thinks about finding out about these and similar materials and becomes motivated to study these things in school. After getting a PhD in England he spends a brief time working at Sandia Laboratories in Albuquerque using sophisticated equipment to study more about the structure of matter.

- **Metals, Alloys, Bronze, Brass, Iron and Steel**. Iron and carbon produce an alloy called steel. The carbon amount must be controlled very accurately which is difficult by hand. Too much carbon produces cast iron which easily cracks. Too little carbon and the alloy is weak easily bent, and unable to maintain a sharpened edge.

The Bessemer process was devised to control the amount of carbon in steel, which had been done formerly by am imprecise hand method. In this new process oxygen is blown through the molten iron to burn away the excess carbon and to produce strong hardenable steel.

- **Paper Makes Books and Education Possible**. Paper is made from wood pulp which is pressed to remove the water with wood and other fibers to give it strength.

- **Concrete** Portland Cement, Roman Cement, Vesuvius, Naples, Roman Structures, Roman concrete has lasted under water for thousands of years, while Portland cement is said to survive in good condition only about 50 years.

- **Chocolate** Chocolate needs quite a lot of processing of its initial ingredients before it becomes the delicious essence that we have come to know. Here is the tale.

- **Foam, Silica Aerogel** Space probe use, Rayleigh Scattering, "Daddy, why is the sky blue?" At Sandia mark encounters a new very light weight foam which is being designed there to capture particles in a NASA space voyage. He is very curious but this is the time of the famous unjustified accusations of Win Ho Lee at Los Alamos, Win being accused of being a spy for China. Being a foreigner himself mark is rather shy about asking too many questions. He returns to Kings College and finds out then that this new miracle foam is called Aerojel. It is the lightest material on earth and pregnant with applications.

- **Plastic** Polymer plastics are the miracle material of the 20th century, but also denigrated for some of their properties, and plastic becoming a common adjective for poor quality, even though its non-conductivity and low weight make it invaluable for many applications. So every day we both admire it and yet curse it strongly as it breaks, decays and fails, causes the demise of our knobs and our electronic gadgets, and our substitute body parts, and heart valves. And becomes trash clogging our oceans, and plastic bags suffocating our children, and occupying our landfills, and uglifying our land. But like global warming, the modern world can not seem to decide to do without this amazing stuff.

- **Glass** Why can we see through it? Why do we admire its sparkle yet wish not to step on it broken, or to eat food containing ground or pulverized glass, placed there by the courtesy of our jealous rivals? What is it anyway that engenders so much love and hate? Some of it we call crystal yet it is not, for it does not have a repeating structure like diamond or calcite. Stained glass windows eventually flow and sag like old women and like expired sacks of potatoes. Still they remain in the beautiful old obsolete churches peopled by the ancient ones possessing too much unwarranted faith in the beliefs created by their even older ancestors with their dark ignorances and purple prejudices.

- **Graphite** Forms of carbon: diamond, graphite, graphene, buckyballs (c60), and organic molecules. Organic molecules were once believed to possess a living force, and different from inorganic molecules. These ideas were only abandoned in the late nineteenth century. This is somewhat like the arguments about matter and mind, thus animals can not think because they have no soul, that is no mind. Humans have not really abandoned these ideas about matter and mind even today. This conception is clinged to especially by non-scientists and some who believe literature is the source of all worthwhile knowledge that should be taught in universities, and also strongly embraced by those with a strong religious spiritual cast of "mind."

- **Porcelain and Ceramics** Piezo Electric Materials, PZT (Lead-Zirconate-Titanate). Piezoelectric motors. Flash googles invented at Sandia laboratories protects people from blindness from a nuclear flash by becoming opaque in a few microseconds. I think these were manufactured at Bendix in Kansas City.

  Bone is piezo electric, and the voltages and currents caused by stress promote growth, its absence causes bone shrinkage and loss. Astronauts suffer serious bone loss after long weightless space trips.

- **Biological Implants and 3D Printing** Is the bionic man with replaceable parts possible?

6 The Secrets of Roman Concrete

http://www.history.com/news/the-secrets-of-ancient-roman-concrete

"Theres no doubt that the ancient Romans were master builders. Many temples, roads and aqueducts constructed during Roman times have held up remarkably well, despite the wear-and-tear–in the form of military invasions, tourist mobs and natural disasters such as earthquakes–theyve had to endure. In particular, geologists and engineers have long been fascinated by Roman harbors, many of which stand almost intact after 2,000 years or more, despite constant pounding by seawater. Now, a team of researchers from Italy and the United States has analyzed a sample of concrete taken from a breakwater in Italys Pozzuoli Bay, at the northern tip of the Bay of Naples, which dates back to 37 B.C. Their findings, reported earlier this month in the Journal of the American Ceramic Society and American Mineralogist, may revolutionize modern architecture.

History contains many references to ancient concrete, including in the writings of the famous Roman scholar Pliny the Elder, who lived in the 1st century A.D. and died in the eruption of Mt. Vesuvius in A.D. 79. Pliny wrote that the best maritime concrete was made from volcanic ash found in regions around the Gulf of Naples, especially from near the modern-day town of Pozzuoli. Its virtues became so well-known that ash with similar mineral characteristicsno matter where it was found in the worldhas been dubbed pozzolan.

By analyzing the mineral components of the cement taken from the Pozzuoli Bay breakwater at the laboratory of U.C. Berkeley, as well as facilities in Saudi Arabia and Germany, the international team of researchers was able to discover the secret to Roman cements durability. They found that the Romans made concrete by mixing lime and volcanic rock to form a mortar. To build underwater structures, this mortar and volcanic tuff were packed into wooden forms. The seawater then triggered a chemical reaction, through which water molecules hydrated the lime and reacted with the ash to cement everything together. The resulting calcium-aluminum-silicate-hydrate (C-A-S-H) bond is exceptionally strong.

By comparison, Portland cement (the most common modern concrete blend) lacks the lime-volcanic ash combination, and does not bind well compared with Roman concrete. Portland cement, in use for almost two centuries, tends to wear particularly quickly in seawater, with a service life of less than 50 years. In addition, the production of Portland cement produces a sizable amount of carbon dioxide, one of the most damaging of the so-called greenhouse gases. According to Paulo Monteiro, a professor of civil and environmental engineering at the University of California, Berkeley, and the lead researcher of the team analyzing the Roman concrete, manufacturing the 19 billion tons of Portland cement we use every year accounts for 7 percent of the carbon dioxide that industry puts into the air.

In addition to being more durable than Portland cement, argue, Roman concrete also appears to be more sustainable to produce. To manufacture Portland cement, carbon is emitted by the burning fuel used to heat a mix of limestone and clays to 1,450 degrees Celsius (2,642 degrees Fahrenheit) as well as by the heated limestone (calcium carbonate) itself. To make their concrete, Romans used much less lime, and made it from limestone baked at 900 degrees Celsius (1,652 degrees Fahrenheit) or lower, a process that used up much less fuel.

The researchers analysis of Roman concrete sheds light on existing modern concrete blends that have been used as more environmentally friendly partial substitutes for Portland cement, such as volcanic ash or fly ash from coal-burning power plants. Monteiro and his colleagues also suggest that adopting materials and production techniques used by the ancient Romans could produce longer-lasting concrete that generates less carbon dioxide. Monteiro estimates that pozzolan, which can be found in many parts of the world, could potentially replace 40 percent of the worlds demand for Portland cement. If this is the case, ancient Roman builders may be responsible for making a truly revolutionary impact on modern architectureone massive concrete structure at a time."

7 Lord Rayleigh (John William Strutt)

From Wikipedia:

"John William Strutt, 3rd Baron Rayleigh, (November 12,1842 to June 30th 1919) was a physicist who, with William Ramsay, discovered argon, an achievement for which he earned the Nobel Prize for Physics in 1904. He also discovered the phenomenon now called Rayleigh scattering, which can be used to explain why the sky is blue, and predicted the existence of the surface waves now known as Rayleigh waves. Rayleigh's textbook, The Theory of Sound, is still referred to by acoustic engineers today."

8 Rayleigh Scattering

Lord Rayleigh published articles on light scattering in the second half of the 19th century. Maxwell's theories on electromagnetic waves had been published by this time. It would be interesting to look up some of his papers given below, and see if his ideas were based on experiment or theory.

It turns out that this scattering is basically an elastic reflection, that is the frequencies and wave lengths are the same as those from the light source and conserve energy. The classical theory takes the gas molecules as polarized, and thus acting as small antennas. The charges oscillate with the received optical radiation, with the oscillations on the "antenna" rebroadcasting the electromagnetic waves, because accelerating charges produce electromagnetic waves. The waves are directed by the orientation of the reflecting molecules, that is by the direction of the molecular antenna. Because the charge oscillation in the antenna is dependent on the length of the antenna and how it matches the incoming light wavelength, the amount of scattered is dependent upon the wave length of the light received. The shorter wavelengths being scattered more, which explains the blue sky. This also explains the red sky during sunrise and sunset, for in this case we are looking at the direct light of the sun where some of the blue has been scattered away, leaving us to see more red."

Now in the nineteenth century there was no quantum mechanics, so theory was classical. Even though the mechanism might be due to quantum mechanics, classical arguments may produce an acceptable theory predicting the experimental outcome. This antenna theory seems a little too simple to me.

Bibliography from Wikipedia:

"Lord Rayleigh (John Strutt) refined his theory of scattering in a series of papers that were issued over a period of decades. Here is a partial list of these papers:

(a) John Strutt (1871) On the light from the sky, its polarization and colour, Philosophical Magazine, series 4, vol.41, pages 107120, 274279.

(b) John Strutt (1871) On the scattering of light by small particles, Philosophical Magazine, series 4, vol. 41, pages 447454.

(c) John Strutt (1881) On the electromagnetic theory of light, Philosophical Magazine, series 5, vol. 12, pages 81101.

(d) John Strutt (1899) On the transmission of light through an atmosphere containing small particles in suspension, and on the origin of the blue of the sky, Philosophical Magazine, series 5, vol. 47, pages 375394."

It would be interesting to look up these references and find out how much of the conclusions depended on experiment, and how much on theory.

9 George Green

From Wikipedia:

"George Green, in 1826, wrote an essay titled **On the Application of Mathematical Analysis to the Theories of Electricity and Magnetism**. Green, who was born on July 14, 1793 and died on May 31, 1841, was a British mathematical physicist. He had little formal education and wrote this very influential essay not having any known teacher in these areas. So much for the putative benefits of formal education. The essay introduced several new ideas including the idea of the potential function, and a theorem that became essentially the modern Green's theorem as is used in vector analysis in current physics, as well as the concepts now known as the Green's functions. His essay apparently had much affect on Maxwell's work, which work appears in the famous book **Treatise on Electricity and Magnetism.** Green's presentation probably put forth the first mathematical theory of electricity and magnetism, and had much influence on potential theory, and on the efforts of later physicists and scientists in the development of electromagnetic theory."

10 George Stokes

From Wikipedia: "Sir George Gabriel Stokes, (August 13, 1819 to 1 February 1, 1903), was a physicist and mathematician. Born in Ireland, Stokes spent all of his career at the University of Cambridge, where he served as Lucasian

Professor of Mathematics from 1849 until his death in 1903. In physics, Stokes made seminal contributions to fluid dynamics (including the Navier-Stokes equations) and to physical optics. In mathematics he formulated the first version of what is now known as Stokes' theorem and contributed to the theory of asymptotic expansions. He served as secretary, then president, of the Royal Society of London.

In 1852, in his famous paper on the change of wavelength of light, he described the phenomenon of fluorescence, as exhibited by fluorspar and uranium glass, materials which he viewed as having the power to convert invisible ultra-violet radiation into radiation of longer wavelengths that are visible. The Stokes shift, which describes this conversion, is named in Stokes' honor. A mechanical model, illustrating the dynamical principle of Stokes's explanation was shown. The offshoot of this, Stokes line, is the basis of Raman scattering."

11 C. V. Raman

Sir Chandrasekhara Venkata Raman (November 7, 1888 21 November 21, 1970) was an Indian physicist, who carried out ground-breaking work in the field of light scattering, which earned him the 1930 Nobel Prize for Physics. He discovered that when light traverses a transparent material, some of the deflected light changes in wavelength. This phenomenon, subsequently known as Raman scattering, results from the Raman effect

12 Raman Scattering

From the Wikapedia article on Raman Scattering:

"The inelastic scattering of light was predicted by Adolf Smekal in 1923 (and in German-language literature it may be referred to as the Smekal-Raman effect). In 1922, Indian physicist C. V. Raman published his work on the 'Molecular Diffraction of Light,' the first of a series of investigations with his collaborators that ultimately led to his discovery (on 28 February 1928) of the radiation effect that bears his name. The Raman effect was first reported by C. V. Raman and K. S. Krishnan, and independently by Grigory Landsberg and Leonid Mandelstam, on 21 February 1928 (that is why in the former Soviet Union the priority of Raman was always disputed; thus in Russian scientific literature this effect is usually referred to as 'combination scattering' or 'combinatory scattering'). Raman received the Nobel Prize in 1930 for his work on the scattering of light"

http://www.kosi.com/Raman_Spectroscopy/rtr-ramantutorial.php?ss=700

References

1. Schrader, B. Infrared and Raman Spectroscopy; Schrader, B. ed., VCH Publishers Inc.: New York, 1995; Chapter 4.

2. Myers, A.B., Mathies, R.A. Biological Applications of Raman Spectroscopy: Volume 2: Resonance Raman Spectra of Polyenes and Aromatics, Spiro, T.G. ed., J ohn Wiley and Sons: New York, 1987; Chapter 1.

3. Kerker, M., Wang, D.-S., Chew, H., Siiman, O., Bumm, L.A. Surface Enhanced Raman Scattering, Chang, R.K., Furtak, T.E. eds., Plenum Press: New York, 1982; pp. 109-128.

4. Morris, M.D. Applied Laser Spectroscopy; Andrews, D.L. ed., VCH Publishers Inc.: New York, 1992; Chapter 6.

From the internet is the beginning of a tutorial on Raman Spectroscopy:

Kaiser Optical Systems Raman Tutorial

http://www.kosi.com/Raman_Spectroscopy/rtr-ramantutorial.php?ss=700

"1. **A brief look at Raman scattering theory.**

1.1. **The Raman Effect and Normal Raman Scattering.**

When light is scattered from a molecule most photons are elastically scattered. The scattered photons have the same energy (frequency) and, therefore, wavelength, as the incident photons. However, a small fraction of light (approximately 1 in 107 photons) is scattered at optical frequencies different from, and usually lower than, the frequency of the incident photons. The process leading to this inelastic scatter is the termed the Raman effect. Raman scattering can occur with a change in vibrational, rotational or electronic energy of a molecule. Chemists are concerned primarily with the vibrational Raman effect. We will use the term Raman effect to mean vibrational Raman effect only."

13 Chicago Pile-1

Source for these few remarks is the Wikipedia article called **ChicagoPile-1**.

Uranium Fuel

The pile consisted of 45,000 graphite block moderators, with holes drilled in the blocks into which were placed 6 tons of uranium metal and 50 tons of uranium oxide. The oxide was from the Mallinckrodt uranium ore processing plant in St. Louis. The uranium metal came from Iowa state university where a new process for reducing the uranium oxide to metal had been developed.

At Columbia University in New York, Enrico Fermi, John Dunning, Herbert L. Anderson, Eugene T. Booth, G. Norris Glasoe, and Francis G. Slack conducted the first nuclear fission experiment in the United States on 25 January 1939.

Szilard drafted a confidential letter to the President, Franklin D. Roosevelt, warning of a German nuclear weapon project, explaining the possibility of nuclear weapons, and encouraging the development of a program that could result in their creation. With the help of Eugene Wigner and Edward Teller, he approached his old friend and collaborator Albert Einstein in August 1939, and convinced him to sign the letter, lending his prestige to the proposal. The Einstein-Szilard letter resulted in the establishment of research into nuclear fission by the U.S. government.

This reactor produced very little energy and went critical on December 2, 1942. For more details see the full article.

14 Viewing Documents and Meeting Notes on the stem2.org WEB Site

A list of documents can be found by clicking "Stem2 Documents." The file is called http://www.stem2.org/je/stemdocs.txt

This file can be downloaded to your computer and searched in a editor or with software provided in the file

http://www.stem2.org/je/stemdocs.zip

which also can be downloaded. Once a document name has been located it can be downloaded by clicking it.

The zip file contains

```
   Date      Time    Attr         Size   Compressed  Name
------------------- ----- ------------ ------------  --------------
2010-11-18 21:27:34 ....A       587776       300814  7za.exe
1999-09-28 08:50:14 .....        49152        25894  grep.exe
2003-05-14 21:20:00 .....       135168       131387  RAR.exe
2015-06-04 15:13:04 ....A          972          474  readmedocs.txt
2014-11-03 11:29:09 ....A        56320        28700  semi2nl.exe
2014-11-03 23:03:28 ....A          778          355  stemdocs.bat
2016-10-14 09:15:11 ....A        40239        13677  stemdocs.txt
------------------- ----- ------------ ------------  --------------
                                870405       501301  7 files
```

To search stemdocs.txt use stemdocs.bat

Example:

stemdocs fibonacci

gives

```
fibonacci.pdf
 Title: Fibonacci Numbers and the Golden Ratio
fibonaccif5.pdf
 Title: A Drawing of Nested Polyhedra
stemsoc101210.pdf Title: Stem Society Meeting, October 12, 2010
 Craig Nulan's Education and Technology,
 Cecile Lagandre Rocks and Geology
 Rick Hines Cave Pictures
 Fibonacci Numbers, the Golden Ratio,
 Drawing a pentagon with ruler and compass
 visit of English Researchers
stemsoc110910.pdf Title: Stem Society Meeting, November 9, 2010
 Fibonacci Numbers, Jim Emery Structure of a Postscript file
 Bob Kessler review of book
 "Something Incredibly Wonderful happens"
 about Frank Oppenheimer and the Exploratorium,
 Cecile Lagandre ultraviolet light and rocks
```

Here is a printout of stemdocs.bat

```
@echo off
rem stemdocs.bat, Version 8/2/14, by Jim Emery
rem lists those lines in file \txt\stemdocs.txt
rem containing specified words
if "%1"=="" goto help
grep -i %1 c:\txt\stemdocs.txt > \tmp\tmp1.txt
copy \tmp\tmp1.txt \tmp\tmp2.txt
:search
shift
if "%1"=="" goto list
grep -i %1 \tmp\tmp2.txt > \tmp\tmp1.txt
copy \tmp\tmp1.txt \tmp\tmp2.txt
goto search
:list
semi2nl \tmp\tmp1.txt \tmp\tmp2.txt
type \tmp\tmp2.txt | more
goto end
:help
echo stemdocs.bat, by jim emery, Version 8/2/2014
echo Lists file names, and titles, for documents on website: stem2.org
echo Prints lines in the file \txt\stemdocs.txt that contain key strings
echo Uses the text data file called stemdocs.txt
echo Usage: stemdocs string1 string2 string3 ...
:end
```

15 Ken Schmitz: What is a Random Sequence?

Reference:

[1] Aczel, Amir D. **Chance A Guide to Gambling, Love, the Stock Market and Just About Anything Else**, 2004, 519.2 Aczel 2004.