FIBONACCI NUMBERS IN PHYSICS

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Since mathematics has great application in Physics, it would be surprising if the Fibonacci numbers, which have a wide application in unexpected branches of science, play no part in Physics. However, Fibonacci numbers do occur in Physics, though the importance of their occurrence is not certain.

ELECTRO-STATICS

Consider the following problem in electrostatics: A charge of $+e$ and two charges $-e$ are to be arranged along a straight line such that the potential energy of the whole system is equal to zero.

The potential energy of a system of static charges is the work done in bringing the charges from infinity to those points. The potential energy of two charges may be taken as the product of the charges divided by the distance between them. In the problem, let the charges $+e$, $-e$, and $-e$ occupy points A, B, and C, respectively. Let $AB = x$, $BC = y$.

$$\begin{array}{ccccc} A & x & B & y & C \\ \hline +e & & -e & & -e \end{array}$$

Potential energy due to $+e$ at A and $-e$ at

$$B = \frac{(+e)\cdot(-e)}{x} = \frac{-e^2}{x}$$

Potential energy due to $+e$ at A and $-e$ at

$$C = \frac{(+e)\cdot(-e)}{x+y} = \frac{-e^2}{x+y}$$

Potential energy due to $-e$ at B and $-e$ at

$$C = \frac{(-e)\cdot(-e)}{y} = \frac{+e^2}{y}$$

For the potential energy of the system to be zero,

$$\frac{-e^2}{x} + \frac{-e^2}{x+y} + \frac{e^2}{y} = 0$$

or

$$-(x + y)y - xy + x(x + y) = 0$$

Therefore

$$x^2 - xy - y^2 = 0$$

or

$$\frac{x^2}{y^2} - \frac{x}{y} - 1 = 0 .$$

Hence, x/y, the golden ratio, $= 1.618 \cdots$.

Thus we find that for the potential energy to be zero, x/y must be the golden ratio.

Now we consider charges in dynamic equilibrium.

THE ATOM

The atom consists of a positively charged nucleus surrounded by electrons orbiting around it in fixed orbits. Bohr, Schroedinger, Pauli and others contributed to the building up of the shell model of the atom that has successfully explained the physical and chemical properties of matter.

Certain gases, called noble or rare gases, are exceptionally stable chemically. On looking at the periodic table, one finds an interesting relationship between the atomic numbers of these inert gases. With the exception of Helium, the atomic numbers of the gases roughly correspond to the Fibonacci numbers. Also, if the atomic numbers are divided by 18 and the results expressed to the nearest integers, the Fibonacci numbers from 0 to 5 are attained.

Gas	Symbol	Atomic No. = Z	F Numbers	Z/18 to Nearest Integer
Helium	He	2	$F_6 = 8$	$0 = F_0$
Neon	Ne	10	$F_7 = 13$	$1 = F_1$
Argon	Ar	18	$F_8 = 21$	$1 = F_2$
Krypton	Kr	36	$F_9 = 34$	$2 = F_3$
Xenon	Xe	54	$F_{10} = 55$	$3 = F_4$
Radon	Rn	86	$F_{11} = 89$	$5 = F_5$

Thus, there is a double correlation between the atomic numbers of stable atoms and the Fibonacci Series.

THE NUCLEUS

The structure of the nucleus remained a mystery for several years. It was known that the nucleus consisted of two kinds of particles — the protons and the neutrons. A proton has a charge equal and opposite to that of an electron, while the neutron is neutral. The atomic number Z = number of protons. The neutron number N = number of neutrons. The mass number $A = N + Z$. Exactly how the particles were arranged in the nucleus was unknown. Various models were put forward, but none was satisfactory. None of them could explain a

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