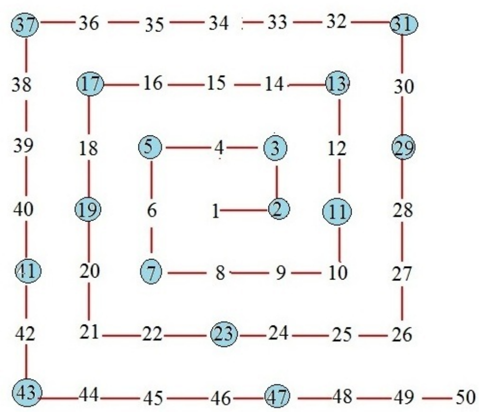
THE ULAM SPIRAL AND ITS SIMPLIFICATION

Back in 1963 the Polish born mathematician Stanislav Ulam sketched on a piece of paper a new type of number spiral while listening to a rather boring talk at a technical meeting. The spiral, now referred to as the Ulam Spiral, consists of a spiral array of the first few positive integers as indicated below-

ULAM SPIRAL CONSTRUCTED FROM THE FIRST FIFTY INTEGERS

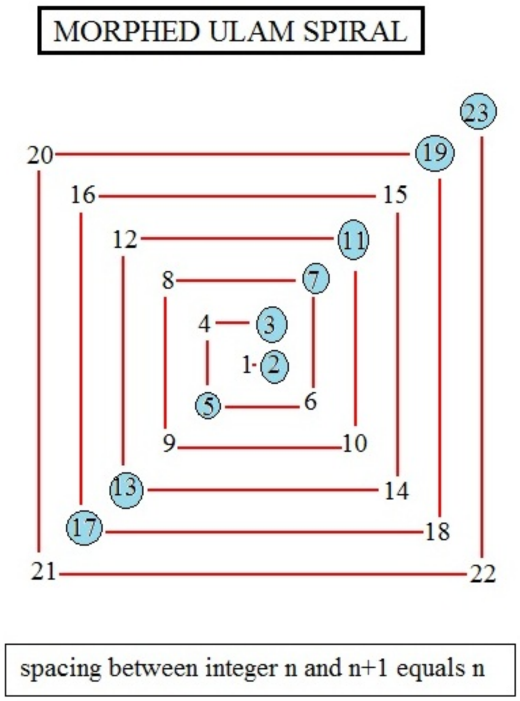


Prime Numbers are shown as light blue Circles

The spacing between neighboring integers is set as one unit and arrangement is in the form of unwinding counterclockwise spiral. On the spiral he marked those numbers which are prime numbers such as 2-3-7-11-13-17-19-23-29-31-37-41-43-47. I have designated these primes with light blue circles in the above diagram. Ulam and others noted that these prime number distributions consisted of segments where the primes aligned in a diagonal manner suggesting that there was certain hidden information concerning primes in the spiral. For years mathematicians studied these semi-regular prime patterns and spent countless hours trying to fit polynomial functions to these patterns without much success. It was not until 2008 that we first recognized that a simple morphing of the Ulam Spiral shows that the prime distributions are no more than a manifestation of the fact that all primes three and above are odd numbers (see http://www2,mae.ufl.edu/~uhk/MORPHING-ULAM.pdf) . Let me show you how this observation came about. To morph the spiral we simply replace the one unit separation between neighboring integers by a spacing equal to the previous number. That is –

1-2—3---4----5-----6------7-------8--------9

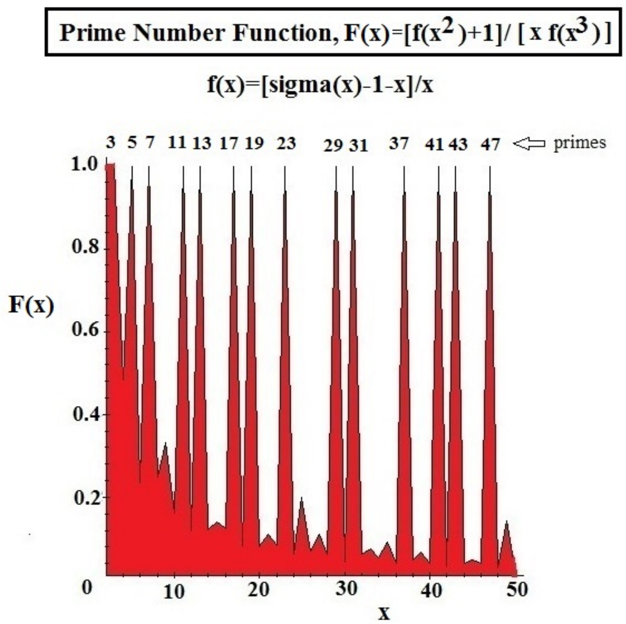
,where the dashes represent unit spacings. Doing this we get the Morphed Ulam Spiral-



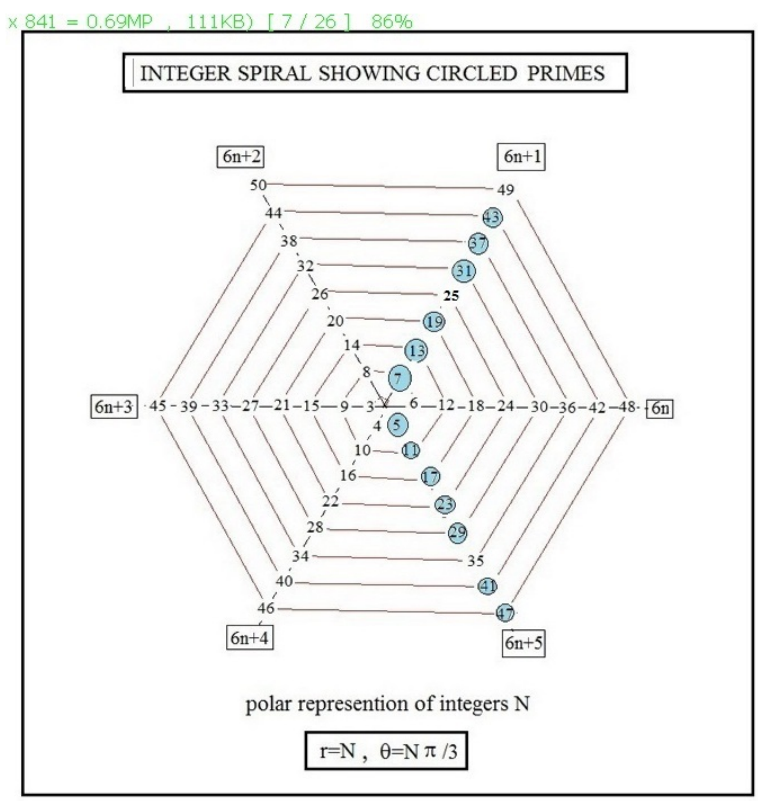
Notice here that the rather intricate prime number pattern in the original spiral has been reduced to the simple alignment of all primes (with the exception of 2) along one of the two left leaning diagonals . These diagonals also contain all odd numbers. Hence one can conclude that -

The partially regular prime distribution pattern in the Ulam Spiral indicates no more than that all primes three or greater are odd numbers.

No extra information is offered showing that searches by mathematicians and computer programmers to try to match the prime patterns with polynomial forms have been futile. The only prime number formula which works for all primes three or greater of which I am aware is one we constructed ourselves based on the number fraction $f(n)=[\sigma-n-1]/n$,with σ representing the sigma function of number theory and n the integer.This prime number function looks like this-



Finally, we mention that all primes five or greater must have the form 6k±1, where k is a positive integer. Although these primes do not separate into the two Q Prime groups (5,11,17,23,29,..) and 7,13,19,31,37,…) in the morphed Ulam Spiral, one can achieve such an arrangement by use of a hexagonal integer spiral pattern differing from the standard rectangular pattern of the Ulam Spiral. Here is a picture of this new spiral including the location of all prime numbers five and above-



The pattern is much simpler and more informative to that obtainable via the Ulam Spiral or its morphed version. We have used it successfully to locate twin primes and also to factor large semi-primes.

U.H.Kurzweg
Gainesville, Florida
June 30, 2017