A proof of the TWIN PRIME CONJECTURE

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Abstract

It is well known to mathematicians, that there is an infinite number of primes as proven via simple logic by Euclid in the 4^{th} Century BC[1,2] and confirmed by Leonhard Euler in 1737[3]. In 1846 French mathematician Alphonse de Polignac[4] proposed that any even number can be expressed in infinite ways as the difference between two consecutive primes, since when or perhaps possibly even before that all the way back to Euclid, mathematicians have been trying to prove that there is an infinite number of TWIN PRIMES. In this paper a relatively simple proof is presented, that there is indeed an infinity of TWIN PRIMES based on a new approach without any assumptions.

1 Introduction

TWIN PRIMES are prime numbers that are separated by two such as 3 and 5, 5 and 7, 11 and 13, 17 and 19 but not 23 and 25 because 25 is composite (5x5). This means that prime numbers can be twinned or isolated as in 23, 37 and 47 but twin composites such as 119 (7x17) and 121 (11x11) plus 143 (11x13) and 145 (5x29) also exist. For completeness it is also pointed out that 2 and 3 are not a TWIN PRIME pair because the primes are only separated by 1 rather than 2. It should also be obvious that all primes greater than 3 must be of the form 6k±1 and that the number of TWIN PRIMES are even rarer than the number of primes as we progress along the number line, to raise the legitimate question of whether the TWIN PRIMES are finite or indeed infinite.

2 History

In 1919, Norwegian mathematician Viggo Brun[5] showed that the sum of the reciprocals of the TWIN PRIMES converges to a sum, now known as Brun's constant. In contrast, the sum of the reciprocals of the primes diverges to infinity[6], which together could have been interpreted as an indication that TWIN PRIMES could be finite. Brun's constant was calculated in 1976 as approximately 1.90216054 using TWIN PRIMES up to 100 billion[7]. In 1994 American mathematician Thomas Nicely discovered a flaw in the then new Pentium chip that was producing inconsistent results in his calculations of Brun's constant[8]. In 2010 Nicely gave a value for Brun's constant[9] of $1.902160583209 \pm 0.000000000781$ based on all TWIN PRIMES less than 2×10^{16}. In 2003, American mathematician Daniel Goldston and Turkish mathematician Cem Yildirim[10] published "Small Gaps Between Primes," that established the existence of an infinite number of prime pairs within a small difference of 16, with certain assumptions, most notably that of the Elliott-Halberstam conjecture[11], which turned out to be false but was corrected with help from Hungarian mathematician János Pintz in 2005[12]. American mathematician Yitang Zhang built on their work to show in 2013 without any assumptions, that there was an infinite number of primes differing by 70 million or less[13]. This bound was improved to 246 in 2014[14], and by assuming either the Elliott-Halberstam conjecture or a generalized form of that conjecture, the difference was 12 and 6, respectively[15]. In 2015 James Maynard introduced a refinement of the GPY sieve to avoid previous limitations[16]. These techniques may enable progress on the Riemann hypothesis, which is connected to the prime number theorem as one of the key Millennium Problems attracting a reward of 1 million dollars[17].

3 Approach taken

Overall, a combination of a bespoke TWIN PRIME sieving process before a proof by contradiction was utilised in a new approach. This ultimately ended up establishing that infinite TWIN PRIMES necessarily follows from having infinite primes as will be shown in the following discussion and arguably can therefore lead to an additional general definition of all 6k±1 prime numbers not just those within a TWIN PRIME.

4 A Sieve for TWIN PRIMES

After much late-night thought when unable to sleep, the idea emerged that a unique identifier was required for each TWIN PRIME. Armed with the knowledge that each prime number greater than 3 must be of the form 6k±1, it was decided to use k as the unique identifier for each TWIN PRIME or composite as shown in Figure 1 below. Note the figure also works for the first TWIN PRIME (k=2/3) and the first two primes that are separated by one (k=5/12), which as indicated earlier is not a TWIN PRIME. In the chart below k= 2/3, 1,2,3, 5, 7, 10, 12, 17, 18, 23 and 25 all

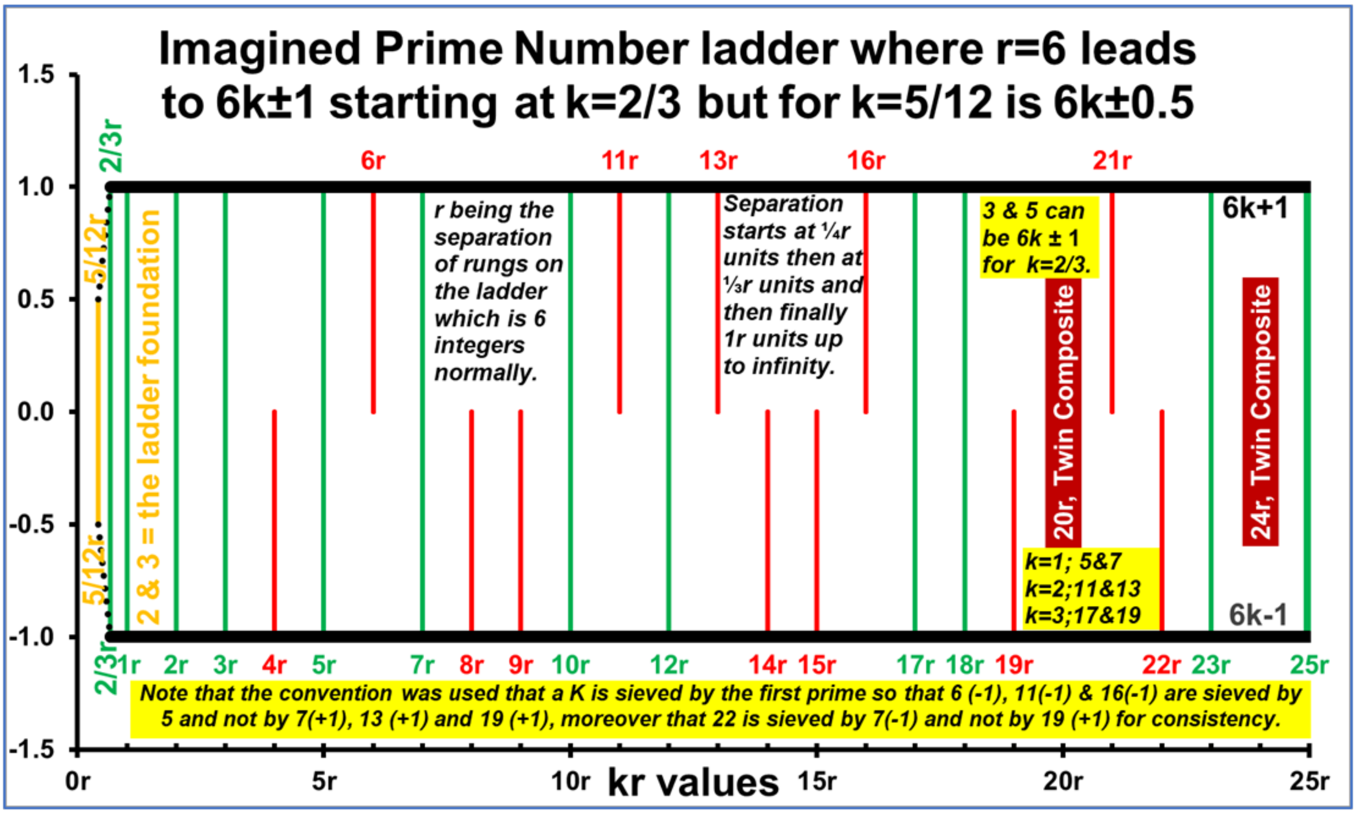

Figure 1: shows a unique identifier for each TWIN PRIME in the form of a ladder

produce TWIN PRIMES, but k=5/12 does not give a TWIN PRIME, k=4, 6, 8, 9, 11, 13, 14,15, 16, 19, 21 and 22 give isolated primes and k = 20 and 24 give twin composites respectively, for k from 5/12 to ∞.

k	i	6k±i	Prime	% Sieved	Sieving Equation pattern determined
1	-1	5	YES	40.000%	‘=2/5
1	+1	7	YES	17.143%	‘=1.2/7
2	-1	11	YES	7.792%	‘=1.2*(1-2/7)/11
2	+1	13	YES	5.395%	‘=1.2*(1-2/7-2*(1-2/7)/11)/13
3	-1	17	YES	3.491%	‘=1.2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17
3	+1	19	YES	2.756%	‘=1.2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17)/19
4	-1	23	YES	2.037%	‘=1.2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17)/19)/23
4	+1	25	NO	0%	
5	-1	29	YES	1.475%	See Text for 29
5	+1	31	YES	1.285%	See Text for 31
6	-1	35	NO	0%	
6	+1	37	YES	1.007%	See Text for 37
7	-1	41	YES	0.860%	See Text for 41
7	+1	43	YES	0.780%	See Text for 43

Figure 2: outlines the composition of each prime and composite and the sieved percent

To determine if an integer K can produce a TWIN PRIME one simply divides K ($K > k$) by each prime number of the form $6k\pm1$ and evaluates the remainder (R), since $K \equiv R \pmod{6k\pm1}$. If the remainder is equal to k or the modulus

|R - 6k±1| = k, then the K under consideration cannot produce a TWIN PRIME. Consider 5 which is 6k-1 where k = 1, then using modulo maths, 4, 6, 9, 11, 14, 16, 19, 21, 24, 29, 31, 34, 36, 39, 41, 44, 46, 49 for K up to 50 cannot produce TWIN PRIMES and are thus sieved out, representing 40 % of integer K values up to ∞ for K>k.

If we then consider the next prime 7, which is 6k+1 where k=1, then using modulo maths, 6, 8, 13, 15, 20, 22, 27, 29, 34, 36, 41, 43, 48, 50; cannot produce TWIN PRIMES and are therefore sieved out but as there are some numbers in common between 5 and 7, only numbers that were not already assigned to 5 are assigned to 7 to make this 8,13,15,20,22,27,42, 43, 48, 50; so far fewer are sieved out up to 50 (approximately half as many).

The next prime 11, which is 6k-1 for k=2 sieves out the values 9,13,20,24,31,35,42,46 etc and yet again there are values in common with 5 and 7 which have been removed so this gives 35,42; for sieved K up to 50, which were assigned to 11 and are far fewer. Using this approach for k from 1 to 7, results are summarised in Figure 2 for the first 14 6k±1 values.

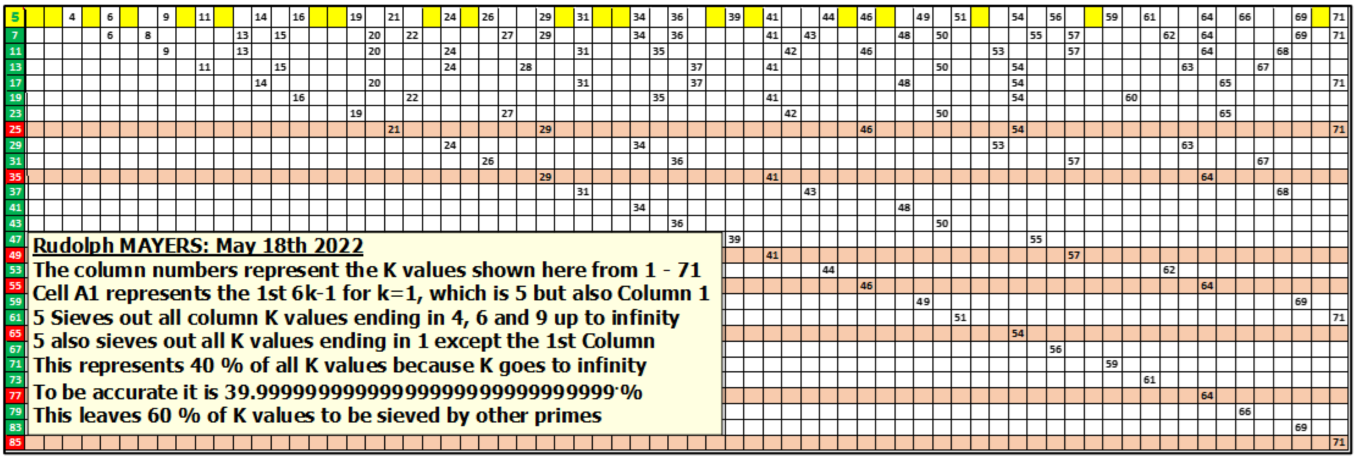

Figure 3: sieving process for 6k±1 up to k=14 to indicate 1st and repeat sieve attempts

It should be obvious that every 6k±1 prime will then sieve out K values that were not sieved out before. It should also be noted that when 6k±1 is a composite the percent sieved out is zero. Details of how the 6k±1percentages were determined is presented above accordingly. Each row in Figure 3 represents the value of 6k±1, whereas the columns represent the potential TWIN PRIME indicator K from 1 to 71 but should obviously go on to infinity.

The numbers in black in Figure 3 show each K value that would be sieved out and one can see where a value is attempted to be sieved out more than once so that only the first row where a K is sieved out is considered since K cannot be removed more than once. The yellow shaded cells represent where that number has not been sieved out and identifies a TWIN PRIME. The diagonal represents the fact that all 6k±1 composites start off from a value that is divisible by 5 thus making it crystal clear to avoid multiple counting of sieved numbers.

Below is explained how percentages for primes greater than 5 were calculated. For 7, first the items that are assigned to 5 were tagged as 5, with the remaining items tagged as 7. Then the repeat pattern of the 7's was established (in this case the 1st 10 repeats). The percentage was then calculated in several ways but ultimately, was shown to be 1.2/7. The repeat pattern for each prime number starting at 7 is the product of all the previous prime numbers, starting at 5 multiplied by 2. Thus for 7 the repeat pattern was 10, for 11 the pattern was 2*5*7 or 70, for 13 the pattern was then 2*5*7*11 or 770 for 17 the pattern was 2*5*7*11*13 or 10010 and so on for each prime.

The additional equations for the sieving by prime numbers are presented below:-

For 29=1.2*(1-2/-2*(12/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1 -2/7-2*(1-2/7)/11)/13)/17-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17)/19-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17 -2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17)/19)/23)/29

For 31=1.2*(1-2/7-2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7-2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23 -2*(1-2/7

-2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/1 1-2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23)/29)/31

For 37=1.2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7-2*(1-2/7)/11 -2*(1-2/7-2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23)/29 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7-2*(1-2/7)/11)/13)/17)/19)/23)/29)/31)/37

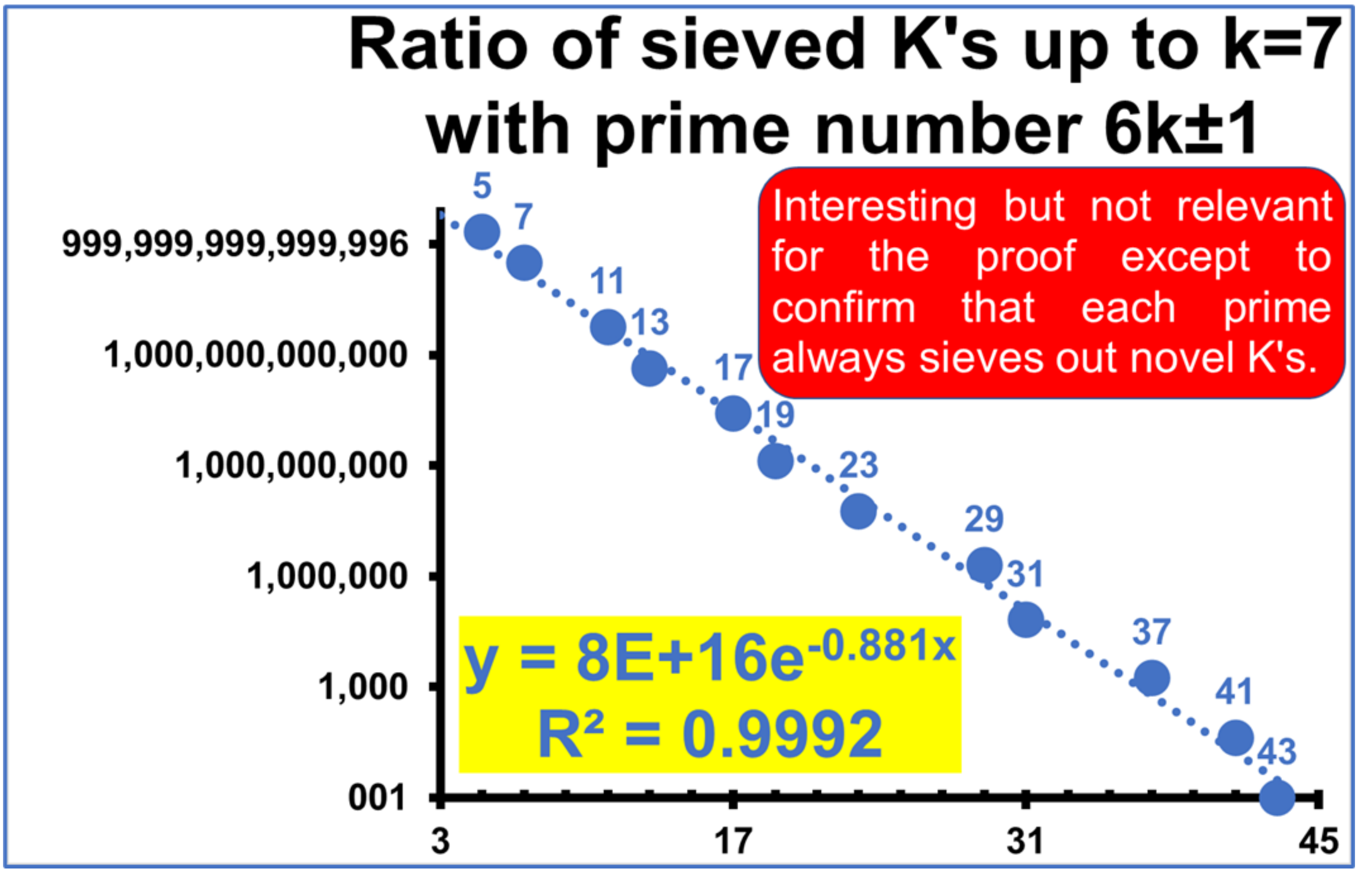

Figure 4: shows the ratio of K's sieved out by prime number which is exponential

For 41=1.2*(1-2/7-2*(1-2/7)/11 -2*(1-2/7-2*(1-2/7)/11)/13-2*(1-2/7-2*(1-2/7)/11-2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23)/29 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7

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2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23)/29)/31)/37)/41

For 43=1.2*(1-2/7-2*(1-2/7)/11-2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17
-2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19 -
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2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17)/19)/23 -
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2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13)/17 -2*(1-2/7 -2*(1-2/7)/11 -2*(1-2/7 -2*(1-2/7)/11)/13 -2*(1-2/7 -2*(1-2/7)/11
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2/7)/11)/13)/17)/19)/23)/29)/31)/37)/41)/43

The procedure was then repeated for 11 to ultimately show that the percentage is 1.2*(1-2/7)/11 so that the percentage reduces to factors of 7 and 11 as shown above. This then did clearly confirm that the percentage assigned as sieved out by each prime number only depended on 1.2, 2 and the previous prime number values. The 1.2 is made up of 0.6, which is the percentage remaining after the 40 percent was removed by 5, which is then multiplied by 2 since each prime number sieves out 6k-1 and 6k+1 from K all the way up to infinity. This clearly explains why a consistent pattern was obtained.

However, it could be argued that this does not prove that every new prime number of the form 6k±1 necessarily sieves out K values that were not sieved out before, so this is addressed below. For 7 it is already outlined above that new K values are sieved out that were not sieved out by 5, so let's consider 11 and above. Note that 5 never sieves out a K values that is a multiple of 5 and nor does 7 sieve a K value that is a multiple of 7 or indeed for any 6k±1prime number. Let's now consider 11 and reflect on the fact that if we take multiples of 5x7 (35) as K then neither 5 nor 7 can sieve out such values.

Performing modulo maths on these K numbers means that if the remainder R obtained matched the 6k±1 prime number k value, then not only is that number sieved out but it cannot have been also sieved out by a previous prime number of the form 6k±1. So for instance Modulo (35,11)=2 and 11=6k-1 for k=2 and this is clearly reflected in Figure 5. Note also that 42 (7x6) is not sieved by 7 and any number ending in 2 is not sieved by 5.

Moreover, there will be an infinity of such K values which are sieved out by 11, since if 35 is multiplied by integers from 1 to 10 and the absolute value of the modulus is taken, then there will be two of each value from 1 to 5 and clearly not only does this not stop at 10 as shown below in figure 6, but also none of these values will be sieved by 5 or 7. Clearly this pattern repeats forever, once multiples of 11 are excluded as shown above. It should be obvious that the process is applicable to products of 6k±1prime numbers.

$$\pi_n = [p_3 * p_4 * p_5 * p_6 * p_7 * p_8 * .... * p_n]$$

can never be sieved out by any of p_3 to p_n and moreover, this means that π_n*N where N is not divisible by p_{n+1} will always produce a value that is sieved out by p_{n+1} and indeed an infinite number of them at the very least, where p_1=2, p_2=3, p_3=5, p_4=7, p_5=11, p_6=13, p_7=17 and p_8=19 and so on all the way to infinity. However, the majority of the K=π_n*N values produced will never be sieved out by p_{n+1}. As the product of all the previous 6k±1prime numbers cannot be sieved out by any of those previous prime numbers and nor can integer multiples of that product, this means that each prime number will necessarily sieve out new K values that were not sieved out by a previous prime number. Although Figure 5 would seem to indicate that these are not the only K values for a 6k±1 that have not been sieved out by a previous prime number of the form 6k±1, it was only necessary to show that each prime number of the form 6k±1 necessarily sieved out K values which were not sieved out before by a previous 6k±1 prime number. As demonstrated with K = 4, 8 and 28, where the K is part of an isolated prime, sometimes the K resulting from the square of a 6k±1 (5, 7 and 13) will only be sieved out by that prime and no other. So even if one doubts

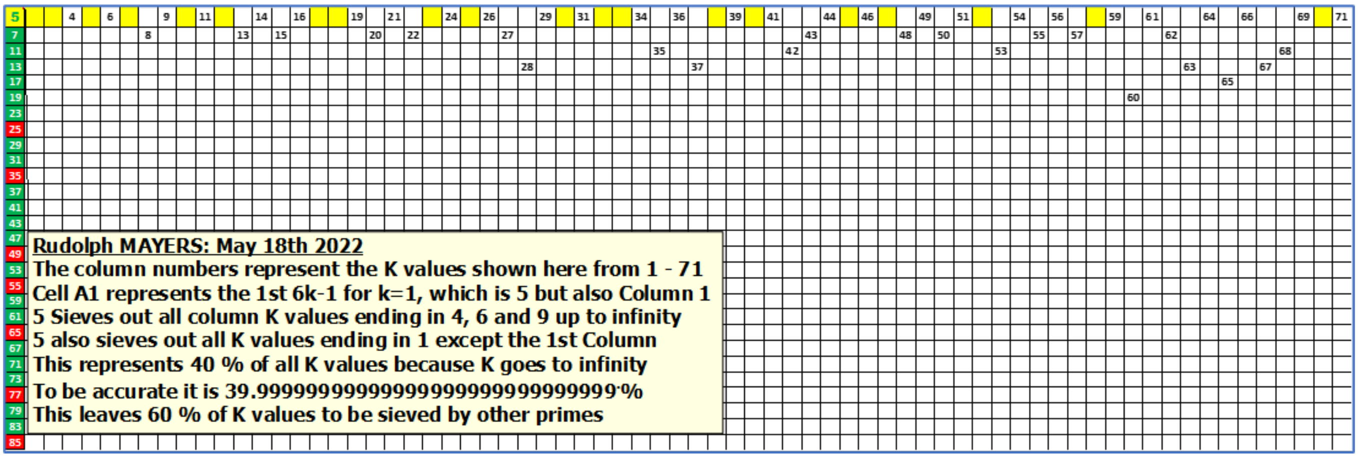

Figure 5: 6k±1 sieved up to k=14 and showing only K values not sieved out before

Consider 6k-1 for k = 2 or 11 where repeats occur after (6k±1)-1 or the 1st 10 repeat			
Value = p_3*p_4*N	Multiplier N	Modulus (Value,11)	ABS(Modulus)
35	1	2	2
70	2	4	4
105	3	-5	5
140	4	-3	3
175	5	-1	1
210	6	1	1
245	7	3	3
280	8	5	5
315	9	-4	4
350	10	-2	2
420	12	2	2
455	13	4	4
490	14	-5	5
525	15	-3	3
560	16	-1	1
595	17	1	1
630	18	3	3
665	19	5	5
700	20	-4	4
735	21	-2	2

Figure 6: shows that for 11 there are then four multiples of K= 35 first sieved out by 11

that there is a well-defined pattern in K values sieved out by each 6k±1prime, it was still established that each 6k±1 prime sieves out K values that were not sieved out before by evaluating the product of prime numbers multiplied by integers. This added to the fact that composites do not sieve out any K values that were not sieved out previously means that there is an infinite number of TWIN PRIMES otherwise there would have been finite prime numbers as will be shown in the proof by contradiction that follows.

5 Other attempts at a proof by the author

5.1 Something similar to Eclid's method

A failed attempt was made to see if Euclid's Prime Number proof approach could apply. Where Euclid multiplied all the prime numbers and added 1, the author added 1 and subtracted 1. This looked promising for a while since

2*3±1 does indeed give a TWIN PRIME (**5;7**), 2*3*5±1 produced another (**29;31**) and while 2*3*5*7±1 did not directly produce another (**11x19**;211), 6k-1 did provide two prime numbers which were part of TWIN PRIMES. Moreover 2*3*5*7*11±1 did produce another directly (**2309;2311**), 2*3*5*7*11*13±1 provided a new one indirectly (30029;**59**x509), 2*3*5*7*11*13*17±1 also provided new ones indirectly (8369***61;19***97*277), 2*3*5*7*11*13*17*19±1 provided new ones indirectly (53***197***929;**347***27953) but 2*3*5*7*11*13*17*19*23±1 did not provide another either directly or indirectly (37*131*46027; 317*703763) and only generated isolated primes. This may have something to do with the fact that 23 is the first isolated prime but whatever the reason the argument could not be sustained that $p_1*p_2*p_3*p_4*p_5*p_6*\ldots*p_{n+1}$ would always produce a new TWIN PRIME directly or indirectly, so this approach was abandoned but left as a curiosity for others to explore. Perhaps using only TWIN PRIMES will work since excluding 23 and using **29** and **31** did.

5.2 Determining if TWIN PRIMES would always increase in a selected range

Since numerous prime numbers are readily available on the internet, it is a relatively trivial matter to check how many TWIN PRIMES occur in selected ranges. The author checked within squares of 6k±1 and observed that the TWIN PRIMES in each range was always greater than or equal to 2 and generally increased as k was increased. The number of TWIN PRIMES between $\mathbf{5}^2$ and $\mathbf{7}^2$ is two because this spans the K range **4** to **8** where neither of the end K's (**4***6+1=25 and **8***6+1=49) nor the midpoint (**6***6-1=35) can produce TWIN PRIMES, which just leaves **5** and **7** which did. Similarly for k=**2**, one can search in the range 20 to 28 to find two TWIN PRIMES at K=**23** and K=**25**. It is left to the reader to continue this process for larger values of k, which will show that the number of TWIN PRIMES in each range does appear to be increasing but this is not proof of infinite TWIN PRIMES as surely many would rightly point out. A similar approach could be taken between the squares or evaluating up to each $(6k+1)^2$ or making the range the product of successive prime numbers, but the author could never find a formula to definitely show that the number of TWIN PRIMES must always increase, so while interesting and compelling this clearly was also not a proof.

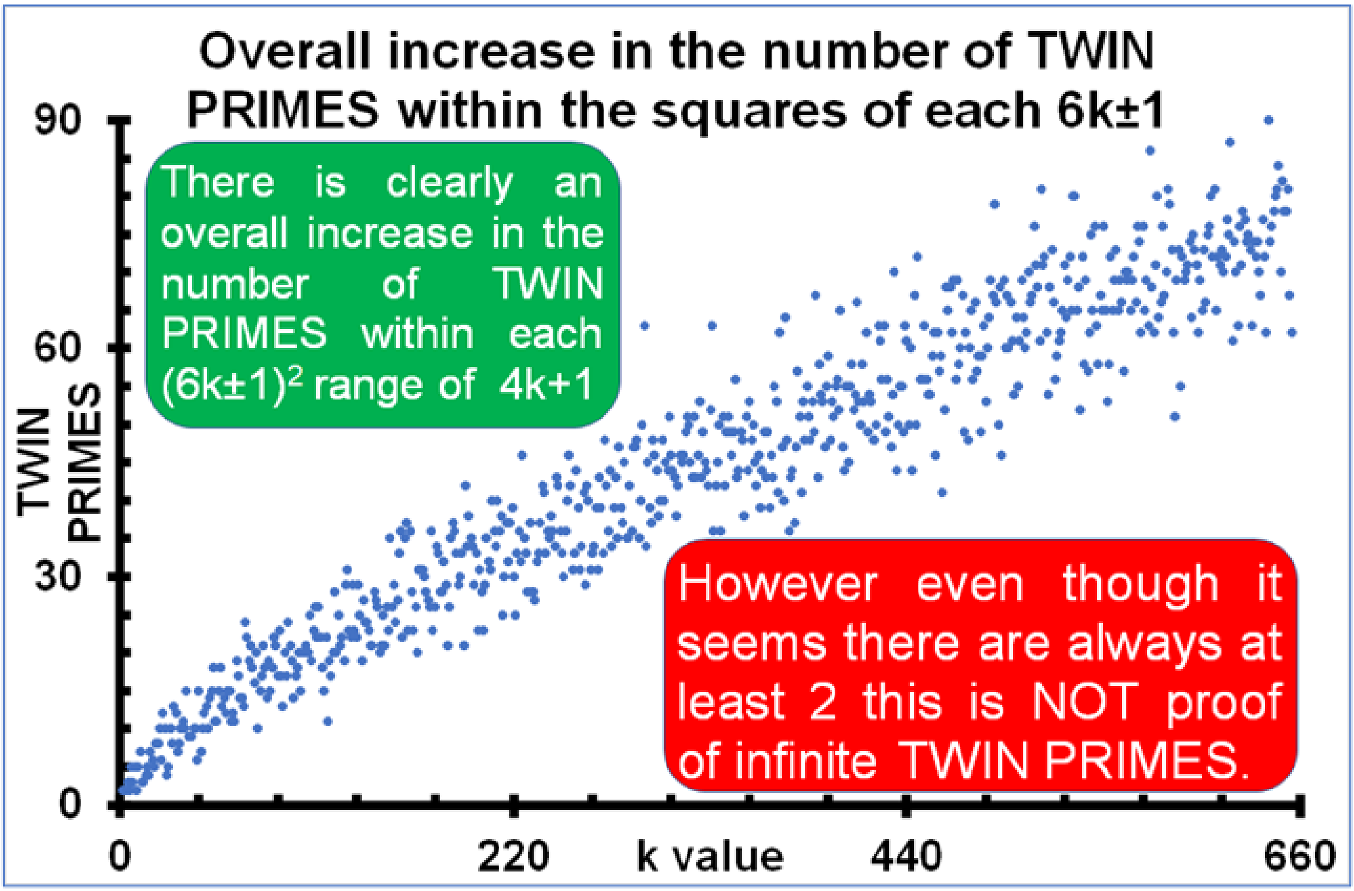

Figure 7: number of TWIN PRIMES within each $(6k\pm1)^2$ range which spans 4k+1

6 Proof by contradiction

Let's assume that there is a finite number of TWIN PRIMES. This means that there must be a prime number where in combination with the previous prime numbers all K values from that point forward up to infinity are sieved out. Now let's consider the next prime number, this prime number will have nothing to sieve out as all remaining K's have been sieved out. But the only 6k±1 values that don't sieve out anything that hasn't already been sieved out are composites, so this would have to be a composite. Indeed, all subsequent 6k±1 values would have to be composites. But not all of the subsequent 6k±1 values can be composite because there is an infinite number of prime numbers thus there must be an infinite number of TWIN PRIMES otherwise there would have been a finite number of prime numbers, and this has already been shown to be false. This then implies that at least for numbers of the form 6k±1, an additional definition of a prime number is a number that sieves out TWIN PRIME K candidates along the integer number line, that were not already sieved out by a previous prime number. Put another way, as one progresses along the number line, each new prime number necessarily sieves out new K values which have not been sieved out before by previous prime numbers, which means that it is not possible to ever exhaust the K values that are available to be sieved out and therefore TWIN PRIMES are infinite.

If the same logic is used for 7, 5, 3 and 2 then 2 cannot sieve out K values that are multiples of 2 and similarly 3 cannot sieve out any K values that are multiples of 3 which together correspond to multiples of 6 being necessary but not sufficient for a TWIN PRIME. So then 5 can sieve out K values that are multiples of 6, which is perhaps another way of saying that all prime numbers greater than 3 must be of the form 6k±1. One could then argue that since 5 cannot sieve out any K value that is a multiple of 5 there will be an infinite number of such K values that can be sieved out by 7. Note that the ladder model also works for 2 and 3 by default since the remainders after dividing an integer by 2 must be 1 but the model k=5/12 cannot ever match. Moreover, the remainders after dividing any integer by 3 must be 1 or 2 (-1 mod 3), but neither of these can be equal to the model 5/12 nor 2/3. In the case of 5, the possible remainders of dividing an integer by 5 (where K > k) are 1, 2, 3 (-2), 4 (-1) so that the modulus of the remainder can be k=1 but not k=2/3. The one oddity of the model is that 3 and 5 occur twice on the ladder since 3 can be 6k+0.5 where k=5/12 so that 2 becomes 6k-0.5. Then 3 can be 6k-1 for k=2/3, where 5 would be 6k+1 to represent the first TWIN PRIME. Finally, 5 can then be 6k-1 for k=1, where 7 would be 6k+1 in the second TWIN PRIME respectively.

For completeness and clarity, it is pointed out that the prime number 2 removes all even numbers from the full number line (50 %), whereas 3 would remove all numbers that are divisible by 3 from the full number line some of which are also divisible by 2. For 5 and above the analysis is of TWIN PRIME indicator K (where mod(K,6k+1) matches k) and not the full number line, which are of the form 6k±1 where 5 sieves 40 % of K values up to infinity.

7 Conclusion

A very simple approach was taken in developing a proof of the TWIN PRIME CONJECTURE since this all began as a coping strategy for insomnia. The sieving process was used to show that 6k±1 composites do not sieve out any new K values and then a proof by contradiction was developed by utilising this key bit of information.

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