

# A Proof of Goldbach's strong conjecture

Author : Sitangsu Maitra (email : maitra.sitangsu@gmail.com)

**Abstract** : The proof includes a series, and its aspects are treated in a special way. The concept of Unique Path of primes is explained and its effects are shown. In the midway of the proof, it is postponed for a while and a deviation from the course is taken to introduce a probably new axiom. Afterwards the proof restarts again and using the axiom and other results the conjecture is proved.

Please note : Every symbol 'p' with or without any suffix or (\*) denotes some prime number.  $a|b$  means a divides b and  $a \nmid b$  means a doesn't divide b. n is a natural number. The word 'prime' will hereafter mean prime number and 'even' mean even positive integer. The sign ' $\exists$ ' means 'there exist'.

First stage : There is at least one prime p ( $3 \leq p < n$ ) for every  $2n > 6$  such that  $p \nmid 2n$ .

Proof : For any even  $2n > 6$ , at least one of the evens  $2n-2$  and  $2n+2$  is not an integral power of 2.

Now  $n-1$  or  $n+1$  is divisible by at least one prime  $p^*$  ( $3 \leq p^* < n$ ).

So  $p^* | 2(n-1) \Rightarrow p^* \nmid 2(n-1)+2 \Rightarrow p^* \nmid 2n$  or, alternatively  $p^* | 2(n+1) \Rightarrow p^* \nmid 2(n+1)-2 \Rightarrow p^* \nmid 2n$

Suitably using any of the above two alternative results we can prove the claim.

Second stage : Consider a prime  $p_1$  ( $3 \leq p_1 < n$ ) such that  $p_1 \nmid 2n$ . Now let  $2n-p_1$  is divisible by a prime  $p_2$ , where  $p_2 < n$ .

So there can be a series

$\exists p_2$ , such that  $p_2 | 2n-p_1$ , where  $p_2 < n$

$\exists p_3$ , such that  $p_3 | 2n-p_2$ , where  $p_3 < n$

...

...  $\exists p_k$ , such that  $p_k | 2n-p_{k-1}$ , where  $p_k < n$

The primes  $p_2, p_3, \dots$  are taken in such a manner, as far as possible, that each one is different from all the other primes (including  $p_1$ ) appearing previous to itself in the series.

It can easily be proved that no such prime divides  $2n$  (since any  $p_k \neq p_{k-1}$ ).

The operation of getting  $p_2, p_3, \dots$  must end at some  $p_k$ , otherwise there will be infinite number of different primes  $< n$ ; k is a finite positive integer. We henceforth shall call  $p_1$  as 'starting prime'.

We further call  $p_2, p_3, \dots, p_k$  (all being different, where  $p_k$  is the last of them) as different outputs or simply as outputs.

Let the course of the proof be postponed for a while to discuss a topic. It is a common sense that we can omit anything from a written or mentioned expression. For that purpose we simply need to wipe out or erase the purported

object from the expression. But when the question comes to the dealing with its logical aspect, we need to introduce an axiom. Namely •••

Axiom of omission : We can omit or erase anything from an expression or a system of expressions if the rest of it bears some logical meaning.

It is a different question what the effect of this axiom should be in the context of other mathematical topics. It is just a logical interpretation of certain human discretion taken in common sense perspectives.

Return to the proof •••••

Observation (1) : For a particular  $p_1$  we can choose arbitrarily particular  $p_2, p_3, \dots, p_k$  ( $p_k$  being the last available different output for the series where  $p_1$  is the starting prime) and in this way they constitute an Unique Path of successive particular selections from the prime factors of various  $2n-p_t$ 's,  $p_t$ 's starting from  $p_1$ .  $p_1$  is also included in the Unique Path and put in its place. Such Unique Path is always strictly ordered.

Observation (2) :  $p_k$  being the last different output ( $<n$ ) {  $p_k$  available from  $2n-p_{k-1}$  as a factor of it } in the series, proceeding similarly beyond it we get  $p_{k+1}$  from  $2n-p_k$ , where  $p_{k+1}|2n-p_k$  with the exception that in this case  $p_{k+1}$  not necessarily  $<n$ .

Now  $p_{k+1}<n$  implies  $p_{k+1}$  is a recycled prime, i.e,  $p_{k+1}$  is any of  $p_1, p_2, p_3, \dots, p_k$  (since  $p_k$  is the last available different output for the series of  $k-1$  unique steps,  $p_1$  being the starting prime).

We define 'a list' as a successive mentioning of items (ignore the commas) and 'a choice' as a selection of mentioned item/s. Evidently a list is an expression. We claim that,

we choose only one item from a particular list  $\Rightarrow$  we omit the rest of the items from the list.

Proof : If not so.

Since a list is an expression and we have to choose from the list, if we retain at least another item in the list, other than the one intended for this choice,

there will be at least two mentioned items for a choice, where none can be excluded. But we have to choose (i.e, select the mentioned) only one item as per requirement. So there is a contradiction.

Hence our claim is true.

Let  $p_{k+1}$  is a recycled prime.

Since  $p_{k+1}$  is a singularly mentioned prime (as evident from its identity), a recycled prime taken as  $p_{k+1}$  is also a singularly mentioned identity which implies we have to choose only one output from the list of different outputs.

Now for an arbitrarily particular  $p_1$  we obtain an unique path of successive particular selection of primes, which must contain an unique starting prime and an unique last output w.r.t the path itself.

Omission of any of these two from the ordered list of primes that can be made going along the above unique path [the unique path  $\Leftrightarrow$  the ordered list, therefore both coincides; for more explanation see Comment below], doesn't make any logical meaning for the expression (i.e, the list) containing any of the rest, when viewed in accordance with the above unique path, that view we are bound to take in this case [The above omissions in this context implies the ordered list here is devoid of a starting prime and/or a last output and thus the whole residual concept drawn from Observation (1) & (2) and related other concepts, goes undefined]. Therefore by Axiom of omission the above omissions are impossible.

This means after every possible omission from the above mentioned ordered list there remains at least two primes to choose as  $p_{k+1}$ , none of which is omissible.

So we can say that we can't omit, all primes other than that intended one for recycling purpose, from the list, which implies we can't choose only one recycled prime as  $p_{k+1}$ .

[Comment : Here it may be counterargued that there is no harm if we select the recycled prime from the list  $p_1, p_2, \dots, p_k$ , ignoring its affiliation with the series and related arguments upto this point, and it doesn't make any difference if we change their proposed order to whatever else we want. In that case we say the recycled one must be chosen from the ordered list along the above unique path only, which couldn't be derived otherwise so as to serve for the 'recycled choice' purpose [because ignoring of the said affiliation means no relevance to the word 'recycled' and giving provision for any possibility at which the list might be created, other than that one described before, which is impossible because the conceptual idea of  $p_{k+1}$  pertains a precondition of proceeding of the series in the same way as it does before this step,  $p_{k+1}$  behaving the same way as  $p_2, p_3, \dots, p_k$ , with the exception that  $p_{k+1}$  not necessarily  $< n$  {see Observation (2)}, hence refuting the very premise of the selection]. Further we can argue that changing of order contradicts the unique path of successive particular selections of primes, which is one of the unavoidable foundations behind the construction of the particular list (though change of the order may only create another unique path with the same (all and nothing more) elements of the original list, if it can be so constituted at all, posing no threat to the basic reasoning as followed in the case of original list and unique path; however it is convenient not to change the original order for better understanding.)]

Summing up the above discussions

we conclude that  $p_{k+1}$  can't be recycled, that implies  $p_{k+1}$  isn't  $< n$ , and since  $p_k < n$ ,

we are bound to accept the conclusion that  $p_{k+1} > n \Rightarrow p_{k+1} = 2n - p_k$ .

[ $2n - p_k$  can't have a factor that is greater than  $n$  and smaller than itself, and  $p_{k+1} \neq n$  for obvious reasons.]

Therefore,  $2n = p_k + p_{k+1}$

Contrary to what we have assumed at the beginning of the Second stage, if  $p_2$  isn't  $< n$ , then as  $p_1 < n$ ,  $p_2$  becomes  $> n$ . This implies  $2n = p_1 + p_2$   
[Reasons are similar as above]

Finally over the question whether the integers 6 & 4 comply to Goldbach's strong conjecture, we write  $6 = 3 + 3$  and  $4 = 2 + 2$

Therefore Goldbach's strong conjecture holds for every  $2n \geq 4$ .