**The conjecture of Erdos-Strauss and its application in demonstrating the twin primes supported by the Bayes´ theorem.**

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**Abstract**

In this brief paper we present the necessary and sufficient conditions within the solution of the Erdos-Straus conjecture when (n) takes the values of any twin prime. Then we conclude with a table for its visualization and analysis proving by the Bayes' theorem that the twin primes are infinite.

**Keywords:**

Erdos-Straus conjecture, Dirichlet theorem, Bayes Theorem, twin primes.

## Introduction

For anyone who is immersed in the mysterious world of mathematics would seem strange that there exist relationship between theories that apparently lack of similarity and the purpose of this short essay is to establish a relationship between the Erdos-Strauss conjecture and the twin primes or Polignac´s conjecture and likewise Golbach´s even conjecture or its application in probability theory in the theory of numbers.

This is the main objective of this short essay and we present the whole development using as a methodological tool the heuristics.

It should be noted that first we present a relationship between the Erdos-Straus conjecture and its solution for twin prime values and this can prove the infinity of twin primes that finally we proof with the Bayes´ theorem.

## Theoretical Framework

**Theorem 1**: If: gcd (a, n) = 1

Then: there is an infinite number of primes congruent

with a modulo n. (Dirichlet)

**Theorem 2**: Bayes.

## Problem Statement

**Problem to demonstrate**:

There are infinitely many Gaussian primes:

Of the form: $\mathbf{P_2 = 4.n+3}$

When: $\mathbf{P_2 = 7 \ (mod\ 12)}$ **(By Dirichlet)**

Such that the corresponding Pythagoras twin prime:

of the form $\mathbf{P_1 = 4.n+1}$

Where: $\mathbf{P_1 = 5 \ (mod\ 12)}$ **(By Dirichlet)**

They are both solution of the Erdos-Strauss conjecture.

If and only if: $\mathbf{4/P_2 = 1/x + 1/y + 1/z}$

Where: $\mathbf{x = (P_2+1)/4}$

$\mathbf{y = 2.x.P_2}$

$\mathbf{z = 2.x.P_2}$

Hence: $\mathbf{4/P_1 = 1/x + 1/y + 1/z}$

Where: $\mathbf{x = P_1}$

$\mathbf{y = (P_1+1)/3}$

$\mathbf{z = (x.y)}$

And therefore the infinity of the twins primes is true.

**Visualization: (see table 1)**

| x | y | z | $P_1$ | $P_2$ | x | y | z |
|---|---|---|---|---|---|---|---|
| 5 | 2 | 10 | 5 | 7 | 2 | 28 | 28 |
| 17 | 6 | 102 | 17 | 19 | 5 | 190 | 190 |
| 29 | 10 | 290 | 29 | 31 | 8 | 496 | 496 |
| 41 | 14 | 574 | 41 | 43 | 11 | 946 | 946 |
| 53 | 18 | 954 | 53 | 55 | 14 | 1540 | 1540 |
| 65 | 22 | 1430 | 65 | 67 | 17 | 2278 | 2278 |
| 77 | 26 | 2002 | 77 | 79 | 20 | 3160 | 3160 |
| 89 | 30 | 2670 | 89 | 91 | 23 | 4186 | 4186 |
| 101 | 34 | 3434 | 101 | 103 | 26 | 5356 | 5356 |
| 113 | 38 | 4294 | 113 | 115 | 29 | 6670 | 6670 |

**Table 1.**

**Proof:**

Since there are infinitely many primes for all arithmetic progression of the form:

**D = n.a + b**

When: **gcd (a, b) = 1 (By Dirichlet Theorem).**

And as: **D = n.12 +5**

Therefore: **D = n.12 + 7**

Then both progressions are fulfilled with that condition. And since the Erdos-Straus conjecture is true for all natural numbers of the form:

**A = n.12 +5**

And also of the form:

**B = n.12 + 7**

When: **n> 0**

So: By all of the above is proved the infinity of the twin primes.

**Visualization: (see table: 2 and 3)**

| x | y | z | $P_1$ | $P_2$ | x | y | z |
|---|---|---|---|---|---|---|---|
| 5 | 2 | 10 | 5 | 7 | 2 | 28 | 28 |
| 17 | 6 | 102 | 17 | 19 | 5 | 190 | 190 |
| 29 | 10 | 290 | 29 | 31 | 8 | 496 | 496 |
| 41 | 14 | 574 | 41 | 43 | 11 | 946 | 946 |
| 53 | 18 | 954 | 53 | 55 | 14 | 1540 | 1540 |
| 65 | 22 | 1430 | 65 | 67 | 17 | 2278 | 2278 |
| 77 | 26 | 2002 | 77 | 79 | 20 | 3160 | 3160 |
| 89 | 30 | 2670 | 89 | 91 | 23 | 4186 | 4186 |
| 101 | 34 | 3434 | 101 | 103 | 26 | 5356 | 5356 |
| 113 | 38 | 4294 | 113 | 115 | 29 | 6670 | 6670 |

**Table 2.**

| x | y | z | n | n | x | y | z |
|---|---|---|---|---|---|---|---|
| 5 | 2 | 10 | 5 | 7 | 2 | 28 | 28 |
| 17 | 6 | 102 | 17 | 19 | 5 | 190 | 190 |
| 29 | 10 | 290 | 29 | 31 | 8 | 496 | 496 |
| 41 | 14 | 574 | 41 | 43 | 11 | 946 | 946 |
| 53 | 18 | 954 | 53 | 55 | 14 | 1540 | 1540 |
| 65 | 22 | 1430 | 65 | 67 | 17 | 2278 | 2278 |
| 89 | 30 | 2670 | 89 | 91 | 23 | 4186 | 4186 |
| 101 | 34 | 3434 | 101 | 103 | 26 | 5356 | 5356 |
| 113 | 38 | 4294 | 113 | 115 | 29 | 6670 | 6670 |

**Table 3.**

**Analysis and discussion of results:**

**As is shown by Dirichlet's theorem that there are infinitely many primes in arithmetic progressions.**

The probability that the term belonging to the progression: **A** be a prime is equal to:

**P (A) = 1/2**

The probability that the term belonging to the progression: A be a Composite is equal to:

**P (A) = 1/2**

The probability that the term belonging to the progression: B be a prime is equal to:

**P (B) = 1/2**

The probability that the term belonging to the progression: B be a Composite is equal to:

**P (B) = 1/2**

**And according to the stated by the Bayes' theorem:**

The probability when the term belonging to the progression: **A** be a composite and the term belonging to the progression: **B** be also a Composite:

**P (A) .P (B) = 1/2. 1/2 = 1/4 (By the Bayes´ theorem)**

The probability when the term belonging to the progression: **A** be a prime and the term belonging to the progression: **B** be a composite:

**P (A) .P (B) = 1/2. 1/2 = 1/4 (By the Bayes´ theorem)**

The probability when the term belonging to the progression: **A** be a composite and the term belonging to the progression: **B** be a prime:

**P (A) .P (B) = 1/2. 1/2 = 1/4 (By the Bayes´ theorem)**

The probability when the term belonging to the progression: **A** be a prime and the term belonging to the progression: **B** is also a prime:

**P (A) .P (B) = 1/2. 1/2 = 1/4 (By the Bayes´ theorem)**

And as the differences of all terms of the progression: **B** minus the corresponding terms of the progression: **A** is constant and equal to: **2**. Therefore, when both are primes are also twins and since in each progression there exist infinitely many primes according to the Dirichlet´s theorem Dirichlet. Then, it is demonstrated that the twin primes are infinite.

**Visualization: (See Table 4)**

| P(A) | n | n | P(B) |
|---|---|---|---|
| P | 5 | 7 | P |
| P | 17 | 19 | P |
| P | 29 | 31 | P |
| P | 41 | 43 | P |
| P | 53 | 55 | C |
| C | 65 | 67 | P |
| C | 77 | 79 | P |
| P | 89 | 91 | C |
| P | 101 | 103 | P |
| P | 113 | 115 | C |

**Table 4.**

Note that this result applies equally to demonstrate Polignac's conjecture and the Golbach´s conjecture.

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