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Chapter
Prime Numbers Distribution Line
Shcherbakov Aleksandr Gennadiyevich

Abstract
During the analysis of the fractal-primorial periodicity of the natural series of numbers, presented in the form of an alternation (sequence) of prime numbers (1 smallest prime factor > 1 of any integer), the regularity of prime numbers distribution was revealed. That is, the theorem is proved that for any integer = N on the segment of the natural series of numbers from 1 to N + 2\( \sqrt[N]{N} \): (1) prime numbers are arranged in groups, by exactly three consecutive prime numbers of the form: \( P_1, P_2, P_3 \). In this case, the distance from the first to the third prime number of any group is less than \( 2\sqrt[N]{N} \) integers, that is, \( P_3 - P_1 < 2\sqrt[N]{N} \) integers. (2) These same prime numbers are redistributed in a line in groups, by exactly two consecutive prime numbers, on all segments of the natural series of numbers shorter than \( 2\sqrt[N]{N} \) integers.

Keywords: residue groups, prime numbers, primorial, sieve of Eratosthenes, alternations, fractal

1. Introduction
1.1 Line-symmetrical primary-repeatable fractals of the positive integers

In the scientific works [7 pp. 142–147, 8 pp. 77–84, 9 pp. 109–116], positive integers are analyzed, hereinafter the P.I. is represented only as the alternance (array) of primes (according to the 1st least prime factor > 1 from every whole number). Type: 12.3.5.7.3.11.3.17.19.3.23.5.3.29 ... 3.р.р.р.р.п.п.п.p ... with for every recurrent prime = \( P_3 \), sieve of Eratosthenes formats the P.I., represented by alternance (array) of the first primes \( \leq P_1 \), in the form line-symmetrical repeating fractal-like structure, situated in the section of P.I. from 1 to \( P_1 \), with “eliminated” sections of P.I. and \( \phi(P_1) \) not eliminated odd numbers are line-symmetrical to the number = \( P_1/2 \) and are repeated without rearrangement of their position with the period = \( P_1 \), on the basis of rhythmical repeating of two even numbers. Every recurrent prime has its own line-symmetrical primary-repeatable fractal = \( P_1 \), then goes fractal = \( P_1 \) (see line 1 Table 1).

Every recurrent line-symmetrical fractal -P1# is situated on the section of P.I. from 1 to \( P_1 \) and contains \( \phi(P_1) \) of the not eliminated odd numbers that are \( \phi(P_1) \) of the least residue, belonging to the indicated residue system (I.R.S) according to mod (\( P_1 \)), type: \( C_n \) to the left from the number = \( P_1/2 \) and (\( P_1-C_n \)) to the right from the number = \( P_1/2 \), with \( C_n \) – is residue according to mod(\( P_1 \)). Hereinafter with the term mod(\( P_1 \)), we shall indicate the period of fractal P1# repetition (I.R.S, sieve of Eratosthenes), equal to product of all first primes \( \leq P_1 \) (primorial = \( P_1 \)) [1–6].
<table>
<thead>
<tr>
<th>$C_1 = 1$</th>
<th>$C_2 = P_2$</th>
<th>$p p p$</th>
<th>$C_3$</th>
<th>$p p p$</th>
<th>$C_n$</th>
<th>$p p p$</th>
<th>$P_1# - C_n$</th>
<th>$p p p$</th>
<th>$P_2# - C_2$</th>
<th>$\ldots$</th>
<th>$(P_1# - 1)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1 \times P_1#$</td>
<td>$\ldots$</td>
<td>$C_2 + P_1#$</td>
<td>$p p p$</td>
<td>$C_3 + P_1#$</td>
<td>$p p p$</td>
<td>$C_n + P_1#$</td>
<td>$p p p$</td>
<td>$2P_1# - C_n$</td>
<td>$p p p$</td>
<td>$2P_1# - C_2$</td>
<td>$\ldots$</td>
</tr>
<tr>
<td>$1 \times 2P_1#$</td>
<td>$\ldots$</td>
<td>$C_2 + 2P_1#$</td>
<td>$p p p$</td>
<td>$C_3 + 2P_1#$</td>
<td>$p p p$</td>
<td>$C_n + 2P_1#$</td>
<td>$p p p$</td>
<td>$3P_1# - C_n$</td>
<td>$p p p$</td>
<td>$3P_1# - C_2$</td>
<td>$\ldots$</td>
</tr>
<tr>
<td>$\ldots$</td>
<td>$\ldots$</td>
<td>$\ldots$</td>
<td>$p p p$</td>
<td>$\ldots$</td>
<td>$p p p$</td>
<td>$\ldots$</td>
<td>$p p p$</td>
<td>$P_2# - C_n$</td>
<td>$p p p$</td>
<td>$P_2# - C_2$</td>
<td>$\ldots$</td>
</tr>
<tr>
<td>$1 \times P_2#$</td>
<td>$\ldots$</td>
<td>$C_2 + P_2#$</td>
<td>$p p p$</td>
<td>$C_3 + P_2#$</td>
<td>$p p p$</td>
<td>$C_n + P_2#$</td>
<td>$p p p$</td>
<td>$p p p$</td>
<td>$\ldots$</td>
<td>$\ldots$</td>
<td>$\ldots$</td>
</tr>
</tbody>
</table>

And so on, repeating of fractal $= P_1\#$ with the period $= P_1\#$, with: $p p p$ is alternance of $\leq P_1$.

Table 1. 
$P_1$ repeating of periodical fractal $= P_1\#$, including I.R.S. according to the mod($P_1\#$).
By term residue according to mod \((P_n#)\), we shall indicate every number, NOT eliminated by Sieve of Eratosthenes, not aliquot to the first primes \(\leq P_n\).

Alternance \(\leq P_n\) is the section of P.I. in the form of array of primes – NOT residues of mod\((P_n#)\), (for the 1 least common factor > 1 from every NOT residue).

Eliminating (according to diagonals) 1 number multiple to \(P_1\) in every column = \(C\), we'll get in \(P_2\) lines of Table 1: \(q(P_1#)\times(P_2#)\) and \(\phi(P_1#)\) multiple \(P_2 = q(P_2#)\) residue of mod\((P_2#)\). Representing the section of P.I. from 1 to \(P_3\#\) as one line, we'll get the fractal = \(P_2\#\) with the period of repeating = \(P_3\#\). And so on: every recurrent prime = \(P_n\) has got its periodical fractal = \(P_n\#\) with \(n\) is the whole.

The numerical illustration is indicated in the scientific works [7–10].

Fractal (\(P_1\#\))-I.R.S. \(\phi(P_1#) =\) (first line of Table 1).

Fractal (\(P_2\#\))-I.R.S. \(\phi(P_2#) = \) \(P_2\) lines in Table 1. \(\phi(P_1#)\) numbers multiple to \(P_2\).

Fractal (\(P_3\#\)) I.R.S. \(\phi(P_3#) = \) \(P_3\) lines in Table 2. \(\phi(P_2#)\) numbers multiple to \(P_3\).

Fractal (\(P_4\#\)) I.R.S. \(\phi(P_4#) = \) \(P_4\) repeating of fractal \(P_3\#\)–\(\phi(P_3#)\) numbers multiple to \(P_4\).

Fractal (\(P_5\#\)) I.R.S. \(\phi(P_5#) = \) \(P_5\) repeating of fractal \(P_4\#\)–\(\phi(P_4#)\) numbers multiple to \(P_5\).

and so on according to cumulative primes.

1.2 Purpose and role of the overall length of the of alternance (array) of the all first primes \(\leq P_n\)

It is quite obvious that \(\phi(P_n#)\) of the least residues of mod\((P_n#)\) type = \(C\) and \(P_n#–C\), of every recurrent fractal = \(P_n#\), gradate P.I. as \(\phi(P_n#)\) “eliminated” sections of P.I. with different lengths of the type: \(\ldots C\ldots P_n\ldots C\ldots 3\ldots P_n\ldots C\ldots \ldots\), “eliminated” sections of P.I. represented as array of “eliminated” NOT residues of mod\((P_n#)\), or on the form of alternance (array) of the first primes \(\leq P_n\), (according to the 1st least prime factor >1 from every NOT residue of mod\((P_n#)\)), hereinafter the alternance \(\leq P_n\), \(C\) – residue of mod\((P_n#)\) (according to the 1st least \(P_n\) from every residue of mod\((P_n#)\)), location from 1 to \(P_n\#\) is line symmetrical relating to number = \(P_n#\)/2. And further, repeated without rearrangement of their position with the period = \(P_n\#\). Then, after we define the overall - maximal length of alternance that we can form using the fist primes \(p \leq P_n\) (NOT residues of mod \((P_n#)\), type \(C_1 \ldots 3p3p3p \ldots C_n\)) that is maximal amount of consequent odd numbers = maximal length of alternance - \(p \leq P_n\) (one least NOT residue of mod \((P_n#)\) >1 from the number), we can evaluate the distance between every two consequent residues of mod \((P_n#)\) that is between two primes \(< (P_n + 1)^2 >\), according to formula: \((C_2 - C_1) - 2/2\) of the odd numbers \(\leq\) maximal length of the alternance, (maximal amount of NOT residue of mod\((P_n#)\)).

In the scientific works [7 pp. 142–147, 8 pp. 77–84, 9 pp.109–116], the distribution of groups of 4 consequent residues in the form of “pairs of residues every two residue” is analyzed. But we have no information on distribution of groups of 4, 3, and 2 consequent residues of mod\((P_n#)\) for every fractal \(P_n#\).

In this scientific work, the \(q(P_n#)\) of the least residue of mod\((P_n#)\) of every recurrent fractal - \(P_n#\) is indexed as continuous sequence of groups: (a) No 4 has got 4 residues, or (b) No 3 has got 3 residues or (c) No 2 has got 2 consequent residues mod\((P_n#)\). These groups No 4-3-2 are analyzed as subgroups with No 4-3-2 consequent residues of mod\((P_n#)\) that are surrounded by the maximal permissible amount of consequent NOT residues of mod\((P_n#)\).

We used the mathematical induction method to define the overall – maximal length of every kind of subgroups No 4, No 3, No 2 and overall maximal length of P.
Table 2.

<table>
<thead>
<tr>
<th>C1 = 1</th>
<th>2 or 2m</th>
<th>C2 = P3</th>
<th>ppp</th>
<th>...</th>
<th>C3 ...</th>
<th>ppp</th>
<th>...</th>
<th>Cn ...</th>
<th>ppp</th>
<th>P2#-Cn</th>
<th>ppp</th>
<th>...</th>
<th>P2#-C2</th>
<th>...</th>
<th>(P2#-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 + P3#</td>
<td>2 or 2m</td>
<td>C2 + P3#</td>
<td>ppp</td>
<td>...</td>
<td>C3 + P3#</td>
<td>ppp</td>
<td>...</td>
<td>Cn + P3#</td>
<td>ppp</td>
<td>2P3#-Cn</td>
<td>ppp</td>
<td>...</td>
<td>2P3#-C2</td>
<td>...</td>
<td>(2P3#-1)</td>
</tr>
<tr>
<td>1 + 2P3#</td>
<td>2 or 2m</td>
<td>C2 + 2P3#</td>
<td>ppp</td>
<td>...</td>
<td>C3 + 2P3#</td>
<td>ppp</td>
<td>...</td>
<td>Cn + 2P3#</td>
<td>ppp</td>
<td>3P3#-Cn</td>
<td>ppp</td>
<td>...</td>
<td>3P3#-C2</td>
<td>...</td>
<td>(3P3#-1)</td>
</tr>
<tr>
<td>...</td>
<td>2 or 2m</td>
<td>...</td>
<td>ppp</td>
<td>...</td>
<td>...</td>
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<td>...</td>
<td>2 or 2m</td>
<td>...</td>
<td>ppp</td>
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<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1 + P5#</td>
<td>2 or 2m</td>
<td>C2 + P5#</td>
<td>ppp</td>
<td>...</td>
<td>C3 + P5#</td>
<td>ppp</td>
<td>...</td>
<td>Cn + P5#</td>
<td>ppp</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>P5#-C2</td>
<td>...</td>
</tr>
</tbody>
</table>

And so on, repeating of fractal = P2# with the period = P3#, with; ppp is alternance of ≤ P3#.

Representing the section of P.I. as line from 1 to P3# we’ll get the fractal P3# and so on.

P3 repeating of periodical fractal = P3#, including I.R.S. according to the mod(P3#).
I. sections in the form of maximal long alternances of all first primes \( \leq P_n \) (that is maximal permissible amount of all NOT residues of \( \text{mod}(P_n\#) \)), situated between two residues from \( C_A \) to \( C_B \), between which, as subgroups are situated the groups of residues of \( \text{mod} \) \( (P_n\#) \). Type:

a. - No 4: \( C_{A..3pp3..P_{1..3}P_{2..3}P_{3..4pp3..}}C_B \).

b. No 3: \( C_{A..3pp3..P_{1..3}P_{2..3..P_{3..3pp3..}}C_B} \).

c. No 2: \( C_{A..3pp3..P_{1..3}P_{2..3pp3..}}C_B \).

As a result, we detected the loopback of these groups rearrangement from No 4 to No 3 up to No 2 according to the growing amount of the modulus, and the primes order distribution is defined.

2. Three groups of “eliminated” sections of every next fractal

It is quite obvious and requires no proof that indexing \( \psi(P_i\#) \) of the least residues of \( \text{mod}(P_i\#) \) of every recurrent fractal-\( P_i\# \), or I.R.S \( \text{mod}(P_i\#) \), is by groups, containing strictly 4 elements; three; two consequent residues of \( \text{mod}(P_i\#) \), we have, that every recurrent fractal-\( P_i\# \) would be represented as array of three groups of the residues of \( \text{mod}(P_i\#) \), between are situated the alternances \( \leq P_1 \) (with different lengths) – the consequent NOT residues of \( \text{mod}(P_i\#) \), of types (a), (b), (c) repeated without changes with period = \( P_i\# \).

a. \( \psi(P_i\#) \) groups No 4 containing strictly FOUR consequent residues of mod \( (P_i\#)_{A,B,C,D} \), between which the alternances of different amounts of different first primes \( \leq P_2 \), NOT residues of \( \text{mod}(P_i\#) \), type: 

\[
A..3pp3..-C..3pp3..-C..-C..3pp3..-C.
\]

with: \( ..3pp3.. \) are alternances of the first primes \( \leq P_1 \) according to the 1st least common factor > 1 from every NOT residue of \( \text{mod}(P_i\#) \). \( (1..4..C) \) – Four consequent residue of \( \text{mod}(P_i\#) \), including the consequent primes of P.I. section from \( P_1 \) to \( (P_2)^2 \) of \( A,B,C,D \) type. Further, the fractal = \( P_i\# \) represented as \( \psi(P_i\#) \) of No 4 groups (4 residues) of mod \( (P_i\#) \). Three adjoined groups No 4 for every residue = \( C \) (Table 3).

The length of group No 4, which means amount odd numbers, restricted by every group No 4 from \( A \) to \( D \) and from \( C_1 \) to \( C_4 \), for the mod \( (P_i\#) \), is \( (R_4–2)/2 \leq (P_2–1) \) of the odd numbers with: \( R_4 = (\varphi(P_i)–A) \), \( R_4 = (\varphi(C–1) \), \( R_4 \leq 2P_2 \) (including 1 group of \( R_4 = 2P_2 \), detailed information is indicated in Section 5) (Table 4).

b. \( \psi(P_i\#) \) groups No 3 containing strictly THREE consequent residues of mod \( (P_i\#)_{A,B,C} \), between which the alternances of different amounts of

| 1,3,5,7 ... | \( A..3pp3..-P_{1..3}P_{2..3}P_{3..4pp3..} ... \) | \( P_i\# \) |
| 3,5,7 ... | \( -P_{1..3}P_{2..3}P_{3..4pp3..} ... \) | \( P_i\# \) |
| 5,7 ... | \( -P_{1..3}P_{2..3}P_{3..4pp3..} ... \) | \( P_i\# \) |

And so on, repeating of fractal = \( P_i\# \) with the period = \( P_i\#, \varphi(P_i) \) is alternance of \( \leq P_2 \).

Table 3.
Fractal = \( P_i\# \), represented as \( \psi(P_i\#) \) of No 4 groups (containing 4 residues) of mod \( (P_i\#) \), Three adjoined groups No 4 for every residue = \( C \).
Table 4.
The numerical illustration of the fractal $\varphi(5\#)$ in the form of $\varphi(5\#) = 8$ groups No 4 (containing four residues).
The three adjoined groups No 4 for every residue $\equiv C$ with $R_1 \leq 2P_2 = 2^7$ (consult Section 5).

<table>
<thead>
<tr>
<th>Type-(a)</th>
<th>$C_1 = 1$</th>
<th>7</th>
<th>11</th>
<th>$C_4 = 13$</th>
<th>17</th>
<th>19</th>
<th>$C_7 = 23$</th>
<th>29</th>
<th>31</th>
<th>$C = 37$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-(b)</td>
<td>$C_2 = 7$</td>
<td>11</td>
<td>13</td>
<td>$C_5 = 17$</td>
<td>19</td>
<td>23</td>
<td>$C_6 = 29$</td>
<td>31</td>
<td>37</td>
<td>$C = 41$</td>
</tr>
<tr>
<td>Type-(c)</td>
<td>$C_3 = 11$</td>
<td>13</td>
<td>17</td>
<td>$C_6 = 19$</td>
<td>23</td>
<td>29</td>
<td>$C = 31$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

And so on, repeating of fractal $>5\#$ with the period $= \text{mod}(5\#)$

different first prime $\leq P_1$, NOT residues of mod $(P_1\#)$, type:

| $A.C.\,3pp\ldots A.C.\,3pp\ldots C.$ with: $\ldots 3pp\ldots$ are alternances of the first primes $\leq P_1$ according to the 1st least common factor $> 1$ from every NOT residue of mod $(P_1\#)$.

(r_1 C) – three consequent residues of mod$(P_1\#)$, including the consequent primes of P.I. section from $P_1$ to $(P_1)^2$ of $\_A,B,C\_P$ type. Further, the fractal = $P_1\#$ represented as $\varphi(P_1\#)$ of No 3 groups (3 residues) of mod$(P_1\#)$.

Two adjoined groups No 3 for every residue $\equiv C$ (Table 5).

With the unknown to us length of the group No 3 from $AP$ to $rP$ and from $C_1$ to $C_3$, for the mod $(P_1\#)$, is $(R_2)/2$ of the odd numbers with: $R_3 = (C_rP – A)$, $R_3 = (C_rC)$, $R_3 = ?$ (it is quite obvious that for mod $(P_2\#)$ $R_3 < < R_4$) (Table 6).

c. $\varphi(P_2\#)$ groups No 2 containing strictly TWO consequent residues of mod $(P_2\#)_{A,B,C}$, between which the alternances of different amounts of different first prime $\leq P_1$, NOT residues of mod $(P_2\#)$, type:

| $A.C.\,3pp\ldots A.P.\,3pp\ldots C.$ with: $\ldots 3pp\ldots$ are alternances of the first primes $\leq P_1$ according to the 1st least common factor $> 1$ from every NOT residue of mod$(P_2\#)$.

(1.2 C) – two consequent residue of mod$(P_2\#)$, including the consequent primes of P.I. section from $P_1$ to $(P_1)^2$ of $\_A,B_P$ type. Further, the fractal = $P_2\#$ represented as $\varphi(P_2\#)$ of No 2 groups (2 residues) of mod$(P_2\#)$ (Tables 7–9).

$1,3,5,7,\ldots \rightarrow A.P.\,3pp\ldots A.P.\,3pp\ldots C.P.\,3pp\ldots C.\ldots C.\ldots C.\ldots C.$ $P_2\#\rightarrow rC.\,3pp\ldots A.C.\,3pp\ldots C.\ldots C.$ $P_1\#$

And so on, repeating of fractal $> P_2\#$ with the period = $P_1\#$, with: $3pp\ldots$ is alternance of $\leq P_2$.

Table 5.
Fractal = $P_1\#$, represented as $\varphi(P_1\#)$ of No 3 groups (containing 3 residues) of mod $(P_1\#)$. Two adjoined groups No 3 for every residue $\equiv C$.

<table>
<thead>
<tr>
<th>Type-(a)</th>
<th>$C_1 = 1$</th>
<th>7</th>
<th>11</th>
<th>$C_3 = 11$</th>
<th>13</th>
<th>17</th>
<th>19</th>
<th>$C_7 = 23$</th>
<th>29</th>
<th>31</th>
<th>$C = 31$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-(b)</td>
<td>$C_2 = 7$</td>
<td>11</td>
<td>13</td>
<td>$C_4 = 13$</td>
<td>17</td>
<td>19</td>
<td>$C_6 = 19$</td>
<td>23</td>
<td>29</td>
<td>$C = 37$</td>
<td></td>
</tr>
</tbody>
</table>

And so on, repeating of fractal $> 5\#$ with the period $= 5\#$.

Table 6.
The numerical illustration of the fractal $>5\#$ in the form of $\varphi(5\#) = 8$ groups No 3 (containing two residues).
The two adjoined groups No 3 for every residue $\equiv C$ with $R_1 ?? (\approx 2^5$ consult Section 6).

| $1,3,5,7,\ldots \rightarrow A.P.\,3pp\ldots A.P.\,3pp\ldots C.\ldots C.\ldots C.\ldots C.\ldots C.\ldots C.$ $P_2\#\rightarrow rC.\,3pp\ldots A.C.\,3pp\ldots C.\ldots C.$ $P_1\#$

And so on, repeating of fractal $> P_2\#$ with the period = $P_1\#$, $3pp\ldots$ is alternance of $\leq P_2$.

Table 7.
Fractal = $P_2\#$, represented as $\varphi(P_2\#)$ of No 2 groups of mod$(P_2\#)$. 6
Table 8.
Fractal = \( P_n \), represented as \( q(P_n) \) of No 2 groups of \( \text{mod}(P_n) \).

Table 9.
Fractal = \( P_n \), represented as \( q(P_n) \) of No 2 groups of \( \text{mod}(P_n) \).

3. Correlations of length limits of the subgroups No 4, No 3, No 2

In the scientific works [7 pp. 142–147, 8 pp. 77–84, 9 p. 109–116, 10 p. 1805], including Section 5 of this work, the overall – maximal length of the subgroup No 4 (containing 4 residual for every recurrent fractal \( -P_n \)), of type is defined:

\[
\max R_4 = (C_4 - C_1) = 2P_{n+1}
\]

Herewith, it is quite obvious and it is beyond argument that relations of limits, unknown to us of groups No 4-3-2 length according to the increasing modulus are indicated in Table 10.

Table 10.
The relation of length limits of the subgroups according to the increasing modulus.
4. Distribution of prime number

Correlation of length limits of the subgroups in Table 10 and distribution of groups of the indexed residues No 4-3-2, in every respective fractal $P_n\#$ according to the increasing modulus is defined by theorem 1.

Theorem 1. The loopback of prime number distribution.

Every prescribed prime number squared $= (P_2)^2$ defines the distribution of all previous prime numbers $< (P_2)^2$, as all first prime numbers are less than every prescribed prime number squared $= (P_2)^2$, are situated in the P.I. as part of fractal $P_1\#$, where they are distributed by subgroups of (a), (b), (c) types.

a. $\phi(P_1\#)$ of subgroups No 4 having pure FOUR consequent prime number $(A, B, C, D)$ of $P_1 < (A-C-B-C-D)^2 < P_2^2$ type. At the P.I. section from $P_1$ to $P_2^2$ (including from $(P_2-2)^2$ to $P_2^2$), and further, from $P_2^2$ to $P_1\#$ pure FOUR consequent residues of $\text{mod}(P_1\#)$ on all P.I. sections with length not exceeding $2P_3$ of whole numbers with length of every subgroup No 4 at every section is:

$$R_4 = (D-C-A) \leq 2P_2.$$

In that case, these primes of fractal $= P_4\#$, by loopback, are distributed by groups:

b. $\phi(P_1\#)$ of subgroups No 3 having pure THREE consequent prime number $(A, B, C)$ of $P_1 < (A-C-B-C)^2 < P_2^2$ type. At the P.I. section from $P_1$ to $P_2^2$ and further, from $P_2^2$ to $P_1\#$ pure THREE consequent residues of $\text{mod}(P_1\#)$ on all P.I. sections with length not exceeding $2P_2$ of whole numbers with length of every subgroup No 3 at every section is:

$$R_3 = (C-A) \leq 2P_1.$$

c. $\phi(P_1\#)$ of subgroups No 2 having pure TWO consequent prime number $(A, B)$ of $P_1 < (A-B)^2 < P_2^2$ type. At the P.I. section from $P_1$ to $P_2^2$ and further, from $P_2^2$ to $P_1\#$ pure TWO consequent residues of $\text{mod}(P_1\#)$ on all P.I. sections with length not exceeding $2P_1$ of whole numbers with length of every subgroup No 2 at every section is:

$$R_2 = (B-A) \leq 2P_0.$$

With: $A, B, C, D, C$ are consequent residues of $\text{mod}(P_1\#)$ including the primes $< (P_2)^2$. $R_{4,3,2}$ is the remainder of the first and the last number of every group No 4-3-2 (of the fractal $P_1\#$). Further, the length of the subgroup No 4-3-2 as the amount of odd numbers, restricted by every group from $A$ to $B, C, D, C$, from $A$ to $B, C, D, P$ are $(R_{4,3,2}-2)/2$ odd numbers.

The order of groups (a), (b), (c) rearrangement according to the increasing modulus for visual clarity is indicated in Table 11.

5. Proof of theorem

5.1 Proof of section a of the Theorem 1

It is feasible that in P.I. using the first prime number $\leq P_n$ (NOT residues of mod $(P_n\#)$), by the only single way, we can form the maximal long P.I. section as the maximal long alternance – array for the 1 least common factor $> 1$ from every NOT residue of mod $(P_n\#)$. That is that maximal amount of NOT residues of mod $(P_n\#)$, maximal long alternance $\leq P_n$. 
| 1 ÷ $P_2\theta$ mod($P_2\theta$) | Length of every section for the group No 4 | $q(P_2\theta)$ groups No 4 for 4 residues of mod($P_2\theta$) (containing 4 simple) $\lambda C_{c}C_{c}C_{c}C_{c}$ | $< P_{n+1}$ | $R_4 < \mu C-A C$ | $\leq 2P_{n+1}$, number |
| 1 ÷ $P_3\theta$ mod($P_3\theta$) | Length of every section for the group No 3 | $q(P_3\theta)$ groups No 3 for 3 residues of mod($P_3\theta$) (containing 3 simple) $\lambda C_{c}C_{c}C_{c}$ | $< P_{n+1}$ | $R_3 < \mu C-A C$ | $\leq 2P_{n+1}$, number |
| 1 ÷ $P_4\theta$ mod($P_4\theta$) | Length of every section for the group No 2 | $q(P_4\theta)$ groups No 2 for 2 residues of mod($P_4\theta$) (containing 2 simple) $\lambda C_{c}C_{c}$ | $< P_{n+1}$ | $R_2 < \mu C-A C$ | $\leq 2P_{n+1}$, number |

Table 11.
Loopback of primes number subgroups distribution according to the increasing meanings of the modulus.
Then for every recurrent prime number \( P_n = P_1 \) at the P.I., formed as recurrent line symmetrical, primary-repeatable periodical fractal \( P_1 \# \) or I.R.S. according to mod\( (P_1 \#) \), (see the first line of Table 1), the maximal long P.I. section, formed as the alternance of the all first primes number \( \leq P_1 \), (NOT residues of mod\( (P_1 \#) \)), shall be situated within the P.I. section from \( C_\Lambda \) to \( C_\Pi \), with as the subgroup is the only maximal long maximal subgroup No 4 \( (C_1-C_2-C_3-C_4) \) with the 4 consequent residues of mod\( (P_1 \#) \): Type: \( C_\Lambda = (P_1 \#-P_3) \ldots C_1 = (P_1 \#-P_2) \).

\[ \ldots C_2 = (P_1 \#-1) \ldots C_3 = (P_1 \# + 1) \ldots C_4 = (P_1 \# + P_2) \ldots C_{\Pi} = (P_1 \# + P_3) \]. The length of such maximally long subgroup No 4 of mod\( (P_1 \#) \), is: max \( R_4 = (C_4-C_1) = (P_1 \# + P_2)-(P_1 \#-P_2) = 2P_2 \) of the whole numbers.

The limit of length of the P.I. section within which from \( C_\Lambda \) to \( C_\Pi \) would be situated maximal as well as all the other \( \varphi(P_1 \#) \) subgroups No 4 (with 4 residues) of mod\( (P_1 \#) \), is: \( (C_\Pi-C_\Lambda) = (P_1 \# + P_3)-(P_1 \#-P_3) = 2P_3 \) of the whole numbers.

It is genuinely:

At the line-symmetrical, primary-repeatable fractal-\( P_1 \# \) or I.R.S. according to mod\( (P_1 \#) \), \( \varphi(P_1 \#) \) of the least residue (indexed in the form of \( \varphi(P_1 \#) \) groups No 4 of mod\( (P_1 \#) \), with the alternances \( \leq P_1 \) with different lengths), are situated line-symmmetrically relating to the center of symmetry of the fractal-\( P_1 \# \), of the number \( = (P_1 \#/2) \). That is they are situated reflecting in pairs and are formed by two different ways: (the left and the right sieve of Eratosthenes), to the left and to the right from the symmetry center of the fractal \( = P_1 \# \) of number \( = P_1 \#/2 \). To the right – for the increasing values numbers of the P.I. from \( P_1 \#/2 \) to \( P_1 \# \) to the left for the decreasing values of the P.I. \( P_1 \#/2 \) up to 1.

To every left group No 4 of mod\( (P_1 \#) \), with the remainder \( R_4 = (C_4-C_1) \), is matched by line-symmetrical right group No 4 mod\( (P_1 \#) \), with reflecting location of the same first primes number in the same amount and of the same length of the alternance \( \leq P_1 ; R_4 = (P_1 \#-C_1)-(P_1 \#-C_4) = (C_4-C_1) \) consult [7 pp. 142-147, 8 pp. 77-84, 9 pp. 109-116].

Besides two not reflecting that is formed solely subgroup of group No 4: with constant remainder for every \( P_n \) of type: \( R_4 = (P_1 \#/2 + 4)-(P_1 \#/2-4) = 8 \).

And the section of the prime fractal \( P_1 \# \) (I.R.S. of mod\( (P_1 \#) \) from \( C_\Lambda \) to \( C_\Pi \)), represented by alternance \( \leq P_4 \) with using of all NOT residues of mod\( (P_1 \#) \), (according to the 1 the least \( > 1 \)), with the subgroup is the situated only maximally long - maximal group No 4 with 4 residues of mod\( (P_1 \#) \) \( (C_1-C_2-C_3-C_4) \). Type: \( C_\Lambda = (P_1 \#-P_3) \ldots 3P_3 \ldots C_1 = (P_1 \#-P_3) \ldots 3P_3 \ldots C_2 = (P_1 \#-1) \ldots 3P_3 \ldots C_4 = (P_1 \# + P_3) \).

Thus in the fractal-\( P_1 \# \)-I.R.S. of the mod\( (P_1 \#) \), there is only one maximally long subgroup No 4, situated within the maximally long alternance \( \leq P_2 \), using all NOT residues of mod\( (P_1 \#) \), at the P.I. section \( (P_1 \# \pm P_3) \) with length maximal \( R_4 = 2P_2 \) restricting \( (R_4-2)/2 = (2P_2-2)/2 = (P_2-1) \) of the odd numbers, situated within the P.I. section, formed solely from \( (P_1 \#-P_3) \) to \( (P_1 \# + P_3) \) with length of \( (P_2-1) \) of odd numbers.

It is quite obvious that all the other, line-symmetrical subgroups No 4 of mod\( (P_1 \#) \), situated within the alternances \( \leq P_1 \) with different lengths or NOT residues, of mod\( (P_1 \#) \), cannot have the maximal length as they are formed by two different ways, that is they would be shorter than \( R_4 = 2P_2 \), and situated within the P.I. sections from \( C_\Lambda \) to \( C_\Pi \) with length not exceeding the maximal long P.I. section \( (C_\Pi-C_\Lambda) \leq 2P_3 \) of the whole numbers, not exceeding \( (P_2-1) \) of the odd numbers.

And so on, for all posterior prime numbers \( P_n \) at the increasing fractals -\( P_1 \# \) with \( n \) - as the whole number and proves the reality of the values of column No 3 of Table 1 and item (a) of Theorem 1.

It is feasible that there is such a prime number \( P_n = P_{(1)} \), for which the P.I. is the line-symmetrical fractal \( P_{(1)} \# \), situated at the P.I. section from 1 to \( P_{(1)} \# \) with
subgroup No 4 (containing 4 residues) of mod\(P(1)\) with length \(R_4 > 2P(2)\), situated within the alternate of all first primes number \(\leq P(1)\) within the P.I. section with length \(> 2P(3)_y > (P(3)-1)\) of the odd numbers. Then every subgroup No 4 would be line-symmetrical to the left and to the right from the center of the fractal \(P(1)\) symmetry of the number \(P(1)/2\). That is, in the result, we'll get in fractal \(P(1)\) using all primes number \(\leq P(1)\), – we can by more than by one way from the maximally long alternate of all the prime numbers \(\leq P(1)\), that is by the sieve of Eratosthenes, focused to the left and to the right (to the left and to the right from the number \(= P(1)/2\), that is contrary to the taken axiom.

6. The maximal length of P.I. section with maximal long subgroups No 3 (with 3 residues) for the mod\(P(2)\)

At the fractal \(-P_1\), there are \(q(P_3)\) subgroups No 4 of mod\(P(2)\), with length \(R_4 \leq 2P_2\) of the whole numbers including one maximal long subgroup No 4 of mod\(P(2)\) with length max \(R_4 = 2P_2\) of the whole numbers. At the transition from mod\(P(2)\) to mod\(P(2)\), the fractal \(P_2\) and \(q(P_1)\) of groups No 4 repeat \(P_2\) times. Then at the P.I. section from 1 to \(P(2)\) (at \(P_2\) lines of Table 1), we’ll get \(q(P_3)\) columns of groups No 4 of mod\(P(2)\), with length \(R_4 \leq 2P_2\), \(P_2\) lines at the column No 4.

It is quite obvious that in Section 8.1, it is proved that if by number \(P_2\), “eliminate,” that is moved to mod\(P(2)\) 1 time every elimination \(C_2\) and \(C_3\), in the column of every \(q(P_i)\) group No 4 of mod\(P(2)\), than at the P.I. section from 1 to \(P_2\), (that is the fractal \(P_2\), we’ll get \(=2q(P_i)\) groups No 3 of mod\(P(2)\) of the same length, that is \(R_4 \leq 2P_2\) of mod\(P(2)\) would become \(= R_3 \leq 2P_2\) of mod\(P(2)\) with changing of the alternances composition from \(P_2\) to \(P_2\).

As all one by one eliminated residues \(C_2\) or \(C_3\), at rearrangement of the groups from No 4 to No3 for the mod\(P(2)\), cannot change the length of none of the subgroups, that is all \(R_3\) would permanently be \(\leq 2P_2\), included in \(2q(P_i)\) groups No 3 of mod \(P(2)\) there is only one \(P_2\) times repeated, maximally long subgroup No 4 of mod\(P(2)\) with the alternate \(\leq P_1\), with length max \(R_4 = 2P_2\), that would be

| a) Fractal + P_1, q(P_1) group No 3 of mod(P_2), alternate \(\leq P_2\), maxR_3 = 2P_2, with n = (multiple \(P_2 + 1)P_2 = P_2 + 2P_2\) the whole. At the P.I. sections \((nP_2 + P_2)\) and \((nP_2 - P_2)\) + P_2. Within the limits of P.I. section \((nP_2 + P_2)\) with n and \((nP_2 - P_2)\) is line number | Table 1 |
|---|---|---|---|---|---|---|---|---|---|
| \(C_1\) | \(C_2\) | \(C_3\) | \(C_4\) | \(C_5\) | \(C_6\) | \(C_7\) | \(C_8\) | \(C_9\) |
| \(\ldots nP_2 + P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 - P_2\) | | |
| \(\ldots nP_2 + P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 + P_2\) | \(\ldots nP_2 - P_2\) | \(\ldots nP_2 - P_2\) | | |

(b) Fractal + P_1, q(P_1) group No 3 of mod(P_2), alternate \(\leq P_2\), maxR_3 = 2P_2, with n = (multiple \(P_2 + 1)P_2 = P_2 + 2P_2\) the whole. At the P.I. sections \((nP_2 + P_2)\) and \((nP_2 - P_2)\) + P_2. Within the limits of P.I. section \((nP_2 + P_2)\) with n and \((nP_2 - P_2)\) is line number | Table 2 |
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<td>(C_3)</td>
<td>(C_4)</td>
<td>(C_5)</td>
<td>(C_6)</td>
<td>(C_7)</td>
<td>(C_8)</td>
<td>(C_9)</td>
<td></td>
</tr>
<tr>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
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</tr>
<tr>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 + P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td>(\ldots nP_2 - P_2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(c) And so on for every mod(P_2), maxR_3 = 2P_2, n = (exp.P_3 + 1)/P_3 = the whole, P_3,1/1 primes

Table 12.
Type and formula for indexing of two line-symmetrical, maximally long subgroups No 3 (having 3 residues) at the increasing fractal according to the increasing modulus (Tables 11 and 14).
Restructured into two maximally long line-symmetrical groups No 3 of mod\((P_2\#)\) by “eliminating” the residues \(C_1\) and \(C_2\) by number multiple to \(P_2\) (1 time at \(P_2\) lines). As all the other \(2\phi(P_2\#)\) subgroups, changed from No 4 to No 3 for mod\((P_2\#)\) are shorter than \(P_2-1\) of the odd numbers that is: \(R_3 < 2P_2\). In Sections 8.1 and 8.3, there are no other ways of making or changing the subgroups No 3 of mod\((P_2\#)\) with length \(R_3 > 2P_2\).

Order, type, and formula of indexing of two subgroups No 3 according to the increasing modulus are represented in Table 12 a, b, c.

The length of these two line-symmetrical subgroups No 3 of mod\((P_2\#)\), that is the length of alternance \(\leq P_2\) from \(C_1\) to \(C_3\) is maximal \(R_3 = (C_3-C_1) = (nP_2\# \pm p_2)-(nP_2\#-p_2)=2P_2; (P_2-1)\) of the odd numbers. Two of these subgroups No 3 are situated within P.I. section \((nP_2\# \pm p_2)\) with length \((C_{n+C_3}) = 2P_3; (P_2-1)\) of the odd numbers from \(C_3\) to \(C_0\). Numerical values of these two maximal subgroups No 3 are defined according to the formula (multiple \(P_2\) and \(C_2\) = multiple \(P_2\# + 2\)) is \((nP_2\# \pm 1)\) and \((P_2-n)P_2\# \pm 1\), with \(n\) and \((P_2-n)\) define the number of the line for the group No 3 of mod\((P_2\#)\) in column \(P_2\) and the repeated maximal of the group No 4 of mod\((P_2\#)\) with the period = \(P_2\#\) (consult Table 1). That is \(n = (multiple P_2; \pm 1)/P_2\# = \) the whole < \(P_2/2\).

Whereas, it is quite obvious that in and proved in Section 8.2, the other subgroups No 3 of mod\((P_2\#)\), with different lengths, changed from groups No 4 would be within P.I. section, with limit length = \(2P_2\) of the whole numbers.

And so on, for every of all posterior primes = \(P_n\), at the increasing fractals \(P_n\#,\) with \(n\) is the whole, represented in Tables 11 and 14 (the proof is indicated in Section 10). (Numerical illustrations are in Table 15).

7. The maximal length of the P.I. section, where two maximally long subgroups No 2 (with 2 residues) for the mod\((P_3\#)\)

Representing as one line, the first \(P_2\) lines in Table 1 we’ll get the fractal \(P_2\#\) according to the mod\((P_2\#)\) – I.R.S. at mod\((P_2\#)\), that is situated at the P.I. section.
The loopback of prime's groups and residues rearrangement according to the increasing modulus. With max R = const from \( mod(P, \phi) \) to \( mod(P, \phi) \).

Table 14.

The loopback of prime's groups and residues rearrangement according to the increasing modulus. With max R = const from \( mod(P, \phi) \) to \( mod(P, \phi) \).
from 1 to \( P_2# \) and represented in 1 line of Table 2 where \( \varphi(P_{2#}) \) of groups No 3 of mod\((P_{2#})\) are situated with length \( R_3 \leq 2P_2 \) of the whole numbers. In this number, the two maximally long groups No 3 of mod\((P_{2#})\) with length max \( R_3 = 2P_2 \) of the whole numbers are represented. Then on the P.I. section from 1 to \( P_3# \) (at \( P_2# \) lines of Table 2), we’ll get \( \varphi(P_{2#}) \) columns of group No 3 of mod\((P_{2#})\), with length \( R_3 \leq 2P_2 \), \( (P_3# \) lines in columns of groups No 3).

It is quite obvious, that in Section 9.1, it is proved that if by number \( P_3 \), “eliminate,” that is to change for the model mod\((P_{3#})\) residue \( C_2 \) in the column of every \( \varphi(P_{3#}) \) group No 3 of mod\((P_{2#})\), then at the P.I. section from 1 to \( P_3# \), that is at the fractal \( P_3# \), we’ll get \( \varphi(P_{2#}) \) groups No 2 of mod\((P_{3#})\) of the same length, that is \( R_3 \leq 2P_2 \), mod\((P_{2#})\), would become \( R_3 \leq 2P_2 \) of mod\((P_{3#})\) with changing the structure of alternance from \( \leq P_2 \) to \( \leq P_3 \).

As any eliminated residue \( C_2 \), during the rearrangement of groups from No 3 to No 2 for the mod\((P_{3#})\) cannot change the length on no subgroup that is all \( R_3 \) would permanently \( \leq 2P_2 \), and included in \( \varphi(P_{2#}) \) groups No 3 of mod\((P_{2#})\) there are two uncial, repeated \( P_2 \) times maximally long subgroups No 3 of mod\((P_{2#})\) with the alternance \( \leq P_3 \) with length maximal \( R_3 = 2P_2 \), that would be rearranged into two maximally long line-symmetrical subgroups No 2 of mod\((P_{3#})\) by “eliminating” the residues \( C_2 \) with the number multiple \( P_3 \), (1 time in \( P_3 \) lines). As all the other \( \varphi(P_{3#}) \), – 2 subgroups, rearranged from No 3 to No 2 for the mod\((P_{2#})\), are shorter than \( (P_2-1) \) of the off numbers, that is: \( R_3 < 2P_2 \), and in Sections 9.1 and 9.3, it is proved that there are no other ways of comparing or rearranging of the subgroups No 2 of mod\((P_{3#})\) with length \( R_3 > 2P_2 \). The order, type, and formula of indexing of two subgroups No 2 according to the increasing modulus are represented in Table 13 b, c, d.

The length of these two line-symmetrical subgroups No 2 of mod\((P_{3#})\), the length of alternance \( \leq P_3 \), from \( C_1 \) to \( C_2 \), that is max \( R_2 = (C_2-C_1) = (nP_{2#} + P_2) – (nP_{2#}-P_2) = 2P_2 ; \ (P_2-1) \) of odd numbers. Two of these subgroups No 2 are situated within the P.I. section \( (nP_{2#} \pm P_2) \) with length \( (C_{2#}–C_{1#}) = 2P_3 ; \ (P_2-1) \) of odd numbers from \( C_{2#} \) to \( C_{1#} \). The numerical values of these maximal groups No 2 is defined according to the formula: (multiple \( P_2 \) and multiple \( P_3 \)) is \( (nP_{2#} \pm 1) \) and \( (P_3N_{3-n})P_{3#} \pm 1 \), with \( n \) and \( (P_2P_{2-n}) \) define the line number for the group No 2 of mod\((P_{3#})\) in the column \(-P_2P_3\) of the duplication of the max group No 4 of mod\((P_{2#})\) with the period = \( P_2 \) (Table 1). That is \( n = \) (multiple \( P_2^2P_{3#,} \pm 1)\) of the whole \( P_{2#} \).

Herewith, it is quite obvious, and proved in Section 9.3, that all the other subgroups No 2 of mod\((P_{3#})\), with different lengths, rearranges from groups No 3 would be within the P.I., with length not exceeding the limit \( = 2P_3 \) of the wholes.

And so on, for every of all posterior primes \( P_{n\#} \), at the increasing fractals \( P_{n\#} \), with \( n \) is the whole, represented in Tables 11 and 14 (the proof is indicated in Section 10) (numerical illustrations are in Table 16).

8. The loopback of rearrangement for \( \varphi(P_{n#}) \) groups No 3 (with 3 residues) from mod\((P_{n-1#})\) for mod\((P_{n#})\)

The loopback order of rearrangement for \( \varphi(P_{n#}) \) groups No 3, according to the increasing modulus, that are represented in column No 3 of Table 14 at Section 8 are examined by steps, for every recurrent increasing fractal \(-P_{n#}\):.

During the transition from mod\((P_{2#})\) to mod\((P_{3#})\) of the fractal \(-P_{2#}\) (1 line of Table 1) and every from \( \varphi(P_{3#}) \) groups No 4-3-2 of mod\((P_{2#})\) are repeated \( P_2 \) times. That at the P.I. section from 1 to \( P_2#, \) we’ll get \( \varphi(P_{3#}) \) columns of No 4-3-2 groups \( P_2 \) lines at the column). Number \( P_2 \) according to diagonals of \( P_2 \) lines.
Table 15.
The numerical examples of the two line-symmetrical maximally long subgroups No. 3 (containing 3 residues = $C_{1-2-3}$), according to the increasing modulus.

<table>
<thead>
<tr>
<th>C_A = 79</th>
<th>C_B = 101</th>
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<tr>
<td>$\lambda C = 109$</td>
<td>$\lambda C = 131$</td>
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<table>
<thead>
<tr>
<th>C_A = 197</th>
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<tbody>
<tr>
<td>$\lambda C = 2087$, $\lambda C = 2310$</td>
<td>$\lambda C = 2113$, $\lambda C = 2111$</td>
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</table>

<table>
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<tr>
<th>C_A = 6913</th>
<th>C_B = 6947</th>
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<tbody>
<tr>
<td>$\lambda C = 23,083$, $\lambda C = 20,041$</td>
<td>$\lambda C = 23,087$, $\lambda C = 20,043$</td>
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</table>

<table>
<thead>
<tr>
<th>C_A = 60,041</th>
<th>C_B = 60,079</th>
</tr>
</thead>
<tbody>
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<td>$\lambda C = 23,043$, $\lambda C = 19,941$</td>
<td>$\lambda C = 23,043$, $\lambda C = 19,941$</td>
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</table>

<table>
<thead>
<tr>
<th>C_B = 9,189,203</th>
<th>C_A = 510,487</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda C = 9,189,157$, $\lambda C = 510,487$</td>
<td>$\lambda C = 9,189,161$, $\lambda C = 510,491$</td>
</tr>
</tbody>
</table>

The numerical examples of the two line-symmetrical maximally long subgroups No. 3 (containing 3 residues = $C_{1-2-3}$), according to the increasing modulus.
“eliminates,” that is rearranges to the mod($P_2$) one time every of $P_2$ repeated numbers of the P.I. section from 1 to $P_2$ (1 number at every $P_2$ line of every column No 4 and No 3), “eliminating” the residues $C_1$-$C_2$-$C_3$-$C_4$ in the groups No 4 (consult Section 8.1), and ALL numbers, besides the residues $C_1$-$C_2$-$C_3$ in the groups No 3 (consult Section 8.3).

8.1
It is quite obvious, that after “elimination” from every $\varphi(P_1\#)$ column of the group No 4 of mod($P_1\#$) one time every residue $C_2$ and $C_3$, we’ll get at $P_2$ lines of every column of the No 4 groups of mod($P_1\#$), –TWO groups No 3 of mod($P_2\#$)

That is, we’ll get $2\varphi(P_1\#)$ subgroups No 3 of mod($P_2\#$) with invariance length of the previous groups, that is $R_4$ $\varphi(P_1\#)$ groups of No 4 mod($P_1\#$), would become $R_3$ for $2\varphi(P_2\#)$ groups No 3 of mod($P_2\#$), with changing the alternance structure from $\leq P_2$ to $\leq P_2$, that are situated at the P.I section from 1 to $P_2$ that is at the fractal-$P_2\#$.

Herewith within the $2\varphi(P_1\#)$ groups No 3 of mod($P_1\#$), there are accounted all residues $= C_4$ and $= C_4$ of mod($P_1\#$) and alternances $\leq P_2$ of such rearranged groups from No 4 of mod($P_1\#$) to No 3 of mod($P_1\#$). As along of $P_2$ duplication of the three adjoined groups No 4 of mod($P_1\#$), represented in Table 17, with every residue $= C_2$ or $= C_3$, situated at one of the 3 lines of Table 3 (for example, at line a of Table 17), is accounted as residue $C_1$ or $C_4$ at the other two adjoined groups No 4 (at lines: b or c of Table 17), where they are situated within 4 consequent residues, going as the second or the third, that is they are “excluded” as $C_2$ or $C_3$ in these adjoined groups (lines):

- for line (b) $C_2$, $C_3$. ($C_4$ = multiple to $P_2$), $C_3$ we’ll get the alternance $\leq P_2$. $R_3$ $< 2P_2$.
- for line (c) $C_2$, ($C_1$ = multiple to $P_2$), $C_2$, $C_3$ we’ll get the alternance $\leq P_2$. $R_3$ $< 2P_2$.

Thus, “eliminating” that means transition to mod($P_2\#$), one time every 4 residue in $\varphi(P_1\#)$ groups No 4 of mod($P_1\#$), at the P.I. sections from 1 to $P_2$, that is at the fractal-$P_2\#$, we’ll get the loopback, represented as $2\varphi(P_1\#)$ groups No 3 of mod($P_2\#$) type: $C_1$ $\mapsto$ $C_2$ $\mapsto$ $C_3$ $\mapsto$ $C_4$ = multiple $P_2$ $\mapsto$ $C_3$, with the alternances $\leq P_2$, length $R_3$ $\leq P_2$. Including, pure 2 subgroups No 3 of mod($P_2\#$) with length maximal $R_3$ $= 2P_2$.

8.2
Herewith, it is quite obvious that every three consequent residues of every subgroup No 3 according to the increasing group of mod($P_1\#$), represented in Table 17, are still within the P.I. section with length not exceeding $- 2P_3\# - 1$ of the whole numbers, as “eliminated” residues $C_{2;3}$ and $C_{3;4}$ of mod($P_1\#$) doesn’t change the location of every subgroup No 3. That is, we’ll get at the three adjoined groups No 3 lines of Table 17 for the mod($P_2\#$): type (a) $=(C_{3;4} - C_{2;3})$ $< 2P_3$; type (b) $=(C_{2;3} - C_{1;4})$ $< 2P_3$.

Including pure two subgroups No 3 max $R_3 = 2P_2$, located within the maximally long section with length $= 2P_3$ of the whole numbers. (The rearrangement is studied in Section 6).

8.3
Within the $P_2$ duplications $\varphi(P_1\#)$ of the groups No 3 of mod($P_1\#$), number $P_2$ “eliminated,” that is rearranges to the mod($P_2\#$) 1 time every of all previously eliminated numbers of group No 3, except three residues $C_1$-$C_2$-$C_3$. That is, transits to the mod($P_2\#$) ($P_2$-$3$) of No 3 groups in every $\varphi(P_1\#)$ column of No 3 groups.

Then at the P.I. section from 1 to $P_2$, (that is included into fractal-$P_2\#$), we’ll get the loop back, represented as ($P_2$-$3$) $\varphi(P_1\#)$ of No 3 groups repetition for the
9. The loopback of rearrangement for \( \varphi(P_{n#}) \) groups No 2 (2 residues) from the mod\((P_{n#})\) to mod\((P_{n#})\)

The looped back order of rearrangement \( \varphi(P_{n#}) \) of No 2 groups, according to the increasing modulus, that are represented in column No 4 of Table 14, in Section 9 are examined by steps for every recurrent increasing fractal -\( P_{n#} \).

Representing the first \( P_{2#} \) lines in Table 1 as one line, we’ll get the fractal -\( P_{2#} \) according to mod\((P_{2#})\)-I.R.S of mod\((P_{2#})\) at the P.I. sections from 1 to \( P_{2#} \) (1 line of Table 2).

With \( \varphi(P_{2#}) \) line-symmetrical the least residues of mod\((P_{2#})\), which according to Section 2 are indexed according to \( \varphi(P_{2#}) \) groups of residues No 4-3-2 for the mod\((P_{2#})\).
<p>| Table 16. | The numerical examples of the two line-symmetrical maximally long subgroups No 2 (containing 2 residues), according to the increasing modulus. |</p>
<table>
<thead>
<tr>
<th>Type-(a) group from 4 to No 3 (C₁–C₄)</th>
<th>C₄</th>
<th>C₃ (C₂ = mtp.P₂)</th>
<th>C₂ (mtp.P₂), C₄</th>
<th>C₁ with R₄ is R₃ (C₄–C₁) &lt; 2P₂</th>
<th>at the P.I. section (C₄–C₃) &lt; 2P₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type-(b) group from 4 to No 3 (C₂–C₃)</td>
<td>C₁</td>
<td>C₂, C₃, (C₄ = multiple to P₂)</td>
<td>C₂ with R₄ is R₃ (C₄–C₂) &lt; 2P₂</td>
<td>at the P.I. section</td>
<td></td>
</tr>
<tr>
<td>Type-(c) group from 4 to No 3 (C₂–C₃)</td>
<td>C₃</td>
<td>C₂, (C₁ = multiple to P₂)</td>
<td>C₄ with R₄ is R₃ (C₄–C₃) &lt; 2P₂</td>
<td>at the P.I. section</td>
<td></td>
</tr>
</tbody>
</table>

Table 17. The representation of rearrangement of every 3 adjoined subgroups No 4 of mod(P₁, #) (represented in Table 3), while P₁, duplication of fractal -P₁# from No 4 groups of mod(P₁, #) to No 3 groups of mod(P₁, #).

At the transition from mod(P₂#,) to mod(P₃#,), the fractal -P₂# and every from the ψ(P₂#,) groups No 4-3-2 mod(P₂#,) are repeated P₁ times. Then at the P.I. section from 1 to P₁# we’ll get ψ(P₂#,) columns of No 4-3-2 groups (P₂ lines at the column). Number P₁ according to diagonals P₁ lines “eliminates,” that is transits for the mod (P₁#,) one time every P₁ of the duplicated numbers of the P.I. section from 1 to P₁#. (One number at every P₁ line of every column No 3 and No 2), “eliminating” the residues C₁-C₃ at the groups No 3 (consult Section 9.1) and ALL numbers, except the residues C₁-C₂ at the groups No 2 (consult Section 9.3).

9.1 It is quite obvious, that after “elimination” in every ψ(P₂#,) column of group No 3 of mod(P₂#,), 1 time the residue - C₂, we’ll get in P₁ line of every column of groups No 3 of mod(P₂#,), one group No 2 of mod(P₂#,), that is totally we’ll get ψ(P₂#,) subgroups No 2 of mod(P₂#,) with invariance length of previous groups, that is R₁ ψ(P₂#,) groups No 3 of mod(P₂#,) would become = R₂ for ψ(P₃#,) groups No 2 of mod(P₃#,) with changing the alternance composition from ≤ P₂ to ≤ P₃, that are situated at P.I. section from 1 to P₃# that is at the fractal -P₃#

Herewith in ψ(P₂#,) groups No 2 of mod(P₃#,) are accounted all residues = C₁ and = C₃ of mod(P₂#,) and alternances ≤ P₃ of such “rearranged” groups from No 3 of mod(P₂#,) to No 2 of mod(P₃#,). As in the course of P₁ duplication of two adjoined groups No 3 of mod(P₂#,), represented in Table 5, we’ll get the table No 11 with each of the residues = C₂, situated on one of two lines of Table 5 (for example, the line (a) Table 18, is accounted as the residue C₁ or C₃ at the other adjoined group No 3 (in line b). Of Table 12), where it is represented in 3 consequent residues as the second one, that is “excluded” as C₂ at this adjoined group (line): -for line (b) 2C, (C₂ = multiple P₂), C₂, we’ll get the alternance ≤ P₂, R₂ = 2P₂

Thus, after “elimination” that is transferring to mod(P₁#,), one time for every of 3 residues at ψ(P₂#,) groups No 3 of mod(P₂#,), at the P.I. sections from 1 to P₁#, that is in fractal -P₁#, we’ll get the loop back in the form of ψ(P₂#,) groups No 2 of mod(P₃#,), type: C₁ = C₂ = multiple P₂, with the alternances ≤ P₃, with length R₂ ≤ 2P₂. Including pure 2 subgroups No 2 of mod(P₃#,) with length maximal R₂ = 2P₂.

9.2 Herewith it is quite obvious that any two consequent residues of any subgroup No 2 according to the increasing mod(Pₙ#,) represented in Table 18 are still within the P.I. section with length not exceeding - 2Pₙ₋₁ of the whole numbers, as the “eliminated” residues C₂ and C₃ of mod(Pₙ#,) doesn’t change the location of any subgroup No 2. That is, in two adjoined groups No 2 lines of Table 18 for mod(P₃#,) we get: type (a) = (C₃–C₁) < 2P₂; type (b) = (C₃–C₁) < 2P₃

Including pure two subgroups No 2 max R₂ = 2P₂, located within the maximally long section with length = 2P₃ of the whole numbers, two rearrangement is studies in Section 7.
9.3

Along with $P_2$ duplications $\varphi(P_2\#)$ of groups No 2 of mod($P_2\#$), the number $P_3$ “eliminates” that is transits to the mod($P_3\#$) 1 time every of all previously eliminated numbers of every group No 2, except two residues $C_1$–$C_2$. That it, it transits to mod($P_3\#$) $(P_2\#–2)$ of groups No 2 in every $\varphi(P_2\#)$ column of No 2 groups.

Then at the P.I. section from 1 to $P_3\#$ that is within the fractal -$P_3\#$ we’ll get the loopback, represented as $(P_2\#–2)$ duplications of No 2 groups for the mod($P_3\#$) with the alternance “changes” from $\leq P_2$ to $\leq P_3$. Without changing the length of groups No 2 for mod($P_3\#$), $R_2 = \text{const}$ and numbers composition at the alternances $\leq P_3$ (as previously eliminated $\leq P_2$, for the 1 least $> 1$ from the number is accounted). Type: $C_1$ $\rightarrow$ $C_2$. With: $R_2 = \text{const} = \? \, (\text{with to mod}(P_2\#) \, R_2 < \leq R_3 = 2P_2)$. 

9.4

Totally at the fractal $P_3\#$ at P.I. section from 1 to $P_3\#$ we’ll get the loopback of the rearranged groups No 2 for mod($P_3\#$) represented in Sections 9.1 and 9.3. That is: $\varphi(P_3\#)$ (Section 9.1 with length $= R_2 \leq 2P_2$) + $\varphi(P_2\#)(P_2\#–2)$ (Section 9.3 with length $R_2 < \leq R_3 = 2P_2$) = $P_3\#$, $\varphi(P_2\#)–2\varphi(P_2\#)$ + $\varphi(P_2\#) = P_3\#$, $\varphi(P_2\#)–\varphi(P_2\#) = \varphi(P_2\#)(P_2\#–1) = \varphi(P_3\#)$ of the subgroups No 2 for mod($P_3\#$), located within the alternances $\leq P_3$ with length $R_2 \leq 2P_2$, including two maximally long subgroups No 2 max $R_2 = 2P_2$.

9.5

As all $\varphi(P_3\#)$ of the subgroups No 2 of mod($P_3\#$) are examines in Sections 9.1 and 9.3, with every eliminated one time in the column residue $C_2$ examined in Section 9.1, can change the length $R_2 \leq 2P_2$, of none of $\varphi(P_2\#)$ groups, rearranged from No 3 to No 2 for mod($P_3\#$), herewith residues $C_1$ and $C_2$ are excluded at the adjoined group of Table 18 as $C_2$ and indiscernibly $(P_2\#–2)\varphi(P_2\#)$ groups No 2 of mod($P_3\#$), examined in Section 9.3 are shorter than limit $R = 2P_2$.

Thus, there are no other ways of making groups No 2 of mod($P_2\#$) with length $R_2 > 2P_2$, but constructing two maximally long subgroups No 2 with length max $R_2 = 2P_2$, as examined in Sections 7 and 9.1.

9.6

And so we get, that for every recurrent prime $= P_3$, $\varphi(P_3\#)$ residues of mod($P_3\#$) are in the fractal -$P_3\#$ (in $P_3$ lines of Table 2), represented as loopback $\varphi(P_3\#)$ of the subgroups No 2 (2 residues of mod($P_3\#$) are indicated in Section 9.4). Thus, pure TWO consequent primes $(A_2\#C)$ of type: $P_3$, $P_2 < \leq (A_2\#–1) C < P_1^2$ at the P.I. section from $P_3$ to $P_1^2$, and further, from $P_3^2$ to $P_3\#$ pure TWO consequent residues of mod($P_3\#$), at every P.I. sections with length not exceeding $2P_2$ of the whole numbers (consult Section 9.2), with length of every subgroup No 2 at every section is: $R_2 = \varphi(C–A_2) \leq 2P_2$ (consult Sections 9.1 and 9.4).

And so on, for every from all eventual primes $= P_n$, in the form of loopback of residues groups No 2 distribution at the increasing fractals -$P_3\#$, with the increasing values of modulus of mod($P_n\#$), that proofs the validity of section (c) of Theorem 1 (loopback of groups No 2 is represented in column No 4 of Table 14).

<table>
<thead>
<tr>
<th>Type-(a) group from 3 to No 2 ($C_1$–$C_3$)</th>
<th>$C_\lambda$</th>
<th>$C_\lambda$ ($C_\lambda$ = multiple $P_3$)</th>
<th>$C_n$</th>
<th>with $R_2$ is $R_2$ ($C_\lambda$–$C_2$) &lt; $2P_2$</th>
<th>at the P.I. section ($C_\lambda$–$C_\lambda$) &lt; $2P_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (a) group from 3 to No 2 ($C_1$–$C_3$)</td>
<td>$\lambda C_\lambda$</td>
<td>$\lambda C_\lambda$ ($\lambda C_\lambda$ = multiple $P_3$)</td>
<td>$C_1$</td>
<td>with $R_1$ is $R_1$ ($C_\lambda$–$C_1$) &lt; $2P_2$</td>
<td>At the P.I. section ($C_\lambda$–$C_\lambda$) &lt; $2P_2$</td>
</tr>
</tbody>
</table>

Table 18.

Representation of rearrangement of any 2 adjoined subgroups No 3 of mod($P_3\#$) (represented in Table 5), within $P_3$ duplications of fractal -$P_3\#$. From groups No 3 of mod ($P_3\#$) to the groups No 2 of mod ($P_3\#$).
10. Proof of section (b) and section (c) of Theorem 1

While examining the P.I., represented in the form of alternance (array) of primes (according to the 1 least prime factor > 1 from every whole number), we’ll get that for every recurrent prime - \( P_n \), the P.I. is the line-symmetrical primary-repeated fractal - \( P_n \# \), located at the P.I. section from 1 to \( P_n \# \), represented as \( \varphi(P_n\#) \) of the I.R.S. residue of mod(\( P_n\# \)), between which the P.I. sections are situated (with different length), represented as the alternances (array) of different amounts of different first primes \( \leq P_n - \text{NOT} \) residues mod(\( P_n\# \)).

By indexing \( \varphi(P_n\#) \) of the least residues of every recurrent fractal - \( P_n\# \), groups pure with 4, 3, and 2 consequent residue of mod(\( P_n\# \)) analogously as in Section 2. We’ll get that every recurrent fractal - \( P_n\# \) has got three types of arrays of the subgroups of residues of mod(\( P_n\# \)) with \( \varphi(P_n\#) \) groups: No 4 (with 4 residues), No 3 (with 3 residues), and No 2 (with 2 residues, repeated without changes with the period = \( P_n\# \)).

At every recurrent transition, for example, from mod(\( P_2\# \)) to mod(\( P_3\# \)), the first line of fractal - \( P_n\# \) and group No 4-3-2 of mod(\( P_2\# \)) are repeated \( P_3 \) times (consult \( P_3 \) lines of Table 2). At the P.I. section from 1 to \( P_3 \# \) we’ll get \( \varphi(P_2\#) \) columns of groups No 4-3-2 of mod(\( P_2\# \)) within the alternances \( \leq P_2 \) (\( P_3 \) lines in column), “eliminating” 1 number multiple to - \( P_3 \) (in line of every column No 4-3-2), that is by transition of this group to mod(\( P_3\# \)) with changing of its length: from \( R_{4,3} \) to \( R_{5,2} \) and the alternance composition from \( \leq P_2 \) to \( \leq P_3 \), we’ll get \( \varphi(P_2\#) \) groups No 4-3-2 of mod(\( P_3\# \)).

The rearrangement order of these subgroups No 4-3-2 at the increasing modulus is proved in Sections 5, 6, 7, 8, and 9. Representing as one line of the P.I. section from 1 to \( P_3 \# \) we’ll get the fractal - \( P_3\# \) of mod(\( P_3\# \)), with \( \varphi(P_3\#) \) groups No 4-3-2 of mod(\( P_3\# \)).

And so on for every recurrent prime = \( P_n \), the results of proof are demonstrated in Sections from 5 to 9 and for visualization they are grouped together in Table 14.

As far as we know that for every recurrent prime - \( P_n = P_1 \), the P.I. is the line-symmetrical primordial repeated fractal - \( P_1\# \), located at the P.I. section from 1 to \( P_1 \# \). There are \( \varphi(P_1\#) \) residues of mod(\( P_1\# \)) between which are located the alternances (arrays) of primes \( \leq P_1 \) (1 the least >1 from every NOT residue of mod(\( P_1\# \))).

According to Section 5, there is the only maximally long subgroup No 4 (with 4 residues) of mod(\( P_1\# \)) with length maxR_4 = 2\( P_2 \).

Let us assume that there are such primes \( P_2 \) or \( P_3 \), for which at the P.I., represented as alternance \( \leq P_2 \), in the form of fractal - \( P_2\# \) we can form more than two maximally long subgroups No 3 of mod(\( P_2\# \)), with: (or) \( R_3 > 2P_2 \) or at the fractal - \( P_3\# \) with P.I. is represented by alternances \( \leq P_3 \), we can compare more than maximally long subgroups No 2 of mod(\( P_3\# \)), with: (or) \( R_2 > 2P_2 \).

Then, in the course of the opposite reduction of the modulus, that is at the result of \( P_2 \cdot P_3 \) repetition of such subgroups as No 3 or No 2 with the repetition period \( P_1\# \) (for the downward meanings of numbers) and backing up the \( P_2 \) and \( P_3 \) numbers as residues (according to the decreased moduli)’, that are situated in \( P_2 \cdot P_3 \) lines analogues to Table 1. At the upper lines of such columns, consisting of \( P_2 \cdot P_3 \) lines, we’ll get the P.I as fractal-\( P_1\# \), represented by alternances \( \leq P_1 \), where at the P.I. section from 1 to \( P_1\# \) would be located more than one subgroup No 4 (with 4 residues) of mod(\( P_3\# \)) or subgroups No 4, with \( R_3 > 2P_2 \). It is quite obvious, that any such group No 4 according to the reestablished mod(\( P_1\# \)) would be line-symmetrical to the left and to the right from the symmetry center of number = \( P_1\# /2 \), that means formed by two different ways, that contradicts to the axiom set.
“Number $P(3)$ of the fractal -$P(3)$# -NOT residue of $\text{mod}(P_3#)$, located in the
group No 2 of $\text{mod}(P(3)#)$ within the alternance $\leq P(3)$ with length $R(2) > 2P(2)$, and
for $\text{mod}(P(2)#)$ would be accounted as the third residue in the group No 3 within
the alternance $\leq P(2)$, without changing the length of this group No 3 with $R(2)$ is
$R_3 > 2P(2)$.

Number $P(2)$ of the fractal -$P(2)$# -NOT residue of $\text{mod}(P_2#)$ is located in the
group No 3 of $\text{mod}(P(2)#)$ within the alternance $\leq P(2)$, with length $R_3 > 2P(2)$, and
for $\text{mod}(P(1)#)$, would be accounted as the fourth residue in the group No 4 within the
alternance $\leq P(1)$, without changing the length of this group No 4 with $R(3)$ is
$R_4 > 2P(2)$.

11. Conclusion

Thus, Theorem 1 allowed us to prove the existence of a new law in
mathematics – “on the plume distribution of Prime numbers.” Since the methods
used in number theory do not allow us to approach the problem of the distribution
of prime numbers, it means that further expansion of the method proposed in the
article for studying the natural series of numbers will simplify and solve many other
problems that are not solved in mathematics.

So from Theorem 1 “Loopback of primes distribution” follows:

**Theorem No 2.** For every whole number $= N$ at the P.I. section from $1$ to $N + 2\sqrt{N}$:

1. Primes are located as groups, pure three consequent primes of $(P_1-P_2-P_3)$
type. Herewith the distance from the first to the third prime of every
group is less than $2\sqrt{N}$ of the whole numbers, that is $(P_3-P_1) < 2\sqrt{N}$ whole
numbers.

2. The same primes are distributed as the loopback, pure two consequent primes
at every P.I. sections, shorter than $2\sqrt{N}$ whole numbers.

Proof. Every whole number $= N$ is located within the squared two consequent
primes: $P_1^2 < N \leq P_2^2$ with: $2\sqrt{N} > 2P_1$.

That means every $N$ is located within the fractal -$P_1$#. Then:

1. From the section (b) of the theorem “Loopback of primes distribution”
follows, that at fractal -$P_1$# of $\text{mod}(P_1#)$ at the P.I. section from $1$ to $P_2^2 \geq (N + 2\sqrt{N})$, at every P.I. section with length not exceeding $2P_2$ of the whole
numbers is located at the subgroup from three consequent primes of $(P_1-P_2-
P_3)$ type, with length of every subgroup, that is distance from the first to the
third prime of every subgroup doesn’t exceed $2P_1$ whole numbers, that is
$(P_3-P_1) < 2P_1$ whole numbers. As length of every section $2\sqrt{N} > length$ of the
section $= 2P_2$. Then from $1$ to $N + 2\sqrt{N}$ – every:

$(P_3-P_1) < 2\sqrt{N}$ of the whole numbers.

2. From the section (c) of Theorem “Loopback of primes distribution” it
follows, that at the fractal -$P_1$# of $\text{mod}(P_1#)$ at the P.I. section from $1$ to
$P_2^2 \geq (N + 2\sqrt{N})$ at every I.P. section with length not exceeding $2P_2$ of the
whole numbers, there is the subgroup from two consequent primes $P_1$ and $P_2$. As $2\sqrt{N}$ whole numbers $>2P_1$ whole numbers, that means, that at the P.I. section from 1 to $N + 2\sqrt{N}$ at every P.I. section with length not exceeding $2\sqrt{N}$ whole numbers, there is the loopback of primes, represented as the subgroup for two consequent primes.

Genuinely: Every P.I. section with length $= 2\sqrt{N}$ of the whole numbers is located at the fractal -$P_1# $ at the P.I. section. $<P_2^2$ as, $P_1^2 < (N + 2\sqrt{N}) \leq P_2^2$, with:
$2\sqrt{N} > 2P_1$.

It is feasible, that there is a P.I. section with length $= 2\sqrt{N}$ of the whole numbers, where there are no two primes, that is, two consequent primes are located at the P.I. section with length exceeding $2\sqrt{N}$ of the whole numbers $>2P_1$, but this contradicts to section (c) of the Theorem “Loopback of primes distribution,” that states, that is every fractal -$P_1#$ according to mod($P_1#$), on every P.I. sections with length not exceeding $2P_1$ of the whole numbers, there is a subgroup No 2 with 2 residues of mod($P_1#$), that is two primes $<P_2^2$.

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References


