

SCIENTIFIC-METHODICAL JOURNAL OF
«SCIENTIFIC PROGRESS»

ISSN: 2181-1601

2021, MARCH 15



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Proceedings of the 3rd International
Scientific-Practical Distance
Conference



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UZBEKISTAN



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TASHKENT, UZBEKISTAN
2021, MARCH 15

ON A NON-LINEAR P-ADIC DYNAMICAL SYSTEM

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Abstract. In this paper, we study p-adic dynamical systems generated by rational functions. We consider the function $f(x) = \frac{a}{x-2b}$ and study the dynamical systems generated by this function in C_p . We give fixed points, periodic points, basin of attraction and Siegel disk of each fixed points.

Keywords: Rational dynamical systems; fixed point; invariant set; Siegel disk; complex p-adic field.

It is known that the theory of p-adic numbers has numerous applications in many branches of mathematics, biology, physics and other sciences.

Consider the dynamical system associated with the function $f: C_p \rightarrow C_p$ defined by

$$f(x) = \frac{a}{x-2b}, \quad a \neq 0, a, b \in C_p,$$

where $x \neq 2b$.

Our goal here is to investigate the behavior of trajectories of $f(x) = \frac{a}{x-2b}$ in the complex p-adic field C_p .

Remark. The case $b=0$ is simple: in this case any point $x \in C_p \setminus \{-b\}$ is two periodic. That is $f(f(x)) = x$. Indeed,

$$f(f(x)) = \frac{a}{\frac{a}{x-2b} - 2b} = a \frac{x-2b}{a - 2b(x-2b)} = x.$$

Therefore, below we consider the case $b \neq 0$.

Since C_p is algebraic closed, this function (for $ab \neq 0$) has two fixed points:

$$f(x) = x \Rightarrow x^2 - 2bx - a = 0 \Rightarrow x_1 = b - \sqrt{b^2 + a}, \quad x_2 = b + \sqrt{b^2 + a}.$$

The following proposition says that f may have periodic (except fixed points) iff $b=0$.

Proposition 1. If $b(b^2 + a) \neq 0$ then $f^n(x) = x, n \geq 2$ does not have any solution (except solutions of $f(x) = x$).

Proposition 2. If $b(b^2 + a) \neq 0$ then the set

$$P = \{x \in C_p : \exists n \in N \cup \{0\}, f^n(x) = 2b\}$$

is the following

$$P = \{2b\} \cup \left\{ 2b - \frac{b_n}{d_n} : d_n \neq 0, n \geq 1 \right\}.$$

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