

ON THE BOHR TRANSFORM OF ALMOST-PERIODIC SOLUTIONS FOR SOME DIFFERENTIAL EQUATIONS IN ABSTRACT SPACES

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ABSTRACT. We consider abstract differential equations of the form $u'(t) = Au(t) + f(t)$ or $u''(t) = Au(t) + f(t)$ in Banach spaces X , where $f(\cdot), \mathbb{R} \rightarrow X$ is almost-periodic, while A is a linear operator, $\mathfrak{D}(A) \subset X \rightarrow X$. If the solution $u(\cdot)$ is likewise almost-periodic, $\mathbb{R} \rightarrow X$, we establish connections between their Bohr-transforms, $\hat{u}(\lambda)$ and $\hat{f}(\lambda)$.

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1. Introduction. If $u(\cdot), \mathbb{R} \rightarrow X$ (a Banach space) is an ultraweak almost-periodic solution of the differential equation

$$u'(t) = Au(t) + f(t), \quad t \in \mathbb{R} \text{ (first order)} \quad (1.1)$$

or

$$u''(t) = Au(t) + f(t), \quad t \in \mathbb{R} \text{ (second order)} \quad (1.2)$$

with linear—not necessarily continuous—operator $A, \mathfrak{D}(A) \subset X \rightarrow X$, and with almost-periodic “forcing” term $f(\cdot), \mathbb{R} \rightarrow X$, then the Bohr transforms

$$\hat{f}(\lambda) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_0^T e^{-i\lambda t} f(t) dt, \quad \hat{u}(\lambda) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_0^T e^{-i\lambda t} u(t) dt, \quad (1.3)$$

will both exist, for all reals λ .

It appears that it is possible to establish a typical relationship between $\hat{u}(\lambda)$ and $\hat{f}(\lambda)$ which implies also connections between the (countable) sets

$$\Lambda_u = \{\lambda \in \mathbb{R}, \hat{u}(\lambda) \neq \emptyset\}, \quad \Lambda_f = \{\lambda \in \mathbb{R}, \hat{f}(\lambda) \neq \emptyset\}, \quad (1.4)$$

(the elements of Λ_u, Λ_f are the Fourier “exponents” of $u(\cdot), f(\cdot)$, resp.).

Some “historical” notes:

(i) In [7] we have (1.2) in a Hilbert space, with $A \geq \Theta$, and the solution is in the usual sense. One obtains the equality

$$(\lambda^2 + \tilde{A}) \hat{u}(\lambda) = -\hat{f}(\lambda), \quad \forall \lambda \in \mathbb{R}, \quad (1.5)$$

where \tilde{A} is a selfadjoint extension of A .

(ii) In [6] the equation is (1.1) and f is continuous almost-periodic in Stepanoff S^p -sense; the operator A is closed in X . One gets the equality

$$(i\lambda - A) \hat{u}(\lambda) = \hat{f}(\lambda). \quad (1.6)$$

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DP Hallahan



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Table of Contents Solution Sets Of Differential Equations In Abstract Spaces

1. Understanding the eBook Solution Sets Of Differential Equations In Abstract Spaces
 - The Rise of Digital Reading Solution Sets Of Differential Equations In Abstract Spaces
 - Advantages of eBooks Over Traditional Books
2. Identifying Solution Sets Of Differential Equations In Abstract Spaces
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Solution Sets Of Differential Equations In Abstract Spaces
 - User-Friendly Interface
4. Exploring eBook Recommendations from Solution Sets Of Differential Equations In Abstract Spaces
 - Personalized Recommendations
 - Solution Sets Of Differential Equations In Abstract Spaces User Reviews and Ratings
 - Solution Sets Of Differential Equations In Abstract Spaces and Bestseller Lists
5. Accessing Solution Sets Of Differential Equations In Abstract Spaces Free and Paid eBooks
 - Solution Sets Of Differential Equations In Abstract Spaces Public Domain eBooks
 - Solution Sets Of Differential Equations In Abstract Spaces eBook Subscription Services
 - Solution Sets Of Differential Equations In Abstract Spaces Budget-Friendly Options

6. Navigating Solution Sets Of Differential Equations In Abstract Spaces eBook Formats
 - ePub, PDF, MOBI, and More
 - Solution Sets Of Differential Equations In Abstract Spaces Compatibility with Devices
 - Solution Sets Of Differential Equations In Abstract Spaces Enhanced eBook Features
7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Solution Sets Of Differential Equations In Abstract Spaces
 - Highlighting and Note-Taking Solution Sets Of Differential Equations In Abstract Spaces
 - Interactive Elements Solution Sets Of Differential Equations In Abstract Spaces
8. Staying Engaged with Solution Sets Of Differential Equations In Abstract Spaces
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Solution Sets Of Differential Equations In Abstract Spaces
9. Balancing eBooks and Physical Books Solution Sets Of Differential Equations In Abstract Spaces
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Solution Sets Of Differential Equations In Abstract Spaces
10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
11. Cultivating a Reading Routine Solution Sets Of Differential Equations In Abstract Spaces
 - Setting Reading Goals Solution Sets Of Differential Equations In Abstract Spaces
 - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Solution Sets Of Differential Equations In Abstract Spaces
 - Fact-Checking eBook Content of Solution Sets Of Differential Equations In Abstract Spaces
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements

- Interactive and Gamified eBooks

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