

THE STROKE THEORY OF WRITING Complete Guide

The stroke theory of writing is a fundamental concept in understanding the development of handwriting, especially in the context of learning Chinese characters and other logographic scripts. It offers insights into how characters are composed, how they are taught, and how writers can improve their writing skills by mastering the basic strokes. This theory emphasizes the importance of stroke order, stroke types, and the strokes' sequence in creating legible and aesthetically pleasing characters. In this comprehensive guide, we delve into the core principles of the stroke theory of writing, its historical background, practical applications, and techniques for mastering stroke techniques efficiently.

Understanding the Foundations of the Stroke Theory of Writing

Historical Background and Development

The stroke theory of writing has its roots in traditional Chinese calligraphy, which dates back thousands of years. Ancient calligraphers observed that most characters are composed of a limited set of strokes, and that the order and manner of writing these strokes significantly impact the character's appearance and readability.

Over time, scholars and calligraphers formalized these observations into systematic rules, leading to the development of stroke order conventions and standardized stroke types. Modern educational practices for Chinese language learners continue to emphasize these principles to ensure correct character formation.

Core Principles of the Stroke Theory

The primary ideas behind the stroke theory include:

- **Stroke Types:** Recognizing the basic strokes that make up characters.
- **Stroke Order:** Following prescribed sequences to write strokes correctly.
- **Stroke Technique:** Applying proper brush or pen techniques to produce strokes with the correct shape and strength.
- **Character Composition:** Understanding how strokes combine to form complete characters.

Fundamental Strokes in the Stroke Theory

Common Types of Strokes

Most Chinese characters are built from a set of fundamental strokes. These strokes serve as the building blocks for more complex characters. The main types include:

- **Horizontal (一, héng):** A stroke drawn from left to right.
- **Vertical (丨, shù):** A stroke drawn from top to bottom.
- **Dot (丶, diǎn):** A small, downward or leftward stroke, often used to add detail.
- **Left-falling (㇏, pǐ):** A stroke slanting downwards to the left.
- **Right-falling (㇏, nà):** A stroke slanting downwards to the right.
- **Hook (乚, gōu):** A stroke ending with a hook, often attached to other strokes.
- **Rising stroke (㇀, tí):** An upward stroke, usually curved.
- **Turning stroke (㇚, zhé):** A stroke that changes direction sharply.

Stroke Variations and Combinations

While these basic strokes are standard, their variations in length, curvature, and pressure contribute to the unique style of different calligraphic scripts. Combinations of these strokes form radicals and entire characters, adhering to specific rules that ensure clarity and harmony.

The Importance of Stroke Order in Writing

Why Stroke Order Matters

Adhering to the correct stroke order is crucial for several reasons:

- **Legibility:** Proper stroke order ensures characters are easily recognizable.
- **Efficiency:** It speeds up writing and helps in memorizing characters.
- **Learning Consistency:** Standardized stroke sequences facilitate learning and teaching.
- **Aesthetic Appeal:** Correct stroke order contributes to balanced and beautiful characters.
- **Digital Recognition:** Many handwriting recognition systems depend on stroke sequences for accurate interpretation.

Basic Rules of Stroke Order

Although there are exceptions, general rules include:

- Write strokes from top to bottom.

- Write strokes from left to right.
- Complete horizontal strokes before vertical strokes crossing them.
- Start with the outer strokes before inner ones.
- Finish with strokes that enclose the character's structure.
- Write diagonal strokes from top to bottom.
- Finish with dots or final strokes.

Applying the Stroke Theory in Practice

Learning Techniques for Mastering Strokes

To effectively apply the stroke theory, learners should adopt specific strategies:

- **Use Stroke Charts:** Refer to standard stroke order diagrams for each character.
- **Practice with Repetition:** Regularly write characters focusing on stroke sequence and technique.
- **Employ Guided Practice:** Use calligraphy tools or digital apps that offer stroke-by-stroke guidance.
- **Break Down Complex Characters:** Decompose characters into radicals and strokes for easier learning.
- **Focus on Stroke Consistency:** Strive for uniformity in stroke thickness and shape.
- **Observe Proper Stroke Pressure and Speed:** Maintain steady pressure and controlled speed to produce clean strokes.

Tools and Resources for Mastery

Modern learners can utilize various resources to reinforce their understanding:

- **Calligraphy Brushes and Ink:** For traditional practice emphasizing stroke flow.
- **Stroke Order Apps:** Digital tools that animate stroke sequences.
- **Workbooks and Practice Sheets:** Repetitive writing exercises focusing on stroke correctness.
- **Online Tutorials and Videos:** Visual demonstrations of stroke techniques.

Advanced Concepts in the Stroke Theory

Stroke Dynamics and Artistic Expression

Beyond basic correctness, skilled calligraphers consider:

- Stroke speed and pressure variations to express emotion and rhythm.
- Stroke endings, such as hooks and flicks, for stylistic effects.
- Balance and spacing between strokes to create harmony.

Stroke Theory and Digital Typography

With the advent of digital fonts and handwriting recognition, stroke order and style influence:

- Font design, ensuring characters are optimized for clarity.
- Input methods, where stroke sequences help in character recognition.
- Development of handwriting input systems that emulate natural stroke flow.

Benefits of Mastering the Stroke Theory of Writing

Mastering the stroke theory provides numerous advantages:

- Improved handwriting clarity and beauty.
- Enhanced memory retention for characters.
- Ability to learn new characters more efficiently.
- Deepened appreciation and understanding of calligraphy arts.
- Better performance in digital handwriting recognition systems.

Conclusion

The stroke theory of writing forms the backbone of effective and elegant handwriting, especially in Chinese and other logographic scripts. By understanding the fundamental strokes, adhering to proper stroke order, and practicing diligently, learners can significantly improve their writing skills. Whether for academic purposes, artistic expression, or digital communication, mastering the stroke theory equips writers with the tools needed to produce clear, beautiful, and meaningful characters. Embracing this theory not only enhances technical proficiency but also fosters a deeper connection to the cultural and artistic heritage embodied in traditional calligraphy.

The Stroke Theory of Writing: An In-Depth Exploration

In the realm of calligraphy, handwriting, and even digital typography, understanding the stroke theory of writing offers invaluable insights into the mechanics and aesthetics of letter formation. This theory not only explains how individual characters are constructed but also provides a framework for improving writing speed, legibility, and stylistic consistency. As educators, designers, and enthusiasts delve deeper into the fundamentals of writing, the stroke theory stands out as a

foundational concept that bridges traditional craftsmanship with modern pedagogical approaches.

What Is the Stroke Theory of Writing?

The stroke theory of writing posits that all written characters—whether in alphabets, scripts, or symbols—are composed of a series of basic strokes. These strokes are the smallest units of movement during handwriting and serve as the building blocks for more complex characters. By analyzing and mastering these fundamental strokes, writers can develop more fluid, accurate, and expressive handwriting.

This theory is rooted in the idea that every complex character can be broken down into simpler components, much like how a painter might start with basic brushstrokes before creating a detailed masterpiece. Understanding these strokes allows for better control over the writing instrument and fosters a deeper appreciation of the visual harmony within characters.

Historical Origins and Development

The stroke theory of writing has historical roots that stretch back centuries, particularly in East Asian calligraphy, where the emphasis on stroke order and technique is central to mastering the art. Chinese, Japanese, and Korean calligraphy traditions have long relied on the mastery of basic strokes to produce characters with aesthetic balance and clarity.

In Western calligraphy and handwriting education, similar principles emerged as educators sought to teach students how to produce consistent, elegant letterforms. The development of stroke theory as a formal concept gained momentum during the 20th century with the rise of pedagogical methods that emphasize motor skill development and visual analysis.

The Core Principles of the Stroke Theory

At its heart, the stroke theory of writing emphasizes several core principles:

- **Simplicity of Basic Strokes:** All characters are constructed from a limited set of basic strokes.
- **Sequential Building:** Characters are formed by combining strokes in specific sequences, respecting stroke order and direction.
- **Motor Memory Development:** Practicing strokes enhances muscle memory, leading to smoother and more natural handwriting.
- **Visual Consistency:** Mastery of strokes ensures uniformity in character size, shape, and style.

The Basic Strokes in Different Writing Systems

The specific strokes vary depending on the writing system and style, but some common foundational strokes include:

In Latin Alphabet Handwriting

- Horizontal stroke: A straight line from left to right.
- Vertical stroke: A straight line from top to bottom.
- Diagonal strokes: Lines slanting either direction.
- Curves: Rounded strokes forming parts of letters like 'c', 'o', or 'g'.
- Hooks and tails: Small extensions at the end of strokes for stylistic or structural purposes.

In East Asian Calligraphy

- Dot: A small, isolated stroke.
- Horizontal stroke: A fundamental stroke used in characters like '一' (one).
- Vertical stroke: Used for characters like '十' (ten).
- Left-falling stroke: Diagonal downward to the left.
- Right-falling stroke: Diagonal downward to the right.
- Hook: An angular stroke that terminates a character or stroke.
- Rising stroke: An upward movement, often used in characters like '山' (mountain).

Understanding these strokes and their variations is essential to both the artistic and functional aspects of writing.

Applying the Stroke Theory: Techniques and Practice

Mastering the stroke theory of writing involves systematic practice and mindful observation. Here are strategies to incorporate into your learning or teaching process:

- Focus on Stroke Formation
 - Practice each basic stroke repeatedly until muscle memory develops.
 - Use guided tutorials or calligraphy guides that demonstrate correct stroke order and direction.
 - Pay attention to the pressure and speed of strokes, adjusting for consistency.
- Learn Stroke Order Rules

- Follow standard conventions for stroke sequencing, which often influence character balance and legibility.

- In Chinese characters, for example, strokes typically follow a top-to-bottom, left-to-right order.

- Break Down Complex Characters

- Analyze intricate characters into their constituent strokes.

- Practice constructing characters step-by-step, emphasizing smooth transitions.

- Use Visual Aids and Templates

- Practice on grid paper to maintain proportions and alignments.

- Use tracing sheets or digital tools to replicate stroke paths.

- Develop Motor Control and Fluidity

- Engage in exercises that enhance fine motor skills, such as drawing basic shapes or repetitive stroke drills.

- Incorporate rhythmic patterns to develop consistent speed and pressure.

Benefits of Mastering the Stroke Theory

Understanding and applying the stroke theory of writing offers numerous benefits:

- Enhanced Legibility: Clear, well-formed strokes lead to more readable handwriting.

- Increased Speed: Motor familiarity with strokes reduces hesitation and improves writing efficiency.

- Aesthetic Consistency: Uniform stroke techniques create visually harmonious characters.

- Cultural Appreciation: In calligraphy, mastering strokes deepens understanding of artistic traditions.

- Skill Transfer: Improved fine motor control benefits other areas such as drawing, design, and even handwriting recognition technologies.

Modern Implications and Technological Integration

In today's digital age, the stroke theory of writing has found relevance beyond traditional pen-and-paper contexts:

- Digital Typography: Font design often begins with stroke analysis, especially for scripts like Chinese or Japanese.
- Handwriting Recognition: Algorithms decode handwritten strokes to convert images into digital text.
- Educational Software: Apps incorporate stroke-based lessons to teach children and learners of calligraphy.
- Assistive Technologies: Stroke analysis helps develop tools for individuals with motor impairments to improve writing.

Challenges and Critiques

While the stroke theory of writing provides a solid framework, it is not without limitations:

- Over-Simplification: Some argue that focusing solely on strokes may overlook the expressive and stylistic aspects of handwriting.
- Cultural Variations: Different scripts and styles may require unique stroke interpretations, challenging a universal application.
- Individual Differences: Handwriting is a personal skill, and rigid adherence to stroke sequences may hinder natural expression.

Nonetheless, when balanced with creativity and personal style, stroke mastery remains a powerful tool for developing effective and beautiful handwriting.

Conclusion: Embracing the Stroke Foundation

The stroke theory of writing continues to influence how we learn, teach, and appreciate the art of handwriting. By breaking down characters into fundamental strokes, practitioners can unlock a deeper understanding of form, function, and aesthetics. Whether in traditional calligraphy, modern education, or technological innovation, mastering strokes lays a robust foundation for all forms of written communication. Embracing this theory encourages a mindful, disciplined approach to writing that can transform mere letters into works of art and effective tools for expression.

QuestionAnswer What is the stroke theory of writing? The stroke theory of writing suggests that all Chinese characters are composed of a limited set of fundamental strokes, and understanding these strokes is essential to mastering character construction and writing efficiency. How does the stroke theory influence Chinese calligraphy? In Chinese calligraphy, the stroke theory emphasizes

the importance of proper stroke order, pressure, and movement, which are crucial for achieving aesthetic harmony and expressing the artist's style. What are the key principles of the stroke theory in learning Chinese characters? Key principles include mastering basic strokes, understanding stroke order rules, and practicing stroke techniques to ensure accurate and efficient character writing. How can understanding stroke theory improve handwriting skills? By understanding stroke theory, learners can write characters more accurately and quickly, develop consistent stroke patterns, and enhance overall legibility and aesthetic appeal. Is stroke theory relevant to digital writing and typing? While stroke theory primarily applies to handwriting and calligraphy, understanding character structure can inform font design and improve recognition in digital handwriting input methods. Are there cultural or historical aspects associated with the stroke theory? Yes, stroke theory is deeply rooted in Chinese cultural traditions, emphasizing the harmony, balance, and rhythm of characters, which reflect broader aesthetic and philosophical values. What are common challenges when applying stroke theory to learning Chinese characters? Common challenges include memorizing the correct stroke order, mastering stroke techniques, and adapting to the variations in stroke styles across different calligraphic traditions.

Related keywords: stroke order, Chinese characters, calligraphy, handwriting, character structure, writing principles, pen strokes, character formation, writing techniques, script development

AN INTRODUCTION TO ERGODIC THEORY GRADUATE TEXTS I

An introduction to ergodic theory graduate texts i serves as a foundational guide for graduate students venturing into this fascinating branch of mathematics. Ergodic theory, at its core, explores the long-term average behavior of dynamical systems and their statistical properties. It has profound applications across mathematics, physics, and even in fields like economics and computer science. For students beginning their journey, selecting the right graduate texts is crucial for building a solid understanding, developing intuition, and engaging with current research directions. This article aims to provide a comprehensive overview of essential ergodic theory texts, their key features, and how they can serve as effective learning tools.

Understanding the Foundations of Ergodic Theory

Before diving into specific texts, it's important to understand what ergodic theory encompasses and why it's a vital area of study. This section offers a brief overview of the fundamental concepts and the scope of graduate-level texts.

What is Ergodic Theory?

Ergodic theory studies the behavior of measure-preserving transformations on probability spaces. Essentially, it addresses questions like: How do points in a dynamical system distribute over time? Do the time averages of functions along trajectories converge to space averages? These questions are rooted in the ergodic hypothesis, which originated from statistical mechanics.

Key concepts include:

- Measure-preserving transformations
- Ergodicity and mixing
- Invariant measures
- Birkhoff's Ergodic Theorem
- Unique ergodicity

Understanding these ideas lays the groundwork for exploring more advanced topics covered in graduate texts.

Essential Graduate Texts in Ergodic Theory

Choosing the right textbooks is essential for mastering ergodic theory. The following sections highlight some of the most influential and widely recommended graduate-level texts, discussing their strengths and targeted audiences.

1. "An Introduction to Ergodic Theory" by Peter Walters

Walters' book is often considered a classic starting point for graduate students.

Key features:

- Clear and rigorous presentation
- Focuses on measure-theoretic foundations
- Covers fundamental theorems such as Birkhoff's and von Neumann's
- Includes numerous exercises for practice

This text is ideal for students new to the field, providing a solid theoretical foundation before moving to more specialized topics.

2. "Ergodic Theory" by Karl Petersen

Petersen's work is comprehensive and slightly more advanced.

Key features:

- Emphasizes both measure-theoretic and topological dynamics
- Discusses entropy, mixing, and applications
- Contains detailed proofs and examples
- Suitable for students with some background in measure theory and topology

This book bridges foundational concepts with more recent developments, making it a good next step after Walters.

3. "Introduction to Ergodic Theory" by Ya. G. Sinai

Sinai's text offers a blend of intuition and formalism.

Key features:

- Focuses on the intuition behind the theorems
- Connects ergodic theory with statistical mechanics
- Includes historical notes and motivations
- Suitable for students who prefer a conceptual approach

Additional Resources and Advanced Texts

Graduate students aiming to deepen their understanding should explore more specialized and advanced texts. Here are some noteworthy options:

1. "Ergodic Theory and Differentiable Dynamics" by Anatole Katok and Boris Hasselblatt

This comprehensive volume covers a broad spectrum of topics.

Highlights:

- Smooth ergodic theory
- Hyperbolic systems and Anosov diffeomorphisms
- Structural stability
- It is suitable for students interested in the interface between ergodic theory and differential dynamics.

2. "Measure Theory and Probability" by Malcolm Adams and Victor Guillemin

While broader in scope, this book provides valuable measure-theoretic background essential for advanced ergodic theory.

Strategies for Studying Ergodic Theory Graduate Texts

Mastering ergodic theory requires more than just reading; active engagement is key. Here are some tips for making the most of these texts:

- **Start with the basics:** Ensure a solid understanding of measure theory, topology, and functional analysis.
- **Work through exercises:** Practice problems reinforce concepts and develop problem-solving skills.
- **Supplement with lectures and seminars:** Engage with online courses or university seminars for different perspectives.
- **Form study groups:** Discussing complex topics with peers enhances understanding.
- **Connect theory to applications:** Explore how ergodic theory applies to physics, information theory, and other fields.

Conclusion

An introduction to ergodic theory graduate texts provides a roadmap for students embarking on this mathematical journey. Starting with foundational books like Walters' "An Introduction to Ergodic Theory" offers an accessible entry point, while advanced texts like Katok and Hasselblatt's work open doors to current research areas. By selecting appropriate resources, actively engaging with the material, and connecting theory with applications, students can develop a deep and lasting understanding of ergodic theory. Whether your interest lies in pure mathematics, statistical mechanics, or dynamical systems, the right graduate texts are invaluable tools for your academic and research pursuits in ergodic theory.

An Introduction to Ergodic Theory Graduate Texts: A Comprehensive Guide for Students and Enthusiasts

Embarking on the study of ergodic theory graduate texts opens a gateway to a rich and profound branch of mathematics that intersects dynamical systems, measure theory, probability, and statistical mechanics. For graduate students venturing into this field, selecting the right textbooks can significantly influence their understanding and appreciation of the subject. This guide aims to shed light on the foundational texts, their structure, strengths, and how they serve as stepping stones into the depths of ergodic theory.

Understanding the Foundations of Ergodic Theory

Before diving into specific texts, it's crucial to grasp what ergodic theory entails. At its core, ergodic theory studies the long-term average behavior of dynamical systems with an invariant measure. Its applications range from statistical physics and information theory to number theory and chaos theory.

Key concepts include:

- Measure-preserving transformations
- Invariant measures
- Ergodicity and mixing
- Birkhoff's Ergodic Theorem
- Ornstein's theory of Bernoulli flows

Graduate texts in ergodic theory typically assume familiarity with measure theory, topology, and basic dynamical systems, making it a challenging yet rewarding subject for advanced students.

The Landscape of Graduate Texts in Ergodic Theory

Choosing a graduate-level textbook involves understanding its approach, prerequisites, and depth. The major texts in the field can generally be categorized based on their focus: foundational theory, applications, or a blend of both.

Classic and Seminal Texts

- "Ergodic Theory" by Peter Walters
 - Overview: Widely regarded as a definitive introductory textbook, Walters' "Ergodic Theory" is praised for clarity, rigorous proofs, and comprehensive coverage.
 - Scope: It covers measure-preserving transformations, ergodic decomposition, mixing properties, and entropy.
 - Strengths:
 - Well-structured for graduate courses
 - Emphasizes the connection between measure theory and dynamics
 - Includes numerous examples and exercises
 - Prerequisites: Measure theory, basic topology, and some familiarity with dynamical systems.

- "An Introduction to Ergodic Theory" by Peter Walters

- Often considered the go-to text for graduate students or advanced undergraduates beginning the subject.

- Focuses on core concepts with detailed proofs.
- Suitable as a primary textbook or supplementary resource.

Advanced and Specialized Texts

- "Ergodic Theory via Joinings" by Eli Glasner

- Overview: Focuses on joinings, a sophisticated tool in ergodic theory, providing a modern perspective.

- Audience: More suitable for students who have already mastered the basics and want to explore advanced topics.

- Features: Incorporates recent developments, emphasizing the structural and classification aspects of ergodic systems.

- "Entropy, Large Deviations, and Statistical Mechanics" by David Ruelle

- While broader in scope, this text delves into the thermodynamic formalism, a key area in ergodic theory.

- Ideal for students interested in the applications of ergodic theory in statistical physics.

Textbooks with a Focus on Applications or Interdisciplinary Approaches

- "Ergodic Theory: with a view towards Number Theory" by Manfred Einsiedler and Thomas Ward

- Overview: Connects ergodic theory with number theory, providing applications to problems like equidistribution and primes.

- Features: Combines rigorous theory with motivating applications, making it accessible and engaging.

How to Choose the Right Graduate Text in Ergodic Theory

When selecting a textbook, consider the following factors:

- Prerequisites: Ensure you have a solid background in measure theory and topology.
- Focus Area: Decide whether you want a foundational understanding or a focus on particular applications.
- Depth: Some texts offer a broad overview, while others delve into specialized topics.
- Teaching Style: Supplementary materials, exercises, and clarity of exposition can greatly impact your learning.

Recommended approach:

- Start with Walters' "Ergodic Theory" for a comprehensive foundation.
- Use other texts, like Glasner's "Ergodic Theory via Joinings," for advanced topics.
- Supplement with research papers and lecture notes for recent developments.

Structuring Your Study of Ergodic Theory

To maximize your understanding, consider a structured approach:

- Build a Strong Measure Theory Foundation
 - Review measure spaces, sigma-algebras, and integration.
 - Study probability theory basics, as ergodic theory often involves probabilistic concepts.
- Understand Dynamical Systems
 - Familiarize yourself with topological and measurable dynamics.
 - Explore examples like rotations, shifts, and hyperbolic systems.
- Dive into Core Ergodic Concepts
 - Invariant measures and ergodicity
 - Birkhoff's Ergodic Theorem

- Mixing properties and their implications
- Explore Advanced Topics
- Entropy theory
- Ornstein's isomorphism theorem
- Joinings and structural classification
- Connections with number theory and statistical mechanics

Supplementary Resources and Learning Strategies

- Lecture series: Many universities offer free lecture notes; for example, the lecture series by Peter Walters or others available online.
- Problem sets: Practice through exercises in textbooks or problem books.
- Research papers: Engage with current developments by reading papers in journals like Ergodic Theory and Dynamical Systems.
- Discussion groups: Join seminars or study groups focused on ergodic theory.

Conclusion

An introduction to ergodic theory graduate texts is essential for anyone aiming to master the subject at an advanced level. The journey begins with foundational texts like Peter Walters' "Ergodic Theory," which offers clarity and depth, and then progresses into more specialized or application-driven materials. By understanding the structure, prerequisites, and scope of these texts, students can tailor their learning path effectively. With dedication, rigorous study, and engagement with supplementary materials, mastering ergodic theory becomes an achievable and intellectually rewarding pursuit.

Final Tips

- Be patient: The subject is challenging but immensely rewarding.
- Connect theory with examples: Visualize systems like rotations or shifts.
- Engage actively: Solve problems and participate in discussions.
- Keep abreast of current research: This enriches your understanding and opens new avenues.

Embark on this mathematical voyage with confidence?ergodic theory offers profound insights into the behavior of complex systems and the nature of randomness and order in mathematics.

Question What is the primary focus of 'An Introduction to Ergodic Theory' by Peter Walters? The book provides a rigorous introduction to ergodic theory, focusing on measure-preserving transformations, ergodic theorems, and their applications in dynamical systems and statistical mechanics. Which prerequisites are recommended before studying this text? A solid background in measure theory, real analysis, and basic topology is recommended to fully grasp the concepts presented in the book. How does the book approach the topic of ergodic theorems? It systematically introduces the mean and pointwise ergodic theorems, providing proofs and discussing their implications in the context of dynamical systems. Are there applications of ergodic theory discussed in this graduate text? Yes, the book explores applications such as statistical properties of dynamical systems, mixing, and entropy, illustrating how ergodic theory connects to various fields. Is this book suitable for self-study or primarily for classroom use? While designed as a graduate textbook, it is also suitable for self-study due to its clear explanations, though some background in measure theory is helpful. What makes 'An Introduction to Ergodic Theory' by Walters a trending choice among graduate texts? Its comprehensive coverage, clear exposition, and balance between theory and applications have made it a popular and influential resource in the field of ergodic theory.

Related keywords: ergodic theory, measure theory, dynamical systems, invariant measures, ergodicity, mixing, entropy, Birkhoff's theorem, stationary processes, ergodic decomposition

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