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Harmonic Structures as Seen *via* Instantaneous Frequency

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Introduction

In order to investigate the generation of terahertz radiation by means of high-order harmonic extraction, graphene has been subjected to oscillatory electric fields on a variety of substrates, including SiO2, h-BN and Al2O3. This was done in order to examine the response of the carriers. We were able to evaluate the high-order harmonic intensity and the spectral density of velocity fluctuations under various amplitudes of the periodic electric field thanks to the characteristics of the ensemble Monte Carlo simulator that was used for this study. This demonstrated that strong field conditions are preferable to achieve the stated objective. In addition, the threshold bandwidth for harmonic extraction has been established by comparing noise level and harmonic intensity. In comparison to III–V semiconductors, graphene on h-BN is a very good option for high-order harmonic extraction in AC electric fields with large amplitudes, as demonstrated by the results [1].

Description

In this work, we propose a set of conditions for defining harmonics that is both simple and powerful. We demonstrate that the idea can be intuitively interpreted through the use of extrema counting and formalize the idea by using instantaneous frequency. In the language of EMD, we discover a natural interpretation of our findings. We continue to investigate the mathematical properties of our definition by selecting an analytically tractable model. Two distinct types of harmonics with distinct extrema are identified when we connect them to analytic number theory findings. Using the FitzHugh-Nagumo equations, we then investigate harmonics in a model of asymmetric shallow water waves and simulated neuronal oscillations. Finally, we investigate rat LFP data by utilizing our framework and masked EMD. On the basis of the asymmetric theta oscillation shape, we verify our assumptions and demonstrate how to resolve the mode splitting issue by deciding whether or not to combine modes produced by nonlinear decomposition techniques.

Harmonic analysis is a field of mathematics that studies the representation of functions as superpositions of basic oscillatory functions known as harmonics. The field has its roots in Fourier analysis, which is the study of the Fourier series, a mathematical technique that represents a periodic function as an infinite sum of sines and cosines. Over the years, harmonic analysis has evolved to encompass a broader range of functions and techniques, including wavelets and Fourier transforms. In this essay, we will explore the history, theory and applications of harmonic analysis.

Harmonic analysis can be traced back to the work of Joseph Fourier, a French mathematician and physicist who lived in the late 18th and early 19th centuries. Fourier's breakthrough came when he discovered that any periodic function could be expressed as a sum of sine and cosine waves of different frequencies. This representation, known as the Fourier series, provided a powerful tool for analyzing the behavior of periodic functions and has since become a cornerstone of modern mathematics. The work of Fourier sparked the interest of other mathematicians, including Gustav Kirchhoff, who applied Fourier's ideas to the study of heat flow and electromagnetic radiation. In the early 20th century, the field of harmonic analysis began to expand beyond the study of periodic functions to include non-periodic functions and functions of multiple variables. This led to the development of new techniques, such as the Fourier transform and wavelet analysis, which could be used to analyze a broader range of functions.

The theory of harmonic analysis is based on the concept of harmonics, which are sinusoidal functions with integer multiples of a fundamental frequency. These harmonics can be combined to form more complex functions, such as the Fourier series, which is a representation of a periodic function as an infinite sum of harmonics. The Fourier series is given by the following formula:

$$f(x)=a0/2+\Sigma(ancos(n\omega x)+bnsin(n\omega x))$$

where a0, an and bn are constants that depend on the function f(x), ω is the fundamental frequency and n is an integer.

The Fourier series provides a way to decompose a periodic function into its constituent harmonics, which can then be studied individually. This can be useful for analyzing the behavior of the function and understanding its properties. For example, the Fourier series can be used to determine the frequency content of a signal, which is important in many applications, such as signal processing and communications. In addition to the Fourier series, harmonic analysis also includes the Fourier transform, which is a generalization of the Fourier series to non-periodic functions. where F(ω) is the Fourier transform of f(x), ω is a frequency variable and it is the imaginary unit. The Fourier transform provides a way to decompose a non-periodic function into its constituent frequencies. This can be useful for analyzing signals and images, as well as for solving differential equations and other mathematical problems [2-5].

Conclusion

Another important concept in harmonic analysis is the wavelet transform, which is a technique for decomposing a function into localized wavelets. Wavelets are short-lived oscillations that can be used to represent functions with localized features, such as sharp edges or discontinuities. The wavelet transform is particularly useful for analyzing signals and images with complex features, such as those found in medical imaging or video processing. Harmonic analysis has many applications in science, engineering and mathematics. Some of the most important applications include: Harmonic analysis is used extensively in signal processing, which is the science of analyzing and manipulating signals.

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Conflict of Interest

No conflict of interest.

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