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On the Wiener Formula of Functions of Two Variables

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Introduction

In dealing with the generalized harmonic analysis of functions of several variables, a problem of basic importance would be to study the so-called Wiener formula which states the equivalence of

$$\lim_{S,T\to\infty} \frac{1}{4ST}\int_{-T}^{T}\int_{-S}^{S} |f(s,\ t)|^2 dsdt$$

and

$$\lim_{\varepsilon,\eta\to 0} \frac{1}{\pi^2\varepsilon\eta}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} |f(s,\ t)|^2 \frac{\sin^2 \varepsilon s}{s^2}\frac{\sin^2 \eta t}{t^2} dsdt\ .$$

Different from the case of functions of one variable, one should keep in mind that there are several kinds of methods about limit processes and this makes the problem more involved than that of one variable. In this paper we restrict ourselves to the case of functions of two variables.

(1) The method of N. Wiener-A.C. Berry [9]. They assumed that the following limit

$$\lim_{R\to\infty} \frac{1}{\pi R^2}\int_0^{2\pi}\int_0^R |f(r\cos\theta,\ r\sin\theta)|^2 rdrd\theta \tag{0.1}$$

exists and developed the spectral analysis.

(2) The method of T. Kawata [1]. He assumed that the following limit

$$\lim_{T,T'\to\infty} \frac{1}{4TT'}\int_{-T'}^{T'}\int_{-T}^{T} |f(s,\ t)|^2 dsdt \tag{0.2}$$

exists and has the same limit no matter how T and T' tend to infinity and, using the Wiener formula, derived some type of law of large num-

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