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The Wiener–Wintner Theorem for the Hilbert Transform

Our main result is an oscillation inequality which is an extension of Carleson's Theorem on Fourier series. As a consequence one obtains the following extension of the Wiener–Wintner Theorem on ergodic averages: for all measure preserving flows (X, μ, T_t) and $f \in L^p(X, \mu)$, there is a set $X_f \subset X$ of probability one, so that for all $x \in X_f$ we have

$$\lim_{s \downarrow 0} \int_{s<|t|<1/s} \mathrm{e}^{i\theta t} \, f(\mathrm{T}_t \, x) \, \frac{dt}{t} \quad \text{exists for all } \theta.$$

This work is joint with Michael Lacey.