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Random walk and Brownian local times, Wiener sheets: an interplay

Let $S(0) = 0$, $S(i)$, $i = 1, 2, \ldots$, be a simple symmetric random walk on the line, and let $X(k, n) := \#\{i : 1 \leq i \leq n, S(i) = k\}$, $k = 0, \pm 1, \pm 2, \ldots$ be its local time process. Let $\{W(t), t \geq 0\}$ be a standard Brownian motion, and let $\{L(x, t), -\infty < x < \infty, t \geq 0\}$ be its local time process. The study of the asymptotic behaviour of the centered local time processes $\{X(k, n) - X(0, n)\}$ and $\{L(x, t) - L(0, t)\}$ has played a significant role in the development of the local time theory of random walks and that of Brownian local times. A glimpse of these developments will be attempted in their historical context, leading up to a strong approximation of the local time difference $\{X(k, n) - X(0, n)\}$ by a Wiener sheet and an independent Brownian motion, time changed by an independent Brownian local time. The latter is based on E. Csáki, M. Csörgő, A. Földes and P. Révész (2008), Annales de l'Institut Henri Poincaré–Probabilités et Statistiques, to appear.