

# Appendix C: Important Mathematical Definitions

**Convolution.** The convolution  $f(x, y) = g(x, y) * h(x, y)$  of two 2-dimensional functions  $g(x, y)$  and  $h(x, y)$  is defined as:

$$f(x, y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} g(u, v)h(x - u, y - v)dudv$$

**Correlation.** The cross-correlation function  $c(x, y) = g(x, y) \star h(x, y)$  of two 2-dimensional functions  $g(x, y)$  and  $h(x, y)$  is defined as:

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$$c(x, y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} g^*(u, v) h(x + u, y + v) du dv$$

**Corresponding relations.** Relation of correlation  $c(x, y)$  and convolution  $*$ :

$$c(x, y) = g^*(x, y) * h(-x, -y).$$

If  $F$  denotes Fourier transform, and  $G$  and  $H$  denote Fourier-transformations of  $g$  and  $h$ , then:

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} |g(x, y)|^2 dx dy = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} |G(k_x, k_y)|^2 dk_x dk_y \text{ (Plancherel or Rayleigh theorem),}$$

$$F[g(x, y) \star g(x, y)] = |G(k_x, k_y)|^2 \text{ (Wiener-Khinchin theorem),}$$

$$F[g(x, y) * h(x, y)] = G(k_x, k_y) H(k_x, k_y) \text{ (See also MacLennan, 1990.)}$$

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