1 Discrete Fourier transform in 2D

$$\textbf{Direct} \quad F(u,v) = \frac{1}{MN}\sum_{y=0}^{M-1}\sum_{z=0}^{N-1} f(y,z)\exp\left[-2\pi i\left(\frac{uy}{M}+\frac{vz}{N}\right)\right] \qquad \textbf{Inverse} \quad f(y,z) = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)\exp\left[2\pi i\left(\frac{uy}{M}+\frac{vz}{N}\right)\right] \tag{1}$$

1.1 Parseval's theorem

$$\frac{1}{MN}\sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)\overline{G(u,v)} = \int_0^N\int_0^M f(y,z)\;\overline{g(y,z)}\;dydz \tag{2}$$

if f and g are real-valued functions and $F(u,v) = A_{u,v} + iB_{u,v}$ and $G(u,v) = C_{u,v} + iD_{u,v}$, then:

$$\sum_{u=0}^{M-1}\sum_{v=0}^{N-1} F(u,v)\overline{G(u,v)} = \sum_{u=0}^{M-1}\sum_{v=0}^{N-1}\left(A_{u,v}C_{u,v} + B_{u,v}D_{u,v}\right) \tag{3}$$

1.2 Fourier spectra

if $k = \sqrt{(u^2+v^2)}$ then:

$$E = \int_0^N\int_0^M f(y,z)\;g(y,z)\;dydz = \frac{1}{MN}\int_k\left(A_{u,v}C_{u,v} + B_{u,v}D_{u,v}\right)dk \tag{4}$$