

$$\widehat{f}(\nu) = \int_{\mathbb{R}} f(t) e^{-i2\pi\nu t} dt$$

$$\widehat{g}(\nu) = \int_{\mathbb{R}} g(t) e^{-i2\pi\nu t} dt$$

$$(f * g)(t) = \int_{\mathbb{R}} f(y) g(t - y) dy$$

$$\widehat{f * g} = \widehat{f} \cdot \widehat{g}$$

$$\widehat{f * g}(\nu) = \widehat{f}(\nu) \cdot \widehat{g}(\nu)$$

$$\begin{aligned} L &= \widehat{f * g}(\nu) \\ &= \int_{\mathbb{R}} \int_{\mathbb{R}} f(y) g(t - y) dy e^{-i2\pi\nu t} dt \\ &= \int_{\mathbb{R}} \int_{\mathbb{R}} f(y) g(t - y) e^{-i2\pi\nu t} dt dy \\ &= \int_{\mathbb{R}} f(y) \int_{\mathbb{R}} g(t - y) e^{-i2\pi\nu t} dt dy \\ &\stackrel{t-y=\tau}{=} \int_{\mathbb{R}} f(y) \int_{\mathbb{R}} g(\tau) e^{-i2\pi\nu y} e^{-i2\pi\nu\tau} d\tau dy \\ &= \left(\int_{\mathbb{R}} f(y) e^{-i2\pi\nu y} dy \right) \left(\int_{\mathbb{R}} g(\tau) e^{-i2\pi\nu\tau} d\tau \right) \\ &= \widehat{f}(\nu) \cdot \widehat{g}(\nu) = R. \end{aligned}$$