Proof.
Let us start with the autocorrelation of $h(t)$ (see Section 24.2.2) and write it in terms of the inverse Fourier transform of its spectra, somewhat in the same manner as we did for the proof of Parseval's theorem, Theorem 24.28.

$$(h \circ h)(\tau) = \int_{-\infty}^{\infty} \overline{h(t)} h(t+\tau) dt \tag{24.425}$$

Recall that,

$$h(t) = \frac{1}{2\pi} \int_{-\infty}^{\infty} H(\omega) e^{i\omega t} d\omega \tag{24.426}$$

and

$$\overline{h(t)} = \frac{1}{2\pi} \int_{-\infty}^{\infty} \overline{H(\omega)} e^{-i\omega t} d\omega \tag{24.427}$$

Therefore, Equation 24.425 may be written as follows,

$$\begin{aligned}(h \circ h)(\tau) &= \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \overline{H(\omega_1)} e^{-i\omega_1 t} d\omega_1 \int_{-\infty}^{\infty} H(\omega_2) e^{i\omega_2 (t+\tau)} d\omega_2 dt \\ &= \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \overline{H(\omega_1)} H(\omega_2) e^{-i\omega_1 t} d\omega_1 e^{i\omega_2 (t+\tau)} d\omega_2 dt \\ &= \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \overline{H(\omega_1)} H(\omega_2) \\ &\qquad \left[\int_{-\infty}^{\infty} e^{-i(\omega_1 - \omega_2)t} dt \right] e^{i\omega_2 \tau} d\omega_1 d\omega_2 \end{aligned} \tag{24.428}$$

Note that by definition,

$$\int_{-\infty}^{\infty} e^{-i(\omega_1 - \omega_2)t} dt = \delta(\omega_1 - \omega_2) \tag{24.429}$$

Plugging the identity of Equation 24.429 for the bracketed expression in Equation 24.428,

$$(h \circ h)(\tau) = \frac{1}{(2\pi)^2} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \overline{H(\omega_1)} H(\omega_2) e^{i\omega_2 \tau} \delta(\omega_1 - \omega_2) d\omega_1 d\omega_2 \tag{24.430}$$

An important property of the Delta function, $\delta(x)$, is that for any function $\varphi(x)$,

$$\int_{-\infty}^{\infty} \varphi(x) \delta(x - x_0) dx = \varphi(x_0) \tag{24.431}$$

Using this property,

$$\int_{-\infty}^{\infty} \overline{H(\omega_1)} \delta(\omega_1 - \omega_2) d\omega_1 = \overline{H(\omega_2)} \tag{24.432}$$