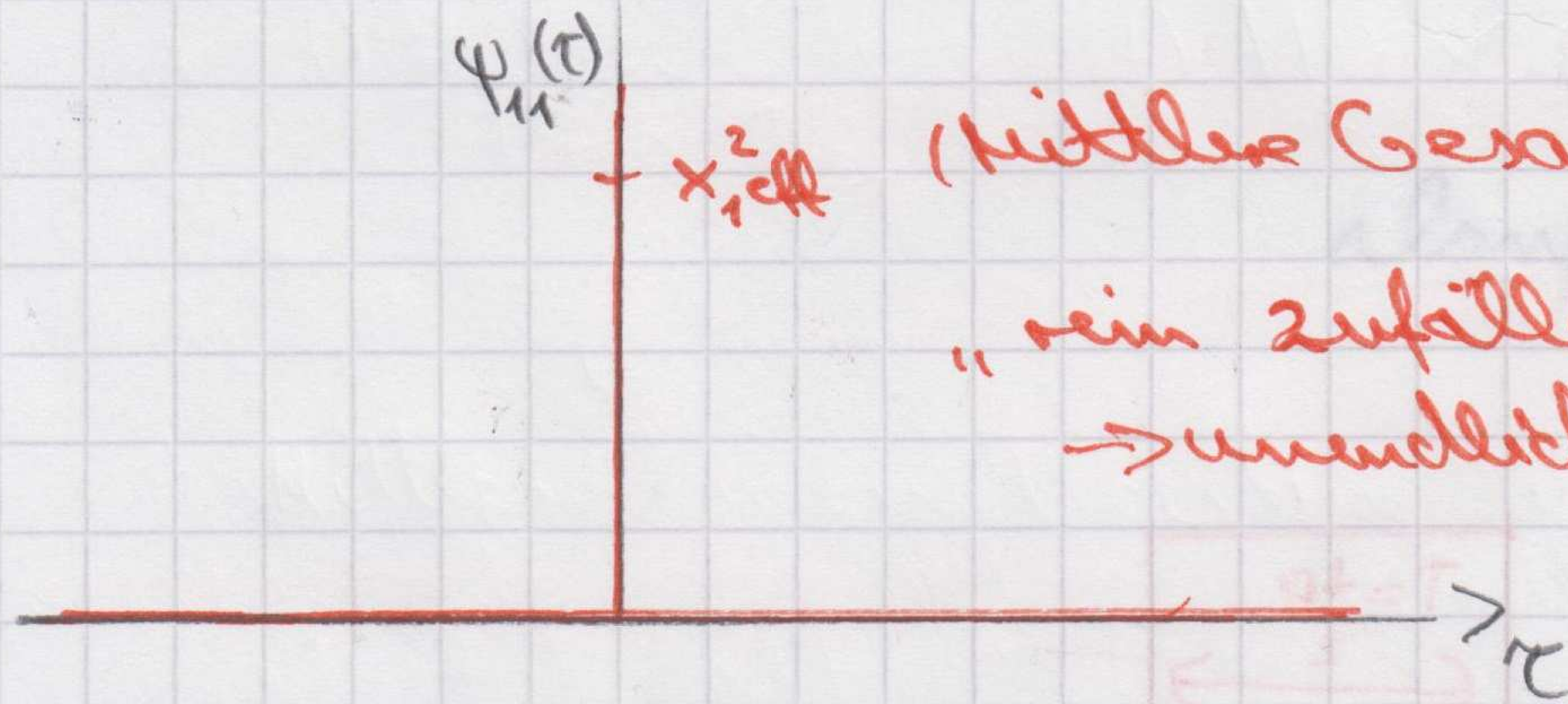
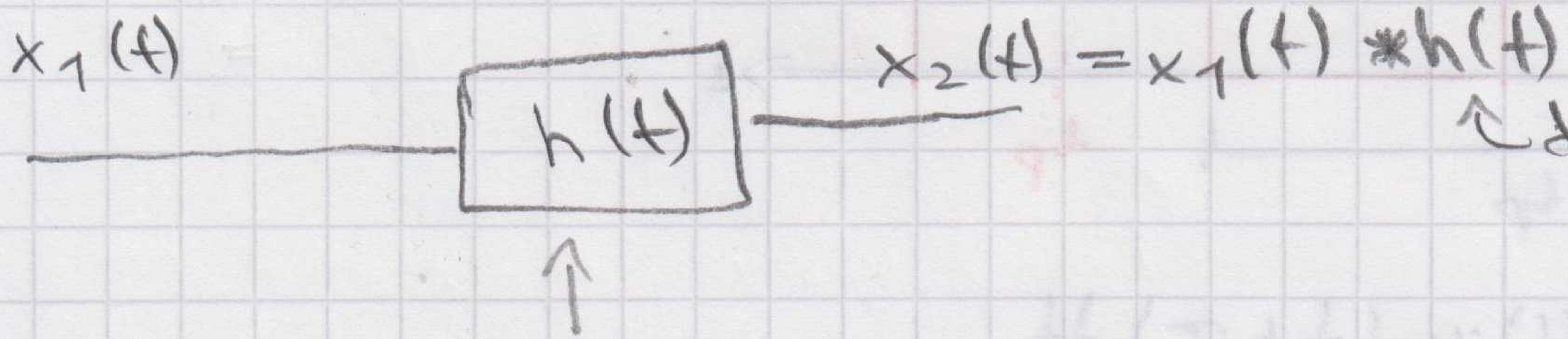


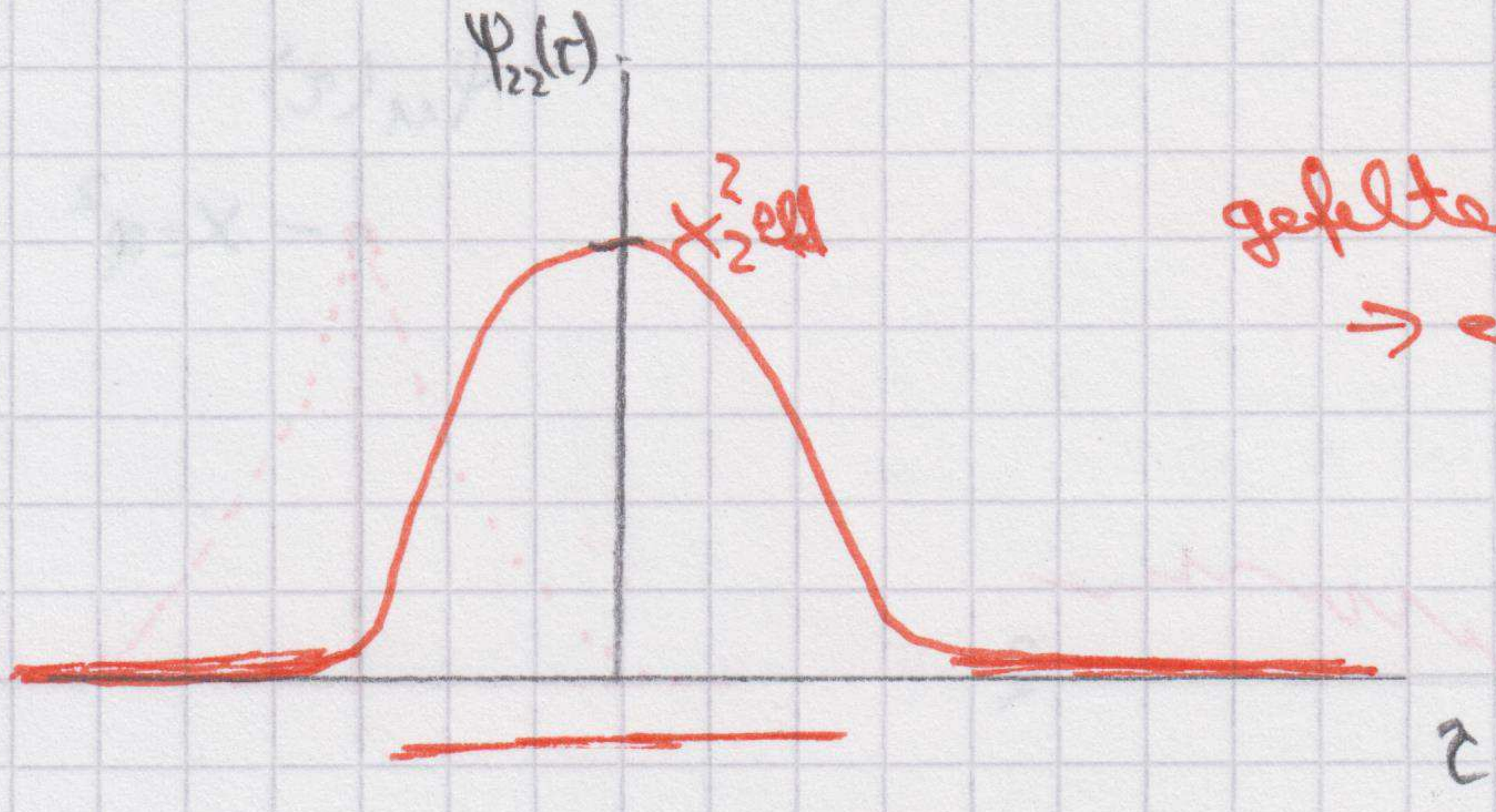
(Mittlere Gesamtleistung)

„rein zufälliges Signal"
→ unendliche Bandbreite



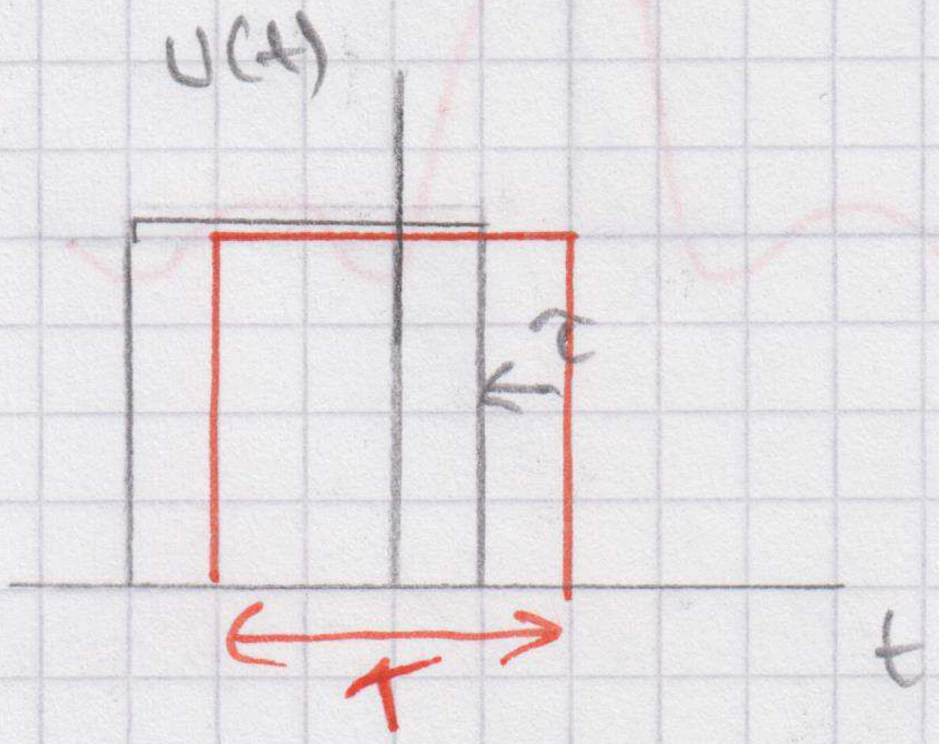
↑ determinierter Anteil

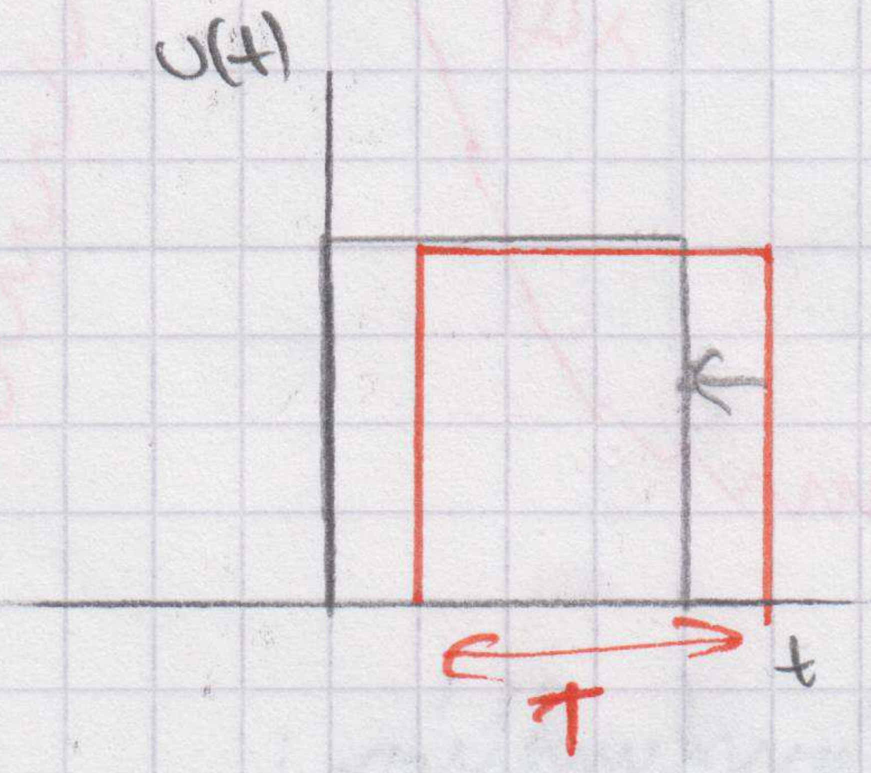
TP, Bandbegrenzung

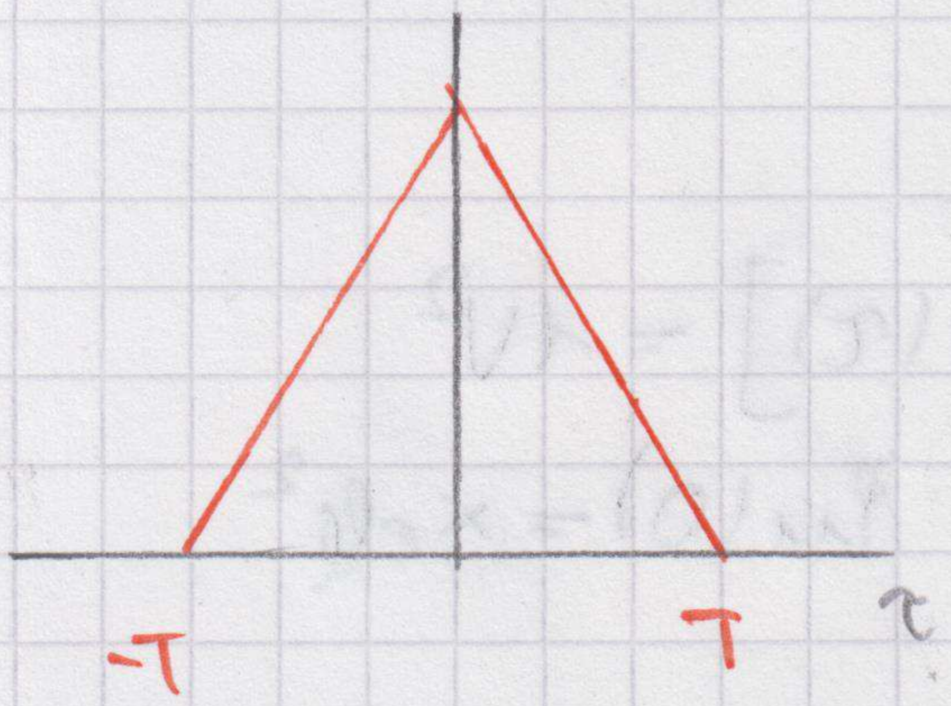


gefiltertes zufälliges Signal
→ endliche Bandbreite

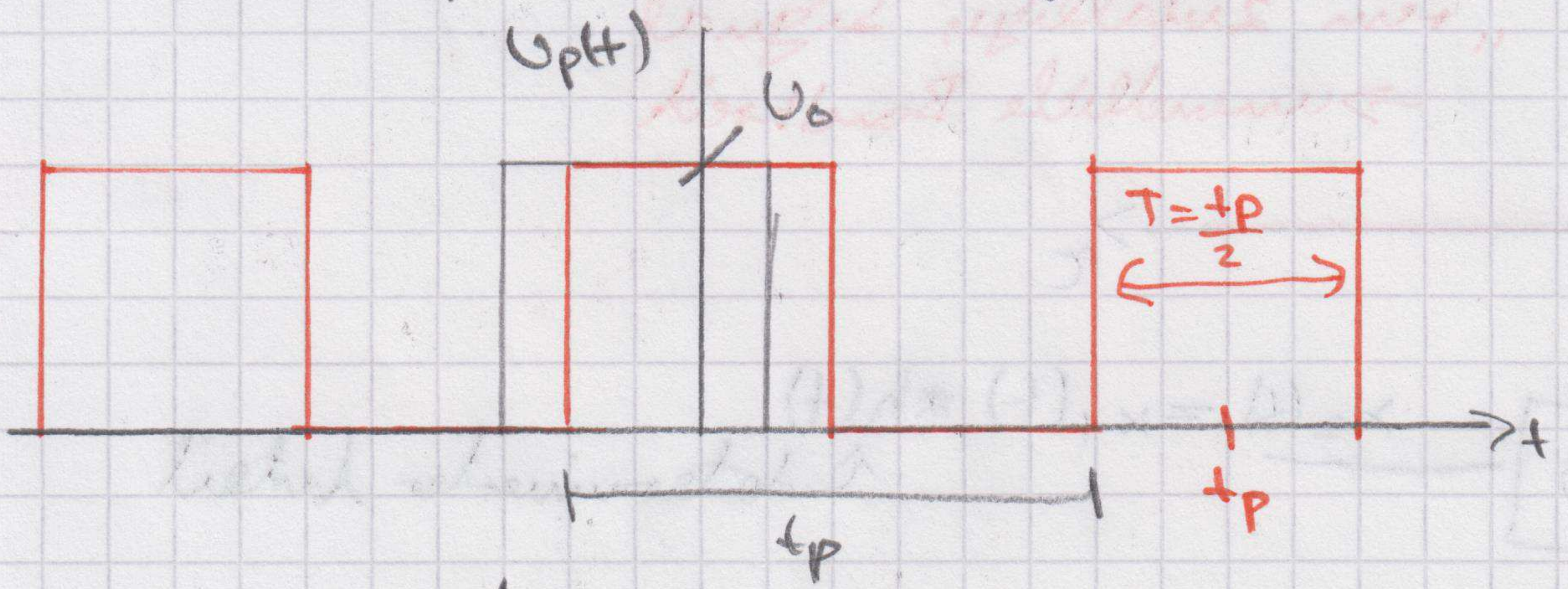
innerer Zusammenhang, in Grenzen vorhersagbar





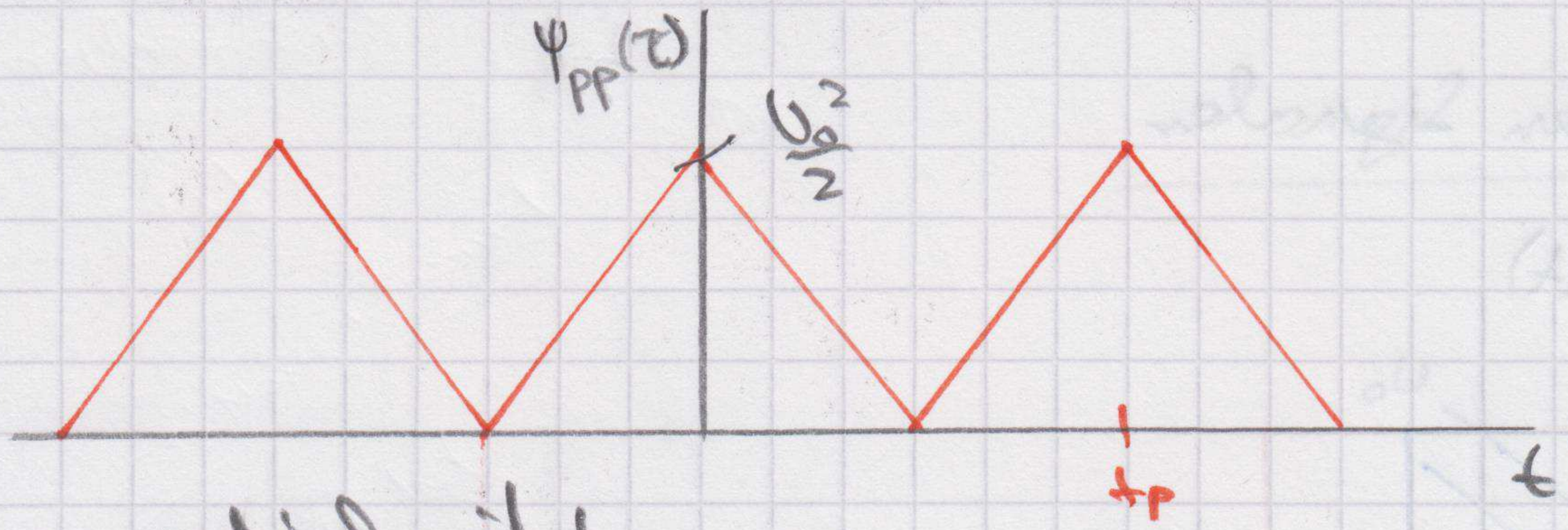


AKF eines periodischen Signals



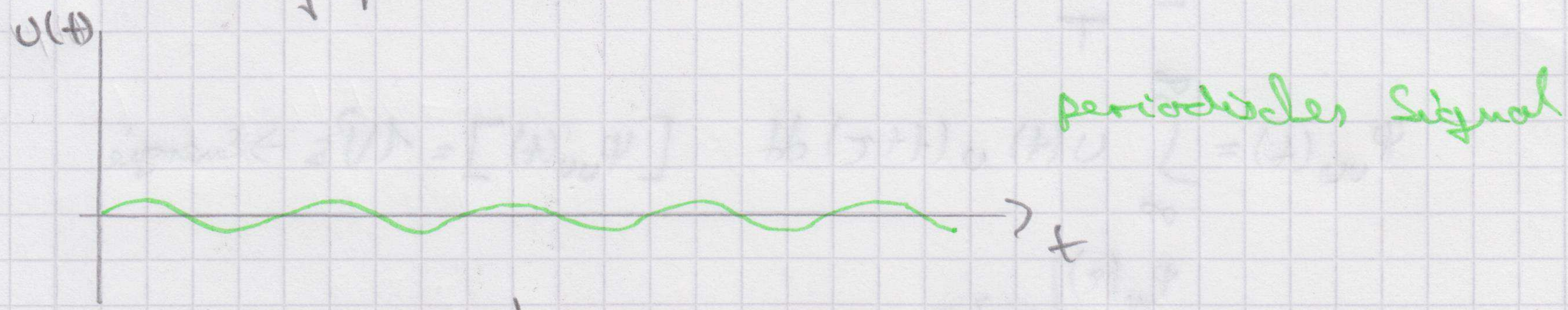
$$\varphi_{pp}(\tau) = \frac{1}{n\cdot t_p}\int_{n t_p} u_p(t)\cdot u_p(t+\tau)\,dt$$

$$= \frac{1}{t_p}\int_{t_p} u_p(t)\, u_p(t+\tau)\,dt$$

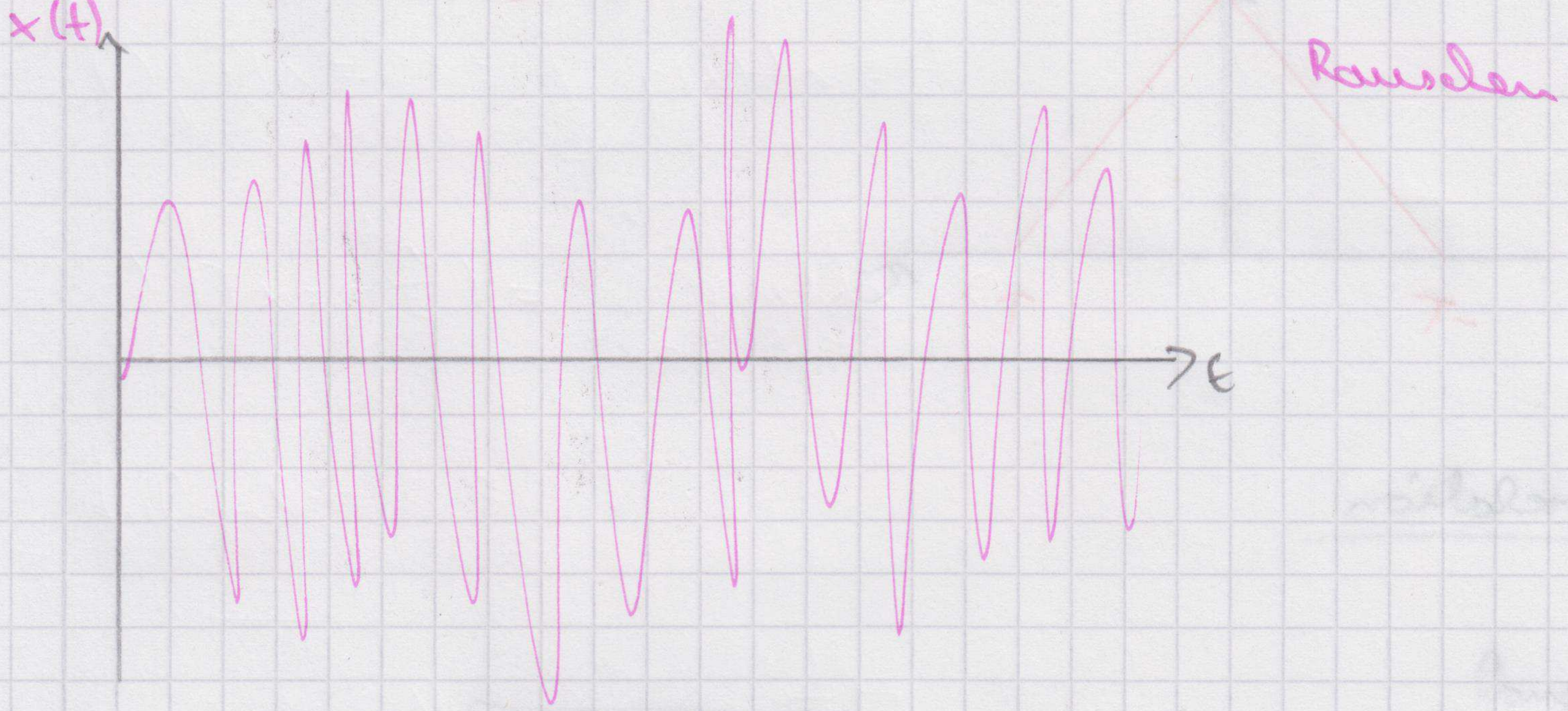


periodisch mit t_p

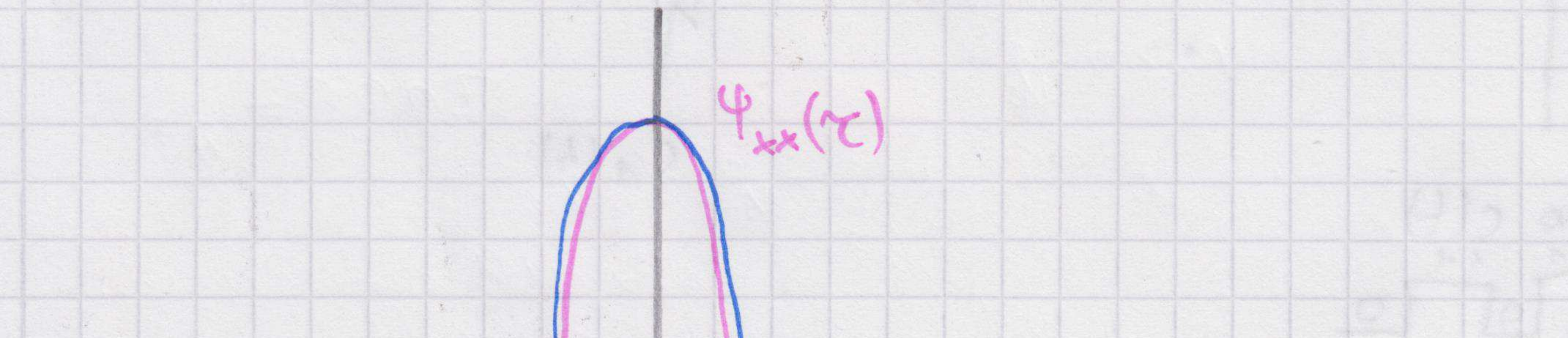
Entdeckung periodischer Signale in Rauschen



+



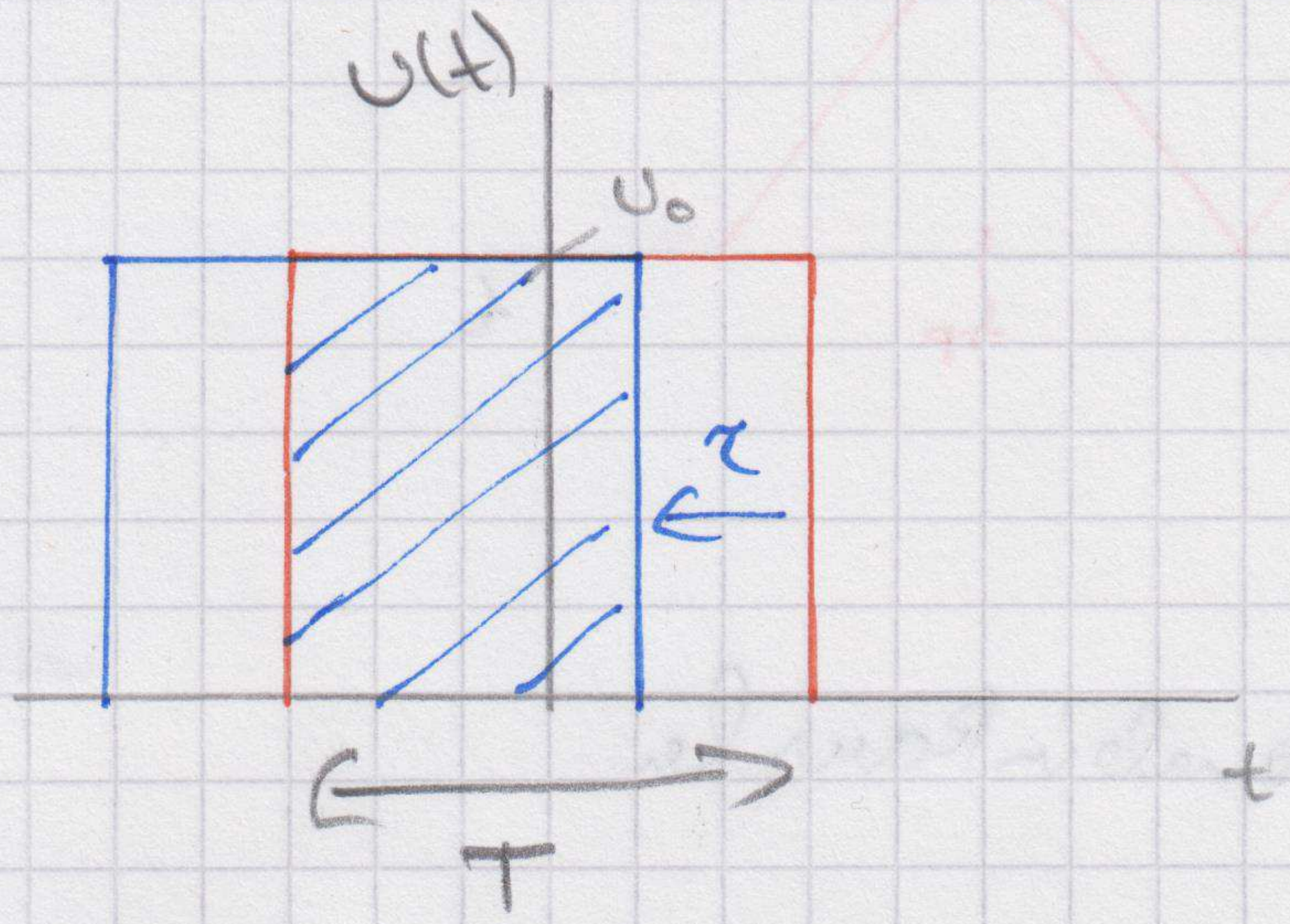
AKF von $u(t)$ + $x(t)$



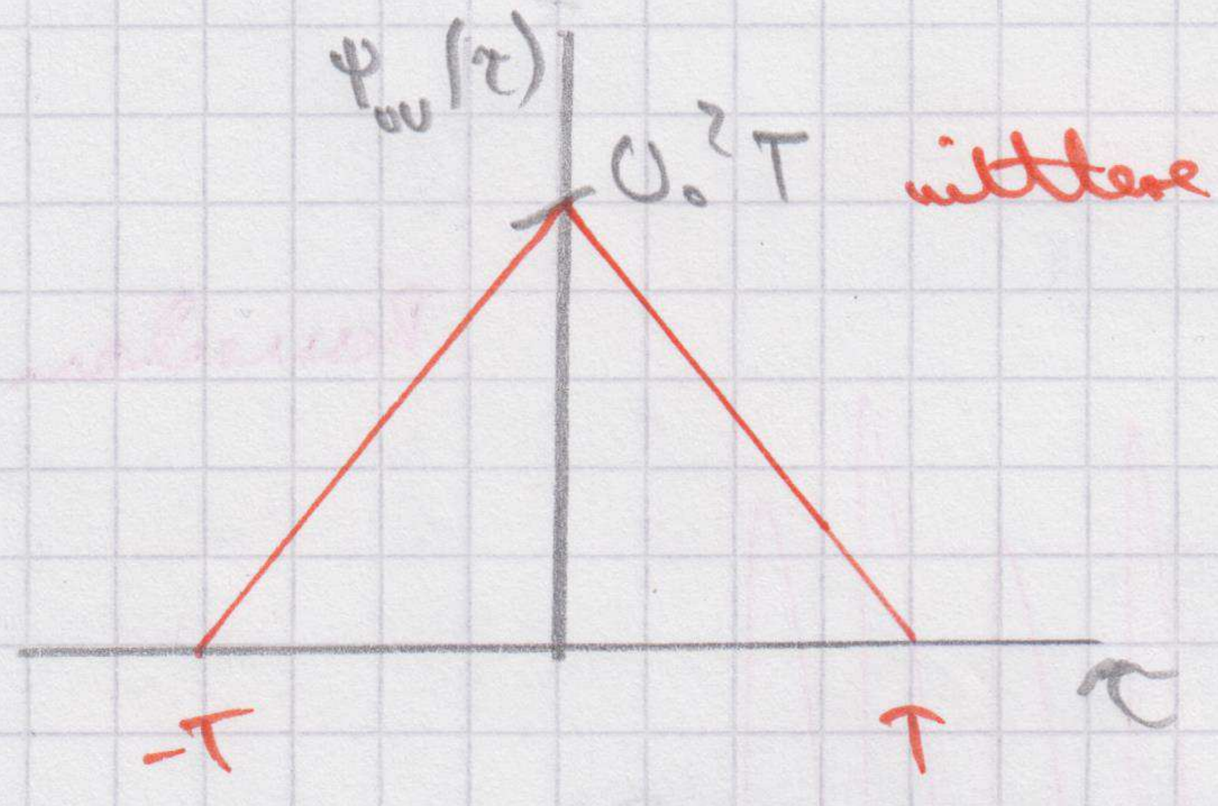
AKF des Rauschens verschwindet für große τ.

↳ übrig bleibt nur der periodische Anteil

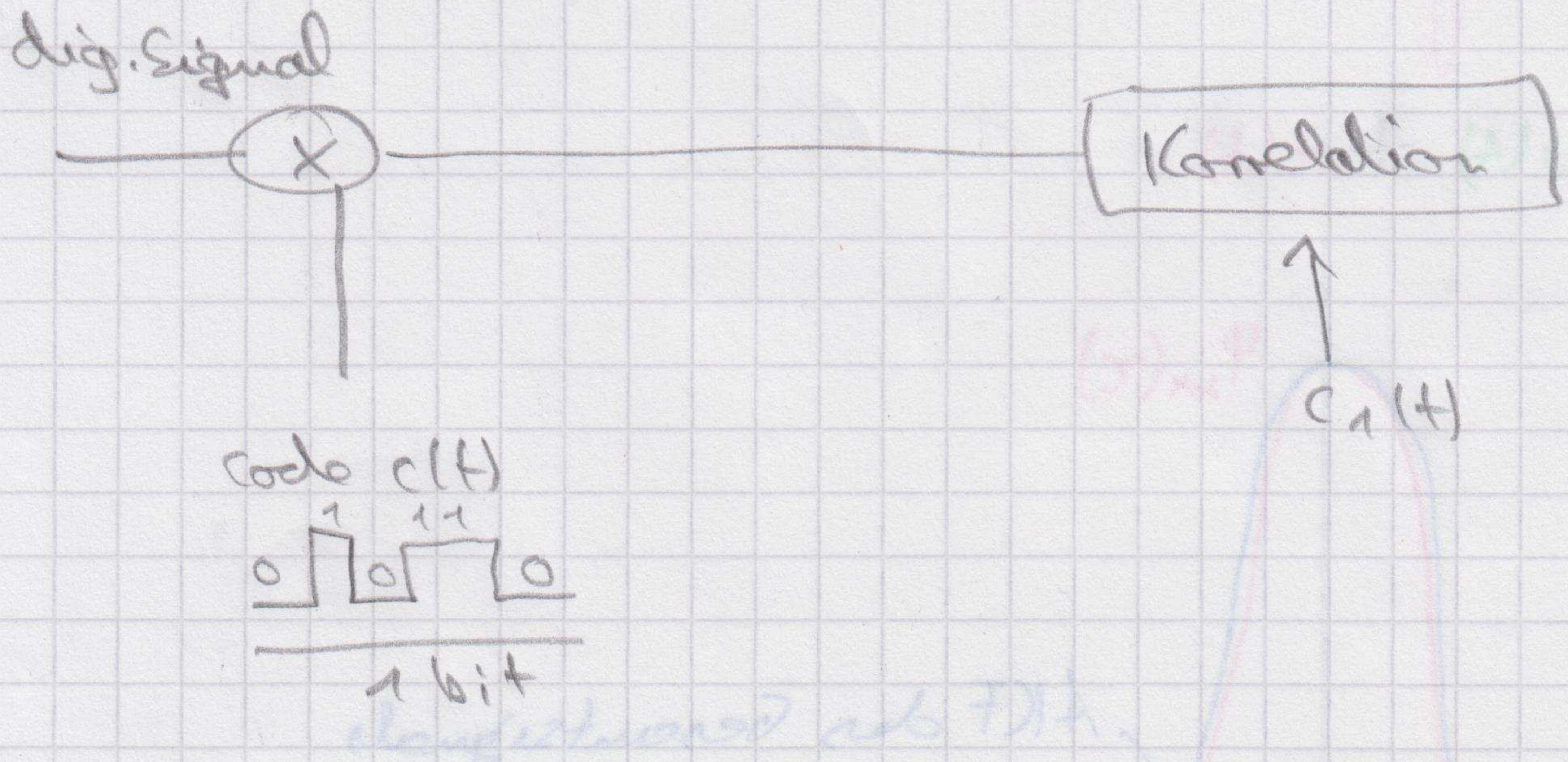
AKF bei aperiodischen Signalen

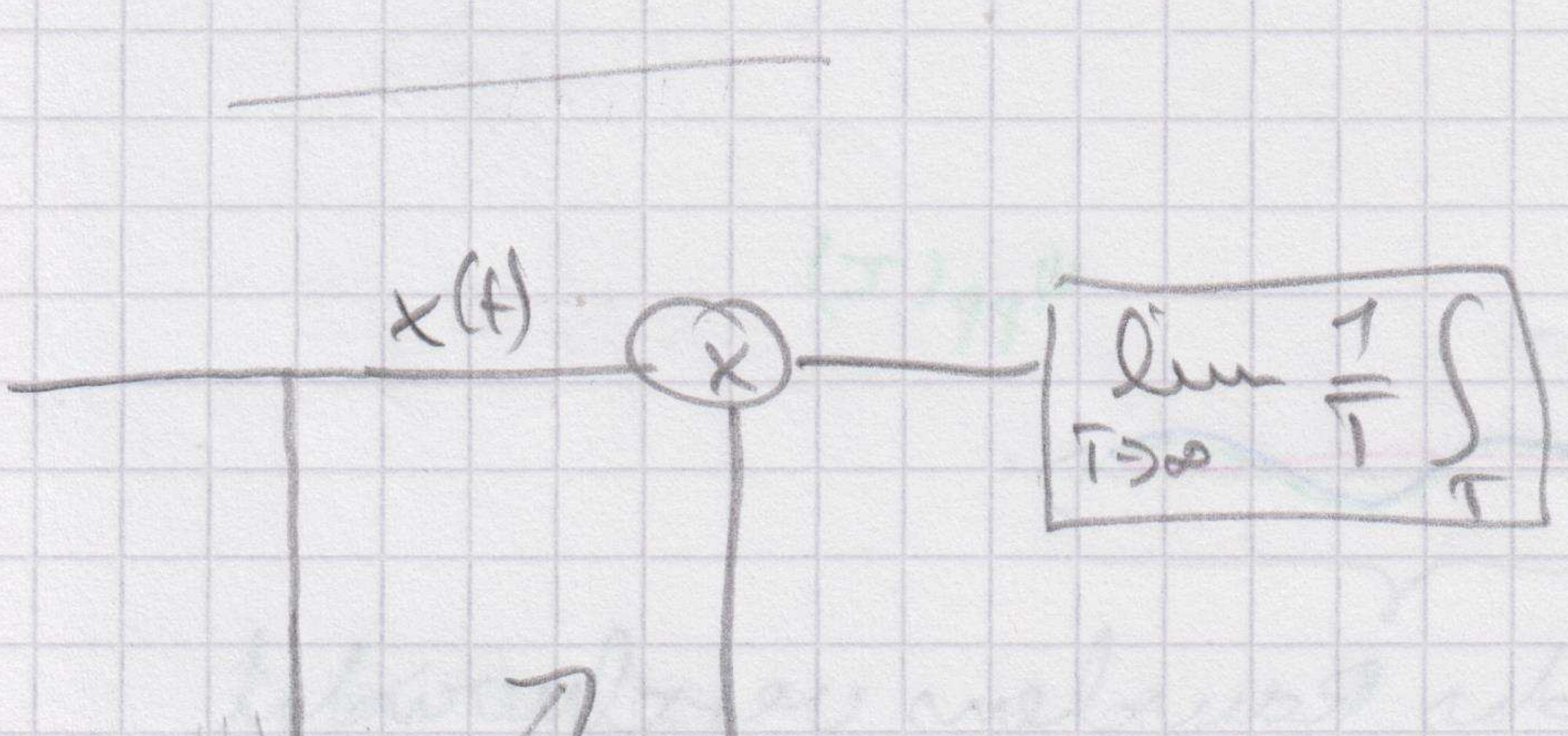


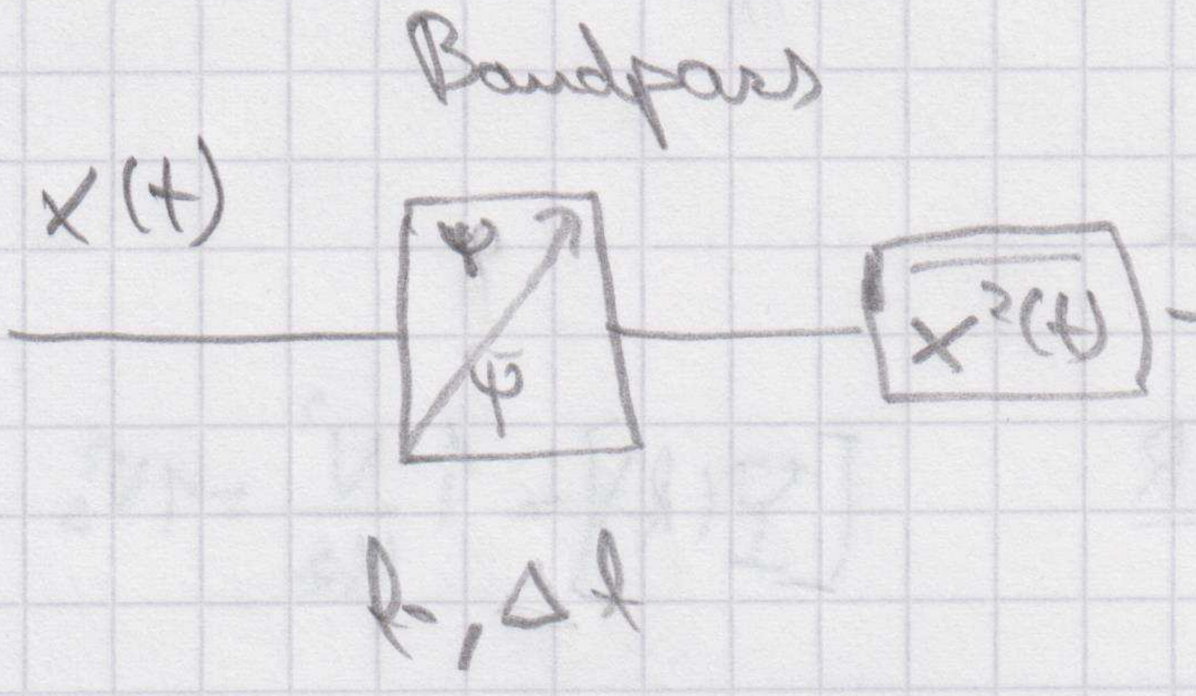
$$\varphi_{uu}(t) = \int_{-\infty}^{\infty} u(t)\, u(t+\tau)\, dt \qquad [\varphi_{uu}(t)] = 1V^2s \rightarrow \text{Energie}$$



Kreuzkorrelation







$x_{eff}^2 \left(f_0 - \frac{\Delta f}{2} < f < f_0 + \frac{\Delta f}{2}\right)$

$$P\left(f_0 - \frac{\Delta f}{2} < f < f_0 + \frac{\Delta f}{2}\right) = \frac{x_{eff}^2(\cdot)}{R}$$

Grenzübergang für $\Delta f \to 0$

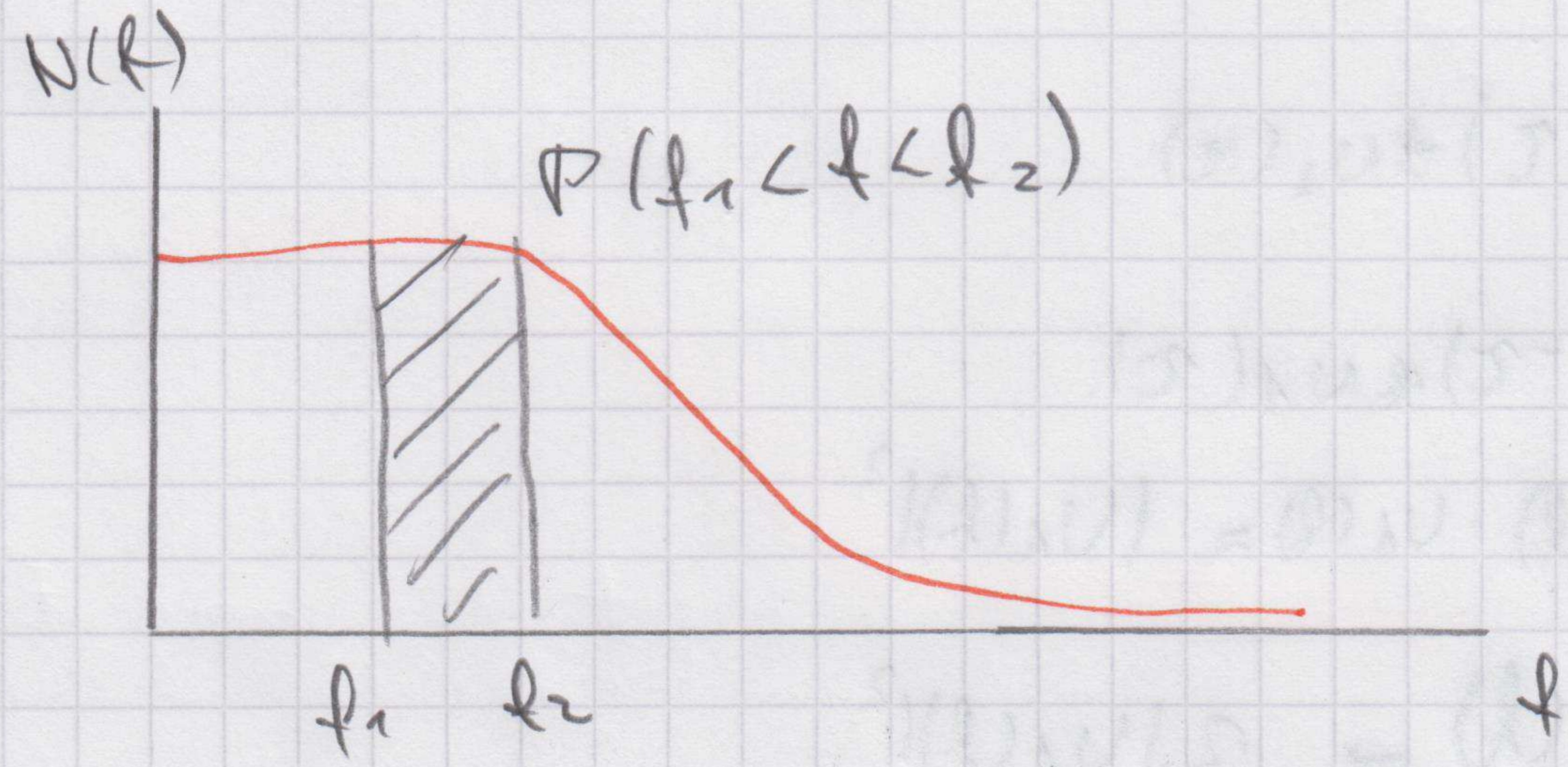
$$\lim_{\Delta f \to 0} \frac{P\left(f_0 - \frac{\Delta f}{2} < f < f_0 + \frac{\Delta f}{2}\right)}{\Delta f} = N(f_0)$$

↓

Leistungsdichte

$$[N(f)] = 1 \frac{W}{Hz} = 1\,Ws$$

$$N(f) = \lim_{\Delta f \to 0} \frac{\Delta P(f)}{\Delta f} = \lim_{\Delta f \to 0} \frac{x_{eff}^2(f)/R}{\Delta f}$$



Leistung im Frequenzintervall

$$P(f_1 < f < f_2) = \int_{f_1}^{f_2} N(f)\,df$$

Leistung bis Grenzfrequenz f_g

$$P(f < f_g) = \int_0^{f_g} N(f)\,df$$

→ Normierung der Leistung: $x_{eff}^2 = P \cdot R$

Erweiterung auf negative Frequenzen

$$\Psi(f) = \lim_{\Delta f \to 0} \frac{1}{2} \frac{x_{eff}^2(f)}{\Delta f} = \frac{N(f)\, R}{2} \qquad [\Psi(f)] = 1 \frac{V^2}{Hz} = 1 V^2 s$$

$\psi(\tau)$

$$N(f) = \frac{2\, \Psi(f)}{R}$$

Aperiodisches Signal

$$\psi_{12}(\tau) = \int_{-\infty}^{\infty} u_1(t) \cdot u_2(t+\tau)\, dt$$

$$u_1(t) * u_2(t) = \int_{-\infty}^{\infty} u_1(t) \cdot u_2(t-\tau)\, dt$$

$$\psi_{12}(\tau) = u_1(-\tau) * u_2(\tau)$$

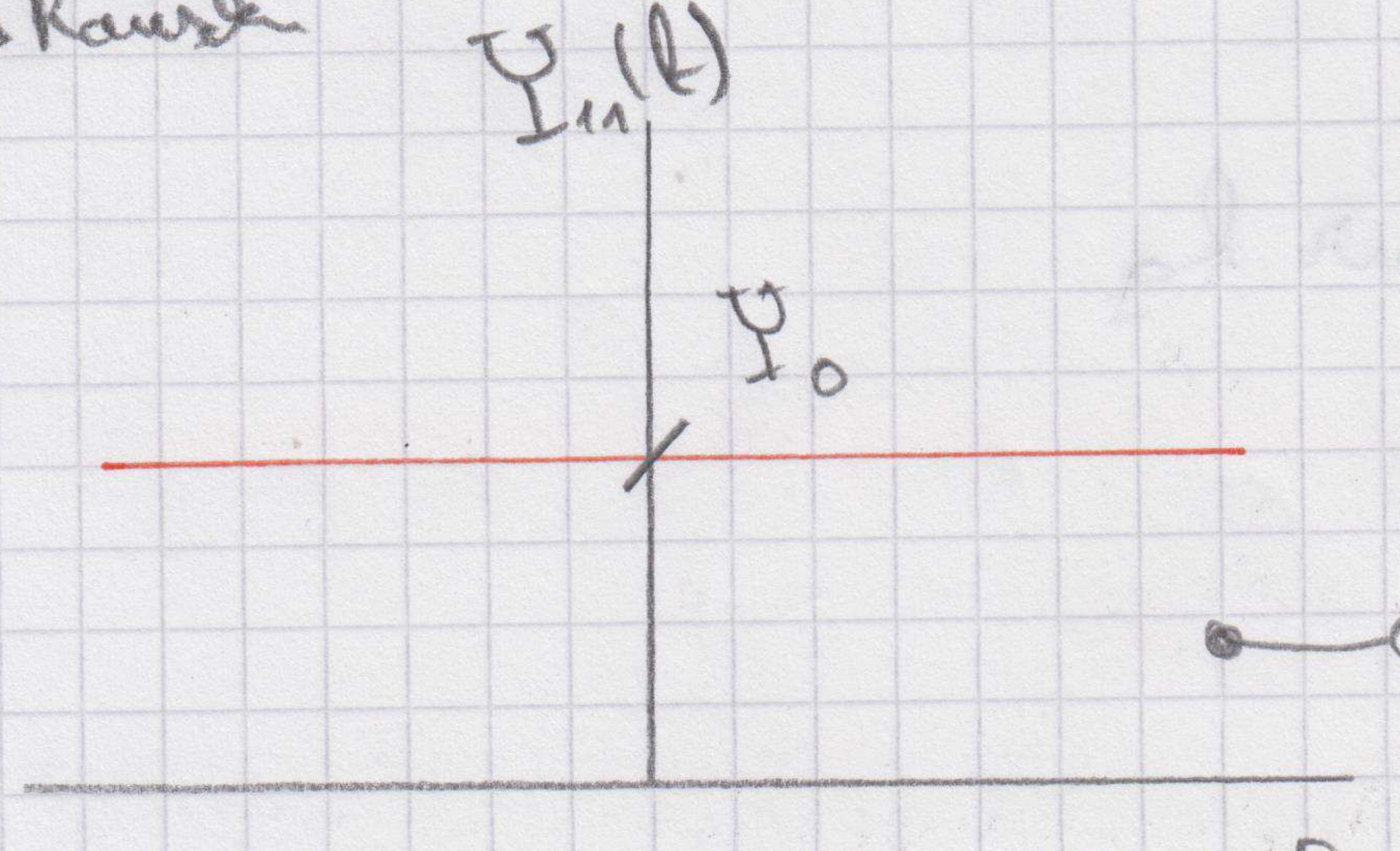
$$\psi_{11}(\tau) = u_1(-\tau) * u_1(\tau)$$

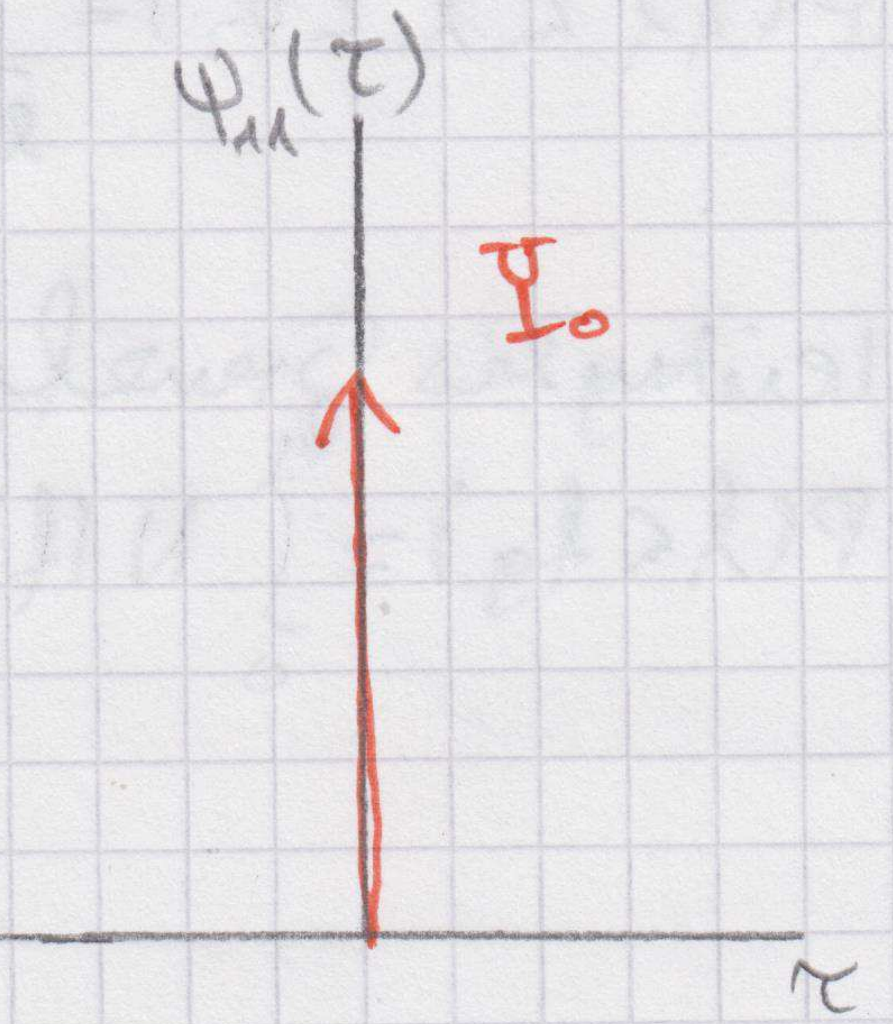
$$\Psi_{11}(f) = U_1(f) \cdot U_1(f) = |U_1(f)|^2$$

$$N(f) = \frac{2\, \Psi_{11}(f)}{R} = \frac{2 |U_1(f)|^2}{R}$$

↳ gilt für determinierte Signale

Weißes Rauschen

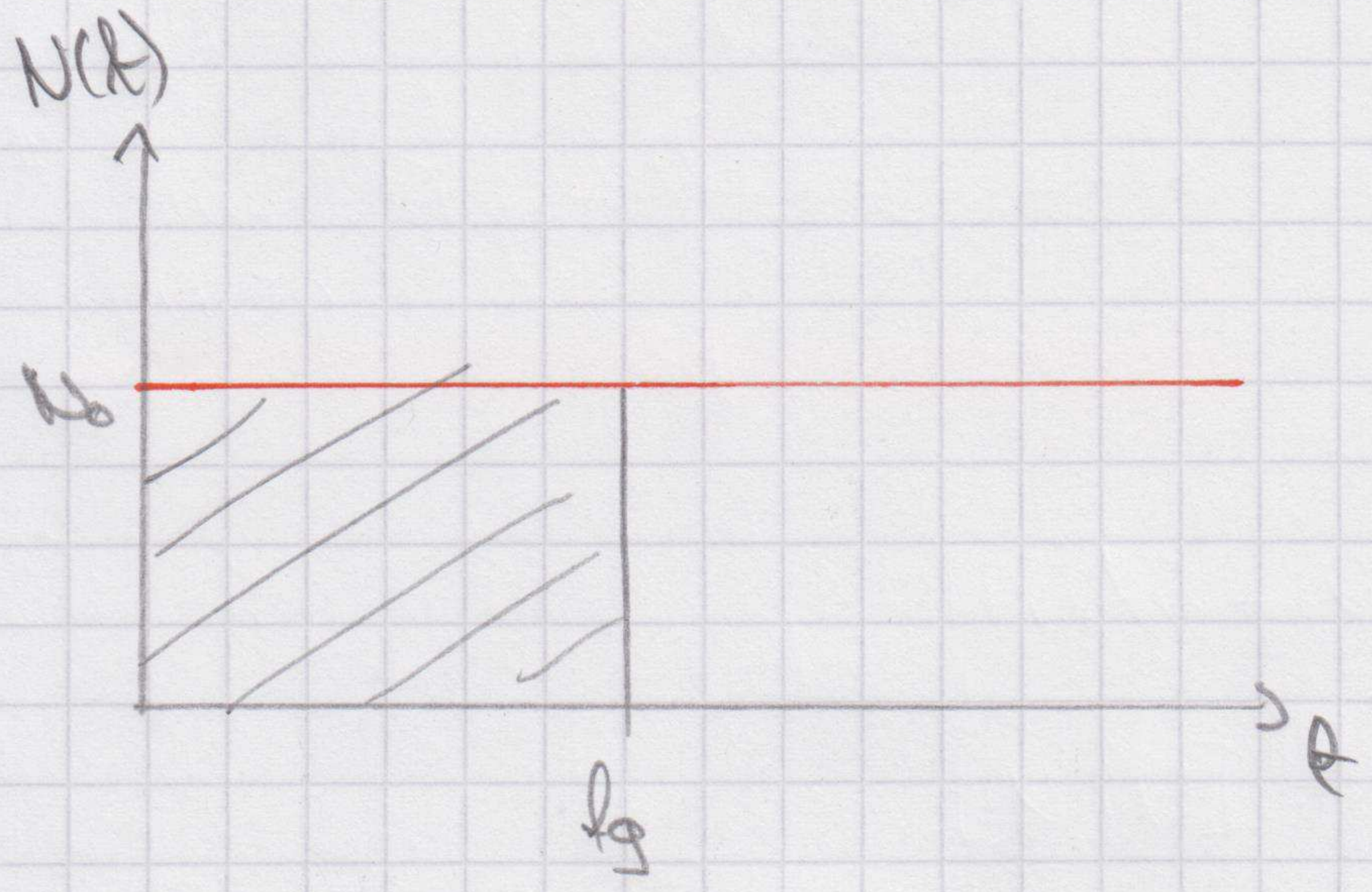




$\Psi(f) = \bar{\Psi} = \text{konst.}$ $\qquad$ $\varphi_{11}(\tau) = \Psi_0 \, \delta(\tau)$

Mittlerer Gesamtleistung:

$$x_{eff}^2 = \int_{-\infty}^{\infty} \Psi_{11}(f)\, df = \varphi_{11}(0) = \infty$$



$$N(f) = N_0 = \frac{2\Psi_0}{R} = \text{konst}$$

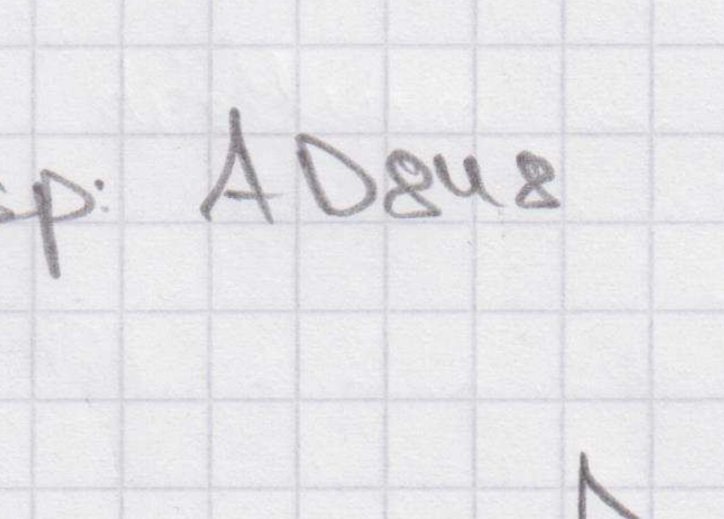
Rauschleistung bis zur Grenzfrequenz f_g:

$$P_N = N_0 \cdot f_g$$

Rauschleistung im Intervalle $\Delta f = f_2 - f_1$

$$P_N = N_0 \Delta f$$

Bsp: AD848



Frequenzbereich: 1KHz ... 11KHz

$$\Delta f = 10\,KHz$$

$$U'(f) = \text{konst} = 5\,nV/\sqrt{Hz} = U'_0$$

$$U_{eff} = U_0' \cdot \sqrt{\Delta f}$$

$$= 5\,nV/\sqrt{Hz} \cdot \sqrt{10000\,Hz} = 500\,nV = 0{,}5\,\mu V$$