Remarks on Einstein Causality

Peter W. Milonni
Los Alamos

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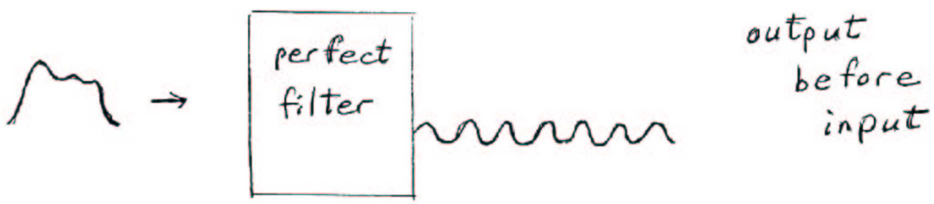
- **No superluminal signalling via EPR correlations**

$|\Psi\rangle = |H_A\rangle|V_B\rangle - |V_A\rangle|H_B\rangle$

(or equivalently $|\Psi\rangle = |R_A\rangle|R_B\rangle - |L_A\rangle|L_B\rangle$)

- **No cloning**

- **No perfect filter** ($\equiv$ filter that absorbs one frequency and affects no others)



$n(\omega)$ must be analytic in upper half of complex plane

$$E(z,t) = \int_{-\infty}^{\infty} dt' G(z, t-t') E(0,t')$$

$$G(z,\tau) = \frac{1}{2\pi} \int_{-\infty}^{\infty} d\omega e^{-i\omega[\tau - n(\omega)z/c]}$$

$G(z,\tau) = 0$ for $\tau < z/c$ **if** $\lim_{\omega\to\infty} n(\omega) = 1$

front velocity $= c/n_R(\infty)$

$$E(z,t) = \mathcal{E}(z,t)e^{-i(\omega_o t - k_o z)}$$

$$\frac{\partial \mathcal{E}}{\partial z} + \frac{1}{v_g}\frac{\partial \mathcal{E}}{\partial t} + \frac{i}{2}\left(\frac{d^2 k}{d\omega^2}\right)_{\omega_o}\frac{\partial^2 \mathcal{E}}{\partial t^2} + \ldots = 0$$

group velocity $v_g = (dk/d\omega)^{-1}_{\omega_o} = \frac{c}{(n+\omega dn/d\omega)_{\omega_o}}$

$$E(0,t) = A(t)e^{-i\omega_o t}$$

In the group velocity approximation,

$$E(z,t) = A(t - z/v_g)e^{-i(\omega_o t - k_o z)}$$

$$A(t - z/v_g) = e^{[c^{-1} - v_g^{-1}]z\partial/\partial t}A(t - z/c)$$

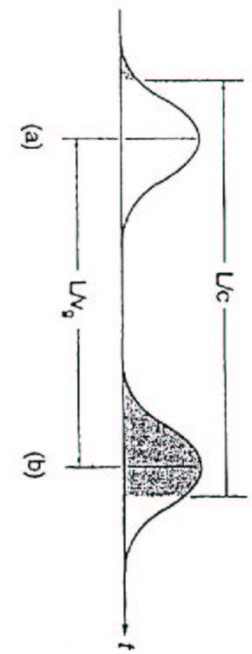


Figure 6. Incident (*a*) and transmitted (*b*) pulses for a propagation length *z* and group velocity $v_g > c$. The shaded portion of (*b*) is completely determined by the shaded portion of (*a*).