Invited talk given at *AG Nichtklassische Strahlung* of the *Humboldt University of Berlin*, Germany, on December 10, 1997

REALISTIC OPTICAL INTERACTION-FREE MEASUREMENTS

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Summary

So far we used *the fact that by void detection in an interferometer one destroys the interference* (as I pointed out already in my PhD Dissertation) to design a highly efficient interaction-free device, and to propose an interaction-free preparation and an interaction-free interference erasure. My co-worker from the Atominstitute of Vienna, Johann Summhammer carried out an interaction-free experiment with neutrons and we are preparing one with photons here in Berlin. In this talk I would like to elaborate on some details of the latter experiment which reveal the physics of the interaction-free measurements. Fig. 1 shows an outline of a variant of the experiment. When there is no object in the device, an incoming laser beam is being (ideally) totally transmitted into detector D_t and when there is an object, an incoming laser beam is being (ideally) totally reflected into detector D_r. The device consists of Pellin–Broca prisms which are designed so that their entrance and exit faces are at Brewster's angles thus minimizing reflection losses at these faces. The entrance prism is coupled to the adjacent loop prism by the frustrated total reflection. A continuous wave laser is used as a source of the incoming beam a continuous wave. Calculations yield the efficiency of the throughput into detector D_t when there is no object in the resonator: $\tau = (1-R)^2 f(\rho, \mathcal{T}, T, \omega, \omega_{res}, \psi)$, where R is the frustrated reflectance, ω is the frequency of the incoming beam, ω_{res} is the selection frequency, ρ is a measure of the losses, and $\mathcal{T}$ is the coherence time, T the round–trip time, and ψ the total reflection phase shift. The coherence length is long enough to allow sufficiently many round trips (at least 200). Calculated τ's for the expected losses ρ are presented in Fig. 2. Calculated values for the suppression of the reflection (as measured by detector D_r) are even closer to 1.

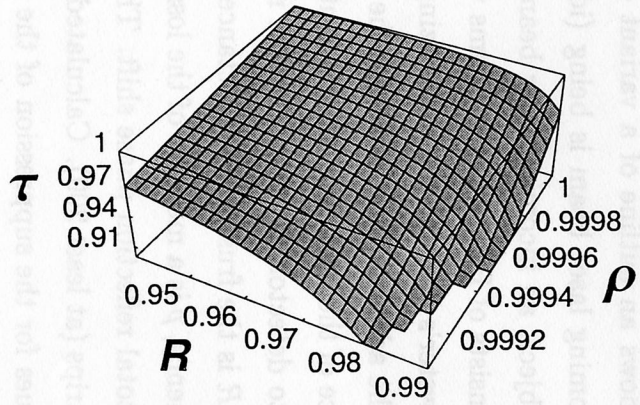

Figure 2. The efficiency of the throughput into D_t when there is no object in the resonator as given by τ.

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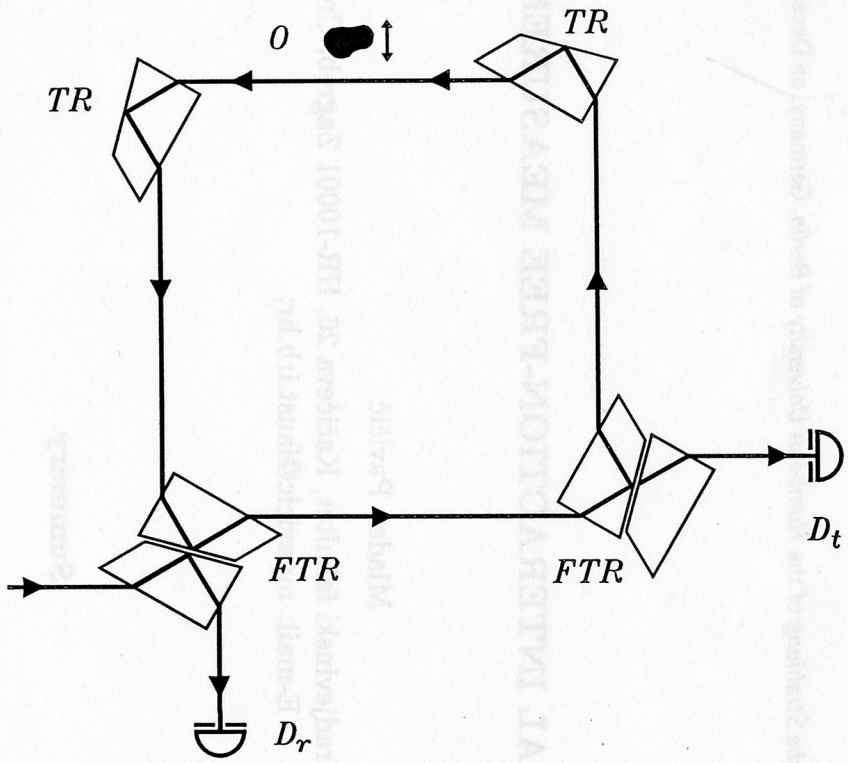

Figure 1. Schematic of the proposed realistic interaction–free device. A single p–polarized photon tunnels (frustrated total reflection, *FTR*) into the resonator made of Pellin–Broca prisms which are designed so that the entrance and exit faces are at Brewster's angles thus minimizing reflection losses. With a realistic efficiency of over 98% the beam makes several hundred loops guided by 2 total reflections *TR* and 2 *FTR*'s to exit into D_t when there is no object in the path and is being reflected into D_r when there is.