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Mesoscopic spectral modulation of light transmitted by a subwavelength aperture

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In present communication we study the transmission of light through a tapered metal-coated optical fiber with a subwavelength aperture (SWA). The problem under investigation is the effect of SWA on the spectrum of the transmitted light. According to our experimental findings, one can observe, under certain conditions, a remarkable modulation of the spectrum of the transmitted light. The effect has a mesoscopic origin: the modulation takes place if the number of transmitted light modes is small but exceeds unity, which indicates the phase shifts between different modes. One possible source of such phase shift could be the different propagation speed for different modes in the fiber, but this effect should be small. In our opinion, the origin of the phase shifts is in the (different for different modes) slowdown of the light near the tip with SWA due to the interaction of propagating modes with surface plasmons of the metal coating of the fiber. One can expect that the interaction strength depend on the actual shape of the light field in the mode, which results in different modes getting different delays before passing through the tip. In case of sufficiently small SWA diameter only few modes can pass through the tapered fiber region [1], and their delay differences can cause an observable modulation of the transmitted light spectrum. In case of larger diameters many light modes can pass out, and no significant spectral modulation can be observed due to the effect of averaging. An observable modulation also disappears for SWA diameters as small as 100 nm, because in this case only one (the fundamental) light mode passes out [1].

[1] L. Novotny and C. Hafner, Phys. Rev. E., **50** (1994) 4094.