Theoretical aspects of Hanbury Brown and Twiss type correlations mediated by surface plasmon oscillations

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Abstract. Intensity-intensity correlations are studied for cases when in the beam splitter surface plasmon oscillations are generated in the Kretschmann geometry.

Due to the possibility of attenuated total reflection (ATR) and the associated generation of surface plasmon oscillations (SPOs), the response of a dielectric-metal-vacuum system can be considerably different, depending on which boundary the exciting radiation impinges. If such a system is used as an “active beam splitter”, nontrivial correlations may show up between two detectors, placed on the opposite sides (see Left and Center in Fig. 1).

Figure 1. Illustration of three possible arrangements for measuring intensity (count number) correlations in split beams. Left: Vacuum→Metal→Dielectric (“V→M→D scattering”); ordinary beam splitter situation. Center: “D→M→V scattering”; ATR situation (the suppressed reflection and the generated and decaying SPOs are symbolized by a vertical black arrow and a red rectangle, respectively). Note, that, depending on the angle of incidence, the reflected signal need not necessarily be exactly zero. Right: The excitation is same as in the center figure, but now the light stemming from the SPO (dotted blue arrow) is split by a second (ordinary) beam splitter, and the counters are at the opposite side of this beam splitter. Various other arrangements for the excitation, detectors and sampling are possible. E.g., besides laterally shifting one of the detectors, one can shift them longitudinally and measure the autocorrelation function of the beam in one of the arms.

Both the conversion of the incoming photons to SPOs [1] and the decay process [2], or simply the interaction of photons with the free electrons [3] can cause non-classical effects. In the present work we attempt to estimate, how these effects may manifest themselves in Hanbury Brown and Twiss type correlations “mediated by surface plasmon oscillations”.

References