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Fluorescent Enhancement in the Frame of Double Plasmon Resonance Investigation via the Discrete Sources Method

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The Extreme Scattering Effect (ESE) consists in a sharp increase of the scattered intensity behind a thin noble metal film deposited upon a glass prism with an irregularity located near the film [1]. This plasmonic effect has some specific features distinguishing it from the conventional plasmon resonance which occurs in frequency domain:

- ESE appears in the evanescent wave area when the incident angle exceeds the total internal reflection angle;
- It consists in a sharp increase (several orders of magnitude) of the scattered intensity both transmitted through the film and reflected back to the glass prism;
- It stays stable with respect to variation of the film thickness, irregularity material, its dimension and shape.

It has been found that the intensity of ESE can be enhanced additionally by three orders via variation of the particle shape and its height over the film [2]. To analyze an interaction of the plasmonic structure described above and a fluorescent molecule located nearby, the process of molecular fluorescence is simply divided into two stages: excitation stage and emission stage. The classical Maxwell's theory is employed for the analysis of each of the stages. Both stages are analyzed by using the Discrete Sources Method (DSM) [1-2].

The advantage of DSM is that it is a semi-analytical surface based meshless method and it does not require any integration procedure over an irregularity surface. In the frame of DSM the scattered field everywhere outside local irregularity is constructed as a finite linear combination of the fields resulting from multipoles distributed inside the irregularity. Besides the DSM scheme enables to estimate errors of the approximate solution by checking the surface residual at the surface of irregularity tracking the real convergence of the approximate solution [1].

In the presentation we will show how to optimize the effective enhancement factor corresponding to a fluorescent molecule located in the gap between plasmonic particle and noble metal film.

References:

1. Eremin Yu., Wriedt T. Analysis of scattered field enhancement in the evanescent wave area based on the Discrete Sources Method. *JQSRT,* **146**, 235-243 (2014).
2. Eremin Yu., Sveshnikov A.G. Double Plasmon Resonance in the Field of Evanescent Waves. *Doklady Mathematics*, **89**, 1, 119–123 (2014).