Local modes in structures with multicomponent plasma

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There exists a tight analogy between electron and plasmon spectra of crystals in the sense of influence of geometric defects. For example, a free surface results in formation of the Tamm states for electrons and the surface plasmon (“sqrt 2 – mode”) provided mobile carriers in the bulk are available. If the Tamm band is not fully occupied a two-component plasma system arises that contains 2D and 3D plasmas. Yet another example of such a symbiosis of 2D and 3D plasmas is topological insulator with doping in the bulk.

In the first part of the present talk surface plasma oscillations are considered in such “2D + 3D” structure. It is shown that three regions of the dispersion law exist (with allowing for the retardation effects): linear dependence of plasmon frequency on the wave vector **k** for very small **k**, nearly linear dispersion for intermediate values of the wave vector (these two regions correspond to polaritons) and the third region (large **k**) gives the “shifted” 2D plasmon : const + sqrt **k**.

The second part deals with multilayer and lateral superlattices (SL) having one defective element meaning by that one layer or one quantum wire (for the case of lateral superlattice) with different value of the effective mass or electron concentration. This problem allows exact analytical solution with the aid of generating function for electrostatic potentials in the layers of multilayer SL or in the quantum wires of a lateral SL. As one could expect the local mode exists above the top of the plasmon band only if the carrier concentration in the defective layer exceeds the concentration in the regular layers. Its frequency is given by a simple analytical expression for multilayer SL whereas for lateral SL of quantum wires the local mode frequency is defined by a transcendental equation derived in the present work.