THERMODYNAMICS OF GASEOUS PLASMA IN VACUUM LIMIT. ON THE WAY TO SOLVING A HALF-CENTURY PROBLEM

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Remarkable limiting structure of gaseous plasma thermodynamic functions is under consideration in the special joint limit of low temperature and low density (T-0; n-0; mu-el=const) The prominent low-temperature tendency, which was claimed many years ago [1], is carried to extreme. All thermodynamic quantities, when their special forms being exposed, vs. chemical potential, mu-el, (as a principal ruling parameter), obtain an outstanding extra-simple form in the limit discussed. Two Equations of State: thermal (PV/RT) and caloric (U -3/2PV) obtain almost identical stepped structure ("ionization stairs"). In the same limit the differential thermodynamic quantities (heat capacity, compressibility etc.) degenerate into the set of positive or negative delta-like peaks ("thermodynamic spectrum"). It should be stressed that the binding energies of all possible stable complexes (atomic, molecular and ionic) in its ground state are the only quantities that manifest itself in meaningful details of this limiting picture: such as the value of each "stair" or the mu-el-location of each "line".

The limiting stepped structure of gaseous zero-Kelvin isotherm is generic prototype of well-known "shell oscillations" in EOS of gaseous plasmas at low, but finite temperatures. It seems to be more important that this limiting form of plasma thermodynamics could be (and should be) used as the most adequate basis for rigorous deduction of well-known quasi-chemical approach ("chemical picture") in frames of systematic asymptotic expansion on the base of "physical picture" (system of bare nuclei and electrons). Principal feature of the approach proposed ought to be emphasized: in contrast to the traditional approach when the activity is the principal ("small") asymptotic parameter of developed expansion, while the temperature being a secondary fixed parameter only, the presently discussed approach seek proper systematic expansion in the limit T=0 on the set of temperature asymptotic functions ... around the discussed "ionization stairs" as a reference system (zero approximation: T = 0).