A statistical field theory approach applied to the liquid vapor interface

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During the recent years, there has been a renewed interest in the utilization of statistical field theory methods to the description of systems at equilibrium both in the vicinity and away from critical points, in particular in the field of liquid state physics. These works deal in general with homogeneous systems, although recently the study of liquids in the vicinity of hard walls has been considered in this way. On the other hand, effective hamiltonian pertaining to the ϕ^4 theory family have been written and extensively used for the description of inhomogeneous systems either at the simple interface between equilibrium phases or for the description of wetting. In the present work, we focus on the field theory description of the liquid vapor interface of simple fluids. We start from the representation of the grand partition function obtained from the Hubbard-Stratonovich tranform leading to an exact formulation of the problem, namely neither introducing an effective hamiltonian nor associating the field to the one-body density of the liquid. Using as a reference system the hard sphere fluid and imposing the coexistence condition, the expansion of the hamiltonian obtained yields a usual ϕ^4 theory without unknown parameter. An important point is that the so-called capillary wave theory appears as a natural approximation of the one-loop level in the functional expansion of the hamiltonian, without any reference to the underlying phenomenology. Further possible developments will be discussed.