that the above theory can be reduced to a free field one. In this case one can verifies by the explicit calculation that there are no other singular contributions to the stress tensor and, therefore, the cancellation of the discussed singularity does not arise. So it appears impossible to construct the multi-loop integration measures, which would be consistent with the requirement of the modular invariance. Therefore, it appears impossible to construct multi-loop amplitudes. This statement concerns the continual theory [3], but not the results obtained by continual limit of matrix models because it is not clear what is a continual theory, which the above results correspond to.

REFERENCES

1. *Polyakov A.M.* //Phys.Lett., 1981. **103B**. 207.
2. *Knizhnik V., Polyakov A., Zamolodchikov A.* //Mod.Phys.Lett., 1988. **A3**. 819.
3. *David F.* //Mod.Phys.Lett., 1988. **A3**. 1651;
   J.Distler J., Kawai H. //Nucl.Phys., 1989. **B321**. 509.
4. *Gupta A., Trivedi S.P., Wise M.B.* //Nucl.Phys., 1990. **B340**. 475.
5. *Danilov G.S.* //Phys.Lett., 1995. **B342**. 73; //Jadernaja Fizika, 1995. **58**. 1904.
6. *Jaskosky Z., Meissner K.* //Nucl.Phys., 1994. **B428**. 331.

NEW APPROACH IN THE MICROSCOPIC FERMI SYSTEMS THEORY

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We present a review of new approach to the microscopic theory of Fermi systems. This approach is based on functional relations between the ground state energy of the system and its linear response function. We have derived an exact functional equation for the effective interaction between particles in medium in terms of the vacuum interaction potential. We have shown that this exact equation can be transformed into a chain of coupled integral equations for the interaction itself and its variational derivatives which is equivalent to an analogous set of coupled equations of the $\exp(-S)$-theory or a system of equations of the Green function approach. We have described a mathematical procedure of solving the equation obtained which includes the calculation of the variational derivatives of the response functions and the Green functions with respect to the density.

The considered approach is closely related to the well-known density functional theory which is based on the remarkable theorem proved by Hohenberg and Kohn, stating that the ground state energy of a many-body system located in an external field is a unique functional of the particle density. In order to apply the Hohenberg-Kohn theorem, one must be able to construct the density functional. Unfortunately, the Hohenberg-Kohn theorem only states the existence of the functional, and so far the density functional theory is unable to derive by itself its key notion — the functional of the density. The considered approach

suggests an alternative method to attack on this main problem, producing an exact set of functional equations which determine the self-consistent single particle potential, the effective interaction between Kohn-Sham quasiparticles, the linear response function and the ground state energy in terms of the bare particle-particle interaction. The availability of the exact equations for the effective interaction and the single particle potential, being a functional of the density, and the developed technique for the calculation of the variational derivatives with respect to the density settle the question of constructing the density functional in principle. So, our approach makes it possible to develop a unified theory of the ground state properties, including phase transitions, and dynamic properties such as the collective and single particle spectra.

We considered an approximate procedure-so called local approximation- of the evaluation of the variational derivatives which permits to reduce the functional equation for the effective interaction to a chain of integro-differential equations, retaining the compressibility self-consistent relation which as a rule does not hold in the other methods. Having in hand the effective interaction, we have constructed the linear response function and calculated the ground state energy and the excitation spectra of the system.

The local approximation is a key element of the mathematical procedure which in the case of a homogeneous system enables one to convert the functional equation to the chain of integro-differential equations. There has been given a body of compelling examples of the capacity of these equations. To this end, we have considered homogeneous electron gas and neutron matter, the Lipkin model and the nuclear matter with a model interaction. As a result, we were able to obtain the approximate analytic expression for the effective interaction in electron gas which fit to describe the correlation energy in a wide range of the density variation much better than the well known RPA. Using the model nuclear matter, we have given the example of the self-consistent description of the liquid-gas phase transition. The application of the approach to the Lipkin model has demonstrated that this approach is highly accurate in describing the ground state energy and the excitation spectra of the simple systems with spin-dependent forces, including the vicinity of the phase transition point where spontaneous breaking of symmetry occurs.

The extension of the formalism to non-uniform and finite systems such as multi-electron atoms allowing for a new treatment of the density functional theory is performed. Having studied finite electron system, we constructed the exact exchange-only potential. An analytical expression for the effective electron-electron interaction is derived. This interaction is of finite radius and density dependent. An analytical expression is also derived for the effective single-particle potential and an equation is presented for the linear response function of the considered system. Thus it is demonstrated that the spectrum, photoeffect and electron scattering cross section for such a system can be calculated by solving a complete system of equations.

The approach is also adaptable to treating the single particle excitation spectra of a system. In the framework of this approach the equations for calculations of the effective mass and the single particle spectrum were derived. Studying the single particle spectrum within our approach, we were led to a conclusion that a new phenomenon, the fermion condensation, can manifest itself in Fermi systems with strongly repulsive interaction. This phenomenon is shown to occur when the necessary stability condition of the normal ground state is violated and the rearrangement of the Fermi occupation numbers occurs. We have discussed the possibility of a new phase transition giving rise to a new class of normal Fermi

liquids with the topological charge differing from that which is inherent in ordinary Fermi liquid. We have analyzed few remarkable features of such systems. Among them: i) presence of two subsystems one of which named the condensate contains the macroscopic number of quasiparticles with the same single-particle energies $\varepsilon(\mathbf{p}) = \mu$ but with the different momenta p, ii) change of the structure of the single particle Green functions which reveals itself in vanishing the jump in the momentum distribution of particles at the point $p = p_F$, iii) nonregular behavior of the density of states $\rho(\varepsilon)$ near the phase transition point, iv) the absence of BSC-exponential smallness of the gap Δ in the single particle excitation spectrum of the superfluid system with the fermion condensate.

REFERENCE

Khodel V.A., Shaginyan V.R., Khodel V.V. //Phys.Rep., 1994. **249**. 1.

A SYSTEMATIC CONTRIBUTION TO THE BINDING ENERGY OF NUCLEI

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The Okamoto–Nolen–Schiffer anomaly in the binding energy differences of mirror nuclei [1] has attracted much interest during the last 3 decades. Most of the earlier attempts of resolving the anomaly addressed many–body effects suspected of being at the root of the problem. During the last years the efforts have shifted towards trying to explain the magnitude of the anomaly in terms of the Charge Symmetry Breaking (CSB) nuclear forces. A correction arising from CBS forces, taken within the usual perturbative estimate, has a volume character and its main term should be proportional to the number of protons (or neutrons). The correction we are discussing here has a completely different mass dependence and is proportional to the nuclear surface, i.e. in case of the Coulomb interaction is $\propto Z^{2/3}$. We show that there is a systematic many–body mechanism, which enhances the contribution due to the Coulomb interaction in particular, and which is based on the common feature of a self-sustaining system, the presence of the surface [2].

The ground state energy E of nucleus can be written in terms of the density functional approach as follows

$$E = F_0[\rho_p(\mathbf{r}), \rho_n(\mathbf{r})] + F_c[\rho_p(\mathbf{r}), \rho_n(\mathbf{r})]. \tag{5}$$

Here F_0 is the main part of the functional related to isospin symmetry conserved forces dependent symmetrically on the densities ρ_p, ρ_n, while F_c is due to CSB forces, i.e., to the Coulomb interaction in our case, the densities $\rho_p(\mathbf{r})$, $\rho_n(\mathbf{r})$ are the single particles densities of neutrons and protons, respectively. The well-known Skyrme functional can be considered as a possible realization of F_0, and F_c is given by

$$F_c[\rho_p(\mathbf{r})] = \frac{e^2}{2} \int \rho_p(\mathbf{r}_1)\rho_p(\mathbf{r}_2)\frac{1}{|\mathbf{r}_1 - \mathbf{r}_2|}\, d\mathbf{r}_1 d\mathbf{r}_2 \tag{6}$$