Contribution ID: **39** Type: **Poster report**

STRUCTURE FUNCTIONS GENERATED BY ZERO SOUND EXCITATIONS

Tuesday, 13 October 2020 19:15 (20 minutes)

We study the form of the structure functions connected to the zero sound excitations in the symmetric and asymmetric nuclear matter (ANM). The density response $\Pi(\omega,k)$ (the retarded polarization operator) of ANM to the small external field $V_0(\omega,k)=\tau_z e^{i\vec{q}\vec{r}-i(\omega+i\eta)t}$ is considered. The structure function $S(\omega,k)$ is defined as $S(\omega,k)=-\frac{1}{\pi}\mathrm{Im}\,\Pi(\omega,k)$ [1].

In [2] the three complex branches of the zero sound excitations in ANM were obtained: $\omega_{si}(k)$, $i=n,p,np$. We calculate these branches as solutions of the dispersion equation $E(\omega,k)=0$. Calculations were made in the framework of RPA with the Landau-Migdal quasiparticle-quasihole isovector interaction $F'(\vec{\tau},\vec{\tau}')$ with $F'=1.0$.

It was shown that in the external field $V_0(\omega,k)$ the total polarization operator is the sum [3]: $\Pi=\Pi^{pp}+\Pi^{nn}-\Pi^{pn}-\Pi^{np}$. Expressions for $\Pi^{\tau,\tau'}$ are obtained from the system of equations M of the type similar to the system for the effective fields in [4]: $\Pi^{pp}=\Pi_0^p(1-\Pi_0^n\,F^{nn})/\det M(\omega,k)\equiv D^{pp}/\det M(\omega,k)$, $\Pi^{np}=\Pi_0^p\,\Pi_0^n\,F^{np}/\det M(\omega,k)\equiv D^{np}/\det M(\omega,k)$. Changing $p\leftrightarrow n$ we obtain Π^{nn}, Π^{pn}. Dispersion equation for the frequencies of zero sound excitations is $E(\omega,k)\equiv\det M(\omega,k)=0$. So, the branches $\omega_{si}(k)$ are the zeros of $\det M$ and the poles of $\Pi^{\tau,\tau'}$ by construction.

In our approach $S(\omega,k)$ must be considered as a sum over three independent processes: the widths of the different $\omega_{si}(k)$ correspond to the different decays of excitations. The imaginary part of $\omega_{sn}(k)$ describes in nuclei the semidirect decay due to emission of a neutron, reaction (γ,n). Decay of $\omega_{sp}(k)$ accompanied by emission of proton. About of $\omega_{snp}(k)$ we can say that one nucleon is emitted and its isospin is not fixed [2]. We rewrite $S(\omega,k)=\Sigma_i S_i(\omega,k)$.

Near the pole at $\omega\approx\mathrm{Re}(\omega_{si})$ we approximate $(\det M(\omega,k))^{-1}=R^i(\omega_{si},k)/(\omega-\omega_{si})+Reg(\omega,k)$. Here $Reg(\omega,k)$ is a smooth function near the pole. This permits us to write
$S(\omega,k)_i=-\frac{1}{\pi}\mathrm{Im}[\Sigma_{\tau,\tau'}(D^{\tau\tau'}(\omega,k))\,R^i(\omega_{si},k)/(\omega-\omega_{si})+Reg]$. Then, let define the envelope curve of the pole terms $S^e(\omega,k)=-\frac{1}{\pi}\Sigma_{\tau,\tau'}\mathrm{Im}[D^{\tau,\tau'}(\omega,k)\Sigma_i\,R^i(\omega_{si},k)/(\omega-\omega_{si})]$.

We demonstrate results for ANM with asymmetry parameter $\beta=0.2$ Fig.1. In the left figure the branches $\omega_{sn}(k)$, $i=n,p,np$ are shown [2]. In the right figure $S^e(\omega,k)$ are presented for $k/p_0=0.6$ and $k/p_0=0.2$ ($p_0=0.268$GeV). For $k/p_0=0.6$ the structure functions for the different processes $S_i(\omega,k)$, $i=n,p,np$ are presented (the numbers $1,2,3$, correspondingly). As it was expected the form of the structure function is decomposed over the contributions of the definite processes, corresponding to $\omega_{si}(k)$. The widths of maxima ($right$) are determined by the imaginary parts of ω_{si} ($left$).

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Session Classification: Poster session 1 (part 1)

Track Classification: Section 1. Experimental and theoretical studies of the properties of atomic nuclei.