The Relativistic Random Phase Approximation and Applications for Nuclei with Large Neutron Excess ◇

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Relativistic Mean Field Theory (RMFT) plays an important role in the microscopic description of nuclei far from stability. Most of these applications are based on the static relativistic Hartree approximation, which has been applied with great success for the description of ground state properties of such nuclei. In order to discuss excited states such as collective modes a dynamical description is necessary. We discuss here the Relativistic Random Phase Approximation (RRPA). It is derived from the Time-dependent Relativistic Mean Field (TD RMF) theory in the limit of small amplitude oscillations. In the *no-sea* approximation of RMF theory, the RRPA configuration space includes not only the usual particle-hole ph-states, but also αh-configurations, i.e. pairs formed from occupied states in the Fermi sea and empty negative-energy states in the Dirac sea. The contribution of the negative energy states to the RRPA matrices is examined in a schematic model, and the large effect of Dirac sea states on isoscalar strength distributions is illustrated for the giant monopole resonance in ^{116}Sn. It is shown that, because the matrix elements of the time-like component of the vector meson fields which couple the αh-configurations with the ph-configurations are strongly reduced with respect to the corresponding matrix elements of the isoscalar scalar meson field, the inclusion of states with unperturbed energies more than 1.2 GeV below the Fermi energy has a pronounced effect on giant resonances with excitation energies in the MeV region. The influence of nuclear magnetism, i.e. the effect of the spatial components of the vector fields is examined. As an application the theory is used to describe low-lying collective dipole strength in nuclei with large neutron excess and new modes of toroidal character in the isoscalar dipole channel.

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