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Investigation of superconducting-ferromagnetic heterostructures by polarized neutron reflectometry with secondary radiation registration

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Nowadays studying of proximity effects at the interface between two media are in focus of view [1-5]. In particular it relates to the interface between superconductor and ferromagnet. The work [3] can be can demonstrate as representative experiment, where diamagnetism of the [Nb(25nm)/Gd(d_f)]$_{12}$ periodic heterostructure was observed. The magnetic field was displaced from the volume of a superconducting-ferromagnetic structure, and the superconducting layers were paired through the ferromagnetic layers. The prospects of using rare earth metals and, in particular, gadolinium, in such structures were demonstrated. Current work is dedicated to investigation of electromagnetic proximity effect [6] at the structures Nb(100nm)/Gd(d_f)/V(70nm). A new experimental approach is used.

Due to the mutual influence of ferromagnetism and superconductivity, because of the finite values of the coherence lengths, a significant modification of the magnetic and superconducting properties occurs. It appears, in particular, as changing of magnetization's spatial distribution. It is important to establish the correspondence of the magnetic spatial profile (spatial dependence of magnetization) to the nuclear spatial profiles of the elements of the contacting media. To determine the spatial magnetic profile, the standard method of reflectometry of polarized neutrons is used, which makes it possible to determine the energy of the potential interaction of a neutron with a medium. At the interface between two media, the interaction potential is the sum of the interaction potentials of elements penetrating each other. Standard neutron reflectometry does not make it possible to establish which elements are associated with changes in the interaction potential and, in particular, in the magnetic profile. To determine the profile of the interaction potential of a neutron with individual elements, it is necessary to register the secondary radiation of the elements. At the moment, channels for recording charged particles [7], gamma quanta and spin-flip neutrons [8] have been implemented at the REMUR spectrometer of the IBR-2 reactor in Dubna. Several tens of isotopes and magnetic elements are available for measurements.

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