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MEASUREMENT OF THE SPIN-WAVE STIFFNESS AND THE ENERGY GAP IN THE MAGNON SPECTRUM OF AMORPHOUS FERROMAGNETS BY SMALL-ANGLE SCATTERING OF POLARIZED NEUTRONS

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Amorphous magnetic materials are of considerable interest, both from a fundamental and applied point of view. The low coercive field in an amorphous magnet is an important property for its application as a core material in electrical transformers. The structural and magnetic properties of amorphous magnetic systems can be quite complex. The presence of structural as well as magnetic disorder plays an important role in amorphous systems. However, understanding the formation and growth of spin clusters in amorphous systems is a difficult task, as they properties depend on their morphology under the influence of an external magnetic field. The properties of spin clusters in an amorphous system under the influence of an external magnetic field depend on their morphology. Therefore, from the magnetism point of view, interesting aspects are: (1) correlation between structural and magnetic properties; (2) understanding the behavior of spin clusters and (3) investigation of collective magnetic excitations in such systems.
This work presents studies of magnetic excitations of amorphous ferromagnetic FeNi alloys by small-angle scattering of polarized neutrons. It is widely known that the most direct method of studying magnetic excitations is neutron three-axis or time-of-flight spectroscopy. These methods have a limited range of applicability at small momentum transfer, where magnetic scattering from the amorphous materials is concentrated. Hence, the technique of small-angle scattering of polarized neutrons in inclined geometry was proposed and implemented at the Petersburg Institute of Nuclear Physics in the mid-eighties [1]. By measuring the difference in the dependence of scattering intensities at different initial polarization of the neutron beam on the momentum transfer, it is possible to register scattering by spin waves only. In this case, a chiral scattering channel of polarized neutrons results in the asymmetry of the scattering intensity and manifests itself best when an external magnetic field is applied at an angle of 45° [2]. In this case, it turns out that the scattering by spin waves is concentrated in a cone bounded by the cut-off angle θc, that is directly related to the spin wave stiffness. Thus, by obtaining the dependence of the cut-off angle on the applied magnetic field or on the wavelength of neutrons, it is possible to measure the energy gap in the spin wave dispersion.
In this work, we conduct the polarized neutron scattering study on spin waves in amorphous FeNi alloys using the SANS-1 instrument. It is shown that the quadratic spin wave dispersion is gapped: $\varepsilon = Aq^2 + g\mu BH + Eg$. The presence of field independent gap in the spectrum of amorphous ferromagnets has already been previously detected in amorphous microconducts of the compound Fe77.5 Si5.5 B15 [3]. In this report, we will discuss details of the measuring protocol and difficulties encountered in detection of the energy gap using this method.

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