Solitons and Spin Waves in Spiral Structures

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Theoretical study of collective excitations in the considerably nonlinear periodic magnetic structures represents complicated and still little-known problem. In this case equations of magnetism can be solved only by the special integration techniques.

We have found exact solutions for localized excitations in helicoid (stripe domain) structures in the framework of sine-Gordon model by the "dressing" technique on a torus. In the physically justified approximations, sine-Gordon equation describes nonlinear dynamics of ferro- and antiferromagnets with the dominant "light-plane" and residual basic-plane anisotropy as well as the magnets without center of inversion with helicoid magnetic ordering.

On the basic of this model, new solitons in spiral structures are analytically described [1,2]. Formation and motion of these solitons, unlike the spin wave, are always accompanied by the local translation of spiral (stripe domain) structure. Such macroscopic shifts of helicoid structure can be observed by magneto-optical techniques. It is shown, that the frequencies of internal oscillations of breathers in spiral structure lie lower than the frequency spectrum of standing spin waves in helicoid structure. Then, the breathers can be detected by the absorption of microwave power.

In addition to the particle-like solitons, dispersing spin-wave packets can be formed in spiral structures. Complete energy spectrum for collective excitations in spiral structure, including solitons and spin waves, is found. Analytic description of nonlinear dynamics of solitons and spin wave in spiral structure is reduced to solution of linear integral equations on a Riemann's surface, related with structure.

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References

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