waveguides) is actively studied. This is due to the possible manifestation in the electrodynamics of the Hartman effect known from quantum mechanics: the tunneling time for a quantum particle is independent of the thickness of the opaque barrier. In the radio wave range, the natural medium that allows modeling this effect is gas discharge plasma, since its permittivity can take negative values. In this work, we performed theoretical estimations of the tunneling time of nanosecond microwave pulse through plasma layer taking into account the electron collision frequency. We used the two approaches to extract the propagation time from our calculations – (i) the time estimated via the pulse center of gravity and (ii) the phase (Wigner) time. We showed that these approaches mostly agree with each other and demonstrate some characteristic features below the plasma frequency. Finally, for experimental verification of the obtained dependencies, we propose the scheme based on nanosecond microwave pulse tunneling through the plasma electromagnetic band gap structure formed by gas discharge plasmas placed in microwave waveguide, in which changing the electronic concentration allows us to switch between the regimes above and below the effective plasma frequency.

Vector magnetometry implemented using 14NV-13C hybrid spin systems in nanodiamonds

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In the modern world, quantum technologies are being actively developed. One of them is quantum magnetometry, in which single nitrogen-vacancy centers (NV centers) in diamond are used as sensors for measuring magnetic fields with nanometer spatial resolution [1]. However, due to the symmetry of the NV center, information about the azimuthal angle of the magnetic field vector is lost. Recently, a method of complete vector magnetometry was proposed [2,3], based on the analysis of experimental spectra of optically detected magnetic resonance (ODMR) of the system NV-13C, in which the electron spin of the NV center is coupled by hyperfine interaction (HFI) with the nuclear spin of 13C.

Here, we simulate ODMR spectra of 14NV-13C systems using HFI matrices calculated by quantum chemistry methods. It is shown that the simulation method ensures the implementation of vector magnetometry. A quantitative description of the ODMR spectra obtained with high spectral resolution in [2] for the 14NV-13C system, in which the 13C atom was the nearest neighbor of the vacancy, is performed. Similar predictive simulation of the ODMR spectra is performed for a number of other NV-13C systems.

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[2] Jiang F.-J. et al. Chin. Phys. B. – 2018. -Vol. 27. - P. 057602.
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Superferromagnetoresistors

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The strong ferromagnetic nanoparticles are analysed within the band structure based shell model [1] accounting for discrete quantum levels of conducting electrons. As is demonstrated such an approach allows to describe the observed superparamagnetic features of these nanocrystals. Assemblies of such superparamagnets incorporated into nonmagnetic insulator, semiconductor or metallic substrates are shown to display ferromagnetic coupling resulting in a superferromagnetic ordering at sufficiently dense packing. Properties of such metamaterials are investigated by making use of the randomly jumping interacting moments model accounting for quantum fluctuations induced by the discrete electronic levels and disorder. Employing the mean-field treatment for such superparamagnetic assemblies we obtain the magnetic state equation indicating conditions for an unstable behaviour. Respectively, magnetic spinodal regions and critical points occur on the magnetic phase diagram of such ensembles. The respective magnetodynamics exhibit jerky deportment expressed as erratic stochastic jumps in magnetic induction curves. At the critical points magnetodynamics display the features of self-organized criticality. Analyses of magnetic noise correlations are proposed as model-independent analytical tools employed in order to specify,