Spin noise spectroscopy (SNS) is a fairly new technique, so, I will first have to say what it is and why experimentalists enjoy it. The basic idea of SNS is simple: if Faraday rotation can feel magnetization of the medium, it can also feel its magnetization noise. Magnetization is a vector, so we can measure its noise along different directions. When measuring it in the direction normal to magnetic field (which is the most interesting), we will see in its spectrum a peak at Larmor frequency or, in other words, we will detect magnetic resonance spectrum of the system. Thus, one may consider SNS as a sort of spectroscopy of magnetic resonance (MR) with appropriate informative capabilities. The main specific properties of such spin-noise-based MR spectroscopy are that (i) the system is not perturbed (when measuring the Faraday rotation noise in the range of transparency), (ii) no population difference between magnetic sublevels of the system is needed, and (iii) the measurements imply high spatial resolution. This experimental approach was primarily proposed and realized on an atomic system in 1981 [1] and nowadays is widely used in studies of semiconductors including nanostructures and low-dimensional structures [2,3].

If we look at SNS as at a sort of optical spectroscopy, we will see a number of its new curious features mainly associated with spectral correlations of the Faraday-rotation noise [4]. The appropriate spectral correlation length, not revealed in conventional optical spectra, provides opportunity to reveal hidden structure of optical transitions and, in a certain sense, to substantially enhance spectral resolution of optical spectroscopy. The most spectacular and simple manifestation of these correlations is provided by optical spectra of spin noise of an isolated absorption band at different degree of inhomogeneous broadening (see the figure). With increasing contribution of inhomogeneous broadening ($\varepsilon$), the initial dip in the spectrum is getting shallower and then turns into a peak, thus providing opportunity to penetrate into ‘anatomy’ of the optical transition with simultaneous increase of sensitivity of the measurements.

There are other unique properties of optical spectroscopy of spin noise that make it close, in some respects, to nonlinear optical spectroscopy without invoking nonlinear optical susceptibility.

2. G.M.Muller, M.Oestreich, M.Romer, and J.Hubner, Physics E, 43, 569 (2010)