## 5. Conclusion

In this paper, we present, for the first time to the best of our knowledge, a consistent analysis of properties of the spin noise spectroscopy as compared with its physical counterpart – optical spectroscopy of Raman scattering. In fact, we compare spectroscopy of the light intensity with that of the light field as applied to the light scattering. In both cases, we detect the scattering-enhancement enrichment of the initially $\delta$-function-wise frequency spectrum, $\propto \delta(\omega - \omega_0)$ for the light field, or at $\propto \delta(\omega)$ for the light intensity. The aim of this work was to attract attention to the spin noise spectroscopy and to justify its remarkable informative capabilities, which may seem, at first glance, paradoxical: On the one hand, the SNS is considered to be just a version of spin-flip Raman spectroscopy and does not imply any optical nonlinearity of the medium, while, on the other, it offers abilities unusual for linear optics. In particular, the SNS signal proves to be dependent on the light power density, it allows one to resolve inner structure of inhomogeneously broadened spectra, and to realize an effective pump-probe spectroscopy with no optical nonlinearity. We show that these unique features of the SNS result, in fact, from linear relationship between the signal and spin fluctuation (in contrast to quadratic one for Raman spectroscopy), Eq. (14). This makes SNS sensitive to spatial and spectral correlations of the polarization noise and thus provides additional informative abilities inaccessible for conventional Raman spectroscopy and even for linear optics in general.

These specific properties of the spin noise spectroscopy are determined, in essence, by correlation nature of the light-intensity measurements, which provides the intensity signal with a fluctuating part having positive or negative sign. As a result, the two light-intensity signals may combine constructively or destructively exactly like it occurs with regular sign-alternating signals. Actually, a similar reason underlies specific properties of the conventional light-intensity-noise spectroscopy [26], which is known to be capable of getting very special information about the source of the field [35–38]. In the latter case, however, the light field under study is usually produced by a primary source, and information extracted from the correlation measurements is not related to inner structure of the self-luminous medium.

It is noteworthy that additional informative abilities of the spin noise spectroscopy technique should be revealed in other effects of inelastic light scattering and may be of interest for a wide range of applications.

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