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LETTERS TO EDITORS

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Necessary additions to the paper by Yu M Tsipenyuk [*Phys. Usp.* 55 796 (2012)] and to the review by B A Knyazev, V G Serbo [*Phys. Usp.* 61 449 (2018)]

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Abstract. This letter, which provides a more detailed description of zero-point vibrations and the Sadovskii effect, is an addition to the papers: Yu M Tsipenyuk "Zero point energy and zero point oscillations: how they are detected experimentally" *Phys. Usp.* 55 796 (2012) and B A Knyazev, V G Serbo "Beams of photons with nonzero projections of orbital angular momenta: new results" *Phys. Usp.* 61 449 (2018).

Keywords: isotope effect in solids, zero-point oscillations, Sadovskii effect

This letter should be considered only as an addition to the reviews published earlier [1, 2]. It is for this reason that the first part of my letter is related to the experimental observation of the isotope effect in the solid state and manifestations of zero-point oscillations. A significant amount of scientific literature has already been devoted to this subject; we only mention here two reviews published in world-known scientific journals [3, 4] that are needed for further presentation, but, unfortunately, have not been even mentioned by the author of Ref. [1].

A brief history of how zero-point oscillation energy as well as zero-point oscillations themselves have emerged in physics can be found in [5]. To be fair, we note here that these concepts were also presented in a fragmentary form by the author of [1]. Unfortunately, Ref. [1] considers mainly the isotope effect in molecules, where the isotopic shift of spectral lines is rather small.

The isotope effect has been studied in detail during the last four decades in the solid state and, in particular, in semiconductors [3, 4] in a wide range of temperatures (2–300 K). To fill that gap, Fig. 1 presents the luminescence spectra of LiD (Fig. 1a) and LiH (Fig. 1b) crystals, which exhibit a very large isotope effect, at 2K [4, 6]. These results clearly demonstrate the isotopic shift of a phononless line (103 meV) that, according to the present-day paradigm, is due to strong nuclear interaction (long-range magnetic-like interaction between neutrons and electrons).

It is adding that in the scientific literature it has long and repeatedly been noted (see, e.g., [3] and references therein) that the experimentally observed low-temperature deviation from the linear behavior of such solid state characteristics as the lattice constant, light refractive index, energy of the longitudinal optical phonon, interband transition energy, and exciton energy is due to zero-point oscillations. As an example Fig. 2 shows the temperature dependence of the lattice constant of silicon crystals according to the results of Ref. [3].

A low-temperature deviation from linear dependence that is related to zero-point oscillations is clearly seen. For the sake of completeness, we add that the stable ground state of the hydrogen atom is determined, according to Puthoff [7], by a balance between radiation of zero-point oscillations due to the electron accelerated in an orbit and absorption of similar radiation of zero-point oscillations of the electromagnetic field. And of course, according to modern quantum electrodynamics, the Casimir effect [5] is a direct manifestation of zero-point oscillations of electromagnetic field. In concluding this part of the letter, it should be noted that it is the

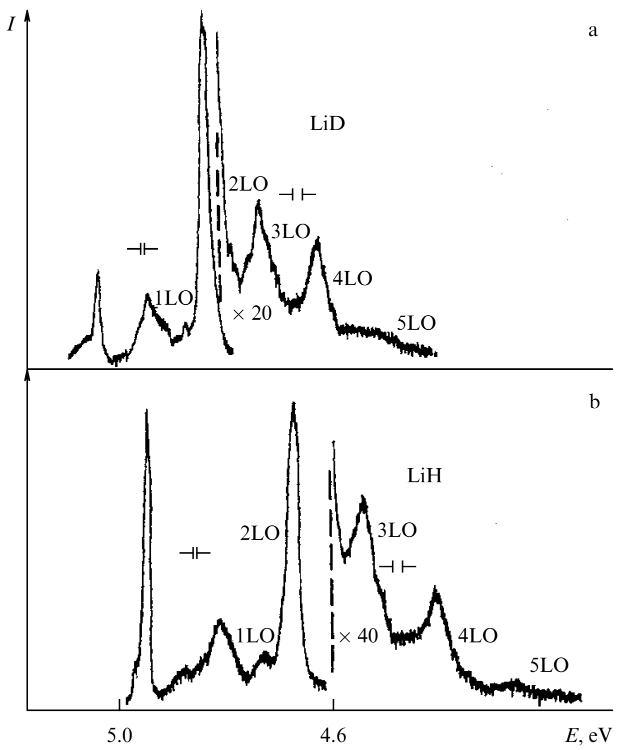

Figure 1. Luminescence spectra of LiD (a) and LiH (b) crystals cleaved in superfluid helium at 2K.

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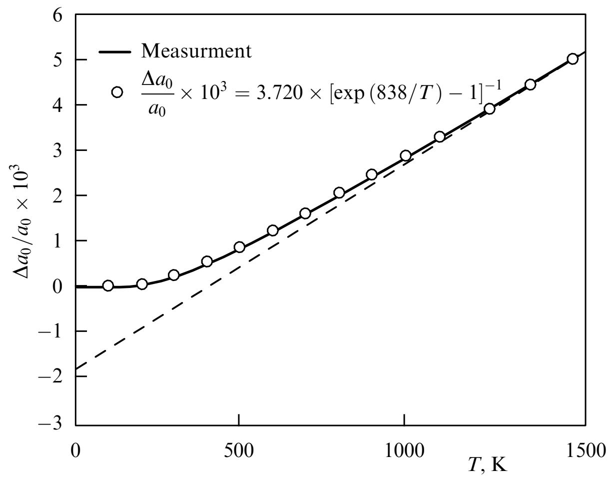

Figure 2. Temperature dependence of the lattice constant of silicon crystals (data from [3]).

measurement of the above solid state characteristics under isotopic substitution that allows measurement of the energy of zero-point oscillations.

Now let us briefly discuss another important and necessary addition to review [2]: the Sadovskii effect [8], which has not been mentioned. The mechanical effect of light on bodies is described in the review in the following way: "This circumstance was mentioned as early as in Pointing's paper [1] issued in 1909." Unfortunately, the authors of the report are unaware of the Sadovskii effect that was discovered ten years earlier than Pointing's study. This is rather strange, since the authors refer to the experimental study [9] where the Sadovskii effect is mentioned first in the list of references. Such reading of the cited papers looks strange. It looks even stranger since a description of the Sadovskii effect may be found in any physical encyclopedia: "an elliptically polarized light wave carries an angular momentum (moment of momentum) that is transferred to the body that absorbs the wave or changes its polarization state...." [10]. In my opinion, Russian physicists deserve a more respectful attitude.

Editorial office's addendum

The authors of review [2] were made aware of V G Plekhanov's letter to the editorial office and submitted the following response:

"Dear editorial office,

We agree with V G Plekhanov's comment that Sadovskii noted that spin moment may be transformed into mechanical moment several years earlier than Pointing (see [11, 12]).

Faithfully yours,

B A Knyazev, V G Serbo."

The author of [1], Yurii Mikhailovich Tsipenyuk (12.04.1938–29.03.2018), was not made aware of V G Plekhanov's letter because of his death.

References

1. Tsipenyuk Yu M "Zero point energy and zero point oscillations: how they are detected experimentally" *Phys. Usp.* **55** 796 (2012); "Nulevaya energiya i nulevye kolebaniya: kak oni obnaruzhivayutsya eksperimental'no" *Usp. Fiz. Nauk* **182** 855 (2012)
2. Knyazev B A, Serbo V G "Beams of photons with nonzero projections of orbital angular momenta: new results" *Phys. Usp.* **61** 449 (2018); "Puchki fotonov s nenulevoi proektsiei orbital'nogo momenta impul'sa: novye rezul'taty" *Usp. Fiz. Nauk* **188** 508 (2018)
3. Cardona M, Thewalt M L W "Isotope effects on the optical spectra of semiconductors" *Rev. Mod. Phys.* **77** 1173 (2005)
4. Plekhanov V G "Elementary excitations in isotope — mixed crystals" *Phys. Rep.* **410** 1 (2005)
5. Rechenberg H "Historical remark on zero-point energy and the Casimir effect", in *The Casimir Effect 50 Years Later. Proc. of the Fourth Workshop on Quantum Field Theory Under the Influence of External Conditions* (Ed. M Bordag) (Singapore: World Scientific, 1999) pp. 10 – 19
6. Plekhanov V G "Macroscopic manifestation of the strong nuclear interaction in the optical spectra of solids", in *Proc. of the 25th Intern. Seminar on Interaction of Neutrons with Nuclei: Fundamental Interactions and Neutrons, Nuclear Structure, Ultracold Neutrons, Related Topics, ISINN-25, Dubna, Russia, May 22 – 26, 2017* (Dubna: JINR, 2018) p. 49
7. Puthoff H E "Ground state of hydrogen as a zero-point-fluctuation – determined state" *Phys. Rev. D* **35** 3266 (1987)
8. Sadovskii A I *Zh. Russk. Fiz.-Khim. Obshch.* **29** 82 (1897); "Ponderomotornye deistviya elektromagnitnykh i svetovykh voln na kristally" ("Pondemotor actions of electromagnetic and light waves on crystals") *Uchenye Zapiski Imperatorskogo Yur'evskogo Univ.* **7** 55 (1899); *Uchenye Zapiski Imperatorskogo Yur'evskogo Univ.* **8** 1 (1900)
9. Beth R A *Phys. Rev.* **15** 115 (1936)
10. Prokhorov A M (Ed.-in-Chief) *Fizicheskii Entsiklopedicheskii Slovar'* (Physical Dictionary) (Moscow: Sovetskaya Entsiklopediya, 1983) p. 651
11. Prokhorov A M (Ed.-in-Chief) *Fizicheskaya Entsiklopediya* (Physical Encyclopedia) (Moscow: Bol'shaya Rossiiskaya Entsiklopediya, 1994) p. 405
12. Sokolov I V "The angular momentum of an electromagnetic wave, the Sadovskii effect, and the generation of magnetic fields in a plasma" *Sov. Phys. Usp.* **34** 925 (1991); "Moment impul'sa elektromagnitnoi volny, effekt Sadovskogo i generatsiya magnitnykh polei v plazme" *Usp. Fiz. Nauk* **161** (10) 175 (1991)