

NONLINEAR OPTICAL PHENOMENA

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Fifty years of nonlinear laser optics

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The issue in your hands is devoted to the event widely celebrated by the international scientific community: the fiftieth anniversary of nonlinear laser optics, a branch of optics that includes 'the study and application of phenomena related to a nonlinear response of matter to optical fields' [1]. It follows from the definition in Ref. [1] however that nonlinear optics originates from the pre-laser era. As early as 1926, working at the Department of Physics, M.V. Lomonosov Moscow State University, S.I. Vavilov and V.L. Levshin detected light absorption saturation in uranium glasses. Later, weak luminescence depolarisation nonlinearity and photoinduced absorption dichroism were discovered. Those studies had a pioneering character, but they were initiated in the years when physics had very modest experimental facilities. Vavilov's important role in the advent and subsequent development of nonlinear optics was repeatedly emphasised by Academician Khokhlov [2]: 'It is well known that S.I. Vavilov was the father of nonlinear optics. His work in this area was begun long before the advent of lasers. The first nonlinear effect – light absorption saturation in uranium glasses – was discovered by Vavilov and Levshin in 1926 .' Moreover, the term 'nonlinear optics' was coined by Vavilov.

Just after the advent of lasers, there was literally an avalanche of new results in nonlinear optics. The fifty-year history of advances in nonlinear laser optics demonstrates that harmonic generation, frequency mixing, and self-action of optical waves are only a few in the long list of conceivable nonlinear effects: the world of nonlinear phenomena is richer, more diverse and, most importantly, finer and much more interesting than the 'linear' world. Nonlinear optics has now become an all-pervading science. Nonlinear optical phenomena are behind the many approaches and instruments for investigation and sensing in a great diversity of areas of physics and technology, as well as in biology, medicine, chemistry, and mineralogy. Fundamentally new possibilities have been offered by nonlinear optics for spectroscopic characterisation of substances. Every year, prestigious scientific journals publish thousands of reports concerned with priority issues in nonlinear optics and spectroscopy. Nonlinear optics is the subject of tens of excellent books written in various languages by outstanding scientists. The first of these books, *Problems in Nonlinear Optics* by S.A. Akhmanov and R.V. Khokhlov, was published in 1964. In many universities around the world, students are offered courses in nonlinear optics and related issues of nonlinear spectroscopy and laser physics. A number of universities have a Department of Nonlinear Optics. The first publications have now emerged that deal with the history of nonlinear optics [3–5]. In response to a query for nonlinear optics, harmonic generation or parametric oscillator, Google and other search engines list hundreds of thousands of web pages. Since 1965, national and international conferences on coherent and nonlinear optics (ICONO) have been held as a key professional forum for fundamental laser physics and nonlinear optics in the Eurasian continent. The main organisers of these events are M.V. Lomonosov Moscow State University (MSU) and the Russian Academy of Sciences (RAS). CLEO, IQEC, Laser Physics Workshop, ALT, MPLP and many other conferences have a Nonlinear Optics section.

It is pleasant to note the significant contribution of Russian scientists to the advent and development of nonlinear optics. Special mention should be given to the research performed at the P.N. Lebedev Physics Institute, RAS; MSU; S.I. Vavilov State Optical Institute; Institute of Applied Physics, RAS; Institute of Spectroscopy, RAS; and Institute of Laser Physics, RAS. A number of Russian scientists received state awards for their work in the field of nonlinear optics and spectroscopy: G.A. Askaryan, S.A. Akhmanov, V.V. Korobkin, V.S. Letokhov, V.N. Lugovoi, N.F. Pilipetskii, A.P. Sukhorukov, V.I. Talanov, R.V. Khokhlov and V.P. Chebotaev were awarded Lenin Prizes, and O.A. Aktsipetrov, P.A. Apanasevich, V.Yu. Aristov, B.V. Bokut', M.S. Brodin, V.D. Volosov, E.S. Voronin, Yu.N. Denisyuk, V.G. Dmitriev, B.Ya. Zel'dovich, I.G. Zubarev, E.V. Ivakin, Yu.A. Ul'inskii, A.M. Ionov, P.K. Kashkarov, D.N. Klyshko, A.I. Kovrigin, A.A. Kulevskii, V.G. Lifshits, I.N. Matveev, O.Yu. Nosach, V.N. Ovsyuk, V.I. Panov, A.N. Penin, A.S. Piskarskas, S.R. Rustamov, V.V. Ragul'skii, A.S. Rubanov, A.I. Sokolovskaya, V.S. Solomatin, M.S. Soskin, B.I. Stepanov, A.P. Sukhorukov, T. Usmanov, N.D. Ustinov, V.V. Fadeev, F.S. Faizullov and G.I. Freidman were awarded USSR and RF State Prizes.

Over the fifty-year history of nonlinear laser optics, our favourite science has become an independent branch of physics which is reliably supported by the theory of nonlinear wave equations, numerical solution techniques, and the diversity of lasers around us. Nonlinear optics will undoubtedly continue to offer new, fascinating physical phenomena.

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References

1. *Fizicheskaya entsiklopediya* (Physical Encyclopedia) (Moscow: Nauka, 1992) Vol. 3, p. 292.
2. Khokhlov R.V. *Nelineinye protsessy v optike* (Nonlinear Processes in Optics) (Moscow: Nauka, 1970).
3. Dmitriev V.G., Tarasov L.V. *Prikladnaya nelineinaya optika* (Applied Nonlinear Optics) (Moscow: Fizmatlit, 2004).
4. Makarov V.A. *Usp. Fiz. Nauk*, **174**, 1131 (2004) [*Phys. Usp*., **47**, 1059 (2004)].
5. Makarov V.A. *Vestn. Ross. Akad. Nauk*, **81**, 528 (2011) [*Her. Russ. Acad. Sci*., **81**, 238 (2011)].