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PERSONALIA

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Nikolay Nikolaevich Rosanov (on his 80th birthday)

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December 26, 2020 was the 80th birthday of doctor of physical-mathematical sciences, professor, corresponding member of the Russian Academy of Sciences (RAS), Nikolay Nikolaevich Rosanov, an outstanding world-renowned scientist in the field of laser physics and nonlinear optics.

N N Rosanov was born on December 26, 1940 into the family of hydraulic engineers Nikolay Semenovich and Marianna Vladimirovna in Leningrad, where they stayed throughout the blockade. In 1948, Nikolay went to School No. 181 (before the revolution, it was gymnasium No. 3, to which S Ya Marshak, D S Merezhkovskii, D I Pisarev, and I I Sollertinskii would go). In his latter school days, Nikolay took part in a math club at the Palace of Pioneers on Nevskii Prospect. In his school days, he found the area of an ellipse (without using integrals) by comparing the areas of two cross sections of a cylinder cut obliquely to the axis and orthogonally. He distinguished himself at the city's physics & math olympics.

In 1958, N N Rosanov entered the Physics Department of Leningrad State University with a specialization in the Department of Theoretical Physics. He was lucky to have good teachers — he attended academician V A Fock's lectures on quantum mechanics and V I Smirnov's on mathematics, and seminars run by O A Ladyzhenskaya, later an academician at the USSR Academy of Sciences.

In 1963, N N Rosanov was employed at the S I Vavilov State Optical Institute (SOI), where the first Russian laser had been put into operation some time before, in June 1961. Since 2019, he has been working at A F Ioffe Physical-Technical Institute of RAS. N N Rosanov did his first scientific work under the guidance of V A Fock's disciple A V Tulub, who suggested that he explain the experiment by American authors on the Zeeman effect in a gas laser. The results were submitted by academician A A Lebedev for publication in the journal *Doklady Akademii Nauk SSSR* (*Soviet Physics – Doklady* in English translation that time) in 1965. Studies of the theory of gas lasers continued. N N Rosanov managed to find an original solution to the important problem of frequency locking in laser gyroscopes, which ruled out the possibility of a traditional determination of angular velocity: it was proposed that the dependence of phase difference of counter waves on the angular velocity of gyroscope rotation be used for this purpose in the entrapment region. In co-authorship with G N Vinokurov, he developed a theory of transverse modes interaction in a gas laser.

N N Rosanov is one of the pioneers of the theory of nonlinear laser dynamics. In the 1970s, long before the frequently cited paper by Lang and Kobayashi appeared, N N Rosanov derived the dynamic equations of a solid-state laser with frequency dispersion, including a laser setup with an additional mirror to show that the delay of optical feedback is one of the laser pulsation mechanisms. Another important problem solved by N N Rosanov together with V A Smirnov was a theory of small-scale self-focusing in multielement laser systems. N N Rosanov supervised the theoretical part of the research, performed at SOI, on a number of applied projects related, in particular, to the development of high-power gas lasers and to the propagation of their radiation through the atmosphere, including the use of adaptive optics. Among the more 'academic' results N N Rosanov obtained were new relativistic optical effects in a medium with a nonuniform velocity distribution, as well as a rigorous proof of the impossibility of ideal invisibility even in the case of monochromatic radiation. A theory of particles, waves, and solitons in dynamic resonators with oscillating walls was also formulated. N N Rosanov carried out pioneering work on nonlinear optical effects in an electron-positron vacuum — a subject that has recently become exceedingly topical owing to achievements in laser physics and technology.

Nikolay Nikolaevich Rosanov

An important field initiated and developed by N N Rosanov concerns bistability in spatially distributed systems. For

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point nonlinear objects, the solution to the hysteresis problem has long been known, while for distributed systems, the very possibility of bistability fostered discussions in the literature. N N Rosanov was the first to obtain a consistent solution to the problem of optical radiation reflection from the boundary of a nonlinear medium and to introduce the concept of a switching wave, which is the key element of spatial hysteresis dynamics. This topic then grew into a new area in optics devoted to the study of spatial and space-time dissipative solitons.

The concept of solitons was introduced into optics by G A Askaryan in 1962, who termed it 'self-focusing', but he considered conservative solitons. N N Rosanov's team showed for the first time that the nonlinearity of dissipative factors leads to the occurrence of a new class of solitons with radically different properties. This type of soliton, referred to as dissipative, was initially found together with G V Khodova in a nonlinear wide-aperture interferometer. Another physical system where N N Rosanov's group revealed such solitons was a wide-aperture laser with saturable absorption (together with S V Fedorov). For such systems, the existence of one-, two-, and three-dimensional dissipative solitons ('laser bullets'), including surprisingly beautiful topological (knotted) solitons, was shown and analyzed in detail (together with N A Veretenov).

In a laser system with a nonlinear resonant absorber, extremely short, subcycle dissipative solitons (attosolitons) were numerically found and examined on the basis of the phenomenon of self-induced transparency in a laser medium (together with N V Vysotina and V E Semenov). Later on, he proposed, with V V Kozlov and S Vabnits, obtaining extremely short dissipative attosolitons in mode-locked lasers based on the same phenomenon. These studies showed that the formation of structures in nonlinear optical systems is not at all necessarily associated with the development of instability, and, in fact, of particular interest are the cases of the rigid, threshold formation of such structures. The conclusion drawn resulted in the reorientation of research by many groups of scientists engaged in the nonlinear dynamics of optical systems.

Related to the study of extremely short solitons is N N Rosanov's discovery of a counterintuitive rule of conservation of electric area (time integral of electric field strength) in virtually any media, including those with dissipation. This rule is especially topical as applied to the generation of extremely short and unipolar pulses, i.e., those with a nonzero electric area. The very existence of unipolar light has repeatedly been called into question in the scientific community. However, at the present time, the group guided by N N Rosanov (together with R M Arkhipov, M V Arkhipov, A V Pakhomov, and I V Babushkin) has obtained convincing proof of the realizability of such pulses in the optical and adjacent ranges and showed a unique possibility of applying unipolar light for an efficient impact on quantum objects. Methods for generating unipolar pulses and systems for electric area detection are being sought.

Along with scientific activity proper, N N Rosanov fulfills the duties of editor-in-chief of two journals: *Optika i spektroskopiya* (*Optics and Spectroscopy* in English translation) and *Opticheskii Zhurnal* (*Journal of Optical Technology* in English edition). For several years, he was a member of the editorial board of the journal *Phys. Rev. A* (2012–2016), the longstanding chair and a member of the program committee of the conference Laser Optics, and president of the D S Rozhdestvenskii Optical Society. Rosanov greatly focuses on scientific expertise — he is chair of the Dissertation Council at the S I Vavilov SOI and a member of several other dissertation councils. He was awarded the rank of Outstanding Reviewer of the American Physical Society. He is a member of the RAS commission for fighting pseudoscience, a member of the RAS committee for awarding the D S Rozhdestvenskii Prize, and a member of the July 1 Club. He was awarded a Medal for the Order for Merits for the Fatherland second class and the Honored Worker of the Armament Industry medal. He received the D S Rozhdestvenskii Prize, the prize of the journal *Uspekhi Fizicheskikh Nauk* (*Physics-Uspekhi*) for the best paper of 2013 (together with S V Bulanov, T Zh Esirkepov, M Kando, and A S Pirozhkov), and the Yu I Ostrovskii Prize of the A F Ioffe Physical-Technical Institute (together with R M Arkhipov, M V Arkhipov, and A V Pakhomov). He was decorated with the S I Vavilov Medal and the D S Rozhdestvenskii Medal of the D S Rozhdestvenskii Optical Society, as well as the diploma of Honorary Member of the D S Rozhdestvenskii Optical Society.

With all our hearts, we give all our best to Nikolay Nikolaevich on this jubilee and wish him good health, happiness, inexhaustible creative energy, and interesting new ideas and discoveries.

E B Aleksandrov, A F Andreev, M V Arkhipov,
V E Zakharov, L M Zelenyi, S V Ivanov,
E L Ivchenko, L P Pitaevskii, M V Sadovskii,
R A Suris, A M Shalagin, I A Shcherbakov