Scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the Academy of Sciences of the USSR (23–24 November 1983)

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On November 23 and 24, 1983, at the P. N. Lebedev Physics Institute of the USSR Academy of Sciences and the Institute of Spectroscopy of the USSR Academy of Sciences (at Troitsk in the Moscow region) the combined scientific session of the Division of General Physics and Astronomy and the Division of Nuclear Physics of the USSR Academy of Sciences was held. The following seven papers were given at the session:

November 23 (Lebedev Institute)

1. *E. M. Dianov, A. Ya. Karasik, and A. M. Prokhorov.* Nonlinear optical phenomena in fiber light pipes.
2. *I. V. Aleksandrov and Z. V. Nesterova.* Competition of nonlinear processes of conversion of the energy of picosecond pulses in optical fibers.
3. *I. N. Sisakyan and A. B. Shvartsburg.* Nonlinear waves in fiber-optics information systems.

November 24 (Institute of Spectroscopy)

4. *S. L. Mandel'shtam.* The work of the Institute of Spectroscopy.
5. *K. K. Rebane.* Phononless lines in laser spectroscopy of molecules and crystals.
6. *V. S. Letokhov.* Laser photoionization spectroscopy with sensitivity at the level of single atoms and molecules.
7. *V. M. Agranovich.* Contemporary problems of surface spectroscopy.

A brief account of five of these reports is given below.

E. M. Dianov, A. Ya. Karasik, and A. M. Prokhorov. *Nonlinear optical phenomena in fiber light pipes.* Progress in the technology of preparation of glass-fiber light pipes with low optical loss of the order of 1 dB/km over a wide spectral range has resulted in the development of an essentially new field—nonlinear optics of fiber light pipes.[1] The extremely small transverse dimensions, amounting in single-mode fiber light pipes to values 5–10 μm, permit densities of radiation of 1 MW/cm^2 to be achieved with a pumping power of only 1 W. This fact together with the very large length of interaction of light with the medium (tens to hundreds of meters) has permitted a sharp reduction of the pumping power at which nonlinear effects are observed. For example, the thresholds of stimulated Raman scattering and stimulated Brillouin scattering in light pipes has reached levels of hundreds or tens of mW.[2,3] Here the possibilities of application of relatively low-power lasers, including tunable lasers, as pumps is greatly extended.

However, it is not only the factors mentioned above which produce great interest on the part of investigators. The possibility, independently of the transverse distribution of the field of the pump, of exciting light-pipe modes which have different effective refractive indices; the possibility, by changing the parameters of the light pipe, for example the radius of the core, of changing the number of modes, going over from the statistical case with a number of modes $> 10^3$ to excitation of a discrete specified number of modes and finally to a single-mode regime; the remarkable fact that the mode does not change the configuration of its field in the entire length of interaction—these aspects have opened up new experimental perspectives.

At the present time the subjects being pursued most actively are four-photon processes in fiber light pipes. Phase synchronism of the interacting waves in a significant length of light pipe was achieved as the result of compensation of the material dispersion either by intermode dispersion or by the waveguide dispersion (see Refs. 4 and 5 and references therein). One realizes with equal efficiency both resonance and non resonance processes with frequency shifts of the Stokes-anti-Stokes components with respect to the pump of up to 5500 cm^{-1}.[4]

The nonlinear process in fiber light pipes with a biharmonic laser pump has been studied at frequencies $\nu_1 > \nu_2$. Stokes generation has been observed at a frequency $\nu_S = 2\nu_2 - \nu_1$ without conditions of phase synchronism being satisfied. Intense Stokes generation is observed for the condition of correspondence of the difference of the frequencies of the biharmonic pump to the frequencies of the vibrational resonances of fused quartz. With smooth tuning of the frequency difference of the biharmonic pump $\nu_1 - \nu_2$ (ν_2 is a tunable laser employing color centers in an LiF crystal and ν_1 is a neodymium garnet laser) within the limits of an inhomogeneously broadened vibrational line of fused quartz from zero to ~ 1100 cm^{-1}, one obtains Stokes generation which is smoothly tunable in the frequency ν_S. On the basis of the process investigated, a smoothly tunable narrow-band transformer of laser radiation is proposed to work over a wide range of the spectrum out to $\lambda = 1.32\,\mu$m.

The substantial width of the spectrum of Raman scattering of fused quartz can be used for creation of tunable lasers based on stimulated Raman scattering, both continuous and pumped, with laser pumping of the light pipe in a dispersion resonator.[2] Gemanium doping of fused quartz light pipes opens up the interesting possibility of shaping the profile of a beam of stimulated Raman radiation, using the fact that the stimulated Raman scattering gain of germanium is significantly greater than that of silicon.[7]

Study of stimulated Brillouin scattering in multimode light pipes at an insignificant pulsed power (several tens of watts) has permitted observation of reversal of the wave front of the pumping radiation.[8]

Interest is presented also by studies involving the formation of ultrashort pulses by means of fiber light pipes. The existence of a strong phase self-modulation and linear sweeping of the frequency over the entire length of a one-mode light pipe enabled Shank *et al.*,[9] using a scheme of pulse compression by means of diffraction gratings, to obtain a record short light pulse of duration 30 femtoseconds.

Another possibility of compression of light pulses was realized in the spectral region of anomalous self-dispersion of fused quartz also in a single-mode light pipe.[10] Here Mollenauer *et al.*[10] experimentally confirmed the soliton optical mode of propagation of light pulses which was predicted more than ten years ago.[11,12]

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