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EFFECTIVE GENERATION OF POWERFUL COHERENT ULTRAVIOLET RADIATION[1)]

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In spite of a number of accomplishments in the generation of coherent ultraviolet (UV) radiation by cascade conversion [1, 2], no effective and powerful sources of coherent UV radiation have been developed to date.

It follows from the published data on the attained UV power that the power efficiency of conversion of the second harmonic of neodymium radiation into UV did not exceed 10%. It has been customary to use fundamental-harmonic radiation with a broad spectrum (modulation by means of a rotating prism), just as in [3], so as to obviate the need for stabilization of the wavelength of the fundamental radiation; this stabilization is essential for effective conversion into the third, fourth, and fifth harmonics of neodymium lasers.

It is known that the power of the harmonic obtained by frequency doubling is given by

$$P_2 \sim P_1^2 k_1^2 \chi^2 \frac{\sin^2\left[\frac{k_2 - 2k_1}{2}\right]}{(k_2 - 2k_1)^2},$$

where P_1 is the power of the fundamental radiation, P_2 the harmonic power, k_1 and k_2 the corresponding wave numbers, and χ the coefficient of nonlinear susceptibility.

We see therefore that the harmonic power is inversely proportional to the square of the wavelength, from which it follows that the efficiency of conversion should greatly increase in a second cascade conversion of neodymium radiation. However, it has been impossible to confirm this experimentally, in view of the large sensitivity of the second doubling stage to fluctuations in the fundamental frequency (the so-called "nonlinear spectrograph") [4]. It was necessary to stabilize the fundamental frequency, in view of the small width of the synchronism of the fourth harmonic and its large dispersion.

We report in this paper the first results of effective stabilized conversion into the UV band at power levels on the order of several dozen megawatts, by using a master generator with stabilized frequency.

The frequency of the master generator was stabilized with a Fabry-Perot etalon, and also with additional anisotropic plates (spar, quartz) cut and oriented in accordance with the results of [5].

A distinguishing feature of this generator is that all the working surfaces of the elements inside the resonator (with the exception of the plates) are cut at the Brewster angle, so that the generator has optimal energy characteristics.

[1)] The results of the paper were reported at the fifth All-union Conference on Nonlinear Optics in Kishinev, 15 November 1970.

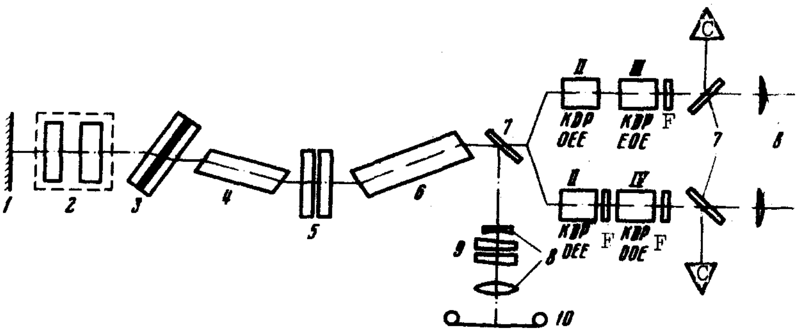

Fig. 1. 1 - Reflecting mirror for λ = 1.06 μ, 2 - stabilizing element with anisotropic plates (spar, quartz), 3 - cell with dye, 4 - active element GLS-110× 158, 5 - Fabry-Perot etalon used as output mirror, 6 - active element GLS-112 × 302, 7 - beam-splitting plates, 8 - lenses, 9 - Fabry-Perot interferometer, 10 - photographic film, C - calorimeter, F - filter

We first stabilized the frequency of the master generator in the absense of an additional stabilizing element. In this case one narrow line was generated, with width on the order of 0.5 cm^{-1} (at the 0.5 level) and stabilization was ensured within ±0.18 cm^{-1}, owing to the absence of the influence of the end faces of the rod and optimization of the etalon gap for the given resonator, in accordance with [7].

Operation of the generator on one longitudinal frequency-stabilized mode was realized with the aid of anisotropic plates whose thickness was chosen to fit the given resonator (spar - 6 mm, quartz - 15 mm) and which were oriented at an angle 45° to each other in the resonator polarization plane.

The anisotropic plates were first tuned with a spectrograph to the center of the luminescence line in the free-generation regime. Final adjustment to the output was made in the Q-switching regime. Introduction of the plates into the resonator worsened the energy characteristics by approximately 10%. A block diagram of the stabilized master generator is shown in Fig. 1. The generator operated on one frequency-stabilized longitudinal mode. The emission line width at the 0.5 level was not larger than 0.005 cm. Reduction of the interference patterns obtained with an interferometer having a base 4.0 cm at λ = 1.06 μ has shown that the frequency instability is within ±0.004 cm for a periodic operating regime and a fixed value of the pump energy; this is seemingly sufficiently "rigid" stabilization.

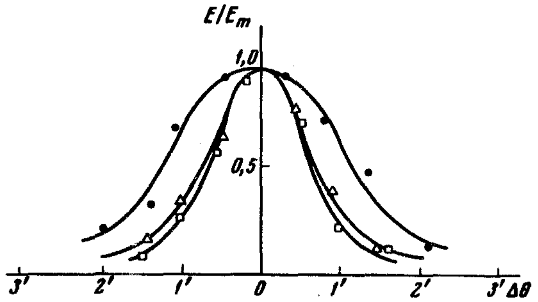

Fig. 2. Angular dependence of the harmonic generation with KDP crystal 4 cm long (o - second harmonic OEE; Δ - fourth harmonic OOE;   - third harmonic EOE).

The energy characteristics of the master generator were as follows: E = 10 J, T = 25 nsec, divergence at the 0.5 level 2 - 3 min. The power rating of the master generator was such as to obtain a fourth-harmonic emission power on the order of 1.0 MW.

The master generator was followed by one amplifying element with a Brewster rod. In the multimode regime, the output power of the amplifier was at the limit of the permissible power density of the KDP crystal.

The frequency stabilization of the single-mode radiation has made it possible to obtain effective conversion to the third and fourth harmonics, and also to obtain the first experimental data on the frequency dependence of the spatial synchromisms of the harmonics (Fig. 2).

The power efficiency of conversion into the fourth harmonic exceeded 50% of the second-harmonic efficiency, because the narrow stable line of the single-mode second harmonic radiation fell in the center of the frequency synchronism of the fourth harmonic. The results are summarized in the table.

Harmonics	Power density MW/cm^2			Interaction
	P_2	P_3	P_4	
2	100			$K^{o}_{(\omega)} + K^{e}_{(\omega)} = K^{e}_{(2\omega)}$
3		68		$K^{e}_{(\omega)} + K^{o}_{(2\omega)} = K^{e}_{(3\omega)}$
4			55	$K^{o}_{(2\omega)} + K^{o}_{(2\omega)} = K^{e}_{(4\omega)}$

The power levels obtained in the UV band have made it possible to observe optical breakdown when the radiation was focused in air by a quartz lens of focal length 75 mm. The breakdown occurred starting with 7 MW for the fourth harmonic and starting with 13 MW for the third.

The main result of the investigation is that, insofar as we know, effective cascade conversion into the UV band was realized for the first time. The obtained UV power amounts to several dozen megawatts.

It is obvious that to increase further the efficiency of the cascade conversion and to increase the power of the obtained UV radiation, it is desirable to work at one spatial and frequency mode of the TEM$_{00}$ type, so as to prevent local damage to the crystals. It is also obvious that the described system is useful for obtaining a high-power fifth harmonic of neodymium radiation, and also for effective generation of the second harmonic of neodymium with lithium niobate, which also has a large frequency dispersion of the synchronism [6].

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HYPERFINE MAGNETIC FIELD FOR Sn^{119} IMPURITY ATOMS IN FERROMAGNETIC TERBIUM

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The magnetic hyperfine fields have been measured by now for many impurity atoms in ferromagnetic 3d matrices (Fe, Co, Ni). At the same time, data on the magnetic fields at the nuclei of impurity atoms in rare-earth ferromagnetic