Letters to the Editor

Franciszek Kaczmarek

On Influence of Flash Lamp Generated Magnetic Field on the Emission of a Nd^{3+}: Glass Laser

Flashlamps are normally used to pump Nd^{3+}: glass (or ruby) laser rods. The most frequently flash-lamp arrangements applied are shown in Fig. 1. During high current discharge through the lamps magnetic field of a strength up to about 1 kOe is generated in the vicinity

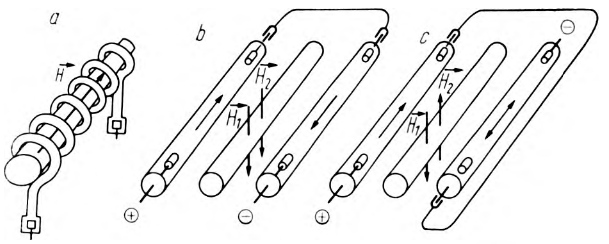

Fig. 1. Typical flash lamps arrangements used in optical pumping of laser rods. Magnetic field generated by the flash lamps discharge current is denoted by H

of these lamps. This field acts on the laser rod causing some disturbing effects, like Zeeman and Faraday. Assuming the discharge current being 10^3 A, which is a real value in most medium power flash lamps, the magnetic field strength amounts to about 1200 Oe (configuration *a* in Fig. 1) and to 400 Oe (for the *b*-case, where the distance between the lamps and the laser rod was taken at 20 cm). There is, of course, no magnetic field at the laser rod when the configuration *c* is used. Magnetic fields generated by the two lamps cancel each other.

In the *a* configuration the magnetic field is aligned within the laser axis causing the emission to split into two Zeeman components, both being polarized circularly. On the other, hand magnetic field generated perpendicularly to the laser rod splits the emission into three lines: the first line linearly and the side ones are circularly polarized. The frequency shift of each Zeeman component, calculated with respect to the undisturbed line, is very small in the field of 1000 Oe and equals $5\cdot10^{-2}$ cm^{-1} (in wavenumbers). This frequency shift can be completely neglected, because the linewidth of Nd^{3+}: glass laser emission is much larger. However, the components circularly polarized appearing in the laser emission do not enter the laser rod with Brewster angle faces without loss, as it is the case of linearly polarized light. More attention should be paid to the Faraday effect, i.e. to the rotation of the plane of polarization after any passage of the light through the laser rod. If the Brewster-angle faces of the glass rod have forced linear polarization of the generated beam, then rotation of the plane of polarization causes a decrease in efficiency of the transmittance properties of the rod faces and also a decrease in coupling between the waves traveling in opposite directions. The magnitude of this rotation was measured in a standard Nd^{3+}: glass rod of LGS-24-5 type (made in UdSSR), using a simple setup illustrated in Fig. 2. In order to increase the angle of rotation of the plane of polarization the rod faces were partially gold coated; in this way the light path within the rod was

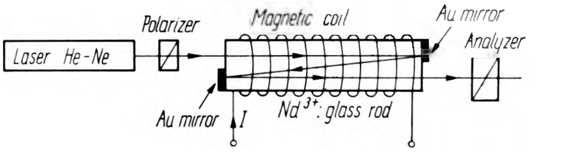

Fig. 2. Setup for measuring rotation of the plane of polarization (Faraday effect)

increased by a factor of 3. The length of the laser rod was 25 cm; the light path — 75 cm. Faraday rotation was measured in several laser rods in a static magnetic field of about 1000 Oe.

All rods under investigations exhibited an initial birefringence of about 2 nm/cm. As a result of many measurements an average rotation of $\Delta\varphi = 2°$ was obtained, so the Verdet constant was calculated:

$$V = \frac{\Delta\varphi}{l \cdot H} = \frac{120'}{75 \cdot 1030} = 1.55 \cdot 10^{-3} \frac{\text{minutes}}{\text{cm Oe}}.$$

One can thus conclude that the rotation of the plane of polarization during high current flash lamp discharge can reach very large values after many passages of the light beam within an optical rezonator of the laser. As a result light loss at the Brewster angle faces of the rod increases and the cavity Q-factor is lowered. These effects can disturb the laser emission, especially when the laser is supposed to work in a very stable regimé or in a mode-locked manner. It is thus preferable to use the *c* configuration of flash lamps in which no magnetic field is generated in the laser rod.

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