**K. I. Zemskov, M. A. Kazaryan, and G. G. Petrash.** *Optical systems with brightness amplifiers.* In ordinary optical systems, the brightness of the light beam at the exit is always lower than the brightness at the entrance. This circumstance places severe limits on the capabilities of optical systems. It is clear that they could be increased greatly if it were possible to use brightness amplifiers extensively in optics.

Quantum electronics is capable in principle of solving this problem. In fact, the stimulated radiation duplicates all properties of the stimulating radiation, i.e., makes it possible to increase the brightness of light beams in all types of optical systems while introducing only the noise associated with spontaneous emission.

The present paper sets out to analyze the factors holding up the developmnet of optical systems with brightness amplifiers and to survey the prospects for their development.

1. It is a peculiarity of optical systems that they operate simultaneously with a large volume of information that is present in the amplitude and phase distributions over the field, whose linear dimension usually contains of the order of $10^3$ resolvable elements. This imposes certain requirements on the dimensions of the amplifying elements and their angular aperture. It would be desirable to have an ampliyfing element with a gain such that saturation of the active medium is attained in one pass. In this case, the efficiency of energy conversion to energy of the output beam that carries the image or other optical information would approach the energy conversion efficiency in the active medium. This would make it possible to develop optical systems with efficiencies far above the conventional levels.

2. To reach saturation in one pass, it is necessary to have a gain of the order of 0.1–1.0 $cm^{-1}$ for typical active-medium lengths. This is what makes it difficult to create amplifying elements, since such gains can be attained only with very high pumping rates. Amplification in the visible region within the limits of the Doppler linewidth requires pumping in the kW/$cm^3$ range at existing laser efficiencies in continuous operation. Adequately high gains can be obtained comparatively easily with pulsed lasers.

3. The use of metal-vapor pulsed lasers, and especially the copper-vapor laser, which works in the green region of the spectrum, made it possible to create the first optical systems with brightness amplifiers that were suitable for practical use and to investigate these systems. A laser projection microscope with a copper-vapor laser amplifier made it possible to produce images of microscopic objects on a screen with an area greater than 10 $m^2$ with linear magnifications up to $15 \cdot 10^3$, which is far beyond the capabilities of conventional projection systems. In this case the amplifying element uses a substantial part of the stored inversion, since it operates near saturation.

Gold- and barium-vapor lasers have been used to obtain brightness-enahnced images of microscopic objects in the red, ultraviolet, and infrared regions of the spectrum. It is also possible to use lead-, manganese-, and europium-vapor pulsed lasers for the same purpose.

4. There are good prospects for the use of optical systems with brightness amplifiers in large-screen projection television, in data processing systems, for high-speed microcinematography (at 10 000–20 000 frames per second), to amplify light beams formed on reconstruction of dynamic holograms, and for various other purposes.

5. Further development of optical systems with brightness amplifiers requires the creation of new highly efficient active media with high gains at large diameters and angular apertures of the amplifying element.

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