We note that the value of the C_2 coincides with that obtained previously by Racah [5], while those of C_3 and C_4 coincide with the values obtained in [3]. In the case of the SU(6) group the operators C_p of (7) give the complete set of independent invariants that can be constructed from A^i_j. From (7) we obtain as a particular case the formulas for the Casimir operators of the SU(3) group

$$\begin{aligned} C_2 &= \frac{2}{3}(p^2 + q^2 + pq + 3p + 3q), \\ C_3 &= \frac{1}{9}(p - q)[(p + 2q)(2p + q) + 9(p + q + 1)] + \frac{3}{2}C_2 \end{aligned} \qquad (8)$$

which have already been used in calculations [6].

The simplest representations of the U(n) and SU(n) groups are the completely symmetrical representations $\{f\}$ and the completely antisymmetrical representations $\{1^k\}$. With the aid of (3) we can obtain the eigenvalues of all the operators C_p for these representations:

$$\begin{aligned} C_p(\{f\}) &= f(f + n - 1)^{p-1} \\ C_p(\{1^k\}) &= k(n - k + 1)^{p-1} \end{aligned} \qquad (9)$$

These formulas pertain to the U(n) group; the values of C_p for the SU(n) group can be obtained from them by taking (5) into account. A more detailed exposition of the results will be published separately.

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1) The method used by us to obtain formula (3) makes use of some ideas taken from [4].

OBSERVATION OF A FAST PHOTOIONIZATION AUREOLE AND OF A CONCENTRATED LONG LIVED IONIZATION CLOUD DUE TO A SHOCK WAVE FROM A SPARK IN A LASER BEAM

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The vigorous release of energy in a gas by a concentrated laser beam ("optical spark") [1-3] should be accompanied by intense ionization induced in the gas by the radiation photons due to the high temperature heating and the resultant strong shock wave. We have observed a rapidly arising aureole of ionization due to the photons, anticipating the shock wave. An important role in its production is apparently played by multiple ionization, absorption, and migration of the intrinsic radiation in the gas. A report of a detailed investigation of this fast aureole with the aid of special probes will be published soon. More concentrated ionization is produced in the shock wave itself. In the present paper we report an investigation of the ionization aureole of a spark, made with the aid of microwave radiation.

The spark was produced in the focus of the emission of an ordinary ruby laser Q-modulated with a rotating prism. The laser radiation was focused by a lens of 5 cm focal length placed between the receiving horn with detector and the 8-mm generator antenna. This system made possible simultaneous measurement of the transmitted and reflected microwave radiation.

Figure 1 shows typical oscillograms obtained with 400 μsec: the upper oscillogram shows the variation of the transmitted radiation, and the lower shows the reflected radiation (with greater magnification).

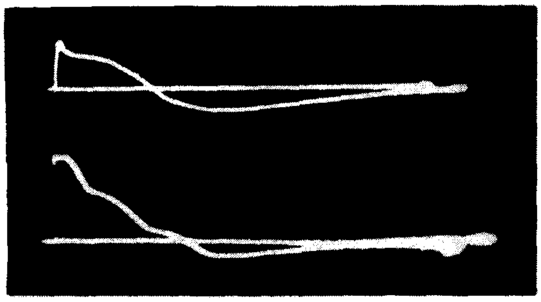

Fig. 1

The degree of overlap of the radio emission was simulated by bodies having different dimensions, made of crushed foil (the detector current variation was set in correspondence with the current corresponding to the voltage pulse produced when the spark appeared). It turned out that the spark and radio signals overlapped in an area on the order of 1 cm, showing that the ionization aureole has considerable dimensions compared with the small initial volume in which the energy is released.

The very fact of reflection and overlap of the radiation shows that the concentration of the ionization in the aureole is not lower than the critical value for the employed wavelength

$$n_{cr} \approx \frac{m(\omega^2 + \nu^2)}{4\pi e^2} \approx \frac{m\omega^2}{4\pi e^2} \approx 10^{13}\ \mathrm{cm}^{-3}$$

The electron collision frequency was $\nu \lesssim \omega$, thus ensuring strong dissipation of the microwave radiation in the plasma aureole; the principal collisions are those with neutrons, since the ion concentration is small and cannot be compensated for by the large difference in the cross sections

$$\frac{\sigma_{ei}}{\sigma_{ea}} \approx 10^{6}\left(\frac{T_0}{T}\right)^2$$

An interesting result is the observed long lifetime of the aureole plasma, reaching hundreds of microseconds.

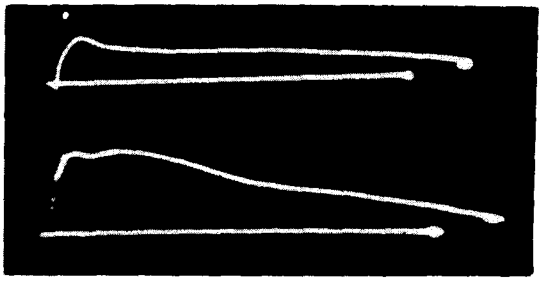

Fig. 2

To determine the speed with which the ionization aureole is produced, we investigated the growth rates of the overlap of radio emission. Figure 2 shows oscillograms of the growth front of the radiation overlap signal (upper trace) and the reflection signal (lower trace), taken with a sweep of 80 μsec. We see that the maximum overlap is obtained after ~ 5 μsec, a time commensurate with the time of passage of the shock wave, which envelopes the aureole after several microseconds. Noticeable overlap is observed also at times that are insufficient for the shock wave to cover the effective transverse dimensions of the overap section. In the initial stage of the overlap, the growth of a signal proportional to the interaction cross section is faster than the time growth of the cross section for scattering by the shock wave. For the shock wave the radius is $\sim t^{2/5}$ and the cross section is $\sigma \sim r^6 \sim t^{12/5}$ for $r < \lambdabar$ and $\sigma \sim r^2 \sim t^{4/5}$ for $r \gtrsim \lambdabar$, while experiment yields a much steeper growth of the signal during the initial stage. The presence of a fast ionization aureole, produced within a fraction of a microsecond and anticipating the shock wave, was clearly recorded by means of special probes.

We note that with increasing microwave wavelength the effective overlap and scattering by the fast aureole should increase, since the aureole does not have too high a concentration, while the critical concentration is proportional to the square of the frequency of the wave. Concentrated ionization and heating of the gas by photoionization and by the shock wave in the vicinity of the spark lengthens the plasma lifetime appreciably compared with normal temperatures. The prolonged existence of the ionization aureole around the spark explains the long-lived disturbance of the magnetic field by the spark plasma, previously observed by the authors [4].

The results obtained for the interaction between microwaves and an optical spark, and an investigation of the ionization aureole, can be used to attempt to transfer energy to the strongly dissipating spark plasma from rapidly varying intense electromagnetic waves, induction fields, or light beams, and also to use the ionizing rays from a laser as reflectors, guidance systems, and radio antennas.

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INCOMPATIBILITY OF RELATIVIZED SU(6) SYMMETRY WITH UNITARITY

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1. Many recent papers are devoted to a relativistic generalization of SU(6) symmetry, and are aimed at constructing S-matrix elements that are invariant relative to the Lorentz group ($\mathscr{L}$) of the SU(3) group and SU(6)-invariant in the static limit (for example, [1,2]).