COHERENT RAMAN EFFECT IN THE OFF-AXIS RAMAN LASER RESONATOR

(20-MW threshold in Raman resonator; E)

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(Received 30 April 1964)

When a Raman active liquid was inserted into the resonator of a laser, there was coherent oscillation at the Raman shifted frequencies;[2] the resonator of the ruby laser was also the resonator for the Raman laser. Since the optical homogeneity of the Raman active liquid is much better than that of the laser crystal, we should expect a more efficient coherent Raman effect if we separate the optical resonators. It is also interesting to study coherent Raman radiation in directions which are different from the axis of the resonator of the exciting laser.

To show the feasibility of the off-axis Raman laser with benzene as the Raman active liquid, we used a *Q*-switching ruby laser which has a peak power of 20 MW and an effective cross section of 0.5 cm^2 to excite the Raman laser. The experimental arrangement is shown in Fig. 1.

The far-field patterns were taken by placing a 305-mm focal length camera on the axis of the resonator system. Figure 2 shows a photograph taken through a Corning CS 7-69 infrared pass filter on Polaroid type 47 film. The largest spot is due to Raman scattering in the forward direction along the axis of the ruby laser beam.[3] The spot to the left of the large spot (arrow) is due to the output of the Raman laser. The other spots in the photograph are presumed to be scattered light from the windows of the Raman cell.

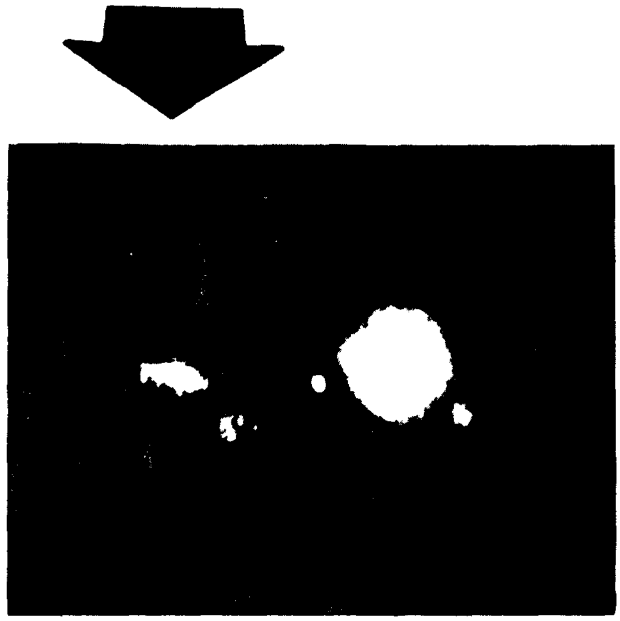
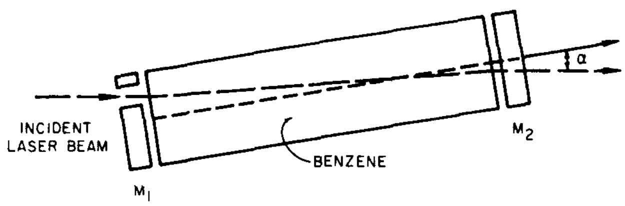


Fig. 2. Photograph, taken through an infrared pass filter, of the output beam.



OFF-AXIS RAMAN LASER

Fig. 1. The optical resonator of the Raman laser consists of two plane mirrors: M_1, which has a hole through it and 99% reflectivity for the ruby and the Raman laser output, and M_2, which has 18% reflectivity for the Raman laser output, but only 2% reflectivity for the ruby laser output.

The two mirrors of the Raman resonator are aligned parallel to within 20 sec of arc. The Raman resonator is placed so that the incident laser beam passes through the hole in M_1. The axis of the Raman resonator is inclined by an angle α to the axis of the ruby laser in the plane perpendicular to the plane of polarization of the incident beam.

The following observations indicated laser action in the off-axis Raman resonator. The angle α between the axis of the Raman cell and the ruby laser beam, measured mechanically, was 0.0397 rad. The angle between the output of the Raman cell and the ruby laser beam as measured from the far-field pattern was 0.0428 rad, which agrees very well with the mechanical measurement. The direction of the Raman radiation (with small angular divergence) coincided with the axis of the Raman resonator. When the mirrors of the Raman resonator were misaligned by a very small amount there was no detectable laser action in its axial direction. There was no detectable laser action in the axial direction of the Raman resonator when the angle α was in the plane of polarization of the ruby laser beam. This last observation is consistent with theoretical considerations. Also, a very pronounced threshold for laser action in the Raman resonator, 20 MW, is consistent with the thresholds reported in our earlier work.[4]

The authors express their gratitude to J. L. Hall of JILA for his valuable comments during the course of the experiment.

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