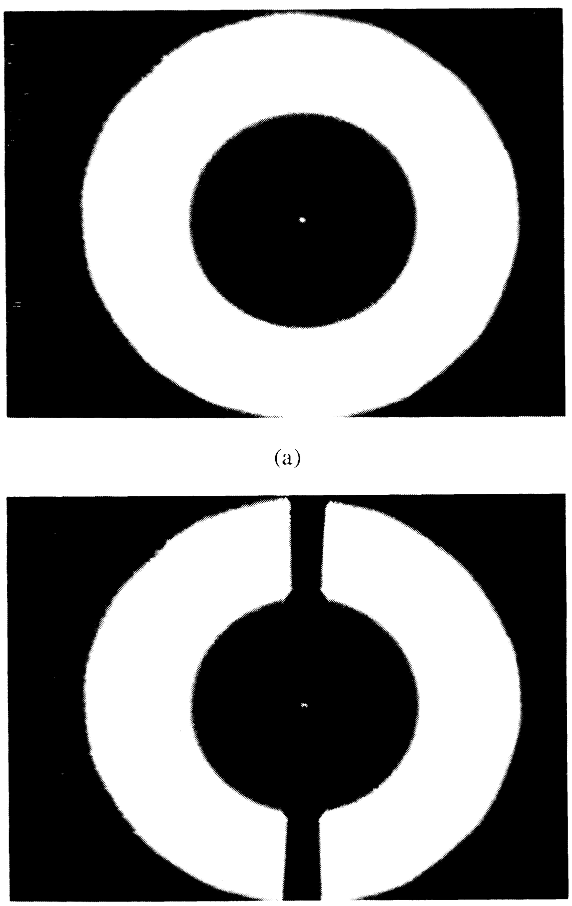
Comment on "Diffraction-Free Beams"

The recent work of Durnin, Miceli, and Eberly[1] on diffraction-free beams brings to mind the experiment which generates the Poisson spot.[2] As normally observed by the diffraction of parallel light around a circular obstacle, the Poisson spot retains its intensity on axis as one recedes from the obstacle, while its radius increases linearly. However, if the obstacle is placed in the focal plane of a following lens, as was the case in Ref. 1, the illuminated spot which is observed in the center of the shadow exhibits the general characteristics which are described by Durnin, Miceli, and Eberly. For our experimental conditions, as described below, the spot retains its intensity and sharpness as the observation point is moved over the latter half of the 156-cm range on which it forms. However, we probably ought not to say that the spot constitutes a diffractionless propagating beam. It is rather a line image, as is shown by the fact that a new obstacle placed in its path does not obliterate the spot further along the axis. In Figs. 1(a) and 1(b) we show the shadow of a 0.8-cm ball bearing illuminated by a 1.5-cm-diam collimated He-Ne laser light beam as observed on a white card 150 cm from a 25-cm lens which is analogous to the lens in the apparatus of Ref. 1. Figure 1(a) shows the normal unblocked situation while Fig. 1(b) was obtained when a 0.3-cm-diam rod was inserted across the beam at a position 40 cm before the white card. The shadow of the rod is clearly visible as is the undisturbed Poisson spot. This shows that the energy in the spot did not get there by traveling along the axis. The rod only blocks that part of the image lying close enough to the rod that it cannot "see" the edge of the ball bearing. Further away, light skimming the edge of the ball bearing has a free path to the image position and hence it is not affected



(a) (b)

FIG. 1. Photographs showing the bright spot of Poisson in the shadow of a circular object (a) without any additional obstructions, and (b) with a rod attempting to block the spot. Both photographs were overexposed to make the Poisson spot more visible.

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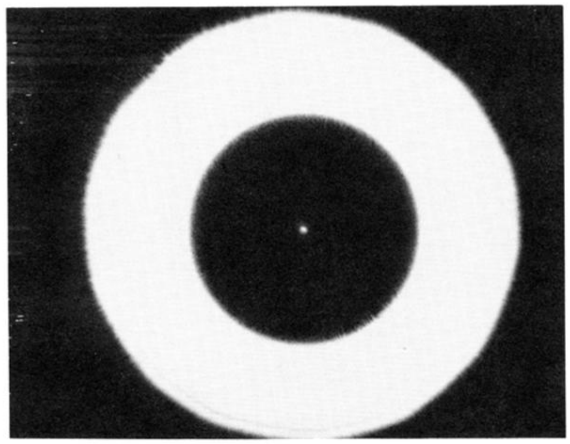
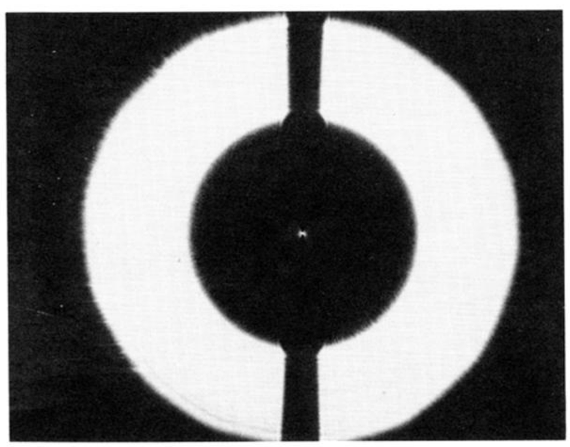
[1] J. Durnin, J. J. Miceli, Jr., and J. H. Eberly, Phys. Rev. Lett. **58**, 1499 (1987).

[2] Also known as the Arago bright spot. Most books on optics describe diffraction in the shadow of a disk. See, for example, J. B. Marion and M. A. Heald, *Classical Electromagnetic Radiation* (Academic, New York, 1980), 2nd ed., p. 377.



(a)



(b)

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