Comment on "Discrimination against Unwanted Orders in the Fabry-Perot Resonator"

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In the above paper,[1] Kleinman and Kisliuk state that "Fox and Li have investigated these configurations and the corresponding frequencies and losses for interferometers consisting of perfectly reflecting plates in air. In the usual laboratory interferometer the Fox and Li modes cannot be resolved because of insufficient reflectivity of the plates. Therefore the role played by these modes in optical masers is not settled."

Unfortunately these statements might be interpreted to mean that there is doubt as to the validity of the normal mode concept applied to maser interferometers.

We should like to correct the impression that the analysis of Fox and Li[2] was limited to perfectly reflecting mirrors. As a matter of fact, the reflectivity of the mirrors is completely unimportant in determining the normal modes, providing only that it is uniform over the mirrors.

It is quite true that in most solid state masers the inhomogeneities of the medium appear to create so much chaos in the radiation fields that correlation with a simple theoretical picture is often hard to demonstrate. However, gas masers appear to behave in a reasonably ideal way, and both the near-field and far-field radiation patterns for these masers appear to confirm the normal mode picture. In the case of such a maser equipped with plane mirrors, Herriott[3] has observed 1.3 mc beats which correspond well with the expected difference frequency between the dominant (even-symmetric) mode and the lowest order odd-symmetric mode.

An even more striking confirmation is seen in Herriott's pictures[3] of the light distribution across the plane mirrors of his helium-neon maser. These show fairly symmetrical multi-lobed distributions, which are at least qualitatively what one would expect for low-order transverse modes.

Finally the very beautiful pictures of Kogelnik and Rigrod[4] have demonstrated convincingly the existence of higher order modes in a helium-neon maser with concave mirrors.

With regard to passive interferometers, E. H. Scheibe has reported[5] that in 1955 a "spurious" resonance was observed in a parallel plate resonator at 9.4 kmc. This turns out to have been the lowest order interferometer mode. Scheibe states that his value of measured Q agrees well with the loss curves of Fox and Li and with a curve given by Goubau and Christian. Christian and Goubau[6] have given a number of measured values for diffraction loss in a parallel-plate resonator over a range of values in N and have shown that these all agree closely with the theoretical loss curve given by Fox and Li for the dominant mode. Good evidence for higher order modes exists in a report by Culshaw[7] on a millimeter wave interferometer in which small subsidiary resonances (Fig. 6 of Culshaw) appeared at slightly greater reflector separations than the main resonances. The observed separations agree within a few per cent with what would be predicted from the results of Fox and Li for a TEM_{03} mode.

These findings leave very little doubt that the iterative normal mode picture does apply to laboratory interferometers, either with loss or with gain.

A. G. FOX
TINGYE LI
D. A. KLEINMAN
P. P. KISLIUK

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