

This Week's Citation Classic

CC/NUMBER 22
MAY 28, 1979

Boyd G D & Gordon J P. Confocal multimode resonator for millimeter through optical wavelength masers. *Bell Syst. Tech. J.* **40**:489-508, 1961.

Most laser oscillators use a pair of opposing mirrors to provide resonant feedback for the lightwave amplification process. The confocal or curved mirror resonator that was proposed and analyzed in this paper is widely used in lasers today. Analytical solutions were found for the resonant modes of the confocal mirror system, and were extended in approximation to the more general class of curved mirror resonators. [The SCI[®] indicates that this paper has been cited over 470 times since 1961.]

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February 1, 1978

"This highly cited paper was my [Boyd] first publication at Bell Laboratories, after I had arrived with a fresh Ph.D. from the California Institute of Technology. I live in fear that upon my retirement it will be looked upon as my best work!

"This work occurred in 1959 and 1960 at the beginning of what is now the field of lasers. In their classic publication, Schawlow and Townes¹ had proposed the plane

parallel Fabry-Perot as the proper open resonator geometry. The analysis was very rudimentary and we were inspired to try to understand laser modes (no laser yet existed) in more detail.

"I was struggling with ray optic analyses of plane parallel interferometers when I wondered how many other kinds of interferometers existed. I read a reference article on interferometry in a handbook of physics and stumbled across the Connes curved mirror interferometer. I recognized that with it a very relaxed alignment criterion was possible.

"At that time, Fox and Li² were using a self-consistent field integral equation approach to Fabry-Perot modes; and in a seminar they gave, W. D. Lewis arose from the audience and suggested that curved wavefronts were analytically soluble.

"In the following discussion, it was pointed out that we were already investigating this experimentally and theoretically. We immediately followed up on Lewis' suggestion analytically and the field of Hermite-Gaussian modes and resonator theory was off to a flying start. The experimental configuration has turned out to be eminently practical and is widely used today."

1. Schawlow A L & Townes C H. Infrared and optical masses. *Phys. Rev.* **112**:1940-9, 1958.
2. Fox A G & Li T. Resonant modes in maser interferometer. *Bell Syst. Tech. J.* **40**:453-88, 1961.