Special Issue Papers

Introduction to the Special Issue on Optical Bistability

OPTICAL bistability can be defined as the existence of two stable output optical states for a single input optical state. The subject per se began with the study of the optical transmission of a saturable absorber in a Fabry–Perot. Experiments revealed that, more often, optical bistability resulted from a nonlinear refractive index. Characteristic hysteresis and nonlinear transfer curves inspired researchers to envision optical computation and signal processing using bistable optical devices. Observations of all-optical switching in semiconductor etalons at milliwatts of input light indicated practical and inspired further research. Additional theoretical and experimental studies showed that not all solutions were stable, that there were dynamic instabilities, sometmes leading to the prediction of optical chaos. Furthermore, plane wave analyses were shown to be limited in their applicability, and transverse effects due to nonuniform spatial distributions were investigated. Lastly, the design of new devices was explored, with the identification of numerous examples exhibiting optical bistability. Thus, the field no longer consists merely of a nonlinear Fabry–Perot, but may include compound cavities, hybrid combinations of optical and electronic components, and several implementations without any cavity.

This Special Issue contains papers which highlight the state of the art in a number of expanding areas. The important observation of bistability in semiconductor etalons using the large nonlinearities at the bandgap has led to the implementation of several optical switching schemes which may have practical applications. Some of these are explored in the first section. The second section contains studies of optical bistability in several new semiconductors.

With the indication that optical switches may indeed be practical, considerable attention has been focused on the instabilities which may occur due to transverse spatial effects, to dynamic effects, or to the introduction of noise. The next four sections of this Special Issue address various aspects of these questions. Both theoretical and experimental progress are being made along many lines.

A new focus of research in the last year has been the understanding of conditions under which bistability may exist without a cavity, with particular emphasis on absorption-induced bistability. Semiconductor structures utilizing electrooptic effects offer promise of exceptionally large sensitivity. The section devoted to absorption-induced bistability highlights these recent studies.

In addition to optical bistability in media with a nonlinear refractive index or absorption, bistability and instabilities have long been studied in lasers. Included in this issue are several interesting papers describing effects seen in CO_2 and semiconductor lasers. Finally, theoretical work is reported on new geometries as well as new mechanisms of bistability.

This issue represents a rather broad overview of the field of optical bistability at the time this issue went to press. In December there will be a Topical Meeting on Optical Bistability which should provide an even more up-to-date view of the field and its potentialities.

ELSA M. GARMIRE, *Guest Editor*
Center for Laser Studies
University of Southern California
Los Angeles, CA 90007

Elsa M. Garmire (M'72–SM'79–F'81) was born in Buffalo, NY, in 1939. She received the A.B. degree in physics from Harvard University, Cambridge, MA, in 1961 and the Ph.D. degree from the Massachusetts Institute of Technology, Cambridge, in 1965.

From 1966 to 1974 she was with the California Institute of Technology. Since 1975 she has been with the University of Southern California, Los Angeles, where she is Professor of Electrical Engineering and Physics and Director of the Center for Laser Studies. After early work in nonlinear optics, she concentrated on integrated optics. More recently, she has also studied optical bistability, semiconductor lasers, and waveguides.

Dr. Garmire is a Fellow of the Optical Society of America, a senior member of the Society of Women Engineers, and a member of Sigma Xi and American Women in Science. She is an elected member of IEEE Lasers and Electro-Optics Society Administrative Committee.