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Special issue on nonlinear diffusion

The first four papers of the present Part, and all papers in the previous Part, together constitute a "Special Issue" of the journal devoted to the theme of nonlinear diffusion, using a liberal interpretation of this terminology. The issue contains contributions from diverse areas, such as flow in porous media, nonlinear diffusion with absorption, microwave heating, dispersion of pollutants, and others, all of which reveal a rich area of current research.

Professor Ian Sneddon often remarked that when he embarked upon his research career, there existed an endless array of "nice" linear problems which willingly submitted to the classical formal devices of linear mathematics. One had only to choose a particular problem and follow a well-trodden path which led to a simple elegant conclusion. In contrast, when I commenced my research career, there remained only the technically difficult linear problems, and an atmosphere existed that the solvable linear problems had all been done. In this environment, the nonlinear problems emerged as the real challenge, and the early books by Professor Bill Ames constituted the only systematic collections of nonlinear mathematical procedures. At about the same time and in a number of countries, known one-parameter Lie transformation groups were exploited to determine special solutions of nonlinear partial differential equations. Subsequently there arose renewed interest in the use of Bäcklund and related transformations for the solution of nonlinear boundary-value problems. Such mathematical developments were not always universally applauded, and were often criticised because frequently the methods lacked the freedom to impose arbitrary initial and boundary data. That is, many nonlinear analytical techniques imply particular initial and boundary data, and it is usually a fluke if they coincide with an interesting physical problem. Thus for a time the isolated and ad-hoc techniques of nonlinear mathematical analysis seemed doomed to languish as curiosities.

However, during this period, numerical techniques and computing capacity developed to such a high degree that many real nonlinear boundary-value problems could be solved readily on the computer, and to a certain extent these developments removed the necessity of concentrating on and solving real physical problems. Today the interest and development in special devices in nonlinear mathematics proceeds unabated. This is because one of the key features of nonlinearity is the range and variety of physical response,