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Special issue on ocean mechanics and a dedication to Sir James Lighthill

The oceans have long been recognized as an essential part of the global environment. They offer mankind food, energy, and minerals. They are used as highways of commerce, recreational facilities, and waste disposal sites.

Over seventy percent of the earth's surface is covered by the oceans. The oceans affect all life on earth directly and indirectly. Without the oceans' moderating effects on land temperatures, man could not inhabit earth. Sixty percent of the world's population lives within 100 km of the coastal waters. The serenity or agitation of these waters can mean the difference between routine or calamity as evidenced by the many occurrences of hurricanes, typhoons and floods. The influence of the oceans extends far beyond the coastal fringes. Scientific evidence now suggests large-scale climatic fluctuations, such as those caused by the El Niño, are tied to seemingly minor changes in the physical processes of the oceans.

The Editorial Board of the Journal has decided to devote a special issue to the general theme of the oceans. The scientific and engineering issues related to the oceans are many. They cannot be covered by a single issue, or even by a single journal. Related fields of study include physical oceanography, atmospheric meteorology, weather and hurricane forecast, coastal geomorphology, ocean engineering, to name a few. Each field focuses on phenomena of their particular scales in time and space and each has its own professional following. The title *Ocean Mechanics* was chosen, not with an intention to encompass all aspects of the oceans, but with the hope that the present subject area will be a catalyst for more collaborative exchanges among scientists and engineers.

The Special Issue is a collection of thirteen articles of original contributions by eminent researchers. The late Sir James Lighthill provided the lead paper before his untimely death while swimming around the island of Sark in the Channel Islands on 17 July 1998. His paper is followed by two groups of articles: the first on Ocean Surface and Interfacial Waves and the second on the Interaction of Waves and Floating Bodies. Following this Introduction is a special article by Norman Riley on 'James Lighthill: The Collected Works', which gives a synopsis of Lighthill's career as an educator and scientist. In reading this article, one is awe-struck by the breadth of subjects that he investigated and the novel skills that he used to solve problems. His contributions were often trend-setting.

In recent years, Lighthill took great interest in the subject of tropical cyclones. His lecture on 'Mathematical Aspects of Severe Storms' at the International Congress of Industrial and Applied Mathematics (ICIAM 95, Hamburg), unannounced in the preliminary program, was attended by over 400 participants. He was an articulate and animated speaker in his usual fashion. In the 1990 International Workshop on Tropical Cyclones held in Vienna, the International Council of Scientific Unions proposed an interdisciplinary project with the World Meteorology Organization to develop a better understanding of how 'air-sea interaction' may alter the intensity of a Tropical Cyclone (TC). The intensification of a TC over pre-existing warm water has been a well accepted idea by this scientific community. However, Lighthill initiated the idea that ocean spray in the presence of extreme wind speeds around the TC could significantly limit the ultimate strength of the cyclone. As a rapporteur of this air-to-sea interaction group, Lighthill developed the new thermodynamics model which is published in this Issue. It represents one of his last completed works on this subject before his death.

An honorary advisory board member, Lighthill was an active supporter of this Journal. He contributed on occasions, and was among the first to submit a completed paper for this Issue. His contributions to ocean science and engineering have been a significant part of his many contributions in the broad area of fluid mechanics. Several representative publications [1–5] in the area of wave kinematics, wind-generated waves, pulsating and moving sources, slender-body theory, and wave loadings are cited from his extensive collection of works. His efforts in these areas left lasting imprints. Those of us who had the fortunate opportunity to interact with him always treasure those experiences. In honor of his memory, the Editors and the contributing authors dedicate this Special Issue to Sir James Lighthill.

The other papers in this Issue deal with fluid mechanics problems related to water waves and ocean engineering. The division between the two groups is a relatively soft one but the categorization is helpful for this Introduction. In the area of surface waves, significant strides have been made in the last two decades on understanding the physics of nonlinear wave-wave interaction. The generation of long waves by short waves [6, 7], the resonant interaction and modulation instability of gravity waves [8, 9], the occurrence of frequency downshift [10, 11], among others, have been the subjects of many contemporary investigations. One may find the recent overviews of Huang *et al.* [12] and Banner and Peregrine [13] useful, the latter addressing aspects of large-amplitude behavior.

The paper by Li and Tulin in this Issue considers the nonlinear interaction of a system of waves propagating with the energy directionally distributed within a sector. It proposes a way for investigating how such a system may experience instabilities related to the Benjamin–Feir instability for propagation in a single direction [8]. Within the framework of the 'mid-slope theory' for waves propagating in slowly-varying bathymetry [14], C. C. Mei's work provides approximate equations for the zeroth and second harmonics for given regular incident waves. These equations are of potential importance to the study of harbor resonance by short wind waves. Density stratification exists in the oceans because of the thermocline and the pycnocline. Two papers address such waves in a stratified ocean. The article by Tuck and Wiryanto presents a new 'composite long-wave equation' that describes the motion of a shallow fluid below an infinite expanse of a lighter fluid. Numerical solutions of nonlinear steady-wave properties are given and compared with the KdV [15] and the Benjamin–Ono [16, 17] equations as special cases. In the context of linear-wave theory, the paper of Yeung and Nguyen extends the well-known solution of the steady Kelvin wave system [18] to the case of a two-layer ocean, with each layer being arbitrary in depth and density. These three-dimensional surface and interfacial wave patterns contain rich physical features. An interfacial wave of a unique kind is explored in Foda's article. Subharmonic resonance is given as an explanation for the existence of ripples on a fluidized sea floor, a nonlinear process.

In the subject area of interaction of surface waves and floating bodies, the classic work of John [19] may be considered as the corner stone of modern-day computational methodology. The appropriate free-surface Green functions were derived in the frequency domain and the uniqueness of solutions of the relevant integral equations were studied. Since then, extension of Green functions to more complex boundary geometry and their numerical computations [20, 21, 22] have been important issues. A somewhat parallel development is the use of the 'Rankine-source method' [23] which requires the explicit imposition of an open-boundary or radiation condition. Concurrently, steady progress has been made in the last decade in the development of theory and methodology to account for second- and higher-order effects on the response of floating bodies, particularly in the context of sum frequency response and low-frequency wave drift [24]. The latter topic results from the nonlinear interaction of waves of nearly identical frequencies in irregular seas [25, 26]. These long-period phenomena have significant effects on the design of tension-leg platforms and other moored structures. The paper by Hermans addresses this last issue using a formulation based on the small current approximation. Another significant nonlinear effect discovered recently is the 'ringing' vibration of an offshore structure when extreme waves pass by a surface-piercing column. The article of Faltinsen extends a higher-order theory [27] that was developed earlier for quantifying such higher-order harmonic loads.

Linear theory still generates much intellectual excitement. The article of Bai *et al.* examines some subtle features of the stagnation flow near a body with a rigid free-surface condition, a flow that is often used as the 'base flow' for computing the steady resistance of ship hulls. For problems with steady ship waves, the Havelock source function is known to exhibit an essential singularity when the field point approaches a surface source along its track [18]. This singularity requires special attention in numerical work [28]. The study of the hydrodynamics of multiple-body interaction has led to some anomalous results: the occurrence of cut-off frequencies in a channel [29] and the possible existence of trapped modes [30, 31] similar to Ursell's solution for edge waves [32]. What possible configurations of multiple bodies and what body shapes may lead to these trapped resonances? The papers by Evans and Porter and by Newman examine these issues in a complementary way. The mathematical behavior of a steadily moving source oscillating at a frequency when the group velocity of the waves coincides with the speed of advance of the source is a critical issue in ship-motion predictions. In their paper, Palm and Grue demonstrate that the hydrodynamic results can be finite at this critical frequency. In the final paper, an elaborate application of matched asymptotics, Korobkin obtains interesting analytical results for the hydrodynamic behavior of a body impacting on a shallow fluid. Recent discussions on the effects of viscosity on wave hydrodynamics can be found in [33, 34].

In these few pages, we have tried to provide a synopsis and the highlights of this Special Issue. We hope this would stimulate the readers' interest in this and the general ocean area. The United Nations has declared 1998 as the International Year of the Ocean (YOTO, http://ioc.unesco.org/iyo/), a window of opportunity to create public awareness and to advocate for the judicious use of the oceans. Sound scientific understanding and prudent engineering will continue to contribute towards such goals, and the oceans will remain as enchanting and valuable to mankind as we have always known them to be.

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