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Roger Chéret
Editors

Classic Papers in Shock Compression Science



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Classic Papers In Shock Compression Science

Isabelle Sochet



Classic Papers In Shock Compression Science:

Classic Papers in Shock Compression Science James N. Johnson, Roger Cheret, 2012-12-06 The field of shock compression science has a long and rich history involving contributions of mathematicians physicists and engineers over approximately two hundred years The middle of the nineteenth century was an especially active period with the contributions of Riemann Rankine and Hugoniot among others The middle of the twentieth century saw another increase in activity related to shock compression of condensed matter as a result of military applications It was also recognized that shock compression provided a means of subjecting solids and liquids to extreme states of temperature and pressure difficult to achieve by static means It has thus become an academic study in its own right The principal modern contributions to this science were summarized in the landmark paper by Rice McQueen and Walsh *Solid State Physics* Vol 6 pp 1 63 1958 As this field has continued to mature interest has increased in tracing the early papers that have served as the foundations of the field Cheret *Shock Compression of Condensed Matter* 1989 Elsevier Sci Pub B V pp 11 19 1990 has contributed to this literature with his review of the life of Hugoniot on the one hundredth anniversary of the publication of Hugoniot's classic paper on the propagation of discontinuous waves in gases This contribution prompted additional historical investigation involving the precursors to Hugoniot

Fundamentals of Shock Wave Propagation in Solids Lee Davison, 2008-05-07 My intent in writing this book is to present an introduction to the thermo mechanical theory required to conduct research and pursue applications of shock physics in solid materials Emphasis is on the range of moderate compression that can be produced by high velocity impact or detonation of chemical explosives and in which elastoplastic responses are observed and simple equations of state are applicable In the interest of simplicity the presentation is restricted to plane waves producing uniaxial deformation Although applications often involve complex multidimensional deformation fields it is necessary to begin with the simpler case This is also the most important case because it is the usual setting of experimental research The presentation is also restricted to theories of material response that are simple enough to permit illustrative problems to be solved with minimal recourse to numerical analysis The discussions are set in the context of established continuum mechanical principles I have endeavored to define the quantities encountered with some care and to provide equations in several convenient forms and in a way that lends itself to easy reference Thermodynamic analysis plays an important role in continuum mechanics and I have included a presentation of aspects of this subject that are particularly relevant to shock physics The notation adopted is that conventional in expositions of modern continuum mechanics insofar as possible and variables are explained as they are encountered Those experienced in shock physics may find some of the notation unconventional **High-Energy-Density Physics** R. Paul Drake, 2006-08-31 This book has two goals One goal is to provide a means for those new to high energy density physics to gain a broad foundation from one text The second goal is to provide a useful working reference for those in the field This book has at least four possible applications in an academic context It can be used for training in high energy

density physics in support of the growing number of university and laboratory research groups working in this area It also can be used by schools with an emphasis on ultrafast lasers to provide some introduction to issues present in all laser target experiments with high power lasers and with thorough coverage of the material in Chap 11 on relativistic systems In addition it could be used by physics applied physics or engineering departments to provide in a single course an introduction to the basics of fluid mechanics and radiative transfer with dramatic applications Finally it could be used by astrophysics departments for a similar purpose with the parallel benefit of training the students in the similarities and differences between laboratory and astrophysical systems The notation in this text is deliberately sparse and when possible a given symbol has only one meaning A definition of the symbols used is given in Appendix A In various cases additional subscripts are added to distinguish among cases of the same quantity as for example in the use of ρ_1 and ρ_2 to distinguish the mass density in two different regions

Detonation Phenomena of Condensed Explosives Shiro Kubota, 2023-01-13 This book presents fundamental theory of shock and detonation waves as well as selected studies in detonation research in Japan contributed by selected experts in safety research on explosives development of industrial explosives and application of explosives It also reports detonation research in Japan featuring industrial explosives that include ammonium nitrate based explosives and liquid explosives Intended as a monographic style book it consistently uses technical terms and symbols and creates organic links between various detonation phenomena in application of explosives fundamental theory of detonation waves measurement methods and individual studies Among other features the book presents a historical perspective of shock wave and detonation research in Japan pedagogical materials for young researchers in detonation physics and an introduction to works in Japan including equations of state which are worthy of attention but about which very little is known internationally Further the concise pedagogical chapters also characterize this book as a primer of detonation of condensed explosives and help readers start their own research

Introduction to Simple Shock Waves in Air Seán Prunty, 2018-12-13 This book provides an elementary introduction to some one dimensional fluid flow problems involving shock waves in air The differential equations of fluid flow are approximated by finite difference equations and these in turn are numerically integrated in a stepwise manner Artificial viscosity is introduced into the numerical calculations in order to deal with shocks The presentation is restricted to the finite difference approach to solve the coupled differential equations of fluid flow as distinct from finite volume or finite element methods This text presents the results arising from the numerical solution using Mathcad programming Both plane and spherical shock waves are discussed with particular emphasis on very strong explosive shocks in air This text will appeal to students researchers and professionals in shock wave research and related fields Students in particular will appreciate the benefits of numerical methods in fluid mechanics and the level of presentation

Hydrodynamics of Explosion Valery K. Kedrinskiy, 2005-11-04 Hydrodynamics of Explosion presents the research results for the problems of underwater explosions and contains a detailed analysis of the structure and the parameters of the wave

fields generated by explosions of cord and spiral charges a description of the formation mechanisms for a wide range of cumulative flows at underwater explosions near the free surface and the relevant mathematical models Shock wave transformation in bubbly liquids shock wave amplification due to collision and focusing and the formation of bubble detonation waves in reactive bubbly liquids are studied in detail Particular emphasis is placed on the investigation of wave processes in cavitating liquids which incorporates the concepts of the strength of real liquids containing natural microinhomogeneities the relaxation of tensile stress and the cavitation fracture of a liquid as the inversion of its two phase state under impulsive explosive loading The problems are classed among essentially nonlinear processes that occur under shock loading of liquids and may be of interest to researchers in physical acoustics mechanics of multiphase media shock wave processes in condensed media explosive hydroacoustics and cumulation

Material Properties under Intensive Dynamic Loading Mikhail V. Zhernokletov, B. L. Glushak, 2007-07-16 Understanding the physical and thermomechanical response of materials subjected to intensive dynamic loading is a challenge of great significance in engineering today This volume assumes the task of gathering both experimental and diagnostic methods in one place since not much information has been previously disseminated in the scientific literature

Frontiers of Shock Wave Research Kazuyoshi Takayama, Ozer Igra, 2022-06-07 The book contains 12 chapters written by well known shock wave researchers from seven different countries Each researcher provides a brief description of his main research interests and results thereby providing the readers with an excellent view of shock wave research conducted in the past fifty years It also provides hints as to what still needs further investigation It will be an excellent guide for young researchers entering the field of shock wave phenomena Among the described investigations are the following topics Blast wave interaction with a body when the body is in the area of interference of two blast waves moving in different directions equation of state for water based on the shock Hugoniot data Mach waves occurring over a backward facing edge in supersonic flow shock waves in dusty gas shock wave interaction with various bodies three shock interactions

Blast Effects Isabelle Sochet, 2017-12-22 This book compiles a variety of experimental data on blast waves The book begins with an introductory chapter and proceeds to the topic of blast wave phenomenology with a discussion on Rankine Hugoniot equations and the Friedlander equation used to describe the pressure time history of a blast wave Additional topics include arrival time measurement the initiation of detonation by exploding wires a discussion of TNT equivalency and small scale experiments Gaseous and high explosive detonations are covered as well The topics and experiments covered were chosen based on the comparison of used scale sizes from small to large Each characteristic parameter of blast waves is analyzed and expressed versus scaled distance in terms of energy and mass Finally the appendix compiles a number of polynomial laws that will prove indispensable for engineers and researchers

Detonation Control for Propulsion Jiun-Ming Li, Chiang Juay Teo, Boo Cheong Khoo, Jian-Ping Wang, Cheng Wang, 2017-12-05 This book focuses on the latest developments in detonation engines for aerospace propulsion with a focus

on the rotating detonation engine RDE State of the art research contributions are collected from international leading researchers devoted to the pursuit of controllable detonations for practical detonation propulsion A system level design of novel detonation engines performance analysis and advanced experimental and numerical methods are covered In addition the world s first successful sled demonstration of a rocket rotating detonation engine system and innovations in the development of a kilohertz pulse detonation engine PDE system are reported Readers will obtain in a straightforward manner an understanding of the RDE PDE design operation and testing approaches and further specific integration schemes for diverse applications such as rockets for space propulsion and turbojet ramjet engines for air breathing propulsion Detonation Control for Propulsion Pulse Detonation and Rotating Detonation Engines provides with its comprehensive coverage from fundamental detonation science to practical research engineering techniques a wealth of information for scientists in the field of combustion and propulsion The volume can also serve as a reference text for faculty and graduate students and interested in shock waves combustion and propulsion

Blast Waves Charles E. Needham, 2017-10-03 This book examines blast waves their methods of generation their propagation in several dimensions through the real atmosphere and layered gases and their interactions with simple structures thereby providing a broad overview of the field The intended audience has a basic knowledge of algebra and a good grasp of the concepts of conservation of mass and energy The text includes an introduction to blast wave terminology and conservation laws and there is a discussion of units and the importance of consistency This new edition of *Blast Waves* has been thoroughly updated and includes two new chapters that cover numerical hydrodynamics and blast injury Authored by an expert with over forty years of experience in the field of blast and shock this book offers many lessons as well as a historical perspective on developments in the field

Explosive Effects and Applications Jonas A. Zukas, William Walters, 2013-12-01 This is a broad based text on the fundamentals of explosive behavior and the application of explosives in civil engineering industrial processes aerospace applications and military uses

Thermo-Gas Dynamics of Hydrogen Combustion and Explosion Boris E. Gelfand, Mikhail V. Silnikov, Sergey P. Medvedev, Sergey V. Khomik, 2012-02-13 The potential of hydrogen as an important future energy source has generated fresh interest in the study of hydrogenous gas mixtures Indeed both its high caloricity and reactivity are unique properties the latter underscoring safety considerations when handling such mixtures The present monograph is devoted to the various aspects of hydrogen combustion and explosion processes In addition to theoretical and phenomenological considerations this work also collates the results of many experiments from less well known sources The text reviews the literature in this respect thereby providing valuable information about the thermo gas dynamical parameters of combustion processes for selected experimental settings in a range of scientific and industrial applications

Magnetocumulative Generators Larry L. Altgilbers, Mark D.J. Brown, Igor Grishnaev, Bucur M. Novac, Ivor R. Smith, Yuriy Tkach, Jaroslav Tkach, 2012-12-06 Devices that convert explosive energy into electromagnetic energy are often called Flux Compression Generators FCGs in the United

States whereas the term Magnetocumulative Generators MCGs is more commonly used in Russia Since the Russian literature is accessed more heavily in this book the latter term is used here In any event the basic process involves using explosives to force an initial magnetic flux into a region of smaller inductance in such a manner that loss of flux is minimized In the event that no flux is lost the magnetic energy associated with the flux inversely proportional to the inductance must increase Flux loss is minimized by confining it with good conductors which in turn are driven rapidly by the explosive to reduce the system inductance The magnetic energy is increased by the work the conductors do as they are forcibly moved against the magnetic field the energy in turn being supplied by the explosive driving them As the reader may infer there are different kinds of generators some of which might be difficult to recognize as MCGs Nonetheless they all possess the features outlined above Explosives have some unique features as energy sources They have very high available energy densities they release energy rapidly or at high power they can develop very high pressures

Toward Detonation Theory Anatoly N. Dremin, 2012-12-06 It is known that the Chapman Jouguet theory of detonation is based on the assumption of an instantaneous and complete transformation of explosives into detonation products in the wave front Therefore one should not expect from the theory any interpretations of the detonation limits such as shock initiation of detonation and kinetic instability and propagation failure diameter The Zeldovich Von Neuman Doring ZND theory of detonation appeared in fact as a response to the need for a theory capable of interpreting such limits and the ZND detonation theory gave qualitative interpretations to the detonation limits These interpretations were based essentially on the theoretical notion that the mechanism of explosives transformation at detonation is a combustion of a layer of finite thickness of shock compressed explosive behind the wave shock front with the velocity of the front However some experimental findings turned out to be inconsistent with the theory A very small change of homogeneous liquid explosives detonation velocity with explosive charge diameter near the rather sizable failure diameter is one of the findings The elucidation of the nature of this finding has led to the discovery of a new phenomenon This phenomenon has come to be known as the breakdown BD of the explosive self ignition behind the front of shock waves under the effect of rarefaction waves

Dynamics of Heterogeneous Materials Vitali Nesterenko, 2013-03-09 This monograph deals with the behavior of essentially nonlinear heterogeneous materials in processes occurring under intense dynamic loading where microstructural effects play the main role This book is not an introduction to the dynamic behavior of materials and general information available in other books is not included The material herein is presented in a form I hope will make it useful not only for researchers working in related areas but also for graduate students I used it successfully to teach a course on the dynamic behavior of materials at the University of California San Diego Another course well suited to the topic may be nonlinear wave dynamics in solids especially the part on strongly nonlinear waves About 100 problems presented in the book at the end of each chapter will help the reader to develop a deeper understanding of the subject I tried to follow a few rules in writing this book 1 To focus on strongly nonlinear

phenomena where there is no small parameter with respect to the amplitude of disturbance including solitons shock waves and localized shear 2 To take into account phenomena sensitive to materials structure where typical space scale of material parameters particle size cell size are presented in the models or are variable in experimental research *High-Pressure Shock Compression of Solids* J.R. Asay, M. Shahinpoor, 2012-12-06 This book presents a set of basic understandings of the behavior and response of solids to propagating shock waves The propagation of shock waves in a solid body is accompanied by large compressions decompression and shear Thus the shear strength of solids and any inelastic response due to shock wave propagation is of the utmost importance Furthermore shock compression of solids is always accompanied by heating and the rise of local temperature which may be due to both compression and dissipation For many solids under a certain range of impact pressures a two wave structure arises such that the first wave called the elastic precursor travels with the speed of sound and the second wave called a plastic shock wave travels at a slower speed Shock wave loading of solids is normally accomplished by either projectile impact such as produced by guns or by explosives The shock heating and compression of solids covers a wide range of temperatures and densities For example the temperature may be as high as a few electron volts 1 eV 11 500 K for very strong shocks and the densification may be as high as four times the normal density

Numerical Fluid Dynamics Dia Zeidan, Jochen Merker, Eric Goncalves Da Silva, Lucy T. Zhang, 2022-05-18 This book contains select invited chapters on the latest research in numerical fluid dynamics and applications The book aims at discussing the state of the art developments and improvements in numerical fluid dynamics All the chapters are presented for approximating and simulating how these methods and computations interact with different topics such as shock waves non equilibrium single and two phase flows elastic human airway and global climate In addition to the fundamental research involving novel types of mathematical sciences the book presents theoretical and numerical developments in fluid dynamics The contributions by well established global experts in fluid dynamics have brought different features of numerical fluid dynamics in a single book The book serves as a useful resource for high impact advances involving computational fluid dynamics including recent developments in mathematical modelling numerical methods such as finite volume finite difference and finite element symbolic computations and open numerical programs such as OpenFOAM software The book addresses interdisciplinary topics in industrial mathematics that lie at the forefront of research into new types of mathematical sciences including theory and applications This book will be beneficial to industrial and academic researchers as well as graduate students working in the fields of natural and engineering sciences The book will provide the reader highly successful materials and necessary research in the field of fluid dynamics *Advances in the Theory of Shock Waves* Heinrich Freistühler, Anders Szepessy, 2012-12-06 In the field known as the mathematical theory of shock waves very exciting and unexpected developments have occurred in the last few years Joel Smoller and Blake Temple have established classes of shock wave solutions to the Einstein Euler equations of general relativity indeed the mathematical and physical con

sequences of these examples constitute a whole new area of research The stability theory of viscous shock waves has received a new geometric perspective due to the work of Kevin Zumbrun and collaborators which offers a spectral approach to systems Due to the intersection of point and essential spectrum such an approach had for a long time seemed out of reach The stability problem for in viscid shock waves has been given a novel clear and concise treatment by Guy Metivier and coworkers through the use of paradifferential calculus The L^1 semi group theory for systems of conservation laws itself still a recent development has been considerably condensed by the introduction of new distance functionals through Tai Ping Liu and collaborators these functionals compare solutions to different data by direct reference to their wave structure The fundamental properties of systems with relaxation have found a systematic description through the papers of Wen An Yong for shock waves this means a first general theorem on the existence of corresponding profiles The five articles of this book reflect the above developments

Fragmentation of Rings and Shells Dennis Grady, 2007-07-13 For a brief period during the latter part of World War II Nevill F Mott led a theoretical group at Fort Halstead in the United Kingdom that tackled scientific issues related to pressing war time concerns Among later awards and honors Mott was knighted and a recipient of the Nobel Prize While at Fort Halstead he undertook an effort to theoretically describe the statistical fragmentation of munitions subjected to intense explosive loading Mott's original internal reports contain seminal theoretical concepts on the physics and statistics of dynamic fracture and fragmentation which have provided the inspiration for numerous later modeling efforts and engineering formulae Some of his most forward looking thoughts on the micromechanical and molecular aspects of fracture are included in these publications The present book surveys the theoretical analysis put forth by Mott with particular focus on his efforts to characterize the size and distribution of fragments resulting from a dynamic fragmentation event Copies of the original internal reports of Mott and his co workers are included The book also pursues additional theoretical analysis with the intent of delving further into the physical ideas and unfinished analysis implicit in Mott's original studies This book will be of interest to all scientists and engineers concerned with the dynamic fracture and fragmentation of solid bodies subject to intense transient loads imparted by explosive detonation and high velocity impact from both the historical and modern perspective

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