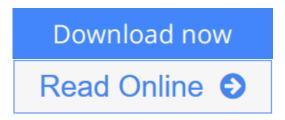# Lattice Sums Then and Now (Encyclopedia of Mathematics and its Applications)

By J. M. Borwein, M. L. Glasser, R. C. McPhedran, J. G. Wan, I. J. Zucker

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The study of lattice sums began when early investigators wanted to go from mechanical properties of crystals to the properties of the atoms and ions from which they were built (the literature of Madelung's constant). A parallel literature was built around the optical properties of regular lattices of atoms (initiated by Lord Rayleigh, Lorentz and Lorenz). For over a century many famous scientists and mathematicians have delved into the properties of lattices, sometimes unwittingly duplicating the work of their predecessors. Here, at last, is a comprehensive overview of the substantial body of knowledge that exists on lattice sums and their applications. The authors also provide commentaries on open questions, and explain modern techniques which simplify the task of finding new results in this fascinating and ongoing field. Lattice sums in one, two, three, four and higher dimensions are covered.

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Editorial Review

About the Author
J. M. Borwein, FRSC, FAAAS, FAA is Laureate Professor in the School of Mathematical and Physical Sciences and Director of the Priority Research Centre in Computer Assisted Research Mathematics and its Applications at the University of Newcastle, New South Wales. He is also Distinguished Professor at King Abdulaziz University in Jeddah. An ISI highly cited scientist and former Chauvenet prize winner, he has published widely in various fields of mathematics.

M. L. Glasser is Emeritus Professor of Physics at Clarkson University, Potsdam, New York. He has published roughly 300 articles on various topics in Solid State Physics, Statistical Mechanics and Applied Mathematics and works, primarily, in the area of matter in strong magnetic fields. He is presently Visiting Professor of Theoretical Physics at the University of Valladolid, Spain.

R. C. McPhedran is Professor in Physics at the University of Sydney and has around 280 papers in international refereed journals. He specialises in problems involving waves interacting with structured systems and became interested in lattice sums in the course of investigations into design of composite materials for harvesting solar energy. He has worked on diffraction gratings, photonic crystals, microstructured optical fibres, composite materials, elastodynamics, metamaterials and techniques of mathematical physics. He is a Fellow of the Optical Society of America, the Australian Institute of Physics, the Institute of Physics (UK) and the Australian Academy of Science.

J. G. Wan is a 2013 PhD graduate in experimental mathematics from the University of Newcastle, New South Wales. He is interested in solving problems related to number theory, classical analysis, special functions and lattice sums using the computer both as a tool for symbolic calculation and a device for exploration and gaining intuition. He has collaborated with J. M. Borwein (his doctoral supervisor) on random walks, with M. L. Glasser and I. J. Zucker on complete elliptic integrals, and has written papers on Ramanujan-style mathematics concerning pi.

I. J. Zucker is a theoretical physicist who has published approximately 70 papers in international refereed journals. He originally worked on problems involving intermolecular forces in rare gas crystals, which involved comparing experimental data of isotherms and 2nd and 3rd order elastic constants, with those calculated theoretically with various two and three body forces. This also involved developing methods for dealing with the lighter rare gases such as helium and neon in which quantum effects are no longer negligible. In this work he met lattice sums and thus slid inexorably into that field and its mathematical offshoots. He has remained entrenched there ever since. He is currently a Visiting Fellow in the Department of Physics at King's College, London and he is a member of the London Mathematical Society.

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