

*SYMMETRY AND ELECTROMAGNETIC INTERACTIONS  
OF FIELDS WITH MULTISPIN*

**Symmetry and Electromagnetic Interactions of Fields with Multispin** – S. I. KRUGLOV, Nova Science Pub Inc, Hauppauge NY, 2000. Un volume de 215 pages.

This book provides a welcome addition to the extensive literature that deals with relativistic wave equations. Most treatments of

relativistic wave equations that appear in standard texts are limited to the Klein-Gordon and Dirac fields; infrequently the spin-3/2 Rarita-Schwinger or the spin-2 tensor field are encountered. There is however a class of wave equations in which the wave function is not associated with a unique spin, but rather can be decomposed into different

representations of the Lorentz group associated with different spins. These "multispin" fields are what receive extensive examination in this book. Fields containing spins (0,1) and (1/2,3/2) receive special attention.

The field equations encountered are extremely general as assumptions usually built into standard analysis of wave equations are dropped. For example, the Lagrangian considered for a vector field in this book is not simply taken to be the usual one of Maxwell, but rather it is the most general bilinear in the fields that can be constructed using at most two derivative operators. An exhaustive treatment of the consequences of such actions then follows. Decomposition of the wave function into normal modes

and quantization through identification of these modes with creation and annihilation operators is examined. The problem of dealing with negative norm states that consequently arise is clearly stated, though not fully resolved. This is regrettable, as it is demonstrated that the wave equation

posses an unusual gauge invariance under a non-compact gauge group which does not commute with the Lorentz transformation,

In recasting the coupled wave equations for fields being considered into a unified first order form, interesting algebras are derived, such as the Petiau-Duffin-Kemmer algebra. Quaternions are employed to further explore the group structure and invariances of these field equations. Supersymmetric extensions are presented. The masses of various spin components of the multispinor field are derived and related to a mass formula that arises in QCD.

An analysis of the Maxwell equation when the field strength is expressed as the sum of the curl of one vector potential

and the dual of the curl of a second vector potential is performed; quantization of this model is studied and consequences of having both magnetic and electric sources for this field that posses duality are examined. The vector field is itself given an electric charge and consequences of this are analyzed, showing how magnetic moments and quadrupole electric moments can be ascribed to this field and solutions are given to the field equations in certain specific electromagnetic backgrounds. Wave equations for higher spin fields (indeed fields with arbitrary spin) in the presence of an electromagnetic background are presented in first order form, and the problem of pair production of higher spin particles in a background of a constant electric field is taken up.

The preceding is but a partial list of the topics dealt with exhaustively in this book. The novelty of many of the results presented certainly provides ample motivation to pursue questions that naturally arise in the discussion of multispin fields. Possibly foremost is the question of having a fully satisfactory way of quantizing these fields in a way that is consistent with unitarity without breaking the invariances inherent in the classical field equations. This would entail elimination of negative norm states from the physical spectrum. Once this problem is resolved, constructing a realistic phenomenological model, capable of incorporating the experimental results currently accounted for by the so-called "standard model", would be of paramount importance.

It is well worth noting that this book is written exceptionally clearly; both physical and mathematical arguments are carefully outlined making it possible to appreciate how conclusions are reached, their significance as well as limitations. An exhaustive list of references allows the reader to

seek more detailed information about various aspects of the topics discussed.

Hopefully the results presented in this book will receive close attention and that it will stimulate further fruitful discussion.

D.G. McKeon

*The University of Western Ontario*  
*Department of Applied Mathematics*  
London, Canada