



AO Bonut

To Asim Orhan Barut on His Sixty-Fifth Birthday

Asim Orhan Barut published his first scientific paper in 1951 under the title “Die Laufzeit, Elektronenbahnen, Kathodenfeldstärke und Potential der Raumladungsdioden für jede Anfangsgeschwindigkeit, Anfangsrichtung und Strom” [*Z. Angew. Math. Phys.* **2**, 35 (1951)]. From that date onward he has successfully probed some of the most complex workings of nature in both the classical and quantum domains and exceptionally enriched our knowledge in nearly every area of modern theoretical and mathematical physics. The early focus of his researches has been on electron theory and scattering theory—classical and quantum, nonrelativistic and relativistic, and both at low and high energies—and this program has enabled him to develop, with meticulous care, highly innovative models for the structure of composite dynamical objects. His physical approach is grounded in classical and quantum field theories; his mathematical tools are complex analysis for one and more variables and representations of compact and noncompact Lie groups. Rigorously pursuing this method of attack, Barut’s papers have frequently produced startling new conclusions and laid the foundation for further investigations.

Many and varied are the innovations to the world of mathematical and theoretical physics made by Asim Barut. Indeed, the catalog of fundamental contributions in this domain that bear his name and those of his collaborators is seemingly without end. Here we shall be content to list only some of those entries that have come to enjoy a conspicuously permanent character:

- The octet symmetry diagrams for mesons and baryons, published in 1958. These octet diagrams are exactly the same as in the subsequent $SU(3)$ models.
- The earliest construction of invariant scattering amplitudes using the representations of the Poincaré group. It is well known that this work has initiated a whole new field in particle physics.
- Introduction of the quantum action principle for higher-order Lagrangians.

- Pioneering work on the theory of complex angular momentum in relativistic field theory.
- The construction of irreducible $(2j + 1)$ -component spinors and the analytic continuation of amplitudes in angular momentum with spin. These spinor constructions were later employed in the development of wave equations.
- The S-matrix theory of electromagnetic and weak interactions—an advance earlier thought to be impossible due to the long-range nature of the forces involved. Within the framework of this S-matrix theory, the first derivation of the electron's anomalous magnetic moment, corresponding to $g - 2 = \alpha/2\pi$.
- Introduction and development of the theory of “dynamical groups,” which initiated a new algebraic structure in mathematics and many successful applications in atomic, nuclear, and particle physics.
- The $O(4, 2)$ model for hadrons, the H atom, and leptons. This model has been successful in predicting the dipole form factor of the proton as well as the mass spectrum that have experimentally been verified at SLAC up to the highest realizable energies.
- Construction and study of new relativistic infinite-component wave equations capable of describing the structure of dynamical composite particles as single relativistic objects and the (long and meticulous) evaluation of all intrinsic properties of such objects.
- A new magnetic-charge model for the proton, called “dyonium,” and the concept of an anti-selection rule for magnetic monopoles.
- The first introduction of a coherent-state representation of the noncompact group $SU(1, 1)$. This study has been generalized to arbitrary semisimple Lie groups, with applications in quantum field theory and quantum optics.
- A new way of looking at the periodic table of elements, incorporating Madelung's rule and its $O(4, 2)$ -group symmetry.
- Formulation of “algebraic scattering theory” and application of noncompact groups to scattering.
- Introduction of the concept of “dynamical electromagnetic string” and the extension of Dirac's second paper on monopoles, as well as the field theory of strings with mass points at their ends.
- Discovery and study of a class of completely integrable N -body problems in three dimensions.

- The concept of “compact dynamical systems.”
- Discovery and formulation of a finite nonperturbative “self-field quantum electrodynamics.” The calculation of the Lamb shift and all other radiative effects opened up new directions for exploring the foundations of relativistic quantum electrodynamics.
- A classical spinor model of the Dirac electron with *Zitterbewegung* and a generalization of the Lorentz–Dirac equation to include spin.
- New covariant two- and many-body equations in QED.
- Initiation of a new deterministic “quantum theory of single events,” distinct from the standard probabilistic quantum mechanics, along with an accompanying resolution of quantum paradoxes.

Asim Barut has authored or co-authored more than 500 scientific papers in refereed journals, and his publication list includes several books. Thus the synopsis given above of some of his major contributions is by no means complete. Four of his books are considered to be classics: *Electrodynamics and Classical Theory of Fields and Particles*, *The Theory of the Scattering Matrix*, *Dynamical Groups and Generalized Symmetries*, and *Theory of Group Representations and Applications* (coauthored with R. Raczka). These monographs have appeared in several editions and in several languages, including Chinese and Russian.

A frequent guest at the Trieste International Centre for Theoretical Physics from its very beginning, Asim Barut has been instrumental in fostering an abiding enthusiasm for scientific research in many young scholars visiting this institution, not only from the developed countries but also from the developing and underdeveloped world. A rare and eclectic combination of traits indeed, Asim Barut is not only highly respected for his scholarly achievements but also loved and admired on a personal level by everyone who makes his acquaintance, whether briefly or over the course of many years.

The contributors to the present set of festive issues of *Foundations of Physics*, all among the friends, past students, and other collaborators of the honoree, appropriately represent to a significant degree many areas of physics and mathematics alike. Speaking also on their behalf, let us say, in warmly congratulating Asim Barut on his sixty-fifth birthday, that we admire his remarkable scholarship, his vitality, his humanity, his clear vision, his uncanny ability to coherently mold several facts into a single, harmonious whole, and his organizational ability—in the matter of science and beyond. We heartily concur with Philip Burt of Clemson University

that “his career has been distinguished by its scope in theoretical and mathematical physics; in addition, Asim’s charm and friendly concern for young physicists, his organizational activities, and his warmth and kindness have enriched the lives of his colleagues throughout the scientific world.” From a broader, historical point of view, we, as editors of the special “Barut” issues of *Foundations of Physics*, are thankful for the opportunity they provide to celebrate and illustrate one man’s mastery of deep physical insights into nature, made possible in no small measure by his equally masterful command of the pertinent mathematical language.

Asim, we all love you. Happy birthday and very many happy returns!

Akira Inomata, *State University of New York at Albany*
Ray Wilson, *The University of Texas at San Antonio*
Alwyn van der Merwe, *University of Denver*