

**Awarding of the Wigner Medal for 2002 to Prof. H.J. Lipkin, of the
Weizmann Institute of Science Rehovoth, Israel**

Laudatio,
composed and read by Y. Neeman on behalf of the
Group Theory Foundation

Ladies and Gentlemen,

ICGTMP 24 is the first conference in the ICGTMP series in the XXIth Century. To a large extent - although not yet entirely so - XXth-century physics has fulfilled the *cloud-clearing* task assigned to it by Lord Kelvin in his April 1900 speech before the British Association in Brighton. Assessing the means used in the process of reconstruction, in laying new foundations, in the making of the new physics - we realize *the importance* and *the power of the algebraic methodology* to which we have dedicated this series. The XIXth Century gave us Group theory, invented by two pairs of youthful figures - the tragic pioneers - Evariste Galois and Hendrik Abel - and the luckier pair, Felix Klein and Sophus Lie. Emmy Noether then provided a link to the *variational* approach in Physics and thereby readapted and repowered that ancient tool, connecting it as the harbinger of Symmetry, to the sometimes (though not always) dynamically perceived Conservation Laws. The variational method had been launched by Aristotle, used by Heron, reintroduced by Fermat and by Young, mathematically sharpened by Leibniz, Bernoulli, Euler, Lagrange and Maupertuis, broadened by Hamilton and Jacobi. It was now used in clearing both of Kelvins clouds, though much more so in the Quantum case. Pauli applied it to the hydrogen spectrum and the algebraically-inspired Matrix Mechanics appeared as an alternative to Schroedingers calculus-based approach. Moreover, it thereby included from the start the extension of the concept of symmetry beyond that which is explicit in the input data - namely to Dynamical Degeneracy Groups (DDG), such as the SO(4) arising in hydrogen as the quantized Kepler problem.

Hermann Weyl strengthened the new algebraic foundations and Eugene Wigner became the Cyrano de Bergerac who first used that sword massively for good causes.. One after the other, the various *levels of matter in the micro* were conquered by the spectroscopic approach in this drive as initiated by Wigner - *atomic, molecular* - followed first by *nuclear* spectroscopy and then, in the early Sixties, *hadron* spectroscopy in particle physics.

The symmetries were those of the Hamiltonian, until 1959 when there occurred a great leap forward, namely the discovery of *spectrum-generating algebras* (SGA) or *spectrum-generating groups* (SGG), by **Prof. Harry J. Lipkin of the Weizmann Institute of Science in Rehovot, Israel**. Professor Lipkin, at that time already considered as a leader in the derivation of symmetries of the Hamiltonian, had now generalized his treatment and discovered, in an article with his then student S. Goshen, the novel algebraic method of a SGG which they applied to nuclear and many-body physics. The context was that of the *harmonic oscillator* in $d = 1 \cdots 3$ dimensions and for 1 to N oscillators. Aside from the conservation of angular momentum - denoting an *explicit* SO(3) symmetry - and the U(3) DDG displayed by the oscillators solutions - it was now shown that *the entire set of solutions forms one infinite-dimensional representation* of Sp(3,R), an SGG whose generators are given by the algebra of double-quanta such as $a_i^+ a_j^+; a_i^- a_j^-; a_i^+ a_j^-$, describing giant monopole vibrations or breathing modes in a many-body system. It has been applied in nuclear physics and in the study of Bose-Einstein condensates.

Goshen and Lipkin had introduced a method which, after it had been rediscovered five years later by Dothan, Gell-Mann, Neeman and by Barut and Bohm, was extended to relativistic particle physics. This was in the nineteen-sixties, during the apparent crisis in

Quantum Field Theory; in view of the on-mass-shell and highly phenomenological methods of Dispersion Relations, the SGG concept was grabbed as a lifebuoy, in the expectation that it might provide a framework for dynamical considerations. This need vanished in 1971, with the successful renormalization of Yang-Mills gauge theories (broken and unbroken). Yet there remained a prominent survivor from the Dispersion era, namely the Superstring. Although this relates to an off-mass-shell methodology, in a sense going beyond Quantum Field Theory, the study of the relevant spectrum is still managed with SGG methodology.

In Particle Physics, Lipkin was the initiator of a very successful drive aiming at extracting the maximal amount of predictive results from both candidate SU(3) symmetries of the early Sixties, the Sakata triplet and the Octet with its structural quark triplet. The triplet Levinson-Lipkin-Meshkov displayed skill and thoroughness in its assault on these models and were the first (1962) to point to an experimental test in the annihilation of $p + \bar{p}$ into two mesons which could clearly distinguish between the two models - a test in which the Sakata triplet failed and which the octet definitely passed. In 1965, Lipkin (with F. Scheck) pushed through a thorough exploration of the Quark Model.

In nuclear and many-body physics, Lipkin developed the methodology for a separation of the *collective* from the *individual* particle degrees of freedom, overcoming in a creative and imaginative way the difficulties generated by the Pauli Principle. Another class of contributions, such as the Lipkin-Meshkov-Glick two-shell SU(2) model, is used nowadays in nuclear and condensed matter physics because of the light it sheds over the dynamical set-up.

The Wigner Medal is awarded for “outstanding contributions to the understanding of physics through group theory”, and is certainly fully warranted here. But in this case, it is impossible not to mention two other very special aspects, namely (1) Lipkin’s didactic contributions, popularizing difficult topics, in his for “pedestrian” series of books - and (2) his humoristic contributions, mostly via the *Journal of Irreproducible Results*, of which he was, with A. Cohen, one of the two central pillars.