Scientific communications

Besides the plenary talks, various other contributions were presented at the conference. We also enumerate them with abstract in the order they were placed in the programme.

Fernando Bartolomé (Zaragoza): Racah Algebra and Sum Rules in magnetism in Solids

The basic theoretical principles of atomic spectra were published in 1935 by Condon and Shortley in the classic book "The Theory of Atomic Spectra". The group-theoretical methods of Giulio Racah, presented in the series of four classic Physical Review papers "Theory of Complex Spectra" enabled the application of atomic theory to systems of broad interest. In particular, the multiplet calculations, allowed by the implementation of Racah and Judd's methods into a workable code for radiative transitions by Bob Cowan in the sixties, have enabled the understanding of complicated core level spectra of transition metal, rare earths and actinide compounds, including x-ray absorption, photoelectron emission, and Auger spectroscopies, among others. The magnetism of compounds and molecules containing 3d and 4f ions was also understood, at least qualitatively, by "crystal field" calculations. In parallel, the Racah methods and the "Cowan code" paved the way to the extremely fruitful Theory of Simple Spectra by Theo Thole: the study of the integrals instead of the details of the x-ray absorption spectral lines allowed the study of branching ratii and the stablishment of the so-called sum rules by Theo Thole and Paolo Carra. The sum rules allow the separate determination of orbital and spinorial magnetic moments. The talk will review the impact of the sum rules in modern magnetism of solids, and some future trends will be discussed, including developments in nanomagnetism, electron microscopy and quantum phenomena.

Joaquín Sánchez-Guillén (Santiago de Compostela): Abelian Ideals and Infinite Conservation Laws

In the generalization of the zero curvarture integrability to any dimension by the author with Alvarez and Ferreira, we show how the flatness follows generally when the relevant d-1 dimensional antisimetric tensor takes values in an abelian ideal of a Lie algebra and it is covariantly constant. When these conditions are the equations of motion of a field theory, the representations of the nonsemisimple algebra provide ifinite conserved currents given by the adjoint action , which also have a continuum expression with interesting geometrical properties. Relevant applications for sigma and Skyrme type models are given.

Juan Mateos (Salamanca): Supersymmetric Quantum Mechanics of Integrable Systems

In standard supersymmetric quantum mechanics the Hamiltonian factorizes as the anti-

commutator of the supercharge and its adjoint. Search for the spectrum of energy eigenfunctions is accordingly very easy in SUSY quantum mechanical systems of one degree of freedom. If there are more than one degree of freedom usually factorization is not enough to find analytically the spectrum. I will describe how to deal with the spectra of SUSY extensions of integrable systems. In particular, I plan to present SUSY extensions of the Kepler, the Euler two Newtonian centers, and the Neumann problems.

Luis Joaquín Boya (Zaragoza):

We frame the definitions of $3j$, $6j$ and $9j$ (Racah-Wigner) symbols for arbitrary tensor products of irreducible representations of compact (mainly simply reducible) groups. Some interesting facts on their properties are discussed.

Mariano del Olmo (Valladolid): q-Coherent States of the Harmonic Oscillator

The time-evolution of the quantized version of the harmonic oscillator obtained through a q-dependent family of coherent states is studied. The semi- classical phase trajectories present interesting features when 1/q is a quadratic Pisot number.

Maria Luisa Sarsa (Zaragoza): Nuclear and Particle Physics at the Canfranc Underground Facility

Underground facilities around the world are devoted to very sensitive experiments impossible at surface level laboratories. The main lines of research are: neutrino physics, direct search for dark matter, nuclear astrophysics and very rare decays (as proton decay) but also new and interesting topics are coming into scene, life under extreme conditions and geological studies are some examples. The Canfranc Underground Laboratory has a 25 years experience in underground physics: starting as two small 10 m^2 labs has recently become one of the few Spanish ICTS (scientific and technological singular facility). Previous efforts in the search for the neutrinoless double beta decay and the galactic dark matter carried out at Canfranc will be reported as well as current experiments and prospects for the future. In between, the relevance of the studied topics in the frame of the Nuclear and Particle Physics will be stated.

Hubert de Guise (Lakehead): $\mathfrak{su}(1,1)$ Intelligent States: Construction and Squeezing

In this contribution I will show how the basic intelligent states of the algebra $\mathfrak{su}(1,1)$ can be easily constructed for the $k = 1/4$ and $k = 3/4$ representations. Two such realizations are then combined to obtain intelligent states for higher k irreps: it will be shown in particular how an $\mathfrak{su}(1,1)$ intelligent state can, for an arbitrary realization, be constructed by combining a "squeezed" vacuum with an appropriately prepared superposition of Fock

number states. A simple application to squeezing of $\mathfrak{su}(1,1)$ observables will be discussed, illustrating some unorthodox properties of $\mathfrak{su}(1,1)$ squeezing and the difficulties in properly defining this concept in $su(1,1)$. In particular it will be shown that $\mathfrak{su}(1,1)$ squeezing can occur in single-particle $\mathfrak{su}(1,1)$ representations ($k = 1/4$ or $k = 3/4$), thus suggesting that squeezing is not necessarily due to multi-particle quantum correlations.

Mariano Santander (Valladolid): Division Algebras, Composition Algebras and Triality

Division algebras are alternative $*$-algebras over the reals admitting a positive definite quadratic form with the composition multiplicative property. There are only four such algebras ($\mathbb{R}$, $\mathbb{C}$, $\mathbb{H}$, $\mathbb{O}$). The octonion algebra, the eccentric member of the family, displays further a surprising triality, which is apparently an specifically octonionic property. Among other things, this triality is somehow behind some of the known constructions of the exceptional Lie algebras out of the octonions.

Triality is however not a specific property of octonions; instead it rests on alternativity and on the composition property; thus the essential token in the triality is not 'to be octonionic' but to be 'composition alternative $*$-algebra'. Here we discuss in gore detail this question, reaching triality in a direct and constructive way for all composition alternative $*$-algebras over the reals. In addition to $\mathbb{R}$, $\mathbb{C}$, $\mathbb{H}$, $\mathbb{O}$, these algebras include only the split variants of complex, quaternions and octonions, denoted ($\mathbb{C}'$, $\mathbb{H}'$, $\mathbb{O}'$) and we discuss for all these the structure of several Lie algebras related with these alternative composition algebras.