



# Examen de Grado

Para optar al grado de Doctor en Ciencia con Mención Física

## LUIS INZUNZA MELO

### “Hidden symmetries and nonlinear (super)algebras”

The relevance of hidden symmetries is explored at the level of classical and quantum mechanics in a variety of physical systems related to conformal and superconformal invariance. Hidden symmetries, that correspond to nonlinear in momenta integrals of motion, generally lead to nonlinear algebras.

First, analyzing the  $\mathfrak{sl}(2, \mathbb{R})$  symmetry, it is concluded that both the asymptotically free (at infinity) and the harmonically confined models are two different forms of dynamics described by the same symmetry algebra. A mapping between these two dynamics is constructed, and its applications are studied in one-, two- and three-dimensional systems.

Second, rational extensions of the conformal mechanics model of de Alfaro, Fubini and Furlan (AFF) are derived by employing the generalized Darboux transformation. In general, the obtained systems have an almost equidistant spectrum with some gaps inside, and their spectral properties imply the presence of hidden symmetries. The supersymmetric extensions of the AFF model are also studied, and the origin of the hidden bosonized superconformal symmetry of the quantum harmonic oscillator is established.

Finally, a three-dimensional generalization of the AFF system is considered. The model describes a particle with electric charge  $e$  in Dirac monopole background of magnetic charge  $g$ , and subjected to the central potential  $\frac{mw^2}{2}r^2 + \frac{\alpha}{2mr^2}$ . When  $\alpha = (eg)^2$ , the classical trajectories are periodic for arbitrary initial conditions and at the quantum level, the spectrum acquires a peculiar degeneration. These characteristics are described by hidden symmetries, which can be obtained from the model without harmonic term by means of the mentioned mapping. A complementary spin-orbit coupling term gives rise to a supersymmetric extension of the system, characterized by superconformal symmetry. The spectrum-generating operators of the new model are shown to be nonlocal.

#### Comité de Tesis

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