Hadron spectroscopy and the new unexpected resonances

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Villas de Paraty

Scientific Program

Brazilian-German WE-Heraeus Seminar on "*Hadron spectroscopy and the new unexpected resonances*"

Spectroscopy is a time-honored and generally a very powerful tool in physics. Spectroscopy experiments have led, for example, to the development of quantum mechanics and the quark model. On the other hand, if we really understood the strong interaction spectrum with the underlying theory, namely Quantum Chromodynamics (QCD), hadron spectroscopy would be merely a standard procedure of collecting more data rather than a challenging and exciting enterprise.

In fact, the contrary seems to be the case and over the past decades we have witnessed an increase of open problems. In particular, in QCD the colored forces allow for various net-colorless combinations of quarks and gluons beyond the well known mesons and baryons. Exotic particles are, amongst others, glueballs solely made of constituent gluons, hybrids in the form of antiquark-quark states with additional gluonic degrees of freedom, as well as compact multi-quark objects and weakly bound molecular states of hadrons.

In the past two decades, many exotic meson- or baryon-like states, still requiring a proper theoretical interpretation, haven been experimentally established. Lattice and functional nonperturbative approaches to QCD provide candidates for gluonic excitations, such as hybrids or glueballs, and effective theories describe or predict many new states in terms of hadronic molecules. To pin down the nature of the many exotic states with experimental data is a difficult task and belongs to the current hot topics in hadron physics.

Spectroscopy

Electromagnetic Form Factors

Heavy Mesons and Quarkonia

Exotics and Glueballs

Tetraquarks and Pentaquarks

Molecular Bound States

Effective Field Theory

Lattice QCD

Functional Methods in QCD

Quark Models