**ANNOTATION**

of thesis presented for the degree of Doctor of Philosophy (PhD) in the “6D060400–Physics”

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**Properties of the heavy and exotic mesons in a relativistic quark model**

**Actuality of the theme.** One of the actual problems of modern research of micro worlds to study the structural features of quantum systems. Each discovery of structural composes and knowledge of the mechanism of formation of the microworld enabled the creation of modern high-tech. Now days in the large international research centers of the world are intensive studying the structure, formation and interaction of hadrons. There are numerous international collaborations in these areas. In particular, the Large Hadron Collider (LHC) –it works on the study of the quark structure of hadrons and the mechanism of the transition from the quark-gluon phase to the hadrons phases.

This dissertation devoted to the study of the structure of hadrons, namely, to study the quark structure and properties of exotic X (3872) meson, with a mass of 3872MeV.

Currently quark structure and properties of hadrons consisting of a quark-antiquark and three- quark are well understood. So first of all exotic X (3872) meson is treated as a quark- antiquark state, which consists of "c" of quarks. It is known that the spectrum of charmonium can be calculated within the framework of the non-relativistic quark model. All predicted charmonium below the threshold of production of particles with open charms at experimentally. Above the thresh old found only five states: one of them, called-meson, quite well established and is observable in several different reactions by several independent collaborations. New states in particularmeson, is very narrow, and its massis close to the thresholds of meson. These facts are not consistent with the predictions of the quark model. Thus, X (3872) -meson can not be composed ofquarks. The most likely candidates would be  either charmonium states. However, the state is significantly below 3872 MeV, and the state is slightly higher. Therefore, in literature extensively discusses the interpretation ofmeson as hadron molecules or as tetraquarks.

**The aim of the dissertation:** study the quark structure and mechanism of formation of a bound state of -meson, definition of the width of its radiative decay and other characteristics, Calculation of the transition form factor of transitions in a full kinetically region of the momentum transfer, the calculation of the width of the nonleptonic decays of mesons such as:  and in the relativistic quark model with infrared confinement.

**The object of investigation:**-meson as tetraquark bound state and  - meson.

**Methods of investigation** are theoretical - a covariant quark model. The covariant quark model is an effective quantum-field approach in description of the properties and interactions of hadrons, both at high and at low energies. A distinctive feature of this approach is that the multiquark states such as baryons tetraquark, etc., may be considered and described in the same level of rigor as simple quark-antiquark systems.

**Scientific novelty** including:

1. For the first time covariant quark model with infrared confinement was used to describe the four-quark bound state.
2. For the first time for four quark bound state introduced the electromagnetic interaction with the P-exponent Mandelstam ensures gauge invariance. As part of this approach is calculated one photon transition exotic X (3872) meson.
3. For the first time on the basis of calculating the width of the strong decays of the exotic meson  and  showed that D meson can be a four-quark bound state.
4. For the first time we calculated the form factors  transitions throughout the kinematic region of the square of the momentum transfer. We calculated the width of the non-leptonic  и  decays.

**The main results are including:**

1. Performed an independent analysis of the properties of the X meson assuming that the state is tetraquarks.
2. As a theoretical basis is used relativistic model of constituent quark staking into account their confinement. Further is used a shorter name for this approach-a covariant quark model, which reflects more of its essence, as this model is based on quantum field theory with particle production
3. In the framework of this approach has been analyzed in detail the radioactive decay. Was calculated matrix element of this transition and it is proved its gauge invariance. Then we calculated the width of this decay and found an agreement with the experimental data.
4. In the framework of the covariant quark model with infrared confinement transition form factors are calculated in the whole kinematic region of the square of the momentum transfer. As an application of the results obtained, the widths of the non-leptonicand decays are calculated.

 **Theoretical and practical meaningfulness of the work:** At the present time, the major research centers in the world, such as LHC and Tevatron, intensively conduct experimental studies on the properties and mechanisms of formation of hadrons, i.e. the transition from quark to hadrons phases. There are also large international collaborations, such as BaBar, Belle, CDF and DØ. In these experiments are mainly studied exotic and rare decays of B-mesons, in which may be opened new laws of the micro world, in particular, chiral symmetry violation. To describe these experimental results obtained, both at high and at low energies it is devoted a lot of theoretical papers. However, these works are mainly devoted for describing only a narrow circle of events. Thereby, the description of in a unified way of these processes is of great theoretical interest. These studies provide an opportunity to understand the structure and mechanism of the interaction of the fundamental constituents of the micro particles.

X (3872) meson is unique among the exotic states. At the moment, themeson is widely studied and requires more experimental researches. A narrow resonance, similar in properties to the charmonium, was opened in 2003 by Belle collaboration in the  reaction. This resonance decays into  and has a mass , which is close to the threshold of production of  and  mesons. It has been found that its width is less than 2.3 MeV to 90% confidence level. This condition was soon confirmed by BaBar collaboration in -collisions at the Tevatron at Fermilab in the CDF and DØ.

Kazakh theorists also conduct intensive research in these areas and work closely with scientists from major research centers, and the results are quite competitive on the international level. This is evidenced by scientific publications in international journals with high impact-factors, and thus shows a high technological level of this dissertation.

**Implementation degree:** the basic results of the dissertation are published in

22 papers (14 articles and 8 abstracts) 3 articles of them are published in the journals included in Thomson Reuters data base, 10 articles are published in the journals recommended by the Committee of control in the region of education and science of the DES of the Republic of Kazakhstan, 7 theses are published in the collected papers of international conferences including the distant abroad.