Current collaboration between PNPI and COSY.

Measurements at ANKE spectrometer

Recently a group physicists of Laboratory of meson physics and a condensed matter PNPI take a part in the investigations at ANKE spectrometer. Topics of these measurements are:

- Investigation of ω- and φ-meson production in *pn*-interactions close-to-threshold and experimental prove of Okubo-Zweig-Izuka (OZI) rule in this channel;
- Test of an isospin invariance in Λ- и $\Sigma^{0,\pm}$ -hyperons production in *pp*- and *pn*-interactions;
- Investigation of a *Λ(1405)*-resonance and antikaon interactions with nucleons and light nucleus in the reaction of K^+K^- and $K^+\bar{K}^0$ pair production close-to-threshold;
- Investigation of the φ-meson's properties modification in nuclear matter.

The main goal of this studies is an experimental investigation of light mesons and hyperons production using ANKE spectrometer, which placed at COSY synchrotron. Investigation of meson production in nucleon-nucleon *(NN)* interactions, where number of partial wave in process is suppressed, helps one to get an important information about *NN*-interactions, because in this case theoretical interpretation of the data is simple.

Last years several experiments on measurements ω- and φ-meson production cross sections have been done (mostly in ANKE experiment). Recently a ratio $\sigma_\varphi/\sigma_\omega$ is well determined for the case of *pp*-interactrions. It is 6 ± 2 times higher than R_{OZI}, but further interpretation of this result requires detailed studies of the productions mechanism. However it should be mentioned that last measurements of differential cross sections (COSY-TOF, ANKE) do not show large anisotropy of meson's yield at excess energy of 90 MeV, which is predicted by calculations which claims that $\sigma_\varphi/\sigma_\omega$ could be 4.5 larger than R_{OZI} without strange quark component in nucleon. In order to define the production mechanism a comparison of cross sections in *pp*- and *pn*- isospin channels is vey impornant. Now precision measurement of the $pn \rightarrow d\varphi$ reaction total cross section (test of OZI-rule) as well as obtaining angular distribution (which depends on mechanism) for this process are needed. High statistical measurements for these process has been done in July 2008. Deuteron cluster target together with detection of spectator protons in silicon detectors were used as a sourse of quasi-free neutrons. These data samples are analyzing now.

Second topic for investigation is systematic studies of Λ- and $\Sigma^{0,\pm}$-hyperon from initial states which are characterized by different isospin. Reactions with light neutral hyperon production (Λ^0, Σ^0) in *pp*-collisions are well studied at present. Data about these reaction obtained at ANKE

spectrometer is in a good agreement with world data. However results of ANKE collaboration on measurement $pp \to nK^+\Sigma^+$ reaction close-to-threshold which are now published do not show breaking of isospin invariance. It should be mentioned that these results are obtained by several methods which coincide between each other. Next stage of these studies will be a measurement of production cross sections for Λ- and Σ^--hyperons in *pn*-collisions. These experiments allow to test isospin invariance in unmeasured channel and will give new data, which is needed for determination of mechanisms of hyperon production. First data sets were obtained in parallel with measurements of $pn \to d\varphi$ reaction. They show that events form $pn \to pK^+\Sigma^-$ reaction could be identified. Total statistics is enough to determine cross section in the excess energy range between 40 and 140 MeV. Now a new experiment which allows to investigate this reaction at low excess energies (<40 MeV) is planned. In parallel new cross section of Λ-hyperon production in the reaction $pn \to nK^+\Lambda$ will be measured.

Third topic is investigation of kaon-antikaon pair production in *pp*-, *pn*- and *pd*-collisions. This will allow to determine mechanism of interaction between antikaons and nucleons (or light nucleus), where deeply bound states are possible. Specifics of these interactions could become strongly apparent in the close-to-threshold regime as final state interactions for the reactions of type $NN \to NNK\bar{K}$. First studies of these processes have been dona at ANKE spectrometer in 2004 – 2009. It was shown that $\bar{K}p$-, $\bar{K}pp$- and $\bar{K}d$ final state interactions are rather strong and coinside with results obtained in studies of kaonic atoms. For 2010 – 2012 new high statistical measurements for $pp \to ppK^+K^-$ reaction are planned. As a result K^-p scattering length will be determined with good precisions. These studies will also give a new information about interactions between nucleons and φ-mesons. For this period new measurements of $pd \to {}^3\mathrm{He}K^+K^-$ reaction is also planned. This data allow to extract $K^-{}^3\mathrm{He}$ scattering length and probably shed a light on possibility of existing of deeply bound state in this system. Some characteristics of $pd \to {}^3\mathrm{H}K^+\bar{K}^0$ reaction also could be determined.

Fourth topic of ANKE activities is modification of hadron's properties (mass, width and coupling constants) in nuclear matter, which could be measured by registration of low momentum component in the reactions of type $p\mathrm{A} \to K^+K^-\mathrm{X}$, wher A = C, Cu, Ag and Au. This work allows to measure K^--nucleus potential and get access to the unknown information about φ-mesons in nuclear matter (because of φ-meson decay to K^+K^--channel in 50% cases). A correlation experiment, when high momentum particles (*p*, *d*, ^{3}H, ^{3}He and ^{4}He) are detected together with K^+K^--pair is also possible. Such measurements will give a new information about mesosn production mehanisms in nucleon-nucleus collisions..