Vector meson production in collisions of nucleons

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Vector meson production in collisions of nucleons has remained largely unstudied well into the 1990ies, when the experimental tools became available that finally allowed detailed studies in the vicinity of the production threshold. A series of experiments at the Saturne facility [1,2] inspired in-depth theoretical considerations [3,4,5]. For a while, it appeared conceivable that the relative cross section for the production of the isoscalar members of the vector meson nonet in SU(3), the ω and ϕ mesons, would hold rather direct information on the strangeness content of the nucleon via the so-called OZI rule violation [6]. Since the ω wave function is almost exclusively composed of up and down quarks, while the ϕ is $s\bar{s}$ apart from a tiny admixture of $u\bar{u} \oplus d\bar{d}$, the cross section ratio R=$\sigma_\phi/\sigma_\omega$, the ϕ production should be largely suppressed. Thus, a small ratio of R=$4 \cdot 10^{-3}$ is expected because the mixing angle, $\Theta_V \approx 39^o$, deviates by 3.7^o only from that of a perfectly decoupled system in SU(3), $\Theta_V = 35.3^o$.

However, as was pointed out early on, the picture purely based on meson exchange may not describe all details of the production mechanism [7]. While for the nucleonic currents, the OZI argument may be appropriate, for meson exchange currents involving e.g. $\rho\pi\omega$ and $\rho\pi\phi$ vertices it is not. Furthermore, it is widely believed that a number of resonances, some of them perhaps not yet known to date, couple to the $N\omega$ system, while others may exist that decay into $N\phi$, so that again different contributions not related to OZI may arise. Therefore, any conclusion concerning the OZI violation is at least premature as long as the reaction mechanism for the production of vector mesons has not been studied in detail. In a first step, ω production in proton-proton collisions was studied at COSY [8]. The theoretical description of the data favors resonant contributions to the reaction [9]. This finding is in line with a very involved partial wave decomposition of πN reaction data [10], which concluded that a series of N^* resonances contributes to the ωN channel near-threshold. A novel approach to the theoretical description of $NN\omega$ and $NN\phi$ solely relies on resonance contributions [11].

While there is evidence for resonant behavior in $NN\omega$, a direct proof has yet to be found. A number of experiments at COSY focusses on the production of ω and ϕ mesons both in elementary NN as well as more complex channels involving bound nuclear systems such as deuterons and ^{3}He [12]. For a deconvolution of partial waves, the polarized beam at COSY offers an additional degree of freedom, which may prove crucial in the future.

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