We discuss the possibility to use the $pp \to pp\phi\phi$ process in identifying the odderon exchange. So far there is no unambiguous experimental evidence for the odderon, the charge conjugation $C = \bar{1}$ counterpart of the C = 1 pomeron, introduced on theoretical grounds in [1]. Last year results of the TOTEM collaboration suggest that the odderon exchange can be responsible for a disagreement of theoretical calculations and the TOTEM data for electron-proton scattering [2]. Here we present recent studies for central exclusive production (CEP) of $\phi\phi$ pairs in proton-proton collisions [3].

We consider the pomeron-pomeron fusion to $\phi\phi$ ($P^T \to \phi\phi$) through the continuum processes, due to the $\ell$- and $d$-channel reggeized $\phi$-meson, photon, and odderon exchanges, as well as through the $s$-channel resonance process ($P^T \to f_2(2340) \to \phi\phi$). This $f_2$ state is a candidate for a tensor glueball. The amplitudes for the processes are formulated within the tensor-pomeron and vector-odderon approach [4]. Some model parameters are determined from the comparison to the WA102 experimental data [6]. The odderon exchange is not excluded by the WA102 data for high $\phi\phi$ invariant masses. The process is advantageous as here the odderon does not couple to protons. The observation of large $M_{\phi\phi}$ and the rapidity difference $Y_{\text{diff}}$ seems well suited to identify odderon exchange.

**Abstract**

**Results**

**Formalism**

The amplitude includes the $pp$-scattering corrections (absorption effects)

$$M_{\text{pp}} = \sum_{\text{disp}} M_{\text{Born}} + \sum_{\text{absorption}} M_{\text{absorption}}(s, t, P_{\text{pp}}) = \frac{1}{4 \pi} \sum_{\text{disp}} M_{\text{Born}}(s, t, P_{\text{pp}}) + \frac{1}{2} M_{\text{absorption}}(s, t, k_2^2),$$

where $P_{\text{pp}} = P_{\text{H}} - k_1$ and $P_{\text{H}} = P_{\text{p}} + k_1$. $M_{\text{absorption}}$ is the elastic $pp$-scattering amplitude with the momentum transfer $k_2^2 = -k_1^2$.

For continuum process with the odderon exchange [diagram (c)] the amplitude is a sum of $\ell$ and $\phi$-channel amplitudes. The $\ell$-channel term can be written as

$$M_{\ell}(s, t, k_1^2) = -\frac{i}{4 \pi} \sum_{\ell} T_{\ell}(P_{\text{p}1}, P_{\text{p}2}, u_{\ell}, u_{\ell}) \phi_{\ell}(P_{\text{p}1}, P_{\text{p}2}, u_{\ell}, u_{\ell}) \times \frac{1}{4 \pi} \sum_{\ell} T_{\ell}(P_{\text{p}1}, P_{\text{p}2}, u_{\ell}, u_{\ell}) \phi_{\ell}(P_{\text{p}1}, P_{\text{p}2}, u_{\ell}, u_{\ell}),$$

where $P_{\text{p}1}, P_{\text{p}2}$ and $u_{\ell}, u_{\ell}$ are defined by the four-momenta and the helicities of the protons and $\ell_{\alpha} = 0, \pm 1$ define the four momenta and helicities of the $\phi$ mesons, respectively.

**Conclusions**

- CEP is particularly interesting class of processes which provides insight to unexplored soft QCD phenomena. The fully differential studies of exclusive $pp \to pp\phi\phi\phi$ reaction within the tensor-pomeron and vector-odderon approach was executed; for more details see [3].
- Integrated cross sections of order of a few nb are obtained including the experimental cuts relevant for the LHC experiments. The distribution in rapidity difference of both $\phi$-mesons could light on the $f_2(2340) \to \phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present. Here we used only one type of $\phi\phi$ coupling (out of 7 possible; see [9]). We have checked that for the distributions studied here the choice of $\phi\phi$ coupling is not important. This is a different situation compared to the one observed by us for the $pp \to pp\phi\phi$. $\phi\phi$ coupling, not known at present.