Photon 2015

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Book of Abstracts

Contents

DVCS and prompt photons / 53

Probing GPDs in photoproduction processes at hadron colliders.

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Ultraperipheral reactions in hadron collisions provide new opportunities to investigate the hadron structure through exclusive photoproduction processes. We review the possibility to access the Generalized Parton Distributions in the Timelike Compton Scattering process and in the exclusive production of heavy vector mesons.

DVCS and prompt photons / 81

Measurements with final-state photons in LHCb

DVCS and prompt photons / 87

Photon-hadron processes at LHCb

DVCS and prompt photons / 47

Revealing transversity GPDs through the production of a rho meson and a photon

Mr. BOUSSARIE, Renaud[1] ; Prof. PIRE, Bernard[2] ; Prof. SZYMANOWSKI, Lech[3] ; Dr. WALLON, Samuel[4]

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Transversity GPDs have yet to be experimentally unraveled. We propose to probe them by studying the electro- or photo- production of a rho meson and a photon. At dominant twist, separating the longitudinal and transverse polarization of the meson allows one to get access to respectively usual (chiral even) and transversity (chiral odd) GPDs.

DVCS and prompt photons / 40

The DVCS physics program at COMPASS

Dr. FERRERO, Andrea[1]

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A major part of the COMPASS-II program will be dedicated to the investigation of generalized parton distributions (GPDs) and transverse momentum dependent parton distributions (TMDs), which aim for the most complete description of the partonic structure of the nucleon.
GPDs are experimentally accessible via lepton-induced exclusive reactions, in particular the Deeply Virtual Compton Scattering (DVCS). At COMPASS, this process will be investigated using an high intensity muon beam of 160 GeV and a 2.5 m-long liquid hydrogen target. In order

to optimize the selection of exclusive reactions at those energies, the target will be surrounded by a new barrel-shaped time-of-flight system to detect the recoiling particles.

COMPASS-II will cover the up to now unexplored x_{Bj} domain ranging from 0.01 to 0.15. The ability to change simultaneously the charge and polarization of the muon beam will allow to access the Compton form factor related to the dominant GPD H, and thus to provide new experimental constraints on the theoretical GPD models in the intermediate x_{Bj} regime. Moreover, the x_{Bj}-dependence of the nucleon transverse size will be investigated by measuring the sum of the DVCS cross-sections corresponding to positive and negative beam polarities.

Projections on the achievable accuracies and preliminary results of pilot measurements will be presented.

Heavy flavor production / 41

ISR Studies of Charmonium Region at Belle

Dr. UGLOV, Timofey[1]

[1] *MIPT and ITEP*

An overview of the Belle studies of the hadron production with initial state radiation is presented. The talk includes results on the D(*)D(*)bar cross-section measurement as well as the results on exotic charmonium-like states search.

Heavy flavor production / 50

Heavy flavour production at HERA

Prof. KARSHON, Uri[1]

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The copious production of charm quarks at HERA has yielded a detailed understanding of QCD dynamics, the only measure of the charm contribution to the proton structure, as well as measurements of the charm mass and the fragmentation parameters of charmed hadrons. Although with smaller samples, measurements of beauty production also place constraints on the structure of the proton and allow a measurement of the beauty quark mass. Several measurements of heavy quark production using different decay modes, are presented, both new individual measurements from the H1 and ZEUS collaborations, as well as combined data. These provide a powerful vindication of the form of the gluon density in the proton derived from scaling violations of inclusive deep inelastic scattering data. QCD fits to the data lead to measurements of the charm and beauty masses and also provide precise predictions for e.g. W and Z production at the LHC. Additionally, fragmentation fractions to the ground state charm hadrons are compared to e+e- data and previous HERA results. The data have a precision similar to that of the e+e- data and support the hypothesis that fragmentation is independent of the production process.

Higgs and photons, electroweak and new physics / 30

Latest results on Higgs final-states with photons in ATLAS

Dr. YAMAGUCHI, Yohei[1]

[1] *Osaka University*

A measurement of the Higgs boson property with photon final states in proton-proton collisions with the ATLAS detector at the LHC is presented. The results are based on the data samples corresponds to integrated luminosities of 4.7 fb^{-1} at $\sqrt{s} = 7$ TeV in 2011 and 20.3 fb^{-1} at $\sqrt{s} = 8$ TeV in 2012. From a narrow resonance in diphoton mass spectrum, the mass of the Higgs boson is measured to be $m_H = 125.98 \pm 0.50$ GeV. The measured signal yield, which is a cross section times branching fraction normalised to the Standard Model expectation, is 1.17 ± 0.27. These results are based on improvements of photon energy reconstruction with the ATLAS detector.

Higgs and photons, electroweak and new physics / 43

Latest results on Higgs final-states with photons in CMS

Mr. TAO, Junquan[1]

[1] *Institute of High Energy Physics, Chinese Academy of Sciences*

Observation of the diphoton decay mode of the recently discovered Higgs boson and measurement of some of its properties are presented. The analysis uses the entire dataset collected by the CMS experiment in proton-proton collisions during the LHC running periods in years 2011 and 2012. The data samples correspond to integrated luminosities of 5.1 fb^{-1} at centre-of-mass energy 7 TeV and 19.7 fb^{-1} at 8 TeV. A clear signal is observed in the diphoton channel at a mass close to 125 GeVwith a local significance of 5.7 σ, where a significance of 5.2 σ is expected for the standard model Higgs boson. The mass is measured to be 124.70 $\pm$ 0.31 (stat.) $\pm$ 0.15 (syst.) GeV, and the best-fit signal strength relative to the standard model prediction is 1.14 $\pm$ 0.21 (stat.) +0.09-0.05 (syst.) +0.13-0.09 (theo.). Additional measurements including the signal strength modifiers associated with different production mechanisms, and hypothesis tests between spin-0 and spin-2 models, are also presented.

Higgs and photons, electroweak and new physics / 60

Higgs and photons

Author(s): Prof. KRAWCZYK, Maria[1] ; SOKOLOWSKA, Dorota[1] ; SWIEZEWSKA, Bogumila[1]
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[2] *Tech.U. Drezden*

[3] *U. Zurich*

In my talk I will describe role of photons in testing scalar sector of the SM and its extensions. In particular constraints on the Inert Doublet Model will be presented in the light of the recent LHC results on gamma gamma decay of the 125 GeV Higgs. They lead to strong limits on Dark Matter mass and its coupling to the Higgs particle.

Higgs and photons, electroweak and new physics / 61

Searches for Dark Forces at e^+e^- Colliders

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A new force beyond the Standard Model (SM) is postulated by several SM extensions and its search is well motivated by many puzzling astrophysical effects recently observed in cosmic ray spectra. The mediator of this "dark force" should be a new neutral light vector gauge boson, known as U boson, weakly coupled to ordinary particles and associated to an abelian gauge symmetry. Moreover, the new symmetry should be broken by a Higgs-like mechanism thus suggesting existence of an additional scalar particle, the dark Higgs (h′). In principle, the dark photon would be produced in any process in which a photon is involved but with a rate strongly suppressed by the small coupling. In this respect, high intensity flavor factories are an ideal place to investigate dark forces due to high statistics, good knowledge of backgrounds and clear event topology. At e^+e^- colliders, dark forces can be probed by exploiting radiative meson decays, dark Higgsstrahlung and Initial State Radiation (ISR) processes. By assuming prompt visible U decays, the KLOE-2 experiment performed five searches by investigating the Dalitz decay $\phi \to \eta U$, $U \to e^+e^-$, tagging the η meson by its $\pi^+\pi^-\pi^0$ and $3\pi^0$ decays and radiative $e^+e^- \to U\gamma$ events with $U \to l^+l^-$ ($l = e, \mu$). KLOE-2 searched also for the dark Higgsstrahlung process by assuming the invisible scenario, where $m(U) > m(h')$ and the dark Higgs escapes detection showing up a missing energy. Complementary searches of dark Higgsstrahlung have been also performed in the BaBar and Belle experiments by considering the visible scenario

$m(U) < m(h')$. BaBar set also a stringent combined limit on U coupling by using the ISR process $e^+e^- \to U\gamma$ with U decaying into leptons. Focus will be made on details of setting limits on the coupling strength between the photon and the dark photon in the KLOE-2, BaBar and Belle experiments.

Higgs and photons, electroweak and new physics / 62

Latest results on anomalous gauge couplings in CMS

Mrs. AVDEEVA, Ekaterina[1]

[1] *University of Nebraska - Lincoln*

The talk covers CMS results for the limits on anomalous triple and quartic gauge couplings based on data collected with LHC center-of-mass collision energy of sqrt(s)=7 TeV and sqrt(s)=8 TeV with corresponding integrated luminosities of 5 fbˆ-1 and 19.5 fbˆ-1 respectively. The limits are derived from the analysis of Vgamma, WV, WVgamma production. All results are consistent with the Standard Model predictions.

Higgs and photons, electroweak and new physics / 20

Diphoton production at NNLO at the LHC

Dr. CIERI, Leandro[1]

[1] *Postdoc*

In this talk we present the diphoton production at NNLO in pQCD. We show the comparison of the NNLO QCD prediction with recent measurements from the LHC. Also we show a study about the isolation prescription and we present the first results on transverse momentum resummation at NNLL+NLO accuracy.

Higgs and photons, electroweak and new physics / 52

New physics possibilities in photon-induced interactions at the LHC

Prof. GONCALVES, Victor Paulo[1]

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In the last years the Large Hadron Collider (LHC) at CERN has collected a large amount of data considering pp, pPb and $PbPb$ collisions, which is allowing to probe the Standard Model in a new kinematical range. In this talk I will show that the LHC can also be considered as a photon collider, which allows to study several aspects of the hadronic physics by the analysis of photon induced interactions in hadronic collisions. The basic idea is that in these interactions the total cross section for a given process can be factorized in terms of the equivalent flux of photons into the hadron projectile and the photon-photon or photon-target production cross section. The main advantages of using hadron - hadron collisions for studying photon induced interactions are the high equivalent photon energies and luminosities that can be achieved at existing accelerators. I review recent results which demonstrate that photon induced interactions at LHC can be used to study the QCD dynamics at high energies, the Odderon, Meson properties, Charmoniumlike Exotic states, and Beyond Standard Model Physics.

Higgs and photons, electroweak and new physics / 59

Highlights from the ATLAS experiment

Dr. KRASZNAHORKAY, Attila[1]

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ATLAS is one of the general purpose experiments at the Large Hadron Collider (LHC), beginning its data taking in 2009. The Run 1 data taking of ATLAS ran from 2009 until the beginning of 2013, collecting ~25 fb-1 of p-p collision data. After LHC's Long Shutdown 1, ATLAS is restarting its Run 2 data taking operations in just these weeks.
In this talk I will give an overview of the most recent results of the experiment, using the full Run 1 (7 and 8 TeV) datasets. Including the recent Higgs combination results, results from searches for beyond the Standard Model processes, and the most recent precision measurements.

Higgs and photons, electroweak and new physics / 92

Higgs studies, present and future

Prof. DE ROECK, Albert[1]

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Higgs and photons, electroweak and new physics / 95

Highlights from the CMS experiment

Prof. SAFONOV, Alexei[1]

[1] *Texas A&M University*

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Higgs and photons, electroweak and new physics / 10

Two-photon Higgs width and triple Higgs coupling in 2HDM in SM-like scenario

Prof. GINZBURG, Ilya[1]

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Within 2HDM deviations of the two-photon Higgs width and the value of triple Higgs coupling from their values in the SM are connected to each other. If SM-like scenario for observed Higgs boson is realized, mentioned deviations can be visible either simultaneously or inaccessible for observation at the LHC. Photon Collider can help in the checking up this connection

Higgs and photons, electroweak and new physics / 37

Results on isolated photon, photon+jet and diphoton production in ATLAS

Dr. ESCALIER, Marc[1]

[1] *LAL*

Isolated photons are a rich probe to explore various physics subjects at LHC. After presenting the strategy to identify the photons and measure the background, the various results of measurements based on photons are reviewed, using collisions based either on protons or lead ions.

Higgs and photons, electroweak and new physics / 90

Latest results on anomalous gauge couplings in ATLAS

Dr. SCHNOOR, Ulrike[1]

[1] *IKTP TU Dresden*

New physics in the electroweak sector can be described in a model-independent way via anomalous gauge couplings. Measurements of these parameters allow for the exclusion or discovery of contributions beyond the Standard Model. Experimentally, the electroweak gauge couplings are accessible via di-boson production, vector boson production through vector boson fusion, vector boson scattering, and triple boson production. The talk describes measurements of various channels of di-boson production, vector boson fusion, vector boson scattering, and triple boson produciton with the ATLAS detector and the derived limits on anomalous triple and quartic gauge couplings. All measurements show good agreement with the Standard Model.

Jets and inclusive reactions / 51

Combination of Measurements of Inclusive Deep Inelastic ep - Scattering Cross Sections and QCD Analysis of HERA data

Dr. SCHNEEKLOTH, Uwe[1]

[1] *DESY*

A combination is presented of all inclusive deep inelastic cross sections previously published by the H1 and ZEUS collaborations at HERA for neutral and charged current ep scattering for zero beam polarisation. The data were taken at proton beam energies of 920, 820, 575 and 460 GeV and an electron beam energy of 27.5 GeV. The data correspond to an integrated luminosity of about 1 fb^{-1} and span six orders of magnitude in negative four-momentum-transfer squared, Q_2, and Bjorken x. The correlations of the systematic uncertainties were evaluated and taken into account for the combination. The combined cross sections were input to QCD analyses at leading order, next-to-leading order and at next-to-next-to-leading order, providing a new set of parton distribution functions, called HERAPDF2.0. In addition to the experimental uncertainties, model and parameterisation uncertainties were assessed for these parton distribution functions. Variants of HERAPDF2.0 with an alternative gluon parameterisation, HERAPDF2.0AG, and using fixed-flavour-number schemes, HERAPDF2.0FF, are presented. The analysis was extended by including HERA data on charm and jet production, resulting in the variant HERAPDF2.0Jets. The inclusion of jet-production cross sections made a simultaneous determination of these parton distributions and the strong coupling constant possible, resulting in alpha_s $(M_Z^2) = 0.1183 \pm 0.0009(\text{exp}) \pm 0.0005(\text{model/parameterisation}) \pm 0.0012(\text{hadronisation}) +0.0037 -0.0030 \text{ (scale)}$. An extraction $of x F_3(\gamma Z)$ and results on electroweak unification and scaling violations are also presented.

Jets and inclusive reactions / 54

Monte Carlo event generation of photon-photon collisions at colliders

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In addition being interesting itself the photon-photon interactions will be an inevitable background for the future electron-positron colliders. Thus it is important to be able to simulate these collisions in a very good accuracy. In my talk I will present our ongoing work to implement the photon-photon collisions in PYTHIA8 event generator. First I will briefly describe how the partonic structure of the photon and differs from the structure of a proton. Then I will discuss about modifications of parton shower generation and beam remnant handling required to accommodate the photon beams into PYTHIA8. Finally I will present some preliminary results on particle production in photon-photon collisions and give an outlook about further developments.

Low-energy photon experiments, vacuum polarization and light-by-light scattering
/ 48

Results and Prospect of measuring vacuum magnetic birefringence with PVLAS

Prof. GUIDO, Zavattini[1] ; Mr. EJLLI, Aldo[1] ; Mr. DELLA VALLE, Federico[2] ; Mr. RUOSO, Giuseppe[3]
; Mr. GASTALDI, Ugo[4] ; Mr. PENGO, Ruggero[3] ; Prof. MILOTTI, Edoardo[2]

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A new highly sensitive ellipsometer is now running at the Department of Physics and INFN of Ferrara, Italy. The apparatus has been designed to detect very small magnetically induced birefringences with the ultimate goal of measuring vacuum magnetic birefringence. This challenging goal is not yet achievable due to excess noise which is under study. Nonetheless new limits on vacuum magnetic birefringence have been recently set and measurements are still underway. Taking advantage of the cavity intrinsic birefringence, our ellipticity limit can also be used to set a dichroism limit. From these two values we set model independent limits on the coupling constant of axion like particles to two photons.

Low-energy photon experiments, vacuum polarization and light-by-light scattering
/ 6

Photons as signature for dark matter and dark energy: The Cast experiment at CERN

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The CAST experiment is designed to search for solar axions which are produced in the interior of the sun via the Primakoff effect. The central part of the experiment, the helioscope is an LHC prototype magnet that has attached different types of sensitive detectors for x-rays in the regime of 1-10 keV. The experiment has been taking data since 2003 and provided the most restrictive limits on the axion-photon coupling in a broad mass range. Beyond $0.02eV/c^{**}2$ the mass the sensitivity is degraded due to coherence loss. In order to restore coherence, the magnet was filled with a buffer gas providing an effective mass to the photon. By changing the pressure of the buffer gas in steps, CAST did scan the range of axion mass values from 0.02eV to 1.18eV. CAST has set the strongest limit yet on Axion-photon coupling across a wide range of Axion masses (i.e., any rest mass below 1.18eV), surpassing astrophysical limits for the first time. An overview of the total data set and data analysis will be presented. The significant upgrades of CAST in 2014 allows first experiments to shed some light into the dark energy sector by searching for axions with its better performance due to a 2nd XRT, while continuing the search for solar chameleons in the sub-keV range. Proposals for the future include an International Axion Observatory (IAXO) as a 4th generation Axion Helioscope. This proposal is currently under review/approval by CERN SPS committee. IAXO follows the conceptual layout of an enhanced Axion Helioscope building on the expertise and the pioneering spirit of the CAST project.

Low-energy photon experiments, vacuum polarization and light-by-light scattering
/ 38

Upcoming Hidden Photons Searches with ALPS-II and FUNK

Dr. DOEBRICH, Babette[1]

[1] *CERN*

One of the simplest Standard Model extensions consists in a 'Hidden Photon', coupled kinetically to the photon of the Standard Model. Such a particle could also constitute the Dark Matter. We highlight the most important theoretical and phenomenological aspects of ultra-light Hidden Photons and report on two upcoming experimental searches for such particles at DESY Hamburg (ALPS-II) and the KIT in Karlsruhe (FUNK).

Low-energy photon experiments, vacuum polarization and light-by-light scattering / 35

All-optical probes of quantum vacuum nonlinearity

Dr. KARBSTEIN, Felix[1]

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We discuss various all-optical probes of quantum vacuum nonlinearity in strong electromagnetic fields. Our focus is on signatures of quantum vacuum nonlinearity in inhomogeneous field profiles, as attainable in the focal spots of realistic high-intensity laser experiments.

Muon g-2 / 84

Recent results from VEPP-2000

Dr. KAZANIN, Vassili[1]

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Since 2010 two detectors, CMD-3 and SND, have been collecting statistics at the electron-positron collider VEPP-2000. Until first technical stop in 2013, the integrated luminosity exceeded 60 pb^{-1} for each detector in the wide c.m. energy range from 0.32 up to 2 GeV. The current status of analysis as well as recent results are reported.

Muon g-2 / 21

Theoretical status of the muon g-2

Dr. NYFFELER, Andreas[1]

[1] *Institute of Nuclear Physics, University of Mainz, Germany*

The anomalous magnetic moment of the muon is sensitive to loop contributions from all sectors of the Standard Model and, potentially, to virtual particles of New Physics. In fact, since many years there is an intriguing discrepancy of 3-4 standard deviations between experiment and theory. However, the hadronic uncertainties from vacuum polarization and light-by-light scattering dominate the theory error and make it difficult to interpret this deviation as a clear sign of New Physics. We present some recent developments in the theory of the muon g-2 and give an update on the current status. We end with an outlook on how to better control the hadronic uncertainties, in order to fully profit from planned future muon g-2 experiments to test the Standard Model and to constrain models of New Physics.

Muon g-2 / 7

Pseudoscalar-exchange contribution to g-2 from rational approximants

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Padé Approximants have been used to describe the light pseudoscalars transition form factors (TFFs) in the space-like region. Once the low energy parameters are determined from a fit to data, they provide a systematic and model-independent tool for describing the TFFs.
We discuss their generalization to the bivariate case, which allows a systematic description for the double-virtual TFF. This is of utmost relevance for the Light-by-Light contribution to g-2. Lacking double-virtual data, we discuss expectations and its connection with pseudoscalar decays into lepton-pairs.

Muon g-2 / 8

Mesurement of the $\pi^+\pi^-$ cross section at BESIII

Mr. KLOSS, Benedikt[1]

[1] *Institute for Nuclear Physics Mainz*

Precise hadronic cross section measurements are an important input for the standard model prediction of $(g-2)_\mu$.
Especially, the most important hadronic cross section as input for $(g-2)\mu, \sigma{\pi\pi} = \sigma(e\hat{}+e\hat{}-\rightarrow \pi\hat{}+\pi\hat{}-), has been measured over decades with ever increasing accuracy at accelerators in Novo$
Unfortunately, this discrepancy is limiting our current knowledge of $a\_\mu \equiv (g-2)\mu/2, which is a famous precision$
$2)\mu, is entirely limited by the knowledge of the hadronic vacuum polarization contribution, which is obtained in a dispersive$
$ratio data on \sigma(e\hat{}+e\hat{}-\rightarrow \rm hadrons). The cross section \sigma\_{\pi\pi} contributes more than 70$

Muon g-2 / 39

VMD/HLS Approach to the muon (g-2) : A solution to the tau-e+e- puzzle

Dr. BENAYOUN, Maurice[1]

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The Hidden Local Symmetry (HLS) Model provides a framework able to encompass several physical processes and give a unfied description of these in an energy range extending up to the ϕ mass. However, in order to account precisely for experimental data, it should be supplied with several symmetry breaking schemes. Among these, an energy dependent mixing mechanism of the vector mesons ($\rho^0 - \omega - \phi$) is generated via loop effects and allows to define an effective broken HLS (BHLS) model. Within this framework the e^+e^- annihilations to $\pi^+\pi^-$, $\pi^0\gamma$, $\eta\gamma$, $\pi^+\pi^-\pi^0$, K^+K^-, $K_L K_S$ and the dipion spectrum in the decay $\tau^\pm \rightarrow \pi^\pm\pi^0\nu$ are *simultaneously* accounted for with the same set of model parameters. These are derived from global fits in procedures involving all existing data samples covering the channels within the BHLS scope. The muon HVP's derived from fits performed with and without the τ dipion spectra are found consistent with each other. Therefore, within the broken HLS approach, one does not observe any clear mismatch between the τ and e^+e^- physics properties.

Muon g-2 / 58

Results and prospects on hadronic cross section at KLOE/KLOE-2

Dr. MANDAGLIO, Giuseppe[1]

[1] *Dipartimento di Fisica e di Scienze della Terra*

The KLOE experiment was the first to exploit Initial State Radiation (ISR) processes to obtain the $e^+e^- \rightarrow \pi^+\pi^-(\gamma)$ cross section below 1 GeV. Three measurements have been published with

small angle photon in the initial state: normalized using luminosity from Bhabha in 2005 and 2008 and using $\pi\pi\gamma/\mu\mu\gamma$ ratio in 2014. An independent measurement with the large angle photon normalized to Bhabha has been published in 2011. These measurements are in good agreement, showing a good consistency among different analyses. The Gounaris-Sakurai fit of the pion form factor of the combined KLOE measurements will be also discussed. We also present the $\gamma\gamma$ physics project of KLOE-2 experiment, made possible after the recent KLOE upgrade with new small angle tagging detectors along the DAFNE beam line. The new detectors combined with KLOE apparatus allow to measure the $\pi^0 \to \gamma\gamma$ decay and $\gamma^*\gamma \to \pi^0$ transition form factor. These measurements provide constraints to the models used to calculate the hadronic light-by-light contribution to the muon anomaly.

Muon g-2 / 17

Low-energy hadronic cross sections measurements at BaBar, and implication for the g-2 of the muon

ANULLI, fabio[1]

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The BABAR Collaboration has an intensive program studying hadronic cross sections at low-energy e+e- annihilations, accessible via initial-state radiation. These measurements allow significant improvements in the precision of the predicted value of the muon anomalous magnetic moment. We report here the results of recent studies on a number of final states, as e+e- -> K+K-, e+e- -> K_S K_L, and e+e- -> K_S K+ pi- pi0.

Muon g-2 / 57

Measuring the Leading order hadronic contributon to g-2 in the space like region

Dr. VENANZONI, Graziano[1]

[1] *LNF-INFN*

I will present a novel approach (see http://arxiv.org/abs/1504.02228 [1] Phys. Lett. B46 (2015) 325-329), to determine the leading hadronic corrections to the muon g-2. It consists in a measurement of the effective electromagnetic coupling in the space-like region extracted from Bhabha scattering data. This method can result in an alternative determination potentially competitive with the dispersive approach via time-like data. I will discuss its possible application at low energy e+e- machines like DAFNE, VEPP2000, BEPCII and SuperKEKB.

Photon collider prospects, new acceleration techniques and future accelerators / 67

Future high energy colliders

Prof. TELNOV, Valery[1]

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During the last three decades linear colliders were considered as best machines for detail study of physics in the energy region 0.1-3 TeV. Observation at LHC of the Higgs boson with rather low mass and still nothing else has triggered new strategies in HEP based on large circular colliders for e+e- and pp collisions. In this talk I give a short review of projects ILC, CLIC, FCC, CEPC-SppC, muon and photon colliders.

Photon collider prospects, new acceleration techniques and future accelerators / 82

Exclusive production of charged Higgs boson pairs via photon-photon mechanism in proton-proton scattering at the LHC and FCC(remote)

Photon collider prospects, new acceleration techniques and future accelerators / 22

Photon spectrum and polarization for high conversion efficiency in Compton backscattering process

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The paper [1] reviewed the principles of creation of high-energy $\gamma\gamma$ collider. However, after the discovery of Higgs boson, the authors of paper [2] proposed the concept of the so-called low-energy $\gamma\gamma$ collider (for which the required energy of the electrons does not exceed 80 MeV, if the energy of the laser photons is equal to 3.5 eV) . In both cases it is necessary to use high power lasers (10^{18} W/cm^2) to obtain a desired luminosity.

The density of photons in a laser flash is so great that the nonlinear interactions and the possibility of multiple scattering of electrons passing through such "light target" should be taken into account when calculating electron-photon collisions.

For such powerful lasers, the conversion coefficient - the ratio of the number of scattered photons to the number of initial electrons [1] - in this case may exceed unity. Since the scattering of laser photons on electrons of the incident beam is a stochastic process, the conversion coefficient is nothing more than the average number of emitted photons $\bar{k}$ [3].

Multiple scattering and substantial change in the energy (and in the cross section) of the electrons along the trajectory in the laser pulse will lead to a deviation of collision statistics from the Poisson law.

To simulate multiple scattering of electrons in the light target, we developed Monte-Carlo code which takes into account the nonlinearity of the Compton scattering including spin-flip processes which affect the polarization characteristics of the final particles.

The results of calculation of the spectra and polarization characteristics of electrons and photons are presented.

Contribution of the electron trajectories with the number of collisions $k \geq 2$ results in substantial enrichment of the resulting spectrum by "soft" photons, which leads to some difference in calculated spectrum from the one obtained by CAIN [4].

[1] V. Telnov, NIMA 355 (1995) 3-18
[2] S.A. Bogasz, J. Ellis, L. Lusito et al., arXiv:1208.2827
[3] A.P. Potylitsyn, A.M. Kolchuzhkin, EPL, 100(2012) 24006
[4] P. Chen, G. Horton-Smith, T. Ohgaki, A. W. Weidemann and K. Yokoya, Nucl. Instrum.Meth. A355, 107 (1995)

Photon collider prospects, new acceleration techniques and future accelerators / 3

Developments of optical resonators and optical recirculators for Compton X/γ ray machines

Dr. MARTENS, Aurelien[1]

[1] *LAL/IN2P3/CNRS*

Optical resonators and optical recirculators are key elements of Compton X/γ-ray machines. Such devices could ultimately be used in the design of polarized positron sources for a future linear electron-positron collider and photon sources for an hypothetical photon-photon collider. With regard to their use in laser physics or in time-frequency metrology, these devices have to obey severe constraints when implemented in the vacuum of an electron accelerator. Our group is developing both types of devices. An original recirculator design is being developed for the ELI-NP γ ray source. It is an aberration free device that recirculates 32 times a short and high intensity laser pulse. It also allows synchronizing each of the 32 passes with the electron RF cavities within approximately 100 fs. The second topic is a description of R&D on optical resonators dedicated to laser-electron interactions, in particular the ThomX Compton ring. Two different picosecond laser oscillators have been locked to the highest cavity finesse F=30000 ever reached in pulsed regime. We also designed and built a new kind of non-planar cavity, tetrahedron shape, providing circularly polarized eigenmodes. This cavity was installed in the ATF accelerator of KEK and successfully used to produce a high gamma ray flux. Thanks to an original fibre amplifier, 100 kW of average power were stacked inside the cavity.

Photon collider prospects, new acceleration techniques and future accelerators / 68

Prospects for Higgs and gauge boson measurements in $\gamma\gamma$ collisions at FCC-e^+e^-.

Mrs. REBELLO TELES, Patricia[1]

[1] *Brazilian Center for Physics Research*

The discovery of the Higgs boson at the LHC, together so far with the absence of any phenomena beyond the Standard Model in collisions at center of mass energies up to 8 TeV, has triggered an interest in future colliders to push the energy and precision frontiers in the search of New Physics. The great potential of high-energy hadron colliders to discover new particles and new phenomena are well-known, but now there is a strong scientific case for an electron-positron (e^+e^-) collider performing high precision studies of the Higgs boson and other known particles.
One of the Future Circular Collider (FCC) design study, FCC-e^+e^-, is a high-luminosity, high-precision e^+e^- collider located in the same tunnel as a possible precursor to the hadron collider FCC-hh, and complementary to it. Delivering e^+e^- center-of-mass collision energies between 90 and at least 350 GeV, FCC-e^+e^- will be sensitive to possible new phenomena at energies measured in tens of TeV.
In addition to e^+e^- program, the FCC will provide a unique opportunity to study $\gamma\gamma$ interactions at high energies and luminosities. $\gamma\gamma$ effective luminosities using the equivalent photon approximation (EPA) fluxes are explored for the Higgs, as well as for the exclusive W pair, production.

Photons in astroparticle physics / 27

UHECR detection

Dr. BESSON, Dave[1]

[1] *MEPhI*

The recent detection of ultra-high energy neutrinos has provided new impetus for similar experiments seeking measurement of neutrinos, photons and other cosmic rays at the highest energy regime. We will discuss recent attempts to measure the GZK neutrino flux via radio techniques, and prospects and plans for the future.

Photons in astroparticle physics / 32

Radio Detection of Ultra High Energy Cosmic Rays with the Telescope Array Radar Remote Stations

Author(s): Mr. PROHIRA, Steven[1]

Co-author(s): Dr. BESSON, Dave [2]

[1] *University Of Kansas*

[2] *University of Kansas*

The Telescope Array Radar (TARA) Remote Station is a novel, autonomous, radio-based detector for Ultra High Energy Cosmic Rays (UHECR). Our bi-static radar approach utilizes the ionized core of an UHECR shower as a reflector for a continuous wave (cw) signal. By analyzing this reflected signal, we can reconstruct the UHECR event. Our detection scheme allows for the coverage of a very large area with a minimum of apparatus, thus lowering the effective cost of UHECR detection, and raising the likelihood of seeing higher energy UHECR per increase in event area.

Photons in astroparticle physics / 31

Recent results from the Telescope Array - studies of ultra-high energy cosmic rays and the prospect -

Dr. SAGAWA, Hiroyuki[1]

[1] *Institute for Cosmic Ray Research, the University of Tokyo*

The Telescope Array (TA) experiment aims at studying the nature and origin of Ultra-high Energy Cosmic Rays (UHECRs) with energies up to around 10^{20} eV. It is located in Utah, USA, and is composed of a ground array of 507 scintillator detectors covering 700 square kilometers and three air fluorescence telescope stations overlooking the array from the periphery. Here I present the recent results of the measurements of UHECR spectrum, anisotropy and composition from TA including the preliminary results at lower energies down to $10^{15.6}$ eV from the TA Low-energy Extension (TALE). And the TA extension plans are also presented.

Related topics / 63

Quasiclassical approach to QED processes in the field of heavy atom

Dr. LEE, Roman[1]

[1] *The Budker Institute of Nuclear Physics, Novosibirsk*

We review the quasiclassical approach to the description of high-energy QED processes in the field of heavy atom.

Related topics / 24

Bound-free pair production in heavy-ion collisions at high energies

Dr. SCHICKER, Rainer[1]

[1] *Phys. Inst., Uni Heidelberg*

The large photon flux of heavy-ion beams at high energy results in electromagnetic processes with large cross sections. Processes which change the magnetic rigidity of the primary beam produce secondary beams. The knowledge of the cross section of these reaction channels is of great interest since they contribute to the finite lifetime of the heavy-ion beam. Electromagnetic excitation of the nucleus, followed by neutron evaporation, is experimentally accessible by measuring the forward neutrons in Zero Degree Calorimeters. The bound-free pair production process is, in principle, measurable by detecting the forward hydrogen-like heavy-ion. I will present the cross section of the bound-free electron-positron pair process, and discuss the bound-free pair constrained photon-photon luminosity for the case of the LHC energy.

Related topics / 25

Proton radius puzzle

Dr. KARSHENBOIM, Savely[1]

[1] *Pulkovo Obs. and MPQ*

Precision tests of QED are limited by our knowledge of the hadronic effects. In particular, predictions for the Lamb shift are suffered from a bad knowledge of the nuclear structure. One can reverse the problem and to determine nuclear parameters from spectroscopy. Studying the Lamb shift in ordinary and muonic hydrogen, values of the proton charge radius have been derived. The ordinary-H value and the muonic-H value do not agree. The e-p scattering value supports the one from ordinary hydrogen.
I will review the situation with determination of the proton charge radius, which is likely the biggest (in terms of sigmas) contradiction in the contemporary QED-related studies.

Related topics / 5

Effects of strong electromagnetic field in ultra-relativistic heavy-ion collisions

Prof. SERBO, Valeriy[1]

[1] *Novosibirsk State University*

V.G. Serbo (Novosibirsk State University)
"Effects of strong electromagnetic field in ultra-relativistic heavy-ion collisions"
Abstract:
In collisions of relativistic nuclei of gold (the RHIC collider) or lead (the LHC collider) electric and magnetic fields may exceed by several orders of magnitude the critical Schwinger field, but these fields act during a very short time. In such conditions one can use perturbation theory, but the corresponding parameter $Z\alpha \approx 0.6$ is not small. It means that the whole series in $Z\alpha$ has to be summed to obtain the cross section with sufficient accuracy. In this report I present a small review about our recent activity related to electromagnetic processes at the RHIC and LHC colliders. It includes such topics as: Strong-field effects in the lepton pair production; Large contribution of the virtual Delbr\"uck scattering into nuclear bremsstrahlung and Production of bound-free e^+e^- pairs.

Related topics / 13

Charge asymmetry in the differential cross section of high energy bremsstrahlung in the field of a heavy atom

Mr. KRACHKOV, Peter[1] ; Prof. MILSTEIN, Alexander[2]

[1] *BINP*

[2] *Budker Institute of Nuclear Physics*

QED processes in the field of a heavy atom are important in different area such as atomic physics, high energy physics, astrophysics and others. These processes are describe interaction of charged particles and photons with matter. Bremsstrahlung and particle-antiparticle photoproduction in the electric field of a heavy nucleus or atom play a dominant role when considering electromagnetic showers in detectors.Because of this the accurate description of such processes are necessary for design of the detectors of charged particles.
In this work the distinction between the charged particle and antiparticle differential cross sections of high-energy bremsstrahlung in the electric field of a heavy atom is investigated. The consideration is based on the quasiclassical approximation to the wave functions in the external field. The charge asymmetry (the ratio of the antisymmetric and symmetric parts of the differential cross section) arises due to the account for the first quasiclassical correction to

the differential cross section. All evaluations are performed with the exact account of the atomic field. We consider in detail the charge asymmetry for electrons and muons. For the longitudinal polarization of the initial charged particle, the account for the first quasiclassical correction to the differential cross section leads to the asymmetry in the cross section with respect to the replacement $\varphi \to -\varphi$, where φ is the azimuth angle between the photon momentum and the momentum of the final charged particle.

Related topics / 36

Delta(1232) contribution to real radiative corrections for elastic electron-proton scattering

Mr. GERASIMOV, Roman[1]

[1] *Budker Institute of Nuclear Physics*

The contradiction currently exists in the results of proton electromagnetic form factors measurements. More accurate calculation of radiative corrections to electron-proton elastic scattering cross section is one of the possible solutions of this problem. Here we consider a potential contribution of Delta(1232) resonance to real radiative corrections. The effect is found to be small for past experiments to measure the unpolarized ep-scattering cross section as well as for the recent experiment at the VEPP-3 storage ring to investigate the two-photon exchange effects.

Resonances and exclusive processes / 80

Theoretical description of resonance production(remote)

Resonances and exclusive processes / 85

COMPASS spectroscopy (remote)

Resonances and exclusive processes / 23

Photon-hadron and photon-photon collisions in ALICE

Author(s): Dr. SCHICKER, Rainer[1]
Co-author(s): ALICE, Collaboration [2]

[1] *Phys. Inst., Uni Heidelberg*

[2] *CERN*

Rainer Schicker for the ALICE collaboration
Heavy-ion beams at high energy generate large photon fluxes which result in a variety of photon-hadron and photon-photon processes with large cross sections. The ALICE experiment at CERN is well suited to measure such reaction channels in the central barrel as well as in the forward muon spectrometer. The ALICE results from Run I of the LHC are presented, and an overview of our Run II plans is given.

Resonances and exclusive processes / 29

Light-quark mesons in two-photon processes at Belle

Dr. UEHARA, Sadaharu[1]

[1] *KEK, High Energy Accelerator Research Organization*

We summarize results of light-quark meson studies for spectroscopy and their particle properties in two-photon processes at the Belle experiment. We report on dozens of different meson-state formation processes in the mass region, 0.9 - 2.6 GeV.

Resonances and exclusive processes / 4

About the physics of the X(3872) resonance

Author(s): Prof. ACHASOV, Nikolay[1]
Co-author(s): Ms. ROGOZINA, Elizaveta [2]

[1] *Sobolev Institute for Mathematics*

[2] *Novosibirsk State University*

Enfant terrible of charmonium spectroscopy, the resonance X(3872), generated a stream of interpretations and ushered in a new exotic XYZ spectroscopy. In the meantime, many (if not all) characteristics of X(3872) are rather ambiguous. We construct spectra of decays of the resonance X(3872) with good analytical and unitary properties which allow to define the branching ratio of the X(3872) \to D*0\bar D0 + c.c.* decay studying only one more decay, for example, the *X(3872)\to\pi+\pi- J/\psi(1S) decay. We next define the range of values of the coupling constant of the X(7872) resonance with the D*0\bar D0 chanel. We show also that our spectra are effective means of selection of models for the resonance X(3872).
Contrary to almost standard opinion that the X(3872) resonance is the D*0\bar Dˆ0+c.c. molecule or the qc\bar q\bar c four-quark state, we prove the scenario where the X(3872) resonance is the c\bar c = \chi_{c1}(2P) charmonium which "sits on" the D*0\bar D0 threshold.
We explain the shift of the mass of the X(3872) resonance with respect to the prediction of a potential model for the mass of the \chi_{c1}(2P) charmonium by the contribution of the virtual D*\bar D+c.c. intermediate states into the self energy of the X(3872) resonance.
We suggest a physically clear program of experimental researches for verification of our assumption.

Resonances and exclusive processes / 9

To study isospin breaking decay $eta(1405) \to f_0(980)\pi^0 \to 3\pi$

ACHASOV, Nikolai[1] ; KOZHEVNIKOV, Arkadii[1] ; Dr. SHESTAKOV, Georgii[1]

[1] *Institute for Mathematics, Novosibirsk*

We elucidate the possible mechanism of the isospin breaking decay $\eta(1405) \to f_0(980)\pi^0 \to \pi^+\pi^-\pi^0$.

Resonances and exclusive processes / 93

Photon-hadron and photon-photon collisions in CMS (including data from p-p, p-A and A-A collisions)

Mrs. REBELLO TELES, Patricia[1]

[1] *Brazilian Center for Physics Research*

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Resonances and exclusive processes / 94

To learn production of the scalar and tensor mesons in $\gamma\gamma^*(Q^2) \to \eta\pi^0$ reaction

Author(s): Dr. KISELEV, Alexey[1]

Co-author(s): Prof. ACHASOV, Nikolay [1] ; Dr. SHESTAKOV, Georgii [1]

[1] *Sobolev Institute for Mathematics*

The prediction of the cross section $\sigma(\gamma\gamma^*(Q^2) \to \eta\pi^0)$ based on the simultaneous description of the Belle data on the $\gamma\gamma \to \eta\pi^0$ reaction and the KLOE data on the $\phi \to \eta\pi^0\gamma$ decay is presented.

Resonances and exclusive processes / 15

Search for the eta' ->e+e- and eta -> e+e- decay at SND

Dr. BERDYUGIN, Aleksey[1]

[1] *Budker Institute of Nuclear Physics*

The decay eta' ->e+e- has been searched for at the VEPP-2000 e+e- collider with the SND detector using the reaction e+e- -> eta'. The following upper limits have been set at the 90% CL: Gamma(eta' -> e+e-) < 0.0020 eV and B(eta' -> e+e-) < 10^-8. Sensitivity of VEPP-2000 for measurement of the e+e- -> eta cross section has been studied.

Resonances and exclusive processes / 14

Branching fractions of $\psi(3770)$, $\psi(4040)$, and $\Upsilon(10580)$ decays to light (non-$D\bar{D}$, non-$D_s\bar{D}_s$, and non-$B\bar{B}$ hadrons.

Prof. ACHASOV, Nikolay[1] ; Dr. KOZHEVNIKOV, Arkadii[2]

[1] *Sobolev Institute for Mathematics*

[2] *S.L. Sobolev Institute for Mathematics*

Branching fractions of decays of heavy quarkonia $\psi(3770)$, $psi(4040)$, and $\Upsilon(10580)$ to the states $\pi^+\pi^-$, $K\bar{K}$, $\omega\pi^0$, $\omega\eta$, $\omega\eta'$, $\rho\eta$, $\rho\eta'$, $K^*\bar{K} + c.c.$, $\rho^+\rho^-$, $K^*\bar{K}^*$ etc are evaluated in the model of the Okubo - Zweig - Iizuka rule violation due to the real intermediate states of mesons with open open heavy flavors. The results are compared with existing experimental upper bounds.

Resonances and exclusive processes / 33

The timelike electromagnetic form factors of proton and charged kaons at high energies

Author(s): Prof. SEREDNYAKOV, Sergey[1]

Co-author(s): Dr. DRUZHININ, Vladimir [2]

[1] *Novosibrsk State University, BINP*

[2] *Novosibirsk State University, BINP*

The Initial State Radiation (ISR) method in the Babar experiment has been used to measure the timelike electromagnetic form factors at the momentum transfer from 9 to 42 GeV2 for protons and from 7 to 56 GeV2 for charged kaons. The obtained data show the tendency to approach the QCD asymptotic prediction for kaons and spacelike form factors values for proton.

Resonances and exclusive processes / 56

Photons interacting with Pions at COMPASS

Dr. FRIEDRICH, Jan[1]

[1] *TU München*

COMPASS is a multi-purpose experiment operated at CERN for investigations of the strong interaction from low to highest energy scales. At low energies, photon-pion interactions provide input for understanding the effective dynamics of strongly bound states of quarks and gluons, mostly prominently the recent measurement of the polarisability of the charged pion. At higher energies, the meson resonance spectrum comes into play. COMPASS investigates the coupling of photons to such resonances, which is described by their radiative widths.

Resonances and exclusive processes / 34

Photoproduction of $\pi^0\pi^0$ on proton and deuteron with the rescattering mechanism $\pi^+\pi^- \to \pi^0\pi^0$ inclusion

Mr. EGOROV, Mikhail[1]

[1] *Tomsk Polytechnic University*

The model of coherent $\pi^0\pi^0$ mesons photoproduction on simplest nuclei of hydrogen and deiterium in the region $E_\gamma \leq 1.4$ GeV is presented. Two pion rescattering amplitude in process $\pi^+\pi^- \to \pi^0\pi^0$ is taken into account from phenomenological fit is accurately defined it in treshold region as well as up to 1100 MeV relative energy in $\pi\pi$ c.m. Strong dependence of the result on the rescattering amplitude is also discussed.

Resonances and exclusive processes / 55

Exclusive processes at HERA

Dr. LUKINA, Olga[1]

[1] *SINP MSU*

The ratio of the exclusive electroproduction of psi(2S) and J/psi mesons has been measured at HERA. The results are sensitive to the wave functions of the vector mesons and are compared to predictions of QCD-inspired models of vector-meson production. Exclusive dijet production in diffractive deep inelastic scattering has been measured at HERA. Cross sections are presented as a function of \beta, the Bjorken variable defined with respect to the diffractive exchange and, in bins of \beta, as a function of \phi, the angle between the \gamma–*dijet plane and the* \gamma–e plane in the rest frame of the dijet final state. The results are compared to predictions from models which are based on different assumptions about the nature of the diffractive exchange. The first measurement of exclusive photoproduction of rho mesons associated with leading neutrons with the H1 detector at HERA is also presented. The data are interpreted in terms of two dominant contributions: diffractive proton dissociation channel and elastic production via virtual pion exchange. Measurements of normalised cross sections for the production of photons and neutrons at very small angles with respect to the proton beam direction in deep inelastic scattering are presented as a function of the Feynman variable xF and of the centre-of-mass energy of the virtual photon-proton system, W. Predictions of deep inelastic scattering models and of models for hadronic interactions of high energy cosmic rays are compared to the measured cross sections.

Small x, diffraction, and total cross sections / 46

Production of a forward J/Psi and a backward jet at LHC as a test of BFKL dynamics

Mr. BOUSSARIE, Renaud[1] ; Dr. DUCLOUÉ, Bertrand[2] ; Prof. SZYMANOWSKI, Lech[3] ; Dr. WALLON, Samuel[4]

[1] *LPT Orsay*

[2] *University of Jyväskylä*

[3] *NCBJ Warsaw*

[4] *LPT Orsay and UPMC University*

J/Psi mesons are copiously produced at LHC. Inspired by the Mueller Navelet jet studies which allows to distinguish between BFKL and DGLAP dynamics, we propose to consider the production of a forward J/Psi accompanied by a backward jet. We make a feasibility study and compute the leading order differential cross section for such events in the BFKL framework.

Small x, diffraction, and total cross sections / 44

Two-photon exchange in electron-proton scattering -the OLYM-PUS experiment at DESY

Dr. SCHNEEKLOTH, Uwe[1]

[1] *DESY*

The OLYMPUS experiment will measure the two-photon exchange amplitude in the elastic electron-proton scattering. This amplitude is a possible explanation for the significant, experimental discrepancy in the determination of the ratio of the proton electric to magnetic form factors, $R = \mu_p G_E^p / G_M^p$, determined using Rosenbluth separation and polarization transfer techniques. A measurement of the elastic scattering cross section ratio, $\sigma_{e^+ p} / \sigma_{e^- p}$, will provide a direct measurement of the two-photon exchange amplitude. The OLYMPUS experiment was carried out at the DESY laboratory in Hamburg, Germany using the 2.01 GeV electron and positron beams of the DORIS storage ring incident on an internal hydrogen gas target. Independent luminosity monitors were operated in parallel to the main spectrometer during data taking to allow for a precise relative luminosity measurement. Approximately 4.45 fb^{-1} of data were collected. The OLYMPUS experiment and the status of the analysis will be discussed.

Small x, diffraction, and total cross sections / 45

Application of the shockwave formalism to diffractive processes

Mr. BOUSSARIE, Renaud[1] ; GRABOVSKY, Andrey[2] ; Prof. SZYMANOWSKI, Lech[3] ; Dr. WALLON, Samuel[4]

[1] *LPT Orsay*

[2] *Budker Institute of Nuclear Physics*

[3] *NCBJ Warsaw*

[4] *LPT Orsay and UPMC University*

The shockwave formalism gives us tools for calculations beyond the usual approximations (dipole model...). Using it , we calculate the impact factor for jet production in diffractive DIS and for jet broadening in pA collisions.

Small x, diffraction, and total cross sections / 42

Low x evolution equation for quadrupole operator

Dr. GRABOVSKY, Andrey[1]

[1] *Budker Institute of Nuclear Physics*

The NLO nonlinear evolution equation for quadrupole operator is presented in the coordinate space. The quasi-conformal evolution equation is presented for the composite quadrupole opertor.

Small x, diffraction, and total cross sections / 89

Double scattering production of two ρ^0 mesons and four pions in ultraperipheral heavy ion collisions(remote)

Author(s): Prof. SZCZUREK, Antoni[1]
Co-author(s): Dr. KLUSEK-GAWENDA, Mariola [1]

[1] *Institute of Nuclear Physics PAN Krakow*

We will discuss a possibility to study the $\rho^0(770)$ mesons production in ultrarelativistic ultraperipheral heavy ion collisions. We evaluate for the first time differential distributions for exclusive production of two $\rho^0(770)$ mesons (four charged pions) in the double scattering (photon-Pomeron) process [1]. The results will be compared with the contribution of two-photon mechanism discussed previously in the literature [2]. The double scattering mechanism populates large dimeson invariant masses and large rapidity distance between mesons. The resulting distributions for four pions will be presented and compared to the STAR data [3]. Predictions for the LHC will be shown. We will discuss a possibility of identifying the double scattering mechanism at the LHC energy. The above analysis includes the smearing of ρ^0 mass which was presented recently by the ALICE Collaboration [4].

[1] M. Klusek-Gawenda and A. Szczurek, Phys. Rev. C 89 (2013) 024912,
[2] M. Klusek, W. Schafer and A. Szczurek, Phys. Lett. B 674 (2009) 92,
[3] B. I. Abelev et al. (STAR Collaboration), Phys. Rev. C 81 (2010) 044901,
[4] Adam, Jaroslav et al. (ALICE Collaboration), arXiv:1503.09177 [nucl-ex].

Two-photon physics history / 28

Two-photon physics from TRISTAN

Dr. UEHARA, Sadaharu[1]

[1] *KEK, High Energy Accelerator Research Organization*

As a part of the historical two-photon session, I summarize achievements from the three TRISTAN experiments, AMY, TOPAZ and VENUS. Results related to a confirmation of the "resolved-photon" processes, where the quark and gluon contents in a photon play a role, are highlight of the measurements.

Two-photon physics history / 64

Observation of two-photon production of C+ resonances at SPEAR with detector MARK-2

Prof. TELNOV, Valery[1]

[1] *BINP, Novosibirsk Univ.*

In this talk I tell on first observation of C+ resonances (eta-prime and f2) in two photon collisions at e+e- storage

Two-photon physics history / 65

Two-photon experiments with detector MD1 at VEPP-4

Prof. TELNOV, Valery[1]

[1] *BINP, Novosibirsk Univ.*

Detector MD-1 worked at storage ring VEPP-4 in 1980-85. Its specific feature was a transverse magnetic field for better detection of two photon processes. Detection of both scattered electrons enabled to measure the total gamma-gamma cross section. Also some other two-photon processes have been studied with and without detection of the scattered electrons.

Two-photon physics history / 66

An idea of high energy , e colliders based on one pass e+e- linear colliders.

Prof. TELNOV, Valery[1]

[1] *BINP, Novosibirsk Univ.*

The gamma-gamma luminosity in collisions of virtual photons at e+e- storage rings is much lower than that in e+e- collisions and the spectrum is rather soft. In 1980 we have noticed that at high energy linear colliders beams are used only ones which makes possible to convert electrons to high energy photons using Compton scattering of laser photons and thus to obtain real gamma-gamma collisions with energies and luminosities similar to e+e- collisions. Such high energy gamma-gamma (gamma-electron) colliders are technically feasible now and are considered as a natural option in all e+e- linear collider projects

Two-photon physics history / 49

A historical retrospect of Two-Photon Physics in the 1980ies at DORIS, SPEAR, PETRA and PEP

Prof. KOLANOSKI, Hermann[1]

[1] *Humboldt University/DESY*

The major developments and achievements in two-photon physics obtained at the electron-positron colliders DORIS, SPEAR, PETRA and PEP are reviewed. These machines allowed for the first time detailed studies of hadron production in high-energy photon-photon collisions. With the advent of sufficiently high energies at PETRA and PEP the studies of resonant two-photon couplings were complemented by investigations of the perturbative QCD regime leading to the first observations of jet production and to measurements of the hadronic structure of the photon.

Two-photon physics history / 76

Two-photon physics from LEP

Two-photon physics history / 75

Two-photon experiments at CESR

Two-photon physics history / 91

Birth of colliding beams in Europe, two-photon studies at Adone(remote)

Dr. PANCHERI, Giulia[1]

[1] *INFN*

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Two-photon physics history / 96

Observation of two-photon production of e+e- pairs at VEPP-2 in Novosibirsk

Dr. PAKHTUSOVA, Elena[1]

[1] *Budker INP*

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Two-photon physics history / 11

Towards to history of two photon physics.

Prof. GINZBURG, Ilya[1]

[1] *Sobolev Inst. of Mathematics SB RAS and Novosibirsk State University*

In this report I present personal view for history of two-photon physics

Two-photon physics history / 18

Two Photon Physics in France : a tribute to Paul Kessler

Dr. KAPUSTA, Frederic[1]

[1] *LPNHE Paris*

The interest in photon-photon collisions in the 70's led to the 1973 Conference. A brief historical review will emphasize the rôle of Paul Kessler and his colleagues.

83

Closing remarks

72

Welcome