XLVI International Symposium on Multiparticle Dynamics 2016

-Abstract Book-

29 August - 02 September 2016

Seogwipo KAL hotel

Jeju Island, Republic of Korea

XLVI International Symposium on Multiparticle Dynamics (ISMD 2016)

Abstract Book

August 29, 2016 – September 2, 2016
Seogwipo KAL hotel
Jeju Island, Republic of Korea

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Session Conveners

- (Session 1) Multi-particle correlations and fluctuations: from small to large systems
  - Ilya Selyuzhenkov, EMMI/GSI, Germany, ilya.selyuzhenkov@gmail.com
  - Soumya Mohapatra, Columbia University, USA, Soumya.Mohapatra@cern.ch
  - Wei Li, Rice University, USA, davidlw@rice.edu
  - Grzegorz Wilk, National Centre for Nuclear Research, Poland, Grzegorz.Wilk@ncbj.gov.pl
  - Gabriel Silveira Denicol, Federal university Fluminense (UFF), Brazil, gsdenicol@id.uff.br

- (Session 2) Hadronic final state in high-p_T interactions
  - Un-Ki Yang, Seoul National University, Korea, ukyang@snu.ac.kr
  - Manjit Kaur, Panjab University, India, manjit@pu.ac.in
  - Nicolas Greiner, Zurich University, Switzerland, greiner@physik.uzh.ch

- (Session 3) Forward physics and diffraction
  - Christophe Royon, University of Kansas, USA, Christophe.royon@ku.edu
  - Hans Jozef H Van Haevermaet, University Antwerpen, Belgium, hans.van.haevermaet@cern.ch
  - Francesco Hautmann, Oxford University, UK, f.hautmann1@physics.ox.ac.uk

- (Session 4) Perturbative and non-perturbative features of QCD
  - Maxim Gouzevitch, Lyon, France, maxime.gouzevitch@cern.ch
  - Bowen Xiao, Central China Normal University, China, bo.w.xiao@gmail.com

- (Session 5) Collectivity in high-energy collisions: jets, flows or other
  - Yen-Jie Lee, MIT, USA, yen-jie.lee@cern.ch
  - Minjung Kweon, Inha University, Korea, minjung@inha.ac.kr
  - Wojciech Broniowski, Jan Kochanowski University, Poland, wojciech.broniowski@ifj.edu.pl

- (Session 6) Proton structure, small and large-x physics
  - Matthias Grosse-Perdekamp, University of Illinois at Urbana-Champaign, USA, mgp@illinois.edu
  - Yoshitaka Hatta, Kyoto University, Japan, hatta@yukawa.kyoto-u.ac.jp

- (Session 7) Cosmic ray and astroparticle physics
  - Maurizio Spurio, Universita di Bologna, Italy, maurizio.spurio@bo.infn.it
  - Martin Pohl, DESY, Germany, martin.pohl@desy.de
  - Hang Bae Kim, Hanyang University, Korea, hbkim@hanyang.ac.kr

Contents

Program

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  Multi-particle correlations and fluctuations: from small to large systems

1. 09:00-09:25 Dong Jo Kim (University of Jyväskylä) News on collectivity in Pb-Pb collisions from the ALICE experiment at the LHC, djkim@jyu.fi
2. 09:25-09:50 Dong Ho Moon (Chonnam National University) News on collectivity in Pb-Pb collisions (CMS), dhmoon@jnu.ac.kr
3. 09:50-10:15 Maya Shimomura (Nara Women's University) Measurement of azimuthal anisotropy at RHIC-PHENIX, mayap@bnl.gov
4. 10:15-10:40 Prithwish Tribedy (BNL) Studies of three-particle correlations and reaction-plane correlators from STAR, ptribedy@bnl.gov

10:40-11:10 Coffee break

- 11:10-12:50, Monday, August 29 (Session 1-II) (Chair: Ilya Selyuzhenkov)
  Multi-particle correlations and fluctuations: from small to large systems

1. 11:10-11:35 Grzegorz Wilk (National Centre for Nuclear Research, Warsaw) Oscillation phenomena in multiparticle production processes, grzegorz.wilk@ncbj.gov.pl
2. 11:35-12:00 Quan Wang (University of Kansas) Correlations and ridge in pp and pPb collisions from CMS, quan.wang@cern.ch
3. 12:00-12:25 Alice Ohlson (CERN) Correlations, multiplicity distributions, and the ridge in pp and p-Pb collisions, alice.ohlson@cern.ch
4. 12:25-12:50 Mariusz Witek (Institute of Nuclear Physics, Krakow) Correlations and ridge in pp and pPb collisions in LHCb experiment, mariusz.witek@ifj.edu.pl

12:50-14:00 Lunch break

- 14:00-15:40, Monday, August 29 (Session 1-III) (Chair: Grzegorz Wilk)
  Multi-particle correlations and fluctuations: from small to large systems

1. 14:00-14:25 Yuji Hirono (Brookhaven National Laboratory) Femtoscopic signature of strong radial flow in high-multiplicity pp collisions, yhirono@bnl.gov
2. 14:25-14:50 Koji Kawaguchi (Sofia University) Analysis of flow observables in small systems using an integrated dynamical model, kawaguchi@eagle.sophia.ac.jp
3. 14:50-15:15 Jie Zhao (Purdue University) Charge dependent particle correlations motivated by chiral magnetic effect and chiral vortical effect, zhao656@purdue.edu
4. 15:15-15:40 Airton Deppman (University of São Paulo), Fractal aspects of hadronic interaction, adeppman@gmail.com

15:40-16:10 Coffee break

- 16:10-17:00, Monday, August 29 (Session 1-IV) (Chair: Grzegorz Wilk)
  Multi-particle correlations and fluctuations: from small to large systems

1. 16:10-16:35 Adam Kisiel (Warsaw University of Technology) Recent femtoscopy results from ALICE, kisiel@if.pw.edu.pl
2. 16:35-17:00 Michael (Felix) Clark (Columbia University) Femtoscopy with identified charged pions in proton-lead collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with the ATLAS detector, michael.ryan.clark@cern.ch

- 17:00-17:25, Monday, August 29 (Special Session) (Chair: Un-ki Yang)
  Future facility

1. 17:00-17:25 Qing Qin (IHEP, China) Performance and perspective of High Energy Physics Collider in IHEP, qinq@ihep.ac.cn

- 17:35-18:50, Monday, August 29 (Special Session) (Chair: In-Kwon Yoo)
  Flash talk session for posters (5-minutes for each talk without question)

1. Beomgon Kim (Korea University) Ultra-peripheral heavy-ion collisions with the CMS experiment, beomgon.kim@cern.ch
2. Minjung Kim (Inha University) Measurements of beauty-decay electrons in ALICE at the LHC, minjung.kim@cern.ch
3. Jonghan Park (Inha University) Studies for an upgrade of the ALICE Inner Tracking System: Pixel chip characterization, hany2203@gmail.com
4. Hyunchul Kim (Chonnam National University) D meson production in heavy-ion collisions with CMS, hyunchul.kim@cern.ch
5. Soyeon Cho (Inha University) Two-particle correlation via Bremsstrahlung, soyeon0817@gmail.com
6. Ji Hyun Kim (University of Seoul) Alternative methods for top quark mass measurements at the CMS, jkim@cern.ch
7. JaeBeom Park (Korea University) Measurement of bottomonia states in pp, pPb and PbPb at 2.76 TeV from CMS, pjwinnetou@gmail.com
8. Wei Yang Wang (National University of Singapore) Statistical modelling of the multiplicity distribution and its source, w.y.wang@u.nus.edu
9. Yeonju Go (Korea University) Isolated photon reconstruction and identification with the CMS detector in PbPb collisions at 5 TeV, ygo@cern.ch
10. Dong Liu (Jeju National University) A pulse shape discrimination method in high energy physics, LIUDONGCN@jejunu.ac.kr
11. Tsubasa Okubo (Hiroshima University) Neutral meson production in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE at the LHC, tsubasa.okubo@cern.ch
12. Myungkuk Kim (Pusan National University) Neutron star mass and radius constraint from X-ray burst in LMXBs, myung.k.kim@gmail.com
13. Dajeong Jeon (University of Seoul) Measurement of normalized differential cross section for the ttbar production in the dilepton channel in pp collisions at $\sqrt{s}$ = 13 TeV, tt8888tt@naver.com

14. Maciej Rybczynski (Jan Kochanowski University) Extensive air shower muons from strange quark matter, maciej.rybczynski@ujk.edu.pl
15. Jewoo Ko (Jeju National University) An algorithm measurement for a neutral kaon decay, $K_L^0 \to \pi^0\pi^0\gamma$, amusejw88@jejunu.ac.kr
16. Songkyo Lee (Korea University) J/psi production in pPb collisions from CMS, songkyo.lee@cern.ch
17. Kisoo Lee (Korea University) B production in pPb at 5.02 TeV from CMS, kilee@cern.ch
18. Zack Sullivan (Illinois Institute of Technology) Searching for charged Higgs bosons with boosted top and bottom jets, zack.sullivan@iit.edu

19:00-21:00 Reception and Poster Session (Crystal Room-1F)

- 08:30-10:10, Tuesday, August 30 (Session 2-I) (Chair: Nicolas Greiner)
  Hadronic final state in high-p_T interactions

1. 08:30-08:55 Katsuo Tokushuku (KEK) Recent results on hard QCD and the hadronic final state at HERA, katsuo.tokushuku@kek.jp
2. 08:55-09:20 Marisilvia Donadelli (University of São Paulo) Measurements of the production of prompt photons, jets and vector bosons+jets in pp collisions with the ATLAS detector, marisilvia@if.usp.br
3. 09:20-09:45 Thoma Flacke (Korea University) Search strategies for vector-like quark partners at LHC run-II, flacke@korea.ac.kr
4. 09:45-10:10 Stefan Kluth (Max Planck Institute für Physik) Measurements of jet rates with the anti-k_t and SISCone algorithms at LEP with the OPAL detector, skluth@mpp.mpg.de

10:10-10:40 Coffee Break

- 10:40-12:40, Tuesday, August 30 (Session 2-II) (Chair: Nicolas Greiner)
  Hadronic final state in high-p_T interactions

1. 10:40-11:05 Bill Gary (University of California at Riverside) Recent studies of light meson production with the BABAR detector, dr.bill.gary@gmail.com
2. 11:05-11:25 Romulus Godang (University of South Alabama) Search for light Higgs boson and muonic dark forces at BABAR, godang@southalabama.edu
3. 11:25-11:50 Mikhail Tokarev (JINR, Dubna) Top-quark p_T-spectra at LHC and flavor independence of z-scaling, tokarev@jinr.ru
4. 11:50-12:15 Michihisa Takeuchi (Kavli IPMU, University of Tokyo) Mono-top signature from supersymmetric ttH channel, michihisa.takeuchi@ipmu.jp
5. 12:15-12:40 Alejandro Ayala (Instituto de Ciencias Nucleares, Universidad Nacional Autonoma de Mexico) Thermal photon production from gluon fusion induced by magnetic fields in relativistic heavy-ion collisions, ayala@nucleares.unam.mx

12:40-14:00 Lunch Break

- 14:00-15:40, Tuesday, August 30 (Session 3-I) (Chair: Voica Redescu)
  Forward physics and diffraction

1. 14:00-14:25 Grzegorz Brona (University of Warsaw) Recent results on forward physics/jets at the LHC, grzegorz.brona@fuw.edu.pl
2. 14:25-14:50 Chrostophe Royon (University of Kansas), Forward physics at the LHC, christophe.royon@ku.edu
3. 14:50-15:15 Rafał Staszewski (Institute of Nuclear Physics, Polish Academy of Sciences) Hard diffraction at Colliders, rafal.staszewski@ifj.edu.pl
4. 15:15-15:40 Gosta Gustafson (Lund University) Effects of diffraction in pp and pA collisions, gosta.gustafson@thep.lu.se

15:40-16:10 Coffee Break

- 16:10-17:50, Tuesday, August 30 (Session 3-II) (Chair: Christophe Royon)
  Forward physics and diffraction

1. 16:10-16:35 Voica Radescu (Oxford University) Parton distribution functions and the role of forward region data, voikitza@gmail.com
2. 16:35-17:00 Itaru Nakagawa (RIKEN) Gluon polarization measurements and the possible role of diffractive process in the transverse single spin asymmetry measurements in RHIC-PHENIX, itaru@riken.jp
3. 17:00-17:25 Simon Stark Mortensen (Niels Bohr Institute) Measurements of the elastic, inelastic and total pp cross section with the ATLAS, CMS and TOTEM detectors, smortens@nbi.dk
4. 17:25-17:50 Yuji Yamazaki (Kobe University) Recent results on diffractive and forward physics at HERA, yamazaki@phys.sci.kobe-u.ac.jp

- 17:50-18:15, Tuesday, August 30 (Special Session) (Chair: Christophe Royon)
  Computing

1. 17:50-18:15 Sang-Un Ahn (KISTI-GSDC) GSDC: A unique data center in Korea for HEP research, sahn@kisti.re.kr

- 08:30-10:10, Wednesday, August 31 (Session 4-I) (Chair: Inkyu Park)
  Perturbative and non-perturbative features of QCD

1. 08:30-08:55 Ivan Vitev (Los Alamos National Laboratory) Perturbative and non-perturbative aspects of jet physics in heavy ion collisions at RHIC and LHC, ivitev@lanl.gov
2. 08:55-09:20 Antonio Uras (Institut de Physique Nucléaire de Lyon) Soft and hard observables of the QCD phase diagram in ALICE, antonio.uras@cern.ch

3. 09:20-09:45 Xiaofeng Luo (Central China Normal University) Search for the QCD critical point: Fluctuations of conserved quantities in high-energy nuclear collisions at RHIC, xfluo@mail.ccnu.edu.cn
4. 09:45-10:10 Fuqiang Wang (Purdue University) Recent hard probe measurements from STAR, fqwang@purdue.edu

10:10-10:40 Coffee Break

■ 10:40-11:55, Wednesday, August 31 (Session 4-II) (Chair: Inkyu Park)
Perturbative and non-perturbative features of QCD

1. 10:40-11:05 Xingbo Zhao (Institute of Modern Physics, CAS) Light-front ab initio approach to QED and QCD, xbzhao@impcas.ac.cn
2. 11:05-11:30 Jason S.H. Lee (University of Seoul) Multi-jet correlations and color coherence phenomena, jason.lee@cern.ch
3. 11:30-11:50 Sanjin Benic (University of Tokyo) Photon from the Color Glass Condensate in the pA collision, sanjinb@nt.phys.s.u-tokyo.ac.jp

11:50-13:15 Lunch Break

13:15-19:00 Excursion

19:00-21:00 Symposium Dinner and Poster Awards

■ 08:30-10:35, Thursday, September 1 (Session 5-I) (Chair: Minjung Kweon)
Collectivity in high-energy collisions: jets, flows or other

1. 08:30-08:55 Shinichi Esumi (Univ. of Tsukuba, CiRfSE) Collective flow measurements at RHIC energies, esumi.shinichi.gn@u.tsukuba.ac.jp
2. 08:55-09:20 Tetsufumi Hirano (Sophia University) Interplay between collective expansion and Mach cone, hirano@sophia.ac.jp
3. 09:20-09:45 Wojciech Broniowski (Jan Kochanowski University) Longitudinal correlations in the initial stages of ultra-relativistic nuclear collisions, Wojciech.Broniowski@ujk.edu.pl
4. 09:45-10:10 Tom Trainor (University of Washington) Rescuing the nonjet azimuth quadrupole from the flow narrative, ttrainor99@gmail.com
5. 10:10-10:35 Michal Praszalowicz (Jagiellonian University) Saturation and geometrical scaling, michal@if.uj.edu.pl

10:35-11:00 Coffee Break

■ 11:00-12:40, Thursday, September 1 (Session 5-II) (Chair: Wojciech Broniowski)
Collectivity in high-energy collisions: jets, flows or other

1. 11:00-11:25 Anton Andronic (GSI) Heavy quarks in deconfined quark-gluon matter, a.andronic@gsi.de
2. 11:25-11:50 Takashi Hachiya (RIKEN BNL research center) Recent heavy flavor measurements from PHENIX at RHIC, hachiya@rcf.rhic.bnl.gov
3. 11:50-12:15 Georg Wolschin (Heidelberg University) Bottomonia physics at RHIC and LHC, wolschin@uni-hd.de
4. 12:15-12:40 Yongsun Kim (Korea University) Overview of the recent jet results in heavy ion collisions at the LHC, kingmking@gmail.com

12:40-14:00 Lunch Break

- 14:00-15:30, Thursday, September 1 (Session 5-III) (Chair: Wojciech Broniowski)
  Collectivity in high-energy collisions: jets, flows or other

1. 14:00-14:25 Daekyoung Kang (Los Alamos National Laboratory) Toward precision jet study with a DIS event shape, kang1@mit.edu
2. 14:25-14:50 Helmut Oesler (University of Heidelberg) Review on light flavour production at LHC energies, H.Oeschler@gsi.de
3. 14:50-15:10 Sungtae Cho (Kangwon National University) Reduction of the K* meson abundance and kinetic freeze-out conditions in heavy ion collisions, sungtae.cho@kangwon.ac.kr
4. 15:10-15:30 Maciej Rybczynski (Jan Kochanowski University) Wounded quarks in A+A, p+A, and p+p collisions, maciej.rybczynski@ujk.edu.pl

15:30-16:00 Coffee Break

- 16:00-17:15, Thursday, September 1 (Session 6-I) (Chair: Yoshitaka Hatta)
  Proton structure, small and large-x physics

1. 16:00-16:25 Anna Maria Stasto (Penn State University) Evolution equations for double parton distributions: initial conditions and transverse momentum dependence, ams52@psu.edu
2. 16:25-16:50 Daniel Boer (VSI, University of Groningen) Multiple scattering aspects of gluon TMDs, d.boer@rug.nl
3. 16:50-17:15 Shuzo Kumano (KEK/J-PARC) Hadron tomography studies by generalized parton distributions and distribution amplitudes, shunzo.kumano@kek.jp

- 17:15-18:05, Thursday, September 1 (Session 7-I) (Chair: Gungwon Kang)
  Cosmic ray and astroparticle physics

1. 17:15-17:40 David Kieda (University of Utah) Recent advances in ground-based gamma-ray particle astrophysics, dave.kieda@utah.edu
2. 17:40-18:05 Antonio Insolia (University of Catania and INFN-Catania) The Pierre Auger Observatory: overview and results, antonio.insolia@ct.infn.it

18:30-21:00 Board of Elders (BoE) Meeting (Dynasty room-B1)

- 09:00-10:15, Friday, September 2 (Session 7-II) (Chair: Antonio Insolia)
  Cosmic ray and astroparticle physics

  1. 09:00-09:25 Denise Boncioli (DESY) Interactions of UHECRs around the Universe - Models for UHECR data interpretation, denise.boncioli@desy.de
  2. 09:25-09:50 Dongchul Son (Kyungpook National University) Recent results from the Alpha Magnetic Spectrometer on the International Space Station, son@knu.ac.kr
  3. 09:50-10:15 SeongJin In (Sungkyunkwan University) Astroparticle Physics in IceCube, seongjin.in@gmail.com

10:15-10:45 Coffee Break

- 10:45-11:35, Friday, September 2 (session 7-III) (Chair: Antonio Insolia)
  Cosmic ray and astroparticle physics

  1. 10:45-11:10 Yu Seon Jeong (KISTI) Prompt atmospheric neutrino flux and its theoretical uncertainties, ysjeong@kisti.re.kr
  2. 11:10-11:35 Gungwon Kang (KISTI) Gravitational Waves: Music of Spacetime, gwkang@kisti.re.kr

- 11:35-12:00, Friday, September 2 (Chair: Byungsik Hong)
  Conclusions

  1. 11:35-12:00 Bill Gary (University of California at Riverside) Final Remarks

Session 1

Multi-particle correlations and fluctuations: from small to large systems

Session 1-I (Monday 09:00-10:40)
Chair: Ilya Selyuzhenkov

Session 1-I. 1
News on collectivity in Pb-Pb collisions from the ALICE experiment at the LHC

Dong Jo Kim[1,*] for the ALICE Collaboration

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The collective expansion of the color-deconfined fireball created in ultra-relativistic heavy-ion collisions can map the initial state of the quark-gluon plasma (QGP) to the final-state particle spectrum. The ALICE experiment has important roles for completing the individual flow harmonic measurements at the highest energies to date as well as improving flow harmonic correlation techniques to understand the properties of the QGP and the full evolution of the heavy-ion collisions. In this talk, a brief summary of the individual flow harmonic measurements, the details of the new observables developed in recent years from ALICE collaboration and their implications to future studies will be given.

Session 1-I. 2
News on collectivity in Pb-Pb collisions (CMS)

Dong Ho Moon[1,*] for the CMS Collaboration

[1]Chonnam National University
*dhmoon@jnu.ac.kr

The flow anisotropies with the Fourier coefficients (n = 2, 3) for the charged particles produced in PbPb collisions at a nucleon-nucleon center-of-mass energy of 5.02 TeV is studied with the CMS detector. In order to extract the Fourier coefficients, several methods were used, such as the scalar product method or multi-particle cumulant method. The results cover both of the low-p_T region ($1 < p_T < 3$ GeV/c) associated with hydrodynamic flow phenomena and the high-p_T region where anisotropic azimuthal distributions may reflect the path-length dependence of the parton energy loss in the created medium for the seven bins of collision centrality, spanning the range of 0-60% most-central events.

Session 1-I. 3
Measurement of azimuthal anisotropy at RHIC-PHENIX

Maya Shimomura[1,*] for the PHENIX Collaboration

[1]Nara Women's University
*mayap@bnl.gov

The azimuthal anisotropy on the particle emission is considered as one of the probes to study properties of the state of deconfined quarks and gluons (QGP) generated in the high-energy heavy-ions collisions. The azimuthal anisotropy is sensitive to the early stage and is the observable that is affected by QGP properties. We will report the recent measurements of azimuthal anisotropy with RHIC-PHENIX.

Session 1-I. 4
Studies of three-particle correlations and reaction-plane correlators from STAR

Prithwish Tribedy[1,*] for the STAR Collaboration

[1]Brookhaven National Laboratory
*ptribedy@bnl.gov

We present STAR measurements of three-particle correlations for various harmonics in Au+Au collisions at RHIC. The quantity $< \cos(m\emptyset_1 + n\emptyset_2 - (m+n)\emptyset_3) >$ is measured for inclusive charged particles as a function of collision centrality, $\sqrt{s_{NN}}$, transverse momentum p_T, pseudo-rapidity difference $\Delta\eta$, and harmonics (m and n). These observables provide detailed information on global event properties like correlations between event planes of different harmonics and are particularly sensitive to the expansion dynamics of the matter produced in the collisions. We compare our measurements to different viscous hydrodynamic models. We argue that these measurements probe the three dimensional structure of initial state and provide unique ways to constrain the transport parameters involved in hydrodynamic modeling of heavy ion collisions.

Session 1-II (Monday 11:10-12:50)
Chair: Ilya Selyuzhenkov

Session 1-II. 1
Oscillation phenomena in multiparticle production processes

Grzegorz Wilk[1,*] and Zbigniew Wlodarczyk[2,**]

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There is good evidence for the presence of oscillation in counting statistics, in many different, apparently very disparate branches of physics. Examples include oscillations of the high-order cumulants of transport through a Mach-Zender interferometer as functions of the Aharonov-Bohm flux, and in transport through a double quantum dot as functions of the energy dealignment between the two quantum dots [1]. Similar oscillations have been seen in quantum optics (in photon distribution function in slightly squeezed states [2]) as well as in elementary particle physics [3], further demonstrating the universality of the phenomenon. We can therefore expect that oscillations of the high-order cumulants in fact constitute a universal phenomenon which is to be expected in a large class of stochastic processes, independently of the microscopic details. In fact, whereas theoretical studies of a number of different systems have found that the high-order cumulants oscillate as functions of certain parameters, so far no systematic explanation of this phenomenon has been given. In this presentation we concentrate on oscillation phenomena seen at LHC energies in transverse momentum distributions and multiplicity distributions. Large transverse momentum distributions apparently exhibit power-like behavior. However, we argue that, under closer inspection, this behavior is in fact decorated with some log-periodic oscillations (seen in all LHC experiments). Assuming that this is a genuine effect and not an experimental artefact, it suggests that either the exponent of the power-like behavior is in reality complex, or that there is a scale parameter which exhibits specific log-periodic oscillations. This problem is discussed using Tsallis distribution with scale parameter T and with complex nonextensivity parameter q [4]. In what concerns multiplicity distributions P(N), they are most frequently described by the Negative Binomial Distribution. However, with increasing collision energy some systematic discrepancies become more and more apparent. The wave structure of the multiplicity distributions already observed by ALICE, CMS (and previously also by UA5) experiments is still hardly significant. They are usually attributed to the possible multi-source structure of the production process and described using a multi-NBD form of the multiplicity distribution. We propose instead a novel phenomenological description of the observed multiplicity distributions which allows for a more detailed quantitative description of the complex structure of the experimental data on P(N) [5]. It is provided by coefficients Cj (connected with "combinants" introduced in [6] but not identical to them) defined by recurrence relation $(N+1)P(N+1) = \langle N \rangle \sum_j CjP(N-j)$ [7]. We observe strong oscillations of Cj at LHC energies [5]. Our result is not directly connected with the wave structure observed in data on P(N) for N> 25. The coefficients Cj are completely insensitive to the P(N > (j +1)) tail of the multiplicity distribution, whereas their oscillatory behavior starts from the very beginning. If experimentally confirmed, these oscillations will await their physical justification, i.e., indication of some physical process which would result in such a phenomenon.

[1] C. Flindt et al., PNAS 106 (2009) 10116-10119.
[2] V. V. Dodonov et al., Phys. Lett. A 193 (1994) 209-217.
[3] I. M. Dremin, J. W. Gary, Phys. Rep. 349 (2001) 301-393.
[4] G. Wilk, Z. Wlodarczyk, Physica A 413 (2014) 53-58; Entropy 17 (2015) 384-400; Chaos, Solitons and Fractals, 81 (2015) 487-496.
[5] G. Wilk, Z. Wlodarczyk, arXiv:1601.03883 [hep-ph].
[6] S. K. Kauffman, M. Gyulassy, J. Phys. A 11 (1978) 1715-1727.
[7] B. E. A. Saleh, M. C. Teich, Proc. IEEE 70 (1982) 229-245.

Session 1-II. 2
Correlations and ridge in pp and pPb collisions from CMS

Quan Wang[1, *] for the CMS Collaboration

[1]University of Kansas
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New CMS results on multi-particle correlations, identified particle spectra and correlations in pp and pPb collisions are presented. Evidence of collective phenomena in small collision systems is observed in high-multiplicity events, which provides strong constraint on theory calculations. The results are compared to PbPb collisions at similar multiplicities.

Session 1-II. 3
Correlations, multiplicity distributions, and the ridge in pp and p-Pb collisions

Alice Ohlson[1,*] for the ALICE Collaboration

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In high-energy hadronic collisions, studies of inclusive single-particle distributions as well as multi-particle correlations are used to investigate particle production in QCD. Charged-particle multiplicity distributions as a function of pseudorapidity will be shown for pp collisions over a range of centre-of-mass energies as well as for p-Pb collisions, including the latest results from pp collisions at the top LHC energy of $\sqrt{s}$ = 13 TeV measured by ALICE. The results are compared to common event generators. Two-particle correlation studies in azimuthal angle and pseudorapidity have yielded surprising results in small collision systems, showing the presence of correlations between particles over large ranges in pseudorapidity in high-multiplicity pp and p-Pb collisions. These correlations are reminiscent of features observed in heavy-ion collisions where they are commonly attributed to anisotropic flow (v_n). The transverse momentum, pseudorapidity, and particle species dependence of v_2 in p-Pb collisions will be reported, and the implications for collective effects in small collision systems will be discussed.

Session 1-II. 4
Correlations and ridge in pp and pPb collisions in LHCb experiment

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The LHCb experiment, besides its main programme of b and c-physics also performs very well as a general purpose forward detector, covering the pseudo-rapidity range 2.0 to 5.0. Exploiting the experiment's unique geometry, the LHCb collaboration is pursuing a rich program of forward QCD measurements. In particular two-particle angular correlations are studied in proton-lead collisions at a nucleon-nucleon center-of-mass energy of $\sqrt{s_{NN}}$ = 5TeV, collected with the LHCb detector at the LHC. The analysis is based on data recorded in two opposing beam configurations, in which either the direction of the proton or that of the lead remnant is analyzed. This is the first measurement of a long-range correlation on the near side in proton-lead collisions in the forward region and extends previous observations in the central region

Session 1-III (Monday 14:00-15:40)
Chair: Grzegorz Wilk

Session 1-III. 1
Femtoscopic signature of strong radial flow in high-multiplicity pp collisions

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Hydrodynamic simulations are used to calculate the identical pion HBT radii, as a function of the pair transverse momentum. This dependence is sensitive to the magnitude of the collective radial flow in the transverse plane, and thus comparison to ALICE data enables us to derive its magnitude. By using hydro solutions with variable initial parameters we conclude that in this case fireball explosions start with a very small initial size, well below 1 fm.

Session 1-III. 2
Analysis of flow observables in small systems using an integrated dynamical model

Koji Kawaguchi,[1,*] Koichi Murase[1], and Tetsufumi Hirano[1]

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We investigate collectivity in small colliding systems by using an integrated dynamical model in which Monte-Carlo initialization of hydrodynamic fields, ideal hydrodynamic description of the QGP fluids and the kinetic description of the hadron gas are incorporated. We implement fluctuations of multiplicity and longitudinal-matter-profile in the initial conditions which are important, in particular, in small colliding systems. We also discuss the effects of hadronic rescatterings on flow observables within this framework.

Session 1-III. 3
Charge dependent particle correlations motivated by chiral Magnetic Effect and chiral vortical Effect

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Metastable domains of topological charges can be formed in quark gluon plasma with approximate chiral symmetry restoration. These topological charges can change the chirality of quarks in the local domains. This can lead to observable charge separation along the direction of the strong magnetic field produced in the early stage of relativistic heavy-ion collisions. Measurement of charge separation can therefore provide a means to studying the nontrivial QCD topological structures, such as the chiral magnetic effect (CME) and the chiral vortical effect (CVE). In this talk, we will present the STAR measurements of three particle azimuthal correlations of charged-particles and identified particles to search for possible signatures of the CME and CVE.

Session 1-III. 4
Fractal aspects of hadronic interaction

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It is known that multiparticle dynamics exhibit finger-prints of a fractal structure, as evidenced in the intermittence of experimental data. The fractal aspects of QCD is also present in other observables, as the parton distribution functions. From a historical perspective, one can say that the first time fractal aspects of strongly interacting systems was addressed is in the work by Rolf Hagedorn, in 1960's, about the self consistent thermodynamics, or in the structure of hadrons as proposed by S. Frautisch a few years later. Although the term fractal was proposed by Mandelbrot only years later, many features of fractals are present in the definitions of fireballs, by Hagedorn, or of hadrons, by Frautisch. A remarkable feature of high energy collisions is the power-law behavior of the transverse momentum distributions. Although at the high momentum sector this can be explained in terms of perturbative QCD, the low momentum sector can be described only by the assumption of a thermodynamically equilibrated system formed in the collision, which is usually described by Hagedron's self-consistent thermodynamics. It has been shown that when Tsallis statistics is used, now extended with the non extensive features, can describe the experimental data with only two free parameters that are independent of the collision energy and of the observed particle mass, namely, the critical temperature, T, and the entropic index, q, which appears in Tsallis statistics. Recently it was shown that the non extensive behavior of the hadronic systems can be related to a fractal structure of its thermodynamical functions. The fractal dimension is determined by those two parameters of the Tsallis statistics and, surprisingly, is in accordance with the fractal dimension obtained from the analysis of intermittence in the high energy distributions. In this talk we present an overview on the developments of the non extensive self-consistent thermodynamics applied for high energy collisions and discuss possible implications in the investigation of non-perturbative QCD.

Session 1-IV (Monday 16:10-17:00)
Chair: Grzegorz Wilk

Session 1-IV. 1
Recent femtoscopy results from ALICE

Adam Kisiel[1, *] for the ALICE Collaboration

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ALICE, an experiment dedicated to the analysis of heavy-ion collisions is ideally suited for femtoscopic analysis, with its excellent PID capabilities at low and intermediate momenta. It studies correlations of pions which provide crucial information on the size and the dynamics of the system. Recent results from p+p, p-Pb and Pb-Pb collisions will be discussed with emphasis on similarities and differences between small and large systems. Results for kaons are used to cross-check the information about the dynamics of the source and provide unique insight into the importance of the hadronic rescattering phase. A new approach to femtoscopcy allows one to study the strong interaction parameters and cross-section for selected pairs. Constraints on these values will be derived from recent femtoscopic results for baryon-(anti-)baryon, and kaon pairs from ALICE.

Session 1-IV. 2
Femtoscopy with identified charged pions in proton-lead collisions at 5.02 TeV with the ATLAS detector

Michael Clark[1,*] for the ATLAS Collaboration

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Bose-Einstein correlations between identified charged pions are measured for p+Pb collisions at $\sqrt{s_{NN}} = 5.02$ TeV with the ATLAS detector with a total integrated luminosity of 28 nb^{-1}. Pions are identified using ionization energy loss measured in the pixel detector. Two-particle correlation functions and the extracted source radii are presented as a function of average transverse pair momentum (k_T) and rapidity (y^*_k) as well as collision centrality. Pairs are selected with a rapidity $-2 < y^*_k < 1$ and with an average transverse momentum $0.1 < k_T < 0.8$ GeV. The effect on the two-particle correlation function from jet fragmentation is studied, and a new method for constraining its contributions to the measured correlations is described. The measured source sizes are substantially larger in more central collisions and are observed to decrease with increasing pair k_T. A correlation with the local multiplicity dN/dy^* is demonstrated. The scaling of the extracted radii with the mean number of participants is also used to compare a selection of initial-geometry models. The cross term R_{ol} is measured as a function of rapidity, and a departure from zero is observed with 4.8σ combined significance in the proton-going side of the most central events.

Special Session (Monday 17:00-17:25)
Chair: Un-ki Yang

(Future facility)
Performance and perspective of High Energy Physics Collider in IHEP

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Initiated by the Beijing Electron Positron Collider (BEPC), high energy physics in China has been developing for more than 30 years, together with the developments of detector and accelerator technologies. Substantial results on particle physics was obtained on the BEPC, stimulating the upgrade of the BEPC, BEPCII, which was finished 10 years ago. Now the BEPCII keeps running with some new physics results every year. The discovery of Higgs boson makes it possible to build a circular electron positron collider as a Higgs factory in the near future. Such a high energy machine (CEPC) was then proposed by IHEP about 4 years ago, and pre-CDR study for the accelerator and detector of CEPC had been carried out in recent years, and the R&D study for CDR is now under way. In the future a super proton-proton collider (SppC) can be constructed in the same tunnel of CEPC after the running for physics. In this talk, the high energy physics machine, BEPC, will be reviewed, and the future project, CEPC+Sppc will be introduced in detail.

Flash-Talk Session (Monday 17:25-18:50)
Chair: In-Kwon Yoo

P1. Ultra-peripheral heavy-ion collisions with the CMS experiment

Beomgon Kim[1,*] for the CMS collaboration

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Ultraperipheral collisions (UPCs) of heavy ions involve long range electromagnetic interactions at impact parameters larger than sum of their radii where hadronic interaction is largely suppressed and the exchanged photon materializes into qq(bar) bound state after interacting with the gluonic field of the target proton or ion. Photoproduction of heavy vector mesons (J/psi, Upsilon) thus provide direct information on the gluon distribution functions in the nucleon/nucleus at very low values of Bjorken-x. The CMS experiment has excellent capabilities for the measurement of the heavy vector mesons in the dimuon decay channel using the tracker and the muon chambers. The measured coherent J/psi photoproduction cross section in ultraperipheral Pb-Pb collisions using 2011 PbPb data and Upsilon photoproduction in ultraperipheral pPb collisions during 2013, will be presented. The prospects for future measurements using the data collected in the 2015 PbPb run will also be described.

P2. Measurements of beauty-decay electrons in ALICE at the LHC

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Heavy quarks (charm and beauty) are essential probes of the evolution of the Quark-Gluon Plasma (QGP) created in heavy-ion collisions, because heavy-quark production in high-energy collisions occurs early compared to the formation time of the strongly-interacting partonic matter. Furthermore, separate measurements of beauty quarks from charm quarks can test the mass dependence of the parton energy loss in the QGP. To quantify medium effects in AA collisions, one needs to study pp collisions and p-A collisions as references. Apart from providing the crucial reference for Pb-Pb collisions, the measurements of beauty production in pp collisions provide tests for perturbative QCD calculations. Measurements in p-A collisions can be used to study cold nuclear matter effects such as the modification of the parton densities in nuclei with respect to nucleons, k_{T} broadening, energy loss in cold nuclear matter.
Thanks to excellent vertex and impact parameter resolution of ITS and electron-identification capability provided by TPC and TOF in the ALICE experimental setup, measurements of beauty production in pp, p-Pb and Pb-Pb collisions could be done via electrons from semi-leptonic decays of beauty hadrons. The measurements of beauty-hadron decay electrons exploit the long lifetime of the beauty hadrons which leads larger impact parameter of beauty-hadron decay electrons. Broader angular correlation distribution of beauty-hadron decay electrons due to different decay kinematics of beauty hadrons from charm hadrons is also used for separation of electrons from charm and beauty hadrons.
Focusing on analysis strategies, we will present the recent measurements of beauty-decay electrons in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV and in Pb-Pb collisions at $\sqrt{s_{NN}}$ = 2.76 TeV in ALICE.

P3. Studies for an upgrade of the ALICE Inner Tracking System: Pixel chip characterization

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Study of production of heavy flavours is regarded as an excellent probe to understand the properties of Quark-Gluon plasma produced in heavy-ion collision experiments. The measurements of heavy flavours need very high precision tracking and vertexing detectors. Inner Tracking System (ITS) of ALICE is used for vertex determination and tracking. The main tracking component of ITS consists of pixel chips. Future heavy-ion program at the LHC aims to run with high luminosity. To address this challenge, upgrade program of ITS is underway, which aims at better position resolution (factor of 3), high detection efficiency (>99%), high-rate readout capabilities (100 kHz for Pb+Pb) and moderate radiation hardness (> 700 krad). The new ITS will be composed with 7 layers of silicon pixel chip based on Monolithic Active Pixel Sensor (MAPS) technology. We have performed the characterisation test of various version of prototype chips at different phases of development. We will present the main characterisation results obtained from the measurements performed at laboratories and using test beam for finalising the pixel chip specification.

P4. D meson production in heavy-ion collisions with CMS

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To investigate the properties of the high-density QCD matter in heavy-ion collisions, the measurement of heavy flavor production is one of attractive tools. In 2.76 and 5.02 TeV PbPb collisions, CMS measured the nuclear modification factor of D^0 mesons. We will present the dependence on the centrality and transverse momentum up to 100 GeV in this poster.

P5. Two-particle correlation via Bremsstrahlung

Soyeon Cho[1,*], Kayoung Park, and Jin-Hee Yoon

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Ridge is the well-known structure in two-particle azimuthal correlations at high-energy heavy-ion collisions. This structure is physically understood through elliptic and higher-order flows at nucleus-nucleus collisions. This structure also appears in small systems, such as proton-proton collisions, recently. However, Ridge structure in small system is hard to well-explain using hydrodynamics, since the small system is not regarded as possibly producing Quark-Gluon plasma. Thus, we try to describe this phenomena through kinematic interaction between jets and medium partons.
In high-energy heavy-ion collision, the energetic particles called jets go out with specific direction and lose their energy while passing through the medium. During such process, photons/gluons are emitted from interaction between jets and medium partons. We concentrate on energy loss via photon radiations, as known as Bremsstrahlung. The study on scattering between jet and medium is already published in 2012 by C.Y. Wong. In this study, two symmetric double scattering process between jet particle and medium parton produce certain constructive interference. This constructive interference gives collective motion, in which medium partons are aglined along incoming jet particles. We adopt such result of study on scattering between jets and medium patons when we describe the Bremsstrahlung process. Therefore, we calculate the two symmetric diagrams of photon emission and medium parton scattering. We expect these two amplitudes to give constructive interference leading to the collective motion of medium. And we also expect that Ridge behaviour might be explained if we combine our results with jet colliding results.

We check the correlation for emitted photon and final jet, and that for medium parton and final jet under the incident jet energy is 10GeV, final jet energy is 9GeV and angles of incident jet are $\theta p = 10\circ$ and $\varphi p = 0\circ$. To describe parton momentum distribution in medium, we use the Maxwell-Boltzmann distribution.

P6. Alternative methods for top quark mass measurements at the CMS

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The top quark mass is a fundamental parameter of the standard model and together with the W boson mass and the Higgs boson mass it provides a strong self-consistency check of the electroweak theory. Recently several new measurements of the top quark mass using alternative observables and reconstruction methods are performed by the CMS collaborations at the CERN LHC. Alternative methods can give a insight by providing different systematic sensitivities while standard ones are constrained by such as jet energy uncertainties. We introduce various results from new methods including the one using a charmed meson, which are found to be consistent with what is obtained in standard measurements.

P7. Measurement of bottomonia states in pp, pPb and PbPb at 2.76 TeV from CMS

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The production of three individual Y states (1S, 2S, 3S) has been investigated using the Compact Muon Solenoid (CMS) in pp and pPb collisions at the center-of-mass energies of 2.76 and 5.02 TeV respectively. The datasets used in this analysis correspond to the recorded integrated luminosities of about 31/nb (pPb) and 5.1/pb (pp), collected in 2013 at LHC.We study upsilons which decay into muons of transverse momentum above 4 GeV/c and pseudo-rapidity in the nucleon-nucleon center-of-mass frame of $|\eta_{CM}| < 1.93$. In particular the upsilon yields are studied as a function of two measures of "event activity", the charged-particle multiplicity measured in $|\eta| < 2.4$, and the transverse energy deposited in forward region $4.0<|\eta|< 5.2$. The ratios of the excited to the ground state Y(nS)/Y(1S) are measured in both datasets and compared to the PbPb results. The ratios decreases with the charged-particle multiplicity, and show a smaller variation with the transverse energy. The double ratios, [Y(nS)/Y(1S)]pPb/[Y(nS)/Y(1S)]pp, integrated by the event activity are 0.83 ± 0.05 (stat.) $\pm$ 0.05 (syst.) and 0.71 ± 0.08 (stat.) $\pm$ 0.09 (syst.) for Y(2S) and Y(3S), respectively.

P8. Statistical Modelling of the Multiplicity Distribution and its Source

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The multiplicity distribution is described in terms of models incorporating the stochastic branching of quarks and gluons, along with fluctuations their production. Results show a reasonable description of data from the CMS collaboration at 0.9, 2.36, and 7 TeV for all pseudorapidity ranges. A prediction for 13 TeV is also given.

P9. Isolated photon reconstruction and identification with the CMS detector in PbPb collisions at 5 TeV

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Measurement of isolated photon gives possibility to constrain the nuclear parton distribution functions (nPDF). Isolated photon is also the clear tag in photon-jet channel for studying energy loss of the jets in medium. The performance of isolated photon reconstruction and identification has been studied in PbPb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV. We describe signal template method to determine the purity of isolated photons. Optimization of isolation cut is important to maximize good quality photons. Isolation and trigger efficiency are measured in Monte-Carlo simulation.

P10. A pulse shape discrimination method in high energy physics

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The success of current high energy physics experiments usually depends on the discrimination of particle signals. As for charged particles, the particle signals can be determined and discriminated through the measurements of the charge number and mass. However, for neutral particles, for instance, gamma photons and neutrons, the method used for discrimination of charged particles are incompetence. Therefore, an excellent Pulse Shape Discrimination method is necessary for the discrimination of particle signals.
The interaction of incident particles and target nuclei can be attributed to the 2-body problem. There are two possible energy states for the combination for 2-body problem, singlet state and triplet state, which are populated depending on the ionizing particle Linear Energy Transfer. This may lead to the difference in pulse shape. Therefore, the characteristic of incident particles can be determined though the analysis of the pulse shape. This presentation will introduce the method for discrimination of using the analysis of pulse shape, as the result, the characteristic of incident neutral particles can be specified.

P11. Neutral meson production in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV with ALICE at the LHC

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Strong suppression of high p_T particles has been observed in heavy-ion collisions at LHC energies, which can be interpreted by invoking various processes involving transport properties of the QCD medium and initial state effects. Proton-nucleus (p-A) collisions are intermediate between proton-proton (pp) and nucleus-nucleus (A-A) collisions in terms of system size and number of produced particles. Comparing particle production in pp, p-A, A-A reactions has frequently been used to separate initial state effects of colliding nuclei from final state effects in quark matter created by the collisions. The study of neutral meson production in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV is of importance to confirm that the strong suppression observed in central Pb-Pb collisions is a final-state effect of the produced dense medium. We have measured neutral mesons (π^0 and η) emitted in p-Pb collisions at $\sqrt{s_{NN}}$ = 5.02 TeV via complementary methods, using the ALICE electromagnetic calorimeters, PHOS and EMCal, and by the central tracking system, identifying photons converted into e^+e^- pairs in the material of the inner barrel detectors, the Time Projection Chamber (TPC) and the Inner Tracking System (ITS). I will present the final results for π^0 and η spectra in p-Pb collisions as well as the nuclear modification factor ($R_{p\text{-}Pb}$) for π^0.

P12. Neutron star mass and radius constraint from X-ray burst in LMXBs

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X-ray bursts which are one of the most energetic explosion events have been observed in low-mass X-ray binaries (LMXBs). Type-I X-ray bursts showing photospheric radius expansion (PRE) are main objects to offer a possibility of determining the neutron star masses and radii in the binary systems. Since 20% of total X-ray bursts show the evidence of PRE explosion, it is difficult to analyze physical quantities such as masses and radii of neutron stars in LMXBs due to the limitation of observation. Neutron stars are thought to be existed in LMXBs, and masses and radii of neutron stars are constrained using the Monte-Carlo analysis with touchdown flux and normalized angular surface area values from observed light curve data. Besides that, various theoretical predictions can be existed according to the relation of photosphere and stellar radius. In this paper, we research the change of mass and radius probability distribution for a fixed hydrogen mass fraction (X) which can be considered to be neutron star's atmosphere since the fraction is not observed directly. Not only the masses but also radii of neutron star have been changed depending on the composition of accreted matter.

P13. Measurement of Normalized Differential Cross Section for the ttbar Production in the Dilepton Channel in pp Collisions at √s=13 TeV

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Differential cross sections of top-quark pair production are measured in the dilepton decay channel with proton-proton collisions at a center-of-mass energy of 13 TeV. The measurement is performed with Run II data using the CMS detector at the Large Hadron Collider. In this analysis, we measure the differential cross sections with respect to the kinematic variables of leptons, b jets, and top-quarks at particle level.

P14. Extensive air shower muons from Strange Quark Matter

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A very important aspect of understanding of primary cosmic ray flux and its composition is a proper description of recent measurement done by the ALICE experiment at CERN LHC, in its dedicated cosmic ray run [1]. ALICE Collaboration registered the presence of large groups of muons produced in EAS by cosmic ray interactions in the upper atmosphere [1]. A special emphasis has been given to the study of high multiplicity events containing more than 100 reconstructed muons. Similar events have been studied in previous underground experiments such as ALEPH [2], DELPHI [3] and L3 [4] at CERN Large Electron-Positron Collider. While these experiments were able to reproduce the measured muon multiplicity distribution with Monte Carlo simulations at low and intermediate multiplicities, their simulations failed to describe the frequency of the highest multiplicity events. The muon multiplicity distribution measured by ALICE when compared with the fits obtained from CORSIKA simulations with proton or iron primary cosmic rays indicates that the expected rate of higher multiplicity muon events is sensitive to assumptions made about the dominant hadronic production mechanisms in air shower development. Although, assuming the presence of only the Fe nuclei in the primary flux it is roughly possible to describe the presence of the low and intermediate muon bundles, the same assumption used in the conventional models of EAS development completely fails to describe observed muon groups at high multiplicities. Surprisingly, the ALICE Collaboration shows in [1] only fits for muon multiplicities up to about 70, neglecting many events with measured muon multiplicities up to 270.

In this talk we discuss a (out) hypothesis that muon bundles of extremely high multiplicity observed recently by ALICE detector can originate from small lumps of Strange Quark Matter (SQM) colliding with the atmosphere. We demonstrate that extremely large groups of muons can be very well described by a relatively minute (of the order of 10^5 of total primary flux) admixture of SQM of the same total energy. Our estimate of SQM flux do not contradict results obtained recently by the SLIM Collaboration [5].

[1] [ALICE Collaboration], JCAP 01, 032 (2016), arXiv:1507.07577.
[2] C. Grupen et al., Nucl. Instrum. Meth. A 510, 190 (2003).
[3] J. Ridky et al. [DELPHI Collaboration], Nucl. Phys. Proc. Suppl. 138, 295 (2005).
[4] P. Achard et al. [L3 Collaboration], Phys. Lett. B 598, 15 (2004), hep-ex/0408114.
[5] Z. Sahnoun et al. [SLIM collaboration], Radiation Measurements 44, 894 (2009).

P15. An algorithm of measurement about one gamma fusion ratio for a neutral kaon decay, $K_L^0 \to \pi^0\pi^0\gamma$

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A neutral kaon decay, $K_L^0 \longrightarrow \pi^0\pi^0\gamma$, totally 5 gamma rays are produced from $2\pi^0$ and gamma. $K_L^0 \longrightarrow \pi^0\pi^0\gamma$, decay rate can be calculated by a Chiral Perturbation Theory (ChPT) that explains well the strong interaction at the low energy-region. In this presentation, we calculated a rate of misunderstanding as $K_L^0 \longrightarrow \pi^0\pi^0\pi^0$ decay mode that can be detected as those 5 gamma rays as $K_L^0 \longrightarrow \pi^0\pi^0\gamma$. This study was researched by GEANT4 simulation. As a result, we found a misunderstanding ratio is about 86.47% for 2 gamma rays make one cluster on the CsI calorimeter. This means that it is difficult to distinguish the signals between $K_L^0 \longrightarrow \pi^0\pi^0\pi^0$ and $K_L^0 \longrightarrow \pi^0\pi^0\gamma$ decay modes.

P16. J/ψ production in pPb collisions from CMS

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The charmonia are important probes to study the properties of the de-confined medium, the so called quark-gluon plasma (QGP), produced by ultra-relativisitc heavy-ion collisions. On the other hand, the prompt and non-prompt J/ψ productions in asymmetric proton-nucleus collisions enable us to investigate the cold nuclear matter effects (CNM), which provide new information to examine quantitatively the genuine hot-medium effects in nuclear collisions. This presentation reports the prompt and non-prompt J/ψ productions from CMS, using 35 /nb of pPb recorded in 2013 at 5.02 TeV. The differential production cross sections are analyzed in $2 < p_T < 30$ GeV/c and the center-of-mass (CM) rapidity $-2.87 < y_{CM} < 1.93$. The ratio of the forward and backward yields is analyzed in several ranges of p_T, rapidity, and the event-activity variable to investigate the CNM.

P17. B production in pPb at 5.02 TeV from CMS

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Hadrons with heavy quarks are promising probes to investigate the detailed properties of hot and dense medium generated by heavy-ion collisions at collider energies. Since heavy quarks are sensitive to the transport properties of the medium, the energy-loss pattern of them is expected to be quite different from that of light

quarks in a strongly-interacting matter. On the other hand, in order to elicit the actual effects caused by the hot and dense medium, it is necessary to understand the cold nuclear matter effect in pA collisions. For example, the pPb data is expected to provide a baseline for the study of the b-quark energy loss in medium produced by PbPb collisions. Therefore, the CMS Collaboration at the Large Hadron Collider (LHC) has analyzed the production cross sections of B^+, B^0, B_S^0 mesons in pPb collisions as a function of rapidity and the transverse momentum at the nucleon-nucleon center-of-mass energy of 5.02 TeV. In addition, the nuclear modification factors of the B mesons have been constructed using the theoretical pp reference spectra estimated by the perturbative Quantum ChromoDynamics (pQCD) model. And CMS collected pp and PbPb collisions at the center-of-mass energy of 5.02 TeV at the LHC in the end of 2015. Analysis of B production in pp and PbPb is ongoing.

P18. Searching for charged Higgs bosons with boosted top and bottom jet

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At moderate values of tan(beta), a charged Higgs boson is exceptionally difficult to find due its small cross section and large backgrounds. A recent paper has suggested that a charged Higgs could be found in this wedge region using boosted top and bottom jets. We improve our boosted bottom jet tag using tracking information and predict the reach for charged Higgs bosons at 14 TeV and 100 TeV colliders using realistic boosted tagging efficiencies and fake rates.

Session 2
Hadronic final state in high-p_T interaction

Session 2-I (Tuesday 08:30-10:10)
Chair: Nicolas Greiner

Session 2-I. 1
Recent results on hard QCD and the hadronic final state at HERA

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Measurements of high-p_T objects and the hadronic final state at HERA provide a detailed understanding of the structure of the proton, precise measures of the strong coupling constant and other powerful tests of QCD. Measurements are presented of prompt photon and jet production in deep inelastic scattering; both are compared with QCD predictions. Given the large sample of one-, two- and three-jet events, this will yield a precise measurement of the strong coupling constant. Using the large statistical samples and precision instrumentation, searches for more exotic QCD objects in the final state were also performed. Pentaquark states have long been a subject of great interest and the ZEUS experiment searched for a strange pentaquark, but observed no signal and so imposed a limit on the production of the postulated theta+. The H1 collaboration searched for QCD instantons; again no signal was observed and a limit on their production was placed.

Session 2-I. 2
Measurements of the production of prompt photons, jets and vector bosons+jets in pp collisions with the ATLAS detector

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The production of jets, photons and of gauge bosons in association with jets at hadron colliders provides a stringent test of perturbative QCD and can be used to probe the gluon density function of the proton. We present recent measurements of the inclusive jet cross section in data collected at center-of -mass energies of 8 TeV and 13 TeV. The measurements have been performed differentially in various kinematic and angular observables and are compared with state-of-the-art theory predictions at NLO in pQCD. ATLAS has performed precise measurements of the inclusive production of isolated prompt photons in data collected at center-of-mass energies of 8 and 13 TeV, differential in both rapidity and the photon transverse momentum. The measurements are compared with NLO pQCD calculations and with several MC generators. The cross section of photons, W and Z bosons in association with one or several jets have been measured differentially in various observables at center-of-mass energies of 8 and 13 TeV and compared with state-of-the-art pQCD calculations up to NNLO QCD and NLO EWK as well as LO and NLO ME+PS generators. Dedicated phase spaces sensitive to emission of massive bosons collinear with jets or the electroweak production of vector bosons are tested.

Session 2-I. 3
Search strategies for vector-like quark partners at LHC run-II

Thomas Flacke[1,*]

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We present results on several new search strategies for heavy vector-like quark partners at the LHC run-II. Run-II has sensitivity to single- and pair-produced quark partners with masses beyond 1 TeV. Decays of such heavy particles yield highly boosted tops, Higgses, and weak gauge bosons, all of which decay dominantly hadronically. At high boost, the SM background of hadronic final states can be substantially suppressed when applying jet-substructure techniques. We present several case studies where the identification of hadronically decaying tops, Higgses, and/or electroweak gauge bosons allow to make new search channels competitive at run-II.

Session 2-I. 4
Measurements of jet rates with the anti-k_t and SISCone algorithms at LEP with the OPAL detector

S. Kluth[1,*], S. Bethke, and A. Verbytskyi for the OPAL Collaboration

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We study jet production in e^+e^- annihilation to hadrons with data recorded by the OPAL experiment at LEP at centre-of-mass energies between 90 GeV and 207 GeV. The jet production rates were measured for the first time with the anti-k_t and SISCone jet clustering algorithms. We compare the data with predictions by modern Monte Carlo event generators.

Session 2-II (Tuesday 10:40-12:40)
Chair: Nicolas Greiner

Session 2-II. 1
Recent studies of light meson production with the BABAR detector

Bill Gary[1,*] for the BABAR Collaboration

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The BABAR Collaboration has an extensive and longstanding program studying hadronic cross sections in low-energy e^+e^- collisions, accessible via initial-state photon radiation. The measurements allow significant improvements in the precision of the standard model prediction for the muon anomalous magnetic moment. Recent results on final states with neutral kaons, and on the $\pi^+\pi^-\pi^0\pi^0$ final state, are presented. This latter channel is one of the most important channels for the muon g-2 measurement. Recent studies of the Dalitz structure of the three-body decays $J/\psi \to \pi^+\pi^-\pi^0$, $J/\psi \to K^+K^-\pi^0$, and $J/\psi \to K_S^0K^+\pi^-$ with the J/ψ produced in the reaction $e^+e^- \to J/\psi\gamma$_ISR are also discussed.

Session 2-II. 2
Search for light Higgs boson and muonic dark forces at BABAR

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Many models of physics beyond Standard Model predict the existence of light Higgs states, dark photons, and new gauge bosons mediating interactions between dark sectors and the Standard Model. Using a full data sample collected with the BABAR detector at the PEP-II e^+e^- collider, we report searches for a light non-Standard Model Higgs boson, dark photon, and a new muonic dark force mediated by a gauge boson (Z') coupling only to the second and third lepton families. Our results significantly improve upon the current bounds and further constrain the remaining region of the allowed parameter space

Session 2-II. 3
Top-quark p_T-spectra at LHC and flavor independence of z-scaling

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We present new results of analysis of top-quark differential cross sections obtained by the CMS and ATLAS Collaborations in pp collisions at the LHC in the framework of z-scaling approach. The spectra are measured over a wide range of collision energy $\sqrt{s}$ = 7, 8, 13 TeV and transverse momentum p_T= 30-1000 GeV/c of top-quark using leptonic and jet decay modes. Proton constituent interactions can be studied up to 10^{-4} fm in the range. New symmetries are expected to be found at high p_T. One of them is self-similarity related to scale transformation in the space of momentum fractions. The symmetry related to the ideas of self-similarity of hadron interactions at a constituent level is manifested by the z-scaling. The scaling was used for analysis of inclusive spectra obtained at the accelerators U70, S$\bar{p}$pS, SPS, ISR, Tevatron and RHIC. The scaling is treated as manifestation of the self-similarity of the structure of the colliding objects (hadrons or nuclei), the interaction mechanism of their constituents, and the process of fragmentation into real hadrons. Universality of the z-scaling is given by its flavor independence. It means that spectra of particles with different flavor content can be described by the same function $\psi(z)$ with values of z and ψ rescaled by a scale factor α_F. We verify the

flavor independence of $\psi(z)$ for top-quark production in pp collisions in the new kinematic range. The results of analysis of the top-quark spectra obtained in pp collisions at the LHC are compared with similar spectra measured in $\bar{p}p$ collisions at the Tevatron energy $\sqrt{s}$=1960 GeV. A tendency to saturation of $\psi(z)$ for the process at low z is demonstrated. A power-law behavior of $\psi(z)$ at high z is observed. The measurements of high-p_T spectra of the top-quark production at highest LHC energy is of interest for verification of the self-similarity of particle production, understanding flavor origin and search for new physics symmetries with top-quark probe.

Session 2-II. 3
Mono-top Signature from Supersymmetric ttH Channel

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We point out that a distinctive mono-top signature is present in Natural SUSY scenarios when a scalar top-quark and higgsinos are almost mass degenerate. Unlike mono-jet signatures exploiting initial state radiation, this channel can be regarded as a smoking gun signature of a light stop and higgsinos, allowing a direct probe of the stop and neutralino sectors. The production rate of this channel largely depends on the up-type higgsino components in the neutralinos while the stop sector is sensitive to angular distributions of top-quark's decay products.

Session 2-II. 4
Thermal photon production from gluon fusion induced by magnetic fields in relativistic heavy-ion collisions

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We compute the production of thermal photons in relativistic heavy-ion collisions by gluon fusion in the presence of an intense magnetic field, and during the early stages of the reaction. This photon yield is an excess over calculations that do not consider magnetic field effects. We add this excess to recent hydrodynamic calculations that are close to describing the experimental transverse momentum distribution in RHIC and LHC. We then show that with reasonable values for the temperature, magnetic field strength, and strong coupling constant, our results provide a very good description of such excess. These results support the idea that the origin of at least some of the photon excess observed in heavy-ion experiments may arise from magnetic field induced processes.

Session 3
Forward physics and diffraction

Session 3-I (Tuesday 14:00-15:40)
Chair: Voica Redescu

Session 3-I. 1
Soft QCD and diffraction physics measurements at CMS

Grzegorz Brona[1,*] for the CMS Collaboration

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The talk will cover newest 13 TeV results on the soft QCD from CMS, inter alia energy flow measurements, leading track and leading jet underlying event measurements, pp inelastic cross section. Also the diffraction results will be discussed including jet-gap-jet measurement at 7 TeV.

Session 3-I. 2
Forward physics at the LHC

Christophe Royon[1,*]

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We will describe possible measurements at the LHC in forward physics that will give more insights on the proton structure in terms of quarks and gluons in the case that protons are intact in the final state. We will finish the presentation by discussing photon-induced processes at the LHC that are relevant to explain the di-photon excess that is observed by the ATLAS and CMS collaborations at about a mass at 750 GeV.

Session 3-I. 3
Hard diffraction at Colliders

Rafał Staszewski[1,*]

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The phenomenon of hard diffraction will be discussed. The measurements performed at the HERA and Tevatron colliders will be summarized. The first LHC data and prospects for new results, in particular the ones involving the forward proton tagging, will be presented.

Session 3-I. 4
Effects of diffraction in pp and pA collisions

Gosta Gustafson[1,*]

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Diffractive excitation is a large fraction of the pp cross section, also at high energies. Diffraction has traditionally been described either by multi-Regge diagrams, or in the Good-Walker formalism as a result of fluctuations. However, within the BFKL dynamics these two pictures are different sides of the same phenomenon. The dipole cascade formalism in impact parameter space is well suited to describe diffractive excitation including essential effects of saturation at high energies. Diffractive excitation is also an important effect in pA scattering, which as intermediate between pp and pA also is used to help interpreting results in AA collisions. In pA scattering the Glauber formalism has been used to estimate the number of NN subcollisions and of "wounded" nucleons. Diffractive excitation has here been included using the Good-Walker formalism in a simplified way, where excitation of the target nucleons is not taken into account. In this talk I will discuss effects from including separate single diffraction of projectile and target nucleons as well as double diffraction. The dipole cascade model DIPSY is used to help estimating the effects, and results are presented for both inclusive and exclusive results in pA collisions.

Session 3-II (Tuesday 16:10-17:50)
Chair: Christophe Royon

Session 3-II. 1
Parton distribution functions and the role of forward region data

Voica Radescu[1,*]

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In the era of searching for new discoveries at LHC, it is crucial to achieve a higher level of precision in understanding the proton structure which it will allow for most unambiguous interpretations of the high energy, luminous data ahead. The knowledge of proton's constituents mainly comes from the deep inelastic scattering data at HERA, complemented by the measurements from the fixed target, Tevatron and, now increasingly precise more data from LHC. The most recent developments sensitive to the proton constituents will be presented here with an emphasis on the forward region data and their role to enhance possible signs of physics beyond Standard Model.

Session 3-II. 2
Gluon polarization measurements and the possible role of diffractive process in the transverse single spin asymmetry measurements in RHIC-PHENIX

Itaru Nakagawa[1,*] for the PHENIX Collaboration

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The polarized proton-proton collider at RHIC provides unique opportunity to study the spin structure of proton. In this talk, I will present highlights in latest gluon polarization measurements through double longitudinally polarized proton+proton collision experiment at PHENIX. In addition to the helicity structure of proton, the transverse structure is also to be discussed. Particularly we have observed quite striking atomic mass dependence in the single spin asymmetry in the very forward neutron production at the collision energy of 200GeV. Since the neutron is detected almost at zero degree, the reaction can be contributed from the ultra peripheral collision (UPC) in addition to the conventional one pion exchange regime. I will discuss the latest interpretation of the data in conjunction with UPC and diffractiveness.

Session 3-II. 3
Measurements of the elastic, inelastic and total pp cross section with the ATLAS, CMS and TOTEM detectors

Simon Stark Mortensen[1,*]

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The total pp cross section is a fundamental property of the strong interaction which cannot be calculated in perturbative QCD but only described based on phenomenological models. The ATLAS and CMS Collaborations have recently measured the total inelastic proton-proton cross section at 13 TeV center-of-mass energy in special data sets with a low interaction probability per bunch crossing. A more precise measurement of the total pp cross section as well as elastic and inelastic contributions can be extracted from a measurement of the differential elastic cross section using the optical theorem. The TOTEM and ATLAS collaborations have collected elastic data in dedicated runs with high beta* optics at 8 TeV center-of-mass energy with Roman Pot

detectors in order to perform this measurement. From the extrapolation of the differential elastic cross section to t=0, using the optical theorem, the total cross section is extracted. In addition the nuclear slope of the elastic t-spectrum and the total elastic and inelastic cross sections are determined.

Session 3-II. 4
Recent results on diffractive and forward physics at HERA

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Diffractive production of heavy quarks in deep-inelastic scattering (DIS) are sensitive to the partonic contents of diffractive exchange. The production of charm quarks in DIS was measured through the production cross section of D* in diffractive DIS. The presence of a jet and a direct photon in the final state in photoproduction allows to estimate the longitudinal fraction of the partons participated in the hard scattering of the diffractive exchange. Cross sections of an isolated photon with jets are measured for the diffractive process in photoproduction through ep collisions. The difference in cross sections between various state of heavy quarkonium gives insight to their production mechanism. The ratio of $\psi(2s)/J/\psi$ in production cross section in DIS was measured as a function of kinematical variables and compared to models. Forward neutron production in ep collisions is dominated by the one-pion exchange, where the exchanged pion is emitted from the proton ($p \rightarrow \pi n$) and the pion is scattered by the electron. The cross sections of the photoproduction processes with a fast neutron is sensitive to additional scattering between two incoming hadrons, the real photon and the neutron. In this presentation ρ^0 production with a forward neutron was measured and the presence of the absorptive correction is discussed.

Special Session (Tuesday 17:50-18:15)
Chair: Christophe Royon

(Computing)
GSDC: A unique data center in Korea for HEP research

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GSDC at KISTI is a unique data center in Korea established for promoting the fundamental research fields by supporting them with the expertise of information technology and the infrastructure for high performance computing and networking. GSDC has supported various research fields in Korea dealing with the large scale of data, e.g. RENO experiment for neutrino research, LIGO experiment for gravitational wave detection, Genome project, and HEP experiments such as CDF at FNAL, Belle at KEK, and STAR at BNL. In particular, GSDC has run a Tier-1 center for ALICE experiment using the LHC at CERN since 2013. In this talk, we present the overview of computing infrastructure that GSDC runs for the research fields and we discuss on the data center infrastructure management system deployed at GSDC.

Session 4
Perturbative and non-perturbative features of QCD

Session 4-I (Wednesday 08:30-10:10)
Chair: Inkyu Park

Session 4-I. 1
Perturbative and non-perturbative aspects of jet physics in heavy ion collisions at RHIC and LHC

Ivan Vitev[1,*]

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One of the principal challenges that calculations of energetic particle and jet production in heavy ion reactions face is the ambiguity associated with the implementation of radiative in-medium effects. A recently developed effective theory of jet propagation in matter, soft-collinear effective theory with Glauber gluons (SCET_G) has allowed us to quantify and greatly reduce the uncertainty in jet quenching phenomenology. SCET_G-based splitting kernels open the unprecedented possibility to treat vacuum and medium-induced parton showers in a unified manner. I will describe how advancements in theory allow us to use hadrons and jets as precision diagnostics of the QGP.

Session 4-I. 2
Soft and hard observables of the QCD phase diagram in ALICE

Antonio Uras[1,*] for the ALICE Collaboration

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The behavior of hadronic matter under extreme conditions can be studied in laboratory with ultra-relativistic heavy-ion collisions, allowing one to test Quantum Chromo-Dynamics (QCD) across its phase diagram. ALICE (A Large Ion Collider Experiment) at the LHC is specifically designed to study the properties of the deconfined state of the hadronic matter, the Quark-Gluon Plasma, in the region of the QCD phase diagram characterised by vanishing baryo-chemical potential, at the highest temperature ever reached in laboratory. A selection of the most recent ALICE results in Pb-Pb collisions will be presented, both on soft (low-Q^2) and hard (high-Q^2) probes.

Session 4-I. 3
Search for the QCD critical point: Fluctuations of conserved quantities in high-energy nuclear collisions at RHIC

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Fluctuations of conserved quantities in heavy-ion collisions are used to probe the phase transition and the QCD critical point for the hot and dense nuclear matter. The STAR experiment has carried out moment analysis of net-proton (proxy for net-baryon (B)), net-kaon (proxy for net-strangeness (S)), and net-charge (Q). These

measurements are important for understanding the quantum chromodynamics phase diagram. In this talk, we present the analysis techniques used in the moment analysis by the STAR experiment and discuss the moments of net-proton, net-kaon and net-charge distributions from the first phase of the Beam Energy Scan program at the Relativistic Heavy Ion Collider.

Session 4-I. 4
Recent hard probe measurements from STAR

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High momentum transfer processes can be reliably calculated by perturbative quantum chromodynamics (pQCD). Products of those hard processes, high transverse momentum particles and heavy quarks (hard probes), interact with the quark-gluon plasma (QGP) created in relativistic heavy ion collisions. Properties of the QGP can be studied by comparing hard probe measurements in heavy ion collisions to those in p+p collisions or from pQCD calculations. I will present recent results from STAR on hard probe measurements, including a wide range of observables: hadron-hadron, photon-hadron, hadron-jet, jet-jet correlations, reconstructed charged jets, and open charm mesons. I will discuss what we have learned from these measurements.

Session 4-II (Wednesday 10:40-11:55)
Chair: Inkyu Park

Session 4-II. 1
Light-front ab initio approach to QED and QCD

Xingbo Zhao[1,*]

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In this talk I give an introduction to our newly constructed light-front ab initio approach to QED and QCD. This method is based on light-front quantization and Hamiltonian formalism of quantum field theory. Its goal is to provide nonperturbative solutions to QCD based on first-principles. In the first part I introduce its applications to stationary problems, where we solve quantum field systems through the eigenvalue problems of the associated Hamiltonian. The resulting eigenvalues give the mass spectrum of the bound states and the eigenvectors are the associated light-front wave functions which encode the structure of the bound states. I will demonstrate this method through applications to the positronium system in QED and the heavy-quarkonium system in QCD. In the second part I introduce its extension to time-dependent regime, where we solve the time-dependent light-front Schroedinger equation for the time-evolution of quantum field configurations. The goal of this method is to provide nonperturbative solutions to time-dependent problems in QED and QCD on the amplitude level. This method is also ideal for treating systems in strong and/or time-dependent background fields. I will illustrate this method through applications to nonlinear Compton scattering in strong-field QED and jet energy-loss processes in QCD.

Session 4-II. 2
Multi-jet correlations and color coherence phenomena.

Jason S.H. Lee[1,*], Hyunyong Kim, Inkyu Park, and Maxime Gouzevitch for the CMS Collaboration

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A study of multi-jet correlations and color coherence effects is performed with data collected with the CMS experiment at the LHC. Multi-jet correlations in the angles between the jets are measured and compared to predictions including higher order corrections via parton showers.

Session 4-II. 3
Photon from the Color Glass Condensate in the pA collision

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In this contribution I will talk about our recent results on photon production from the Color Glass Condensate (CGC) in the high energy pA collision. The nucleus is considered as a dense source of soft gluons while the proton is more dilute. This allows a systematic expansion of the amplitude in the powers of the gluon density of the proton. The zeroth order approximation comes from bremsstrahlung of valence quarks in the proton and was originally calculated by Gelis and Jalilian-Marian (PRD D66 (2002) 014021). The first order correction has two processes with the soft gluons in the proton emitting a quark-antiquark pair. In the first process the pair subsequently annihilates to a photon, while the second is of a bremsstrahlung type with the quark-antiquark pair and the photon in the final state. The main results I will report on are:

1. The full analytic formula for the photon rate, that is, taking into account the annihilation as well as the bremsstrahlung process.
2. The numerical evaluation of the photon rate for the annihilation process by using the McLerran-Venugopalan model for the color average through which the rate becomes characterized by the saturation scale.
These results are partially contained in arXiv:1602.01989.

Session 5
Collectivity in high-energy collision: jets, flows or other

Session 5-I (Thursday 08:30-10:35)
Chair: Minjung Kweon

Session 5-I. 1
Collective flow measurements at RHIC energies

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Recent results on collective flow measurements from RHIC experiments are shown and discussed especially on the higher order azimuthal event anisotropy measurements and their relation to the ridge like phenomena including the possible collective flow evolution in the small systems. Current results from the beam energy scan program (BES) and future programs are also discussed.

Session 5-I. 2
Interplay between collective expansion and Mach cone

Tetsufumi Hirano[1,*], Yasuki Tachibana, and Michito Okai

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We develop a hybrid model in which space-time evolution of the bulk matter, jet propagation and their interactions are described within one framework. When an energetic jet traverses the bulk matter, it loses its energy into the matter and forms a Mach-cone like structure. On the other hand, the bulk matter expands radially due to pressure gradient. As a result, there happens an interplay between radial expansion and the Mach cone. We discuss possible phenomena and observables related with this in asymmetric gamma-jet events. We also discuss phenomena in which many jets with relatively smaller energies (mini-jets) propagate the bulk matter at once in an event.

Session 5-I. 3
Longitudinal correlations in the initial stages of ultra-relativistic nuclear collisions

Wojciech Broniowski[1,*] and Piotr Bozek[2]

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We present results for longitudinal correlations (for collective flow and for the multiplicities) based on simple modeling of the initial stages of the collision. We discuss key ingredients needed to generate the necessary initial correlations in rapidity, with focus on the torque effect (decorrelation of the forward and backward event planes), and on the integral measures of the two-particle multiplicity correlations. Particular sensitivity of the results to the physics of the initial state is found for collisions of the light-heavy systems, such as p+Pb collisions. Our results reproduce semiquantitatively the basic features of the recent measurements at the LHC.

Session 5-I. 4
Rescuing the nonjet azimuth quadrupole from the flow narrative

Tom Trainor[1,*]

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According to the flow narrative commonly applied to high-energy nuclear collisions a cylindrical-quadrupole component of 1D azimuth angular correlations is conventionally represented by quantity v_2 and interpreted to represent elliptic flow. Jet angular correlations ("nonflow") may also contribute to v_2 data depending on the method used to calculate v_2, but 2D graphical methods are available to insure accurate separation. The nonjet (NJ) quadrupole has various properties inconsistent with a flow interpretation, including the observation that NJ quadrupole centrality variation in A-A collisions has no relation to strongly-varying jet modification (jet "quenching") in those collisions commonly attributed to jet interaction with a flowing dense medium. In this presentation I describe isolation of quadrupole spectra from p_t-differential $v_2(p_t)$ data from the RHIC and LHC. I demonstrate that quadrupole spectra have characteristics very different from the single-particle spectra for most hadrons, that quadrupole spectra indicate a common boosted hadron source for a small minority of hadrons that "carry" the NJ quadrupole structure, that the narrow source-boost distribution is characteristic of an expanding thin cylindrical shell (strongly contradicting hydro predictions), and that in the boost frame a single universal quadrupole spectrum (Levy distribution) on transverse mass m_t accurately describes data for several hadron species scaled according to their statistical-model abundances. The quadrupole spectrum shape changes very little from RHIC to LHC energies. Taken in combination those characteristics strongly suggest a novel nonflow QCD mechanism for the NJ quadrupole conventionally represented by v_2.

Session 5-I. 5
Saturation and geometrical scaling

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Saturation and geometrical scaling (GS) of gluon distributions are a consequence of the non-linear evolution equations of QCD. After a short theoretical introduction we confront the hypothesis of GS in different systems with experimental data.

Session 5-II (Thursday 11:00-12:40)
Chair: Wojciech Broniowski

Session 5-II. 1
Heavy quarks in deconfined quark-gluon matter

Anton Andronic[1,*]

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A brief overview of recent studies on heavy quarks as probes of the deconfined matter created in high energy nucleus-nucleus collisions is given, with focus on the most recent measurements at the LHC and RHIC and their understanding in theoretical models.

Session 5-II. 2
Recent heavy flavor measurements from PHENIX at RHIC

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Heavy flavor is a useful probe to study the property of the strongly coupled quark gluon plasma created in high-energy heavy-ion collisions. They are produced in the early stage of the collisions, and then propagate through QGP. Therefore, they carry information of QGP. PHENIX measures the separated bottom and charm production using the precise tracking by the silicon vertex detector installed at mid-rapidity and forward rapidity. In this talk, we will present the recent results of separated charm and bottom production in Au+Au collisions at the mid-rapidity and bottom production in Cu+Au collisions at forward rapidity.

Session 5-II. 3
Bottomia physics at RHIC and LHC

G. Wolschin[1,*]

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The suppression of Υ-mesons in the hot quark-gluon medium (QGP) versus reduced feed-down is investigated in UU collisions at RHIC energies and PbPb collisions at LHC energies. Our centrality- and p_T-dependent model encompasses screening, collisional damping and gluodissociation in the QGP. For $\Upsilon(1S)$ it is in agreement with both STAR and CMS data provided the relativistic Doppler effect, and the reduced feed-down from the Υ(nS) and χ_b(nP) states that accounts for more suppression than the in-medium dissociation are properly considered. In contrast, most of the suppression for the $\Upsilon(2S)$ state occurs in the medium. A prediction for the centrality-dependent $\Upsilon(1S)$-suppression in PbPb at $\sqrt{s_{NN}}$ = 5.02 TeV is made, and pPb results are discussed.

[1] J. Hoelck, F. Nendzig and G. Wolschin, arXiv:1602.00019v2 (2016).

Session 5-II. 4
Overview of the recent jet results in heavy ion collisions at the LHC

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The modification of jets in heavy ion collision at a center of mass energy of 2.76TeV was observed via various analyses carried out in Run I experiments at the LHC. In November 2016, LHC delivered the Run II phase lead-lead beams at 5.02TeV and proton-proton beams at the same energy for reference. The high luminosity PbPb data, more than twice of the previous run, provided an opportunity for elaborate researches based on high-pt probes. This presentation discusses the development of jet finding algorithms and jet observables, including the production rates, fragmentation patterns and flavor dependence, published by CMS, ALICE and ATLAS collaborations. The results from 2.76TeV data are briefly reviewed and then the introduction of the recent results at 5.02TeV are followed.

Session 5-III (Thursday 14:00-15:30)
Chair: Wojciech Broniowski

Session 5-III. 1
Toward precision jet study with a DIS event shape

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Event shapes provide a key method of measuring jets in deep-inelastic scattering (DIS). This was done successfully by H1 and ZEUS and compared with theoretical calculations with next-to-leading-logarithmic (NLL) resummation. I will present our progress for a high precision calculation of a event shape called DIS thrust, with next-to-next-to-next-to-leading-logarithmic resummation. I will also show a rigorous treatment of hadronization corrections. Perturbative resummation uncertainties in the cross section are reduced to the 2% level for a significant region of the HERA phase space in x and Q, thus allowing for new accurate measurements of $\alpha_s(m_Z)$.

Session 5-III. 2
Review on light flavour production at LHC energies

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The production of light flavour hadrons, mainly of strange particles has been studied intensively over the last decades as they are very promising probes to study the dynamics of the high-density state created in heavy-ion collisions. At LHC energies, a rather complete set of data for pp, p-Pb and Pb-Pb collisions is now available. Together with the results at lower collisions energies, a comprehensive review is possible. It will be discussed (i) whether these three collision systems exhibit a continuous evolution or whether distinct features are seen; (ii) whether the idea of an equilibrated system at freeze out is still valid; (iii) whether the concepts of chemical and kinetic freeze out still holds. Additional information is obtained from the study of anti-/hyper-nuclei at LHC energies. These results will be discussed together with the interpretation within a thermal concept and a coalescence mechanism.

Session 5-III. 3
Reduction of the K* meson abundance and kinetic freeze-out conditions in heavy ion collisions

Sungtae Cho[1,*], Su Houng Lee, and Taesoo Song

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We study the K* meson reduction in heavy ion collisions by focusing on the hadronic effects on the K* meson abundance. We evaluate the absorption cross sections of the K* and K meson by light mesons in the hadronic matter, and further investigate the variation in the meson abundances for both particles during the hadronic stage of heavy ion collisions. We show how the interplay between the interaction of the K* meson and kaon with light mesons in the hadronic medium determines the final yield difference of the statistical hadronization model to the experimental measurements.
We also investigate the freeze-out conditions of a particle in order to understand the productions of resonances,

hadronic molecules and light nuclei in heavy ion collisions. Applying the kinetic freeze-out condition to the daughter particles of K* mesons, we find that the larger suppression of the yield ratio of K*/K at LHC than at RHIC compared to the expectations from the statistical hadronization model reflects the lower kinetic freeze-out temperature at LHC than at RHIC.

Session 5-III. 4
Wounded quarks in A+A, p+A, and p+p collisions

Maciej Rybczynski[1,*], P. Bozek, and W. Broniowski

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We explore predictions of the wounded quark model for particle production and properties of the initial state formed in ultrarelativistic heavy-ion collisions. The approach is applied uniformly to A+A collisions in a wide collision energy range, as well as for p+A and p+p collisions at the CERN Large Hadron Collider (LHC). We find that generically the predictions from wounded quarks for such features as eccentricities or initial sizes are close (within 15%) to predictions of the wounded nucleon model with an amended binary component. A larger difference is found for the size in p+Pb system, where the wounded quark model yields a smaller (more compact) initial fireball than the standard wounded nucleon model. The inclusion of subnucleonic degrees of freedom allows us to analyze p+p collisions in an analogous way, with predictions that can be used in further collective evolution. The approximate linear dependence of particle production in A+A collisions on the number of wounded quarks, as found in previous studies, makes the approach based on wounded quarks natural. Importantly, at the LHC energies we find approximate uniformity in particle production from wounded quarks, where at a given collision energy per nucleon pair similar production of initial entropy per source is needed to explain the particle production from p+p collisions up to A+A collisions. We also discuss the sensitivity of the wounded quark model predictions to distribution of quarks in nucleons, distribution of nucleons in nuclei, and to the quark-quark inelasticity profile in the impact parameter. In our procedure, the quark-quark inelasticity profile is chosen in such a way that the experiment-based parametrization of the proton-proton inelasticity profile is properly reproduced. The parameters of the overlaid multiplicity distribution is fixed from p+p and p+Pb data.

Session 6
Proton structure, small and large-x physics

Session 6-I (Thursday 16:00-17:15)
Chair: Yoshitaka Hatta

Session 6-I. 1
Evolution equations for double parton distributions: initial conditions and transverse momentum dependence

Anna Maria Stasto[1,*]

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Multiparton interactions have been shown to play an important role in the hadronic interactions at very high energies. The theoretical description of such processes is possible under the assumption of the presence of sufficiently hard scales. The computation of the cross sections for the double parton scattering makes use of the double parton distribution functions which contain important information about proton structure in particular about correlations between partons. In this talk I discuss recent progress in constraining the initial conditions for the double parton distirbution, such that they obey momentum sum rules. In addition I will also discuss the possible extension of the double parton densities to include the transverse momentum dependence.

Session 6-I. 2
Multiple scattering aspects of gluon TMDs

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Scattering processes that are sensitive to the transverse momentum distributions (TMDs) of gluons inside hadrons turn out to also be sensitive to multiple interactions. Initial and/or final state rescattering contributions lead to process dependence of gluon TMDs and to observable effects that are otherwise absent, such as single spin asymmetries. This talk will discuss this for unpolarized and linearly polarized gluons inside unpolarized hadrons (relevant for LHC, RHIC and EIC) and for unpolarized gluons in transversely polarized hadrons (relevant for RHIC and EIC). The limit of small x will be discussed, focussing particularly on Wilson loop TMD correlators, the polarization of the Color Glass Condensate, and the spin-dependent odderon.

Session 6-I. 3
Hadron tomography studies by generalized parton distributions and distribution amplitudes

Shuzo Kumano[1,2,*]

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I discuss our recent investigations on generalized parton distributions (GPDs) and generalized distribution amplitudes (GDAs). First, hadron tomography studies are introduced by explaining basics of the GPDs and

GDAs. Next, I discuss our works on these topics. The GPDs have been investigated mainly by the virtual Compton process at lepton accelerator facilities; however, there are unique opportunities to investigate them at hadron facilities such as J-PARC by the inclusive pion-proton Drell-Yan process and hard branching hadronic processes $N + N \rightarrow N + \pi + B$ [1]. Feasibilities of these studies are explained. Furthermore, the GDAs can be investigated by two-photon processes, which are the s-t crossed processes to the virtual Compton scattering ones. Such studies should be possible at electron-positron colliders like KEKB, and they could be used also for probing internal structure of exotic hadron candidates [2]. To understand the three-dimensional structure of the nucleon is necessary for clarifying the origin of the nucleon spin including orbital-angular-momentum contributions of quark and gluons, and the studies of the GPDs and GDAs should play an important role.

[1] S. Kumano, M. Strikman, and K. Sudoh, Phys. Rev. D80 (2009) 074003; T. Sawada, W.-C. Chang, S. Kumano, J.-C. Peng, S. Sawada, and K. Tanaka, Phys. Rev. D93 (2016) 114034.
[2] H. Kawamura and S. Kumano, Phys. Rev. D89 (2014) 054007; S. Kumano, Q.-T. Song, et al., research in progress.

Session 7
Cosmic ray and astroparticle physics

Session 7-I (Thursday 17:15-18:05)
Chair: Gungwon Kang

Session 7-I. 1
Recent advances in ground-based gamma-ray particle astrophysics

David Kieda[1,*]

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Observations of Very High Energy (VHE) astrophysical gamma-rays can provide a powerful method for exploring fundamental aspects of astrophysics and particle physics, including probing the origin, propagation, and interactions of cosmic rays, exploration of the particle nature of astrophysical Dark Matter, and searching for potential Lorentz Invariance violation due to effects of Quantum Gravity. In this talk I will describe recent advances in gamma-ray astrophysics that have resulted from the coordinated use of Imaging Atmospheric Cherenkov Detectors and High Altitude Water Cherenkov detectors (VERITAS and HAWC, respectively). By combining the capabilities of these two techniques through joint observations, we have opened a new frontier for the exploration of fundamental issues in cosmic ray and particle astrophysics.

Session 7-I. 2
The Pierre Auger Observatory: Overview and results

Antonio Insolia[1,*] for the Pierre Auger Collaboration

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In my presentation, I will briefly discuss the main results obtained so far by the Pierre Auger Collaboration which operates in Malargue (Argentina). The Pierre Auger Observatory is collecting data in the present configuration since 2008. Equipped with 27 Fluorescence Telescopes and 1660 Cherenkov Surface Detector, it has been the first largest cosmic ray observatory to make advantage from the hybrid technique. I will discuss the all particle energy spectrum covering a range from 10^{17} eV up to 10^{20} eV, the well-established experimental evidence for the strong flux suppression at highest energies and the current status of the mass composition and the anisotropy studies. Finally, I will mention the update program activity (AugerPrime) planned for the next 10 years.

Session 7-II (Friday 09:00-10:15)
Chair: Antonio Insolia

Session 7-II. 1
Interactions of UHECRs around the Universe - Models for UHECR data interpretation

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Ultra high energy cosmic rays (UHECRs) are expected to be accelerated in astrophysical sources and to travel through extragalactic space before hitting the Earth atmosphere. They interact both with the environment in the source and with the intergalactic photon fields they encounter, causing different processes at various scales depending on the photon energy in the nucleus rest frame. An overview on the most recent interpretation of UHECR measurements as energy spectrum and composition will be given, including a discussion on implications on secondary messengers. The sensitivity of UHECR propagation to uncertainties in the extragalactic background spectrum and in the photodisintegration models will be described from the point of view of UHECR observables. The general implications of the situation of nuclear measurements for cosmic ray astrophysics will be also discussed.

Session 7-II. 2
Recent results from the Alpha Magnetic Spectrometer on the International Space Station

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The Alpha Magnetic Spectrometer (AMS) is a precision particle physics detector deployed in space to measure charged cosmic rays and study their characteristics. In 5 years on ISS, AMS has collected over 80 billion cosmic rays. In this presentation some examples of physics results are presented; new results on the positron fraction from 11 million events, AMS measurements of the electron and positron spectra and proton and helium fluxes. New results on flux ratios of positrons, anti-protons and protons and fluxes of some light elements are also presented.

Session 7-II. 3
Astroparticle physics in IceCube

Seongjin In[1,*]

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The IceCube neutrino observatory, the worlds largest neutrino telescope, is located at the South Pole. It consists of 86 strings with 60 digital optical modules (DOMs) each, distributed over a volume of 1km^3 of ultrapure Antarctic ice. IceCube detects Cherenkov radiation from relativistic particles produced as a result of neutrino interactions in the ice. Different event topologies can be used to distinguish muon neutrinos from other neutrino flavors. IceCube recently reported the observation of high-energy astrophysical neutrinos, which marks the beginning of the age of neutrino astronomy. The talk will review the high-energy neutrino observation and conclude by introducing plans for possible future upgrades.

Session 7-III (Friday 10:45-11:35)
Chair: Antonio Insolia

Session 7-III. 1
Prompt atmospheric neutrino flux and its theoretical uncertainties

Yu Seon Jeong[1,*], Atri Bhattacharya[2], Rikard Enberg[3], C. S. Kim[4], Mary Hall Reno[5], Ina Sarcevic[6], and Anna Stasto[7]

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[2]Universitè of Liège, Belgium
[3]Uppsala University, Sweden
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Atmospheric neutrinos can be produced from the decays of charmed hadrons as well as from pion and kaon decays. The neutrinos from the heavy quark associated hadrons are called the prompt neutrinos while those from the pion and kaon are called the conventional neutrinos. The flux of the charm induced prompt neutrinos dominates the conventional neutrino flux at the high energies above about 1 PeV. These are the important backgrounds to the astrophysical neutrino search. Using the most recent PDFs and the cosmic ray spectrum, we evaluate the charm induced prompt atmospheric muon neutrino fluxes including nuclear corrections. Their impact is investigated in different frameworks: perturbative QCD and the dipole models. With the results from the various models, we estimate the comprehensive uncertainties. The b quark contributions to the prompt neutrino flux and the prompt atmospheric tau neutrino flux are also presented.

Session 7-III. 2
Gravitational waves: Music of Spacetime

Gungwon Kang[1,*] for the LIGO Collaboration

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Main results of the recent detections of gravitational waves from merging black hole binaries (e.g., GW150914 and GW151226) are reviewed briefly with future perspectives. LIGO uses a Michelson interferometer with Fabry-Perot cavities which measures the path difference between two arms of 4km when a gravitational wave passes the Earth. It is extremely sensitive so that it could measure a tiny change of length, $\sim 10^{-21}$ times 4km. The recent discovery is not only the direct verification of Einstein's prediction for gravitational waves given 100 years ago, but also the first observation of a binary black hole in the universe. Most importantly, it opened up a new window to the universe, i.e., gravitational wave astronomy. A new low-frequency detector project SOGRO proposed in Korea is also introduced briefly.

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한라산
Hallasan


오설록 녹차밭
Osulloc Green Tee Farm


만장굴
Manjanggul, Lava Tube


제주 오름
Oreum in Jeju


주상절리
Jusanjeolli