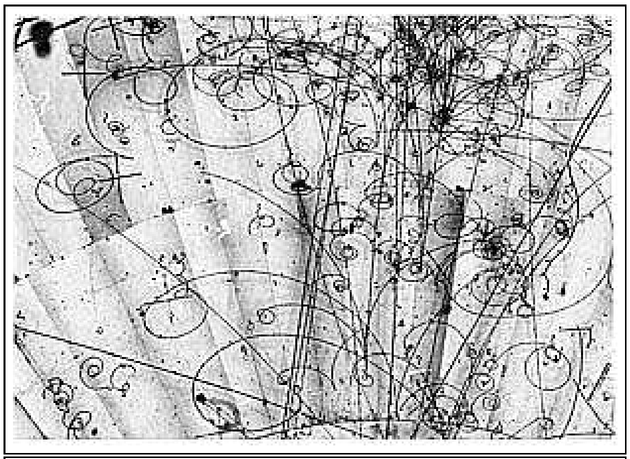
CORRELATIONS AND FLUCTUATIONS '98



June 14-21, 1998.
Mátraháza, Hungary

8TH INTERNATIONAL WORKSHOP ON
MULTIPARTICLE PRODUCTION

Correlations and Fluctuations '98

Mátraháza, Hungary
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Collected Abstracts

Edited by

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Research Institute for
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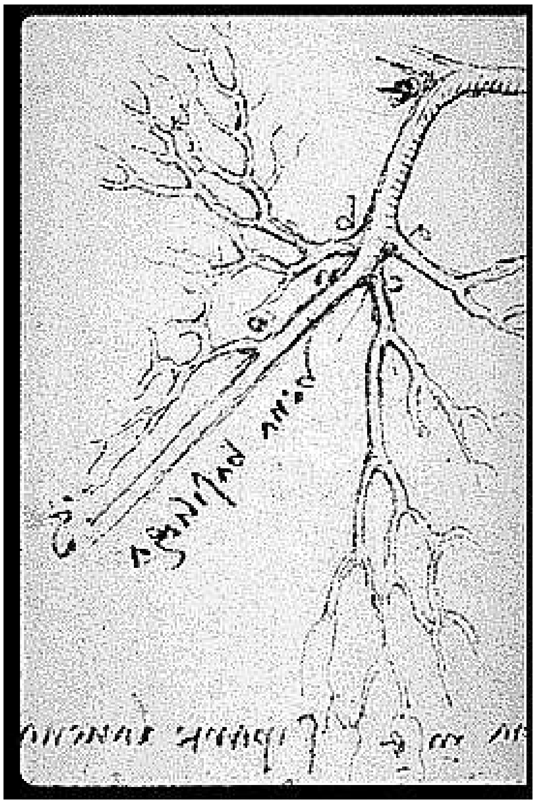

The above picture shows one of the marvellous anatomical drawings of Leonardo da Vinci. The 500 years old sketch is probably the first illustration of the branching tree - like fractal structure of the human arterial system. Multiparticle production, the central theme of the workshop, is often regarded as a self-similar branching process and the Leonardo drawing could be the illustration of that as well. It is the hope of the organizers that our week-long interaction here in Mátraháza will produce many branches of interesting new developments in a stimulating environment well suited to the interchange of fresh ideas among the participants in an optimally efficient manner — like the supply of blood to various parts of the human body by the arteries.

Effect of fluctuation and dissipation on disoriented chiral condensates

Csaba Anderlik

University of Bergen, Bergen, Norway

Abstract

Langevin type equations of motion are derived in the linear sigma model, with particular attention to applications in final stages of heavy ion reactions. A fluctuation dissipation theorem is derived, and the correlation functions of fluctuating fields, as well as dissipative coefficients are evaluated. This approach enables us to describe the final stages of rapid hadronization in heavy ion collisions and to assess the observability of chiral phase transition via the analysis of Disoriented Chiral Condensates realistically.

Is there order or chaos at the end of the QCD cascades?

Bo Andersson

University of Lund, Lund, Sweden

Abstract

The irregularities, known as "anomalous dimensions" in QCD may together with the recoil contributions lead to a chaotic behaviour at the infrared limit or, due to helicity conservation and the properties of the running coupling, to a semi-classical ordered color-field of helix character. Although we feel pretty sure of order by now, there are (with unfortunately high probability) also effects in this limit from the chiral condensate that may destroy the predictions from the ordered scenarium and I want to discuss the basic physics possibilities.

Influence of the source evolution on identical particle production

Igor V. Andreev

Lebedev Institute of Physics, Moscow, Russia

Abstract

Modification of the quantum fields (corresponding to final state particles) in the course of the source evolution is considered. Influence of this effect on multiplicities and correlations of identical particles is displayed.

Instantons and fractals in critical systems

Nikos G. Antoniou

Athens University, Athens, Greece

Abstract

We investigate the geometry of the critical fluctuations for a general system undergoing a thermal second-order phase transition. Adopting a generalized free-energy for the local description of the fluctuations of the order parameter at the critical temperature we show that instanton-like configurations corresponding to the minima of the free-energy functional, build up clusters with fractal geometry characterizing locally the critical fluctuations. For sufficiently small coarse-graining scales these configurations dominate the partition function and provide an exact description of the critical system. The connection between the corresponding (local) fractal dimension and the critical exponents is derived. Implications of these ideas to chiral QCD phase transition in relativistic heavy ion collisions are also discussed.

Hadronization transchemistry: from quarks to hadrons

Tamás S. Bíró, Péter Lévai and József Zimányi

Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Abstract

We present a model of fast hadronization of quark matter in relativistic heavy ion collisions based on rate equations and capture cross sections of massive quarks in non-relativistic potential. We utilize a thermodynamically consistent approach with a non-ideal equation of state based on string phenomenology. We investigate which physical parameters are decisive for final particle ratios observed in CERN experiments.

Dissipation and fluctuation at the chiral phase transition

TAMÁS S. BÍRÓ AND CARSTEN GREINER

Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Abstract

Utilizing the Langevin equation for the linear sigma-model we investigate the interplay of friction and white noise on the evolution and stability of collective pionic fields in energetic heavy ion collisions. We find that the smaller the volume, the more stable transverse (pionic) fluctuations become on a homogeneous disoriented chiral field background (the average transverse mass increases).

On the other hand the variance of m_t increases even more, so for a system thermalized in an initial volume of 10 fm^3 about 96% and even in 1000 fm^3 about 60% of the individual trajectories enter into unstable regions ($m_t^2 < 0$) for a while during a rapid one dimensional expansion. In contrast the ensemble averaged solution in this case remains stable.

This result supports the idea of looking for disoriented chiral condensate (DCC) formation in individual events.

Two deficiencies in fractal phenomenology at high energies

Mikuláš Blažek

Comenius University, Bratislava, Slovakia

Abstract

The presence of the intermittency and multifractality is usually recognized by the scaling properties of the factorial and the associated frequency moments, namely by the fact that the corresponding scaling indices do not vanish. It has become quite customary to accept the view that these two kinds of scaling indices satisfy a well-known equation. Moreover, simple considerations allow to obtain a fundamental equation which is satisfied by the scaling indices of the frequency moments. Both equations, if combined by the condition specifying the presence of the (thermal) phase transition, lead to physically unacceptable conclusions. In the present contribution it is shown that both aforementioned equations can be extended in such a way that the corresponding deficiencies are removed.

Patterns of collective flow in heavy ion collisions

Jakob P. Bondorf

Niels Bohr Institute, Copenhagen, Denmark

Abstract

For heavy ion collisions at intermediate energy experimental data suggest that the the matter is not only heated but has also correlated motion, flow, which may result from compression in the initial stages of the collision. The flow field indicates lack of equilibrium of the matter. It is interesting to note that both heating and expansion flow in a nucleus could result in its multifragmentation. Therefore the mass distribution in multifragmentation is in general not sufficient to decide if there is flow. Energy spectra are also needed.

In the much more violent collisions at relativistic energies, features resembling flow in directions perpendicular to the beam direction are seen in spectra of several kinds of reaction products. The interpretation of these “flow”-spectra are model dependent, and thus the nature of the deduced correlations in the flowing matter are subject to considerable uncertainty. In the talk I will discuss various aspects of the flow theme.

Multiplicity dependence of like-sign (Bose-Einstein?) and unlike-sign particle correlations in $\bar{p}p$ reactions

Brigitte Buschbeck

Institut für Hochenergiephysik, Wien, Austria

Abstract

Recent discussions about Bose-Einstein correlations between decay products of two coproduced W-bosons raise generally the question about the behaviour of correlations if several strings are produced. This is studied by the multiplicity dependence of like-sign and unlike-sign correlations in $\bar{p}p$ reactions at $\sqrt{s} = 630$ GeV.

Correlations in deep-inelastic scattering

SERGEI V. CHEKANOV
for the ZEUS Collaboration

DESY and *Institute of Physics, Minsk, Belarus*

Abstract

We discuss both short-range and long-range correlations measured in the Breit frame of deep-inelastic *ep* scattering. The short-range correlations are studied in angular intervals in terms of normalized factorial moments. The long-range correlations are analyzed between the current and target regions in terms of the correlation coefficient.

Canonical ensemble of initial states of DCC fluctuations

László Csernai

University of Bergen, Bergen, Norway

Abstract

Critical fluctuations of chiral degrees of freedom are one of the most promising signals of QGP formation. Calculations to estimate the effect depend strongly on the choice of initial state. We calculated the canonical ensemble of initial states of a homogeneous domain for an initial temperature of $T = 130$ MeV. The subsequent, nonthermal evolution of the ensemble is also calculated indicating the observability of these fluctuations.

Particle interferometry for hydrodynamical systems, $U_A(1)$ restoration and mass-shifted bosons

TAMÁS CSÖRGŐ

Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Abstract

Some new results are discussed concerning the theory of particle interferometry for hydrodynamically expanding, locally thermalized systems. Special emphasis will be on the core/halo model and its application for the correlation signal of partial $U_A(1)$ symmetry restoration in hot and dense matter; we discuss the generic theory of particle interferometry for medium modified quanta. We find that the generic quantum state of the matter shall be multi-mode squeezed state, new kind of back-to-back correlations appear and we find a connection to the quantum-statistical correlations from DCC formation.

Continuous wavelets as a tool for correlation studies

Igor M. Dremin

Lebedev Institute of Physics, Moscow, Russia

Abstract

Continuous wavelets have been used for pattern recognition in high multiplicity events. Such patterns as mini-jets, jets, fractal structures, ring-like events have been found. More complicated structure is suspected in some events of Pb+Pb interaction at 158 GeV related to azimuthal correlation of the second and higher orders in terms of the Fourier coefficients (elliptic flow, ...).

Squeezed and Schrödinger cat states in sling model

IGOR M. DREMIN AND VLADIMIR I. MAN'KO

Lebedev Institute of Physics, Moscow, Russia and *INFN, Italy*

Abstract

Correlations and fluctuations of the boson fields in such nonclassical states as squeezed states, correlated states, and even and odd coherent states (Schrödinger cats) are considered. The possibilities of sling mechanism to create nonclassical field states are discussed.

Analytic solution for multivariate statistics in random multiplicative cascades

Hans C. Eggers

University of Stellenbosch, Stellenbosch, South Africa

Abstract

We present an analytic solution for a multivariate generating function governing all n-point statistics of random multiplicative cascades. Written in terms of the logarithm of the multiplicative random variable (e.g. the energy dissipation, particles in a bin etc.), the multivariate generating function becomes a sum of "branching generating functions", one for each branching point. Consequently, multivariate cumulants become simple sums of the cumulants at each branching, while moments factorize into the moments of each parent branching. The branching generating function is fully determined by the splitting function, which can therefore in principle be inferred from the former. The branching generating function can be considered as a generalization of the multifractal mass exponents, whose limitations become clear in the new formalism. Toy models and possible applications in various fields (turbulence, multiparticle dynamics, ...) are briefly explored.

Bose-Einstein effect in Monte Carlo generators: weight methods

Krzysztof Fialkowski

Jagellonian University, Cracow, Poland

Abstract

Justification for using weight methods to incorporate the Bose-Einstein effect in Monte Carlo generators is presented and a short review of the methods used is given. A new method using a clustering algorithm is presented in detail. First results and plans for future applications are discussed.

Expectations in MPP in hh collisions in the TeV region: full phase space

Alberto Giovannini

University of Torino, Torino, Italy

Abstract

Starting from UA5 and UA1 results in the GeV region on how to interpret observed shoulder structure in full phase space in hh collisions three possible scenarios for final particle multiplicity distributions in the TeV region are explored. H_q vs. q oscillations are also discussed and explained in terms of the same cause which originated above mentioned shoulder structure i.e. the weighted superposition of soft and semihard events.

Jet fragmentation and correlations in AA

Miklós Gyulassy

Columbia University, New York NY, USA

Abstract

New results obtained together with Péter Lévai on the interference of hard and radiative amplitudes are presented connected with jet quenching at RHIC and unquenching at SPS.

Estimation of hydrodynamical model parameters from the invariant spectrum and the correlations of negative pions

Raphael Hakobyan

Institute of Physics, Yerewan, Armenia

Abstract

The invariant spectra of π^- mesons produced in $(\pi^+/K^+)p$ interactions at 250 GeV/c are analysed in the framework of the hydrodynamical model of three-dimensionally expanding cylindrically symmetric finite systems. A satisfactory description of experimental data is achieved. The data favour the pattern according to which the hadron matter undergoes predominantly longitudinal expansion and non-relativistic transverse expansion with mean transverse velocity $\langle u_t \rangle = 0.20 \pm 0.07$, and is characterized by a large temperature inhomogeneity in the transverse direction: the extracted freeze-out temperature at the center of the tube and at the transverse rms radius are 140 ± 3 MeV and 82 ± 7 MeV, respectively. The width of the (longitudinal) space-time rapidity distribution of the pion source is found to be $\Delta\eta = 1.36 \pm 0.02$. Combining this estimate with results of the Bose-Einstein correlation analysis in the same experiment, one extracts a mean freeze-out time of the source of $\langle \tau_f \rangle = 1.4 \pm 0.1$ fm/c and its transverse geometrical rms radius, $R_G(\text{rms}) = 1.2 \pm 0.2$ fm.

Fluctuation effects in high-energy collisions

Yogiro Hama, Takeshi Kodama and Samya Paiva

Instituto de Física, Universidade de São Paulo, Brazil

Abstract

One of the main characteristics of the high-energy hadronic or nuclear collisions is the existence of large event-by-event fluctuations, manifested in several observed quantities. We investigated the effects of fluctuations in the initial conditions, by using the *Interacting Gluon Model*, modified by the inclusion also of the impact-parameter fluctuation [1]. Some observables which follow directly from this model, such as the inelasticity and leading-particle distributions as well as the energy-dependence of the average inelasticity, exhibit a good agreement with all the existing data including those obtained in cosmic-ray experiments, indicating the soundness of the model and showing the importance of correctly accounting for the impact-parameter fluctuation. The rapidity and pseudo-rapidity distributions calculated by applying the one-dimensional hydrodynamical model with fluctuating mass and momentum show a considerable deviation from those computed with the average initial conditions, using the same mechanism. To account for the semi-inclusive distributions and the forward-backward correlation, it is necessary to take into account also the multiplicity fluctuation, for fireballs of fixed masses. This has been done within the longitudinal phase-space model, with the energy and momentum distributions of the fireballs given by the IGM.

[1] S. Paiva, Y. Hama and T. Kodama, *Phys. Rev.* **C55** (1997) 1455.

[2] Y. Hama and S. Paiva, *Phys. Rev. Lett.* **78** (1997) 3070.

[3] Y. Hama, T. Kodama and S. Paiva, to appear in *Found. Phys.* dedicated to Mikio Namiki's 70th birthday.

Beyond KNO scaling

Sándor Hegyi

Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Abstract

A generalization of the Koba-Nielsen-Olesen scaling law of the multiplicity distributions $P(n)$ will be presented. It consists of a change in the normalization point of $P(n)$ compensated by a suitable change in the renormalized parameters and a rescaling. The iterative repetition of the transformation yields the sequence of higher-order moment distributions of $P(n)$. Each member of this sequence may exhibit data collapsing behavior in case of violation of the original KNO scaling hypothesis. I shall show that the iterative procedure can be viewed as varying the collision energy, i.e. the moment distributions of $P(n)$ can represent the pattern of pre-asymptotic KNO scaling violation. The fixed points of the iteration will be determined and a consistency test based on Feynman scaling is to be given.

A generalized negative binomial distribution

Sándor Hegyi

Research Institute for Particle and Nuclear Physics, Budapest, Hungary

Abstract

In 1984 Pete Carruthers called attention to the Poisson transform of the asymptotic KNO function $f(x) = N\,x^{d-1}\exp(-bx^{\gamma})$. This probability density is the generalized gamma distribution. I shall give a brief historical account of the Faxén integral, i.e. the Laplace transform of $f(x)$, whose analytic form was derived in the early 70s making use of the H-function of Fox. The closely related Poisson transform of $f(x)$ specifies a discrete probability law which generalizes the distribution of n Bose-Einstein particles in k phase-space cells. It is capable of reproducing a large variety of multiplicity data measured in different reactions, rapidity bins and collision energy domains. In this talk the Poisson transformed generalized gamma distribution will be investigated in connection with the sign-changing oscillations of the $H(q)$ moments.

The Color Mutation Model for soft interaction

Rudolph C. Hwa

University of Oregon, Eugene OR, USA

Abstract

A comprehensive model for soft interaction is to be presented. It overcomes all the shortcomings of the existing models — in particular, the failure of Fritiof and Venus models in predicting the correct multiplicity fluctuations as observed in the intermittency data. The Color Mutation Model incorporates all the main features of hadronic interaction: eikonal formalism, parton model, evolution in color space according to QCD, branching of color neutral clusters, contraction due to confinement forces, dynamical self-similarity, resonance production, and power-law behavior of factorial moments.

Chaos and phase transition

Rudolph C. Hwa

University of Oregon, Eugene OR, USA

Abstract

The fluctuations of spatial patterns can be analyzed for the study of chaotic behaviors in hadron production. A measure of those fluctuations is the entropy index. Applying that measure to the Ising model in 2D, it is found that the entropy index exhibits a sharp peak at the critical temperature. The use of entropy index as a signature of quark-hadron phase transition will be discussed.

Probing hot and dense matter via single hadrons and two particle correlations

BARBARA V. JACAK
for the NA44 Collaboration

SUNY at Stony Brook, NY, USA

Abstract

The NA44 Experiment at CERN measures hadrons emitted at midrapidity in ultrarelativistic heavy ion collisions. Two-particle interferometry is traditionally used to provide a snapshot of the colliding system at the time the particles cease to interact. We extend these studies to yield information about the dynamics of the collision and evolution of the system before freeze-out. Single particle inclusive distributions also reflect the dynamics and show increased radial expansion for larger colliding nuclei. NA44 has measured both. I will also discuss prospects for correlation measurements at RHIC.

Angular multiplicity fluctuations in hadronic Z decays and QCD

Wolfram Kittel

HEFIN, University of Nijmegen, Nijmegen, The Netherlands

Abstract

Local multiplicity fluctuations in angular phase space intervals are studied by means of factorial moments measured in hadronic events at 91 GeV, which were collected by the L3 detector at LEP. Parton-shower Monte Carlo programs agree well with the data. On the other hand, first-order QCD calculations in the Double Leading Log Approximation and the Modified Leading Log Approximation are found to deviate significantly from the data.

Correlations and H_q moments in instanton-induced processes

VIATCHESLAV KUVSHINOV AND R. SHULYAKOVSKY

Institute of Physics, Minsk, Belarus

Abstract

For the multiparticle processes induced by the strong instantons in deep-inelastic ep scattering correlation function, factorial moments, H_q moments and local moments are calculated taking into account both quasi-classical contribution and quantum corrections. All of these quantities have spesific properties which could be the additional signatures for the instanton search in high energy physics proceses.

Fluctuation and dissipation in discretized fluid dynamics

Zsolt I. Lázár

University of Bergen, Bergen, Norway

Abstract

Coarse grained Langevin-type effective field equations are derived for classical systems of particles. These equations include the effects of thermal fluctuation and dissipation that may arise from coupling to an external bath, as in the Brownian motion of a single particle, or from statistical fluctuations in small parts of an isolated many-particle system, as in sound waves. These equations may provide some guidance for the analysis of mesoscopic or microscopic molecular systems or for systems of hundreds to thousands of subatomic particles produced in high-energy nuclear collisions. Suggestions for consistent realization of random fluctuations in discretized fluid dynamics will be presented.

Searching for space-time asymmetries in particle production

Richard Lednicky

FZU, Prague, Czeh Republic and *SUBATECH, Nantes, France*

Abstract

The possibilities of the unlike particle correlations for a study of the space-time asymmetries in particle production, including delays in particle emission, are demonstrated.

Are the gravitational waves quantised?

István Lovas

Kossuth Lajos University, Debrecen, Hungary

Abstract

The question whether gravitational waves are quantised or not can be investigated by the help of correlation measurements. If the gravitational waves are classical objects then the value of their correlation function is 1. However, if they are quantised, then there exist two possibilities: the gravitational waves are either completely coherent, then the correlation function is again 1, or they are partially coherent, then the correlation function is expected to deviate from 1. If the gravitational waves are generated by the change of the background metrics then they can be in a squeezed state. In a squeezed state there is a chance for the correlation between the phase of the wave and the quantum fluctuations.

Modelling Bose-Einstein correlations at LEP-2

Leif Lönnblad

University of Lund, Lund, Sweden

Abstract

I discuss briefly some pros and cons of different strategies for modelling Bose-Einstein correlations in event generators for fully hadronic WW events at LEP-2.

I also present a few new algorithms based on shifting final-state momenta of identical bosons in WW events generated by PYTHIA and discuss the resulting predictions for the effects on the W mass measurement.

Bose-Einstein correlations in heavy-ions and e^+e^- : similarities and differences and their interpretations

Bengt Lörstad

University of Lund, Lund, Sweden

Abstract

The dependence on transvers mass, m_t, of charged boson correlations has been studied in detail in data from heavy-ions and e^+e^- interactions. At first glance similarities are striking but small differences show that quite different models seem to be needed to understand the data.

Three-pion correlations

Bengt Lörstad

University of Lund, Lund, Sweden

Abstract

The $\pi^+\pi^+\pi^+$ correlations for $S+Pb$ and $Pb+Pb$ collisions will be presented, as measured by the NA44 Collaboration at CERN. Three-particle correlations are sensitive to phases not present in two-particle correlations. I will discuss the sensitivity to these phases in the data and present some results indicating not totally chaotic production of particles.

QCD description of high order factorial moments and $H(q)$ moments in quark and gluon jets and in e^+e^- annihilation

Sergio Lupia

Max-Planck Institut für Physik, München, Germany

Abstract

The complete QCD evolution equation for factorial moments in quark and gluon jets is numerically solved with absolute normalization at threshold. Within the picture of Local Parton Hadron Duality, perturbative QCD predictions are compared with existing experimental data for the factorial cumulants, the factorial moments and their ratio both in quark and gluon jets and in e^+e^- annihilation. The main differences with previous approximate calculations are also pointed out.

Analysis of the charged particle multiplicity distribution using the ratio of cumulant factorial to factorial moments

Dominique Mangeol

HEFIN, University of Nijmegen, Nijmegen, The Netherlands

Abstract

The ratio of the cumulant factorial to factorial moments of the charged particle multiplicity distribution is known to show a quasi-oscillatory behaviour when plotted versus the order of the moments. This peculiar behaviour is also predicted by the NNLLA of perturbative QCD assuming the validity of the LPHD hypothesis. Using the subjet multiplicity distribution obtained from both Durham and Cambridge jet algorithms, instead of the charged particle multiplicity distribution, in order to vary the dependence on the LPHD hypothesis; we show that the oscillations appear only for non-perturbative energy scales.

Quantum and classical kinetic equations in probability representation

Vladimir I. Man'ko

Lebedev Institute of Physics, Moscow, Russia and *INFN, Italy*

Abstract

Using sympletic tomography method, in which a quantum state is described by marginal probability distribution (instead of wave function or density matrix), quantum kinetic equations (including Schrödinger equation and Moyal equation) are reduced to the form of the Fokker-Planck - type equation. Classical Boltzmann equation can be also rewritten in terms of the marginal probability distribution function and, in this new probability representation, quantum and classical kinetic equations become similar in the form. Examples of quantum parametric oscillator and free motion are considered in detail.

Multiproduction in the soft limit and QCD coherence

Wolfgang Ochs

Max-Planck Institut für Physik, München, Germany

Abstract

Whereas the gross features of multiparticle production in hard processes can be derived from an underlying parton cascading process, the particles with small transverse momenta $k_\perp < k_\perp^{cut}$, $k_\perp^{cut} \to 0$, are shown to be produced by independent emission from the primary parton as showering is suppressed for the low $k_\perp$ gluons by coherence. Conseqently, the low $k_\perp$ gluons follow a Poisson distribution, very much like the soft photons radiated by a charged particle in QED. On the contrary, the distribution of soft partons in a spherical phase space with $k < k^{cut}$ remains non-Poissonian even for small k^{cut}. It will be interesting to find out, to what extent this perturbative prediction for partons survives the hadronization process.

Two-particle correlations in heavy-ion collisions at AGS energies

SERGEI PANITKIN

LBL, Berkeley CA, USA

Abstract

One of the goals of the relativistic heavy ion physics is the study of the nuclear matter under extreme conditions — high energy and/or baryon densities. Information about space-time properties of the systems created in the collisions is important for our understanding of the dynamics of the heavy ion reactions and is a subject of intensive experimental and theoretical studies. I will discuss recent experimental measurements of two-particle correlation functions obtained in central collisions at AGS energies.

Resonance decays and BE correlations in hadronic collisions

Ján Pišút

Comenius University, Bratislava, Slovakia

Abstract

A simple model of resonance formation and decay in hadronic collisions is studied and compared to the data of the EHS/NA22 Collaboration on $\pi^- p$ interactions. The data indicate a rather short formation time of resonances, about 0.2-0.4 fm/c.

New families of scaling multiparticle distributions

MAREK PLOSZAJCZAK

GANIL, Caen Cedex, France

Abstract

Equations for the generating functional in the perturbative quantum chromodynamics (QCD) have been extended by including non-perturbative dissipation in QCD jets. The resulting equations, which are special cases of the fragmentation-inactivation process, have been solved *rigorously*. New families of scaling solutions for the hadron multiplicity distributions have been found, which generalize the well-known Koba-Nielsen-Olesen scaling law.

Phase space overpopulation at CERN and possible explanations

Scott Pratt

Michigan State University, East Lansing MI, USA

Abstract

By combining information from correlations from Pb+Pb collisions at CERN, one comes to the conclusion that pionic phase space is significantly overpopulated compared to expectations based on chemical equilibrium. A variety of explanations will be addressed.

Three-particle Bose-Einstein correlations as sensitive probes for a Lund Model treatment

Markus Ringnér

University of Lund, Lund, Sweden

Abstract

I will discuss how a difference in the correlation length longitudinally and transversely, with respect to the jet axis in e^+e^- annihilation, arises naturally in a model for Bose-Einstein correlations based on the Lund string picture. This difference, due to the longitudinal stretching of the string field, is more apparent in three-particle correlations. They can therefore be used as a sensitive probe of Lund model fragmentation.

Study of intermittency and correlations in hadronic Z decays

EDWARD K. SARKISYAN
for the OPAL Collaboration

Tel-Aviv University, Tel-Aviv, Israel

Abstract

Multidimensional study of local multiplicity fluctuations and genuine multiparticle correlations is carried out with the multihadronic Z^0 decay events recorded by the OPAL detector during 1991 to 1995. The local fluctuations are investigated in the framework of the intermittency approach based on the method of the normalised factorial moments. The large statistics allows us to study in e^+e^- annihilations for the first time the normalised factorial cumulants to search for the genuine multiparticle correlations and to investigate their contributions to the observed dynamical fluctuations. The results are compared with generated samples obtained from the Jetset 7.4 and Herwig 5.9 Monte Carlo models.

Coherence vs. stochasticity in multiparticle spike production in nuclear collisions at intermediate energies

L.K. Gelovani, G.L. Gogiberidze and Edward K. Sarkisyan

Tel-Aviv University, Tel-Aviv, Israel

Abstract

Multiparticle spike-production process is investigated in central $C+Cu$ collisions at 4.5 AGeV/c per nucleon. The spike-center pseudorapidity distributions are analyzed in frame of a coherent gluon-jet emission model. To observe manifestation of the stochastic dynamics, intermittent structure of the multiplicity distributions is studied. The entropy indices are calculated based on the erraticity approach.

Bose-Einstein correlations and the equation of state of nuclear matter in relativistic heavy-ion collisions

Bernd Schlei

LANL, Los Alamos NM, USA

Abstract

In my talk I am going to discuss, to which features of an equation of state the pair correlations of identical particles (Bose-Einstein correlations) are sensitive to. I shall discuss — within a relativistic hydrodynamical framework — how one first has to provide a reasonable reproduction of hadronic single inclusive particle momentum spectra. Then, as a next step, one has to take into account also — among many other things — the correct detector acceptances (for a particular experiment under consideration) and the experimental prescription for how to generate the Bose-Einstein correlation functions. Finally, I shall show the results of the calculations of the correlation functions. In doing so, I vary the freeze-out condition and/or the softness of the equation of state and then show the effects on the correlation functions and the single inclusive particle momentum spectra. In my theoretical calculations I shall consider mainly heavy-ion collision for $Pb+Pb$ at 158 AGeV.

Recent results on correlations from NA49

Peter Seyboth

Max-Planck Institut für Physik, München, Germany

Abstract

Recent results from the 2-particle correlation analysis of NA49 in central Pb+Pb collisions will be discussed. The $\pi\pi$ correlations were studied in the Bertsch-Pratt and Yano-Koonin-Podgoretsky systems as a function of rapidity and transverse momentum of the pairs leading to a determination of size and transverse flow at freeze-out. A search for non-gaussian components in the correlation functions will be shown. Preliminary proton-proton correlations will also be presented.

The thermodynamics of multi-boson phenomena

Yuri M. Sinyukov

Institute for Theoretical Physics, Kiev, Ukraine

Abstract

We discuss the properties of multi-bosonic systems at high phase-space densities. The consideration is based on statistical operator formalism for thermal locally equilibrium systems. Inclusive spectra and BE correlation function for such systems are obtained.

Finite size Coulomb correction for interferometry analysis of expanding, partially coherent sources

Yuri M. Sinyukov

Institute for Theoretical Physics, Kiev, Ukraine

Abstract

We discuss in details the problems of the Coulomb correction to the two-boson correlation functions for systems formed in ultra-relativistic heavy ion collisions with large effective volumes. The modification of the standard zero-distance correction (so-called Gamow or Coulomb factor) has been proposed for such kind of systems. For $\pi^+\pi^+$ and K^+K^+ correlation functions the analytical approach for the Coulomb correction is compared with the exact numerical results and good agreement is found at SPS, RHIC and LHC energies. The procedure of an extraction of a possible coherent component in the particle radiation from the particle spectra and two-boson correlation function is proposed.

Tests of BE correlation models in e^+e^- annihilation process

Oxana Smirnova

JINR and *University of Lund, Lund, Sweden*

Abstract

Several implementations of the Bose-Einstein effect in the JETSET particle generator are tested using various sensitive analysis methods. Features and side effects, such as effective appearance of the new length scale, particle mass shifts and changes in the shape of the boson source are investigated and compared to the DELPHI experiment data.

Testing hydrodynamical model on correlations and particle spectra in NA44, WA93 and WA98 heavy ion experiments

ANDRÁS STER, TAMÁS CSÖRGŐ AND BENGT LÖRSTAD

Research Institute for Materials Science, Budapest, Hungary

Abstract

Analytic and numerical approximations to a hydrodynamical model describing three-dimensionally expanding, cylindrically symmetric, finite systems are fitted to NA44, WA93 and WA98 data measured in 200 AGeV central $S+Pb$ and 158 AGeV central $Pb+Pb$ reactions. The model describes the measured spectra and HBT radii of pions, kaons and protons, simultaneously. The fits indicate that the source of particles have a generic central freeze-out temperature of about $T_0 = 140 - 150$ MeV and that a strong mean transverse flow is found in the range of $\langle u_t \rangle = 0.4 - 0.5$. The well-known transverse mass dependencies of the measured radius parameters are well fitted by the model. The absolute normalization of the measured particle spectra together with the experimental determination of both the statistical and the systematic errors were necessary for a unique determination of the source parameters.

Isotopic spin effect in three-pion Bose-Einstein correlations

Naomichi Suzuki

Shinshu University, Matsumoto, Japan

Abstract

Bose-Einstein (BE) correlations of identical particles in multiple production processes are extensively studied last years because they give an information on the space-time region of interaction. The basic effect is analogous to Hanbury-Brown - Twiss (HBT) interferometry in optics and suggests statistical production of the particles (mainly π mesons). The possible presence of coherent pionic component (for example, in the case of disoriented chiral condensate formation) modifies the HBT effect. This modification in particle physics was taken formerly in close analogy with optics.

On the other hand, the pions (contrary to photons) are subject to isotopic spin (and electric charge) conservation and so they can not be emitted independently. While the corresponding change of the statistical part is not essential for large multiplicities, the coherent part changes substantially when isotopic spin conservation is taken into account. So we reconsider BE correlations of the pions in the presence of both statistical and coherent components taking into account isotopic spin conservation in the coherent part. That will result in appearance of additional contribution to pionic correlation function.

Simulation of Bose-Einstein effect using Lund string fragmentation model

Sharka Todorova-Nova

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Abstract

The experimentally observed enhancement of number of close boson pairs in e^+e^- collisions is reproduced by local weighting according to the QM prescriptions for production of identical bosons. The space-time picture of the process, inherently present in the Lund fragmentation model, is explicitly used. The model is used to check systematic errors in the W mass measurements due to the BE effect, and comparison with data (DELPHI) is made. The possibility of direct implementation of the BE effect into string fragmentation is discussed.

Novel scaling behavior for the multiplicity distribution under second-order quark-hadron phase transition

CHUN-BIN YANG

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Abstract

Multiplicity distribution in small bins is studied within the Ginzburg-Landau description for second-order quark-hadron phase transition. Dynamical factor d_q for the distribution and ratio $D_q \equiv d_q/d_1$ are defined and novel scaling behaviors between D_q are found which can be used to detect the formation of quark-gluon plasma.

Expectations in MPP in hh collisions in the TeV region: rapidity intervals

Roberto Ugoccioni

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Abstract

Starting from the past experimental results on multipliticy distributions in intervals of rapidity and of their analysis in terms of the superposition of events of soft and semi-hard type (see the talk of A. Giovannini) we discuss three possible scenarios for hh collisions in the TeV energy region.

Pion interferometry of the pion source in e^+e^- collisions in L3

Jorn van Dalen

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Abstract

A study of the directional dependence of two-particle correlations in the hadronic decays of the Z is performed on L3 data. Comparisons are made with results from hadron-hadron and heavy-ion collisions.

Impressionism and surrealism in multiparticle dynamics

Richard Weiner

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Abstract

Various topics of multiparticle dynamics, to which Peter Carruthers brought important contributions will be discussed. Also some conclusions drawn recently in writing a monograph on Bose-Einstein correlations will be presented. These will include pasers, Wigner function and pseudo-hydrodynamics, photon HBT, higher order correlations.

Multi-pion BE correlations on source distribution

Qing-Hui Zhang

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Abstract

Ultrarelativistic hadronic and nuclear collisions provide a unique environment to create dozens, and in some cases hundreds, of pions. To study the pion source distributions in these processes, therefore, one must take into account the effects of multi-pion Bose-Einstein (BE) correlations. The bosonic nature and isospin of the pion should affect the single pion spectrum distribution in coordinate space. However, this issue has not yet been discussed in the literature. The purpose of this talk is to analyse the effects of multi-pion correlation and isospin on the source distribution in coordinate space. It is shown that multi-pion Bose-Einstein correlations make the average radius of the pion source become smaller. The isospin effect on the pion multiplicity distribution and the source distribution is also discussed.

Improved intermittency analysis of single event data

Beata Ziaja

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Abstract

The intermittency analysis of single event data (particle moments) in multiparticle production is improved, taking into account corrections due to the reconstruction of history of a particle cascade. This approach is tested within the framework of the α-model.

Analytic solution of the pion-laser model

József Zimányi and Tamás Csörgő

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Abstract

Brooding over bosons, wave packets and Bose-Einstein correlations, we present a generic quantum mechanical system that contains arbitrary number of bosons characterized by wave-packets and that can undergo a Bose-Einstein condensation either by cooling, or increasing the number density of bosons, or by increasing the overlap of the multi-boson wave-packet states, achieved by changing the size of the single-particle wave-packets. We show that the n-particle correlations may mimic coherent or chaotic behaviour for certain limiting wave-packet sizes. Effects of complete n-particle symmetrization are included. The resulting weights which fluctuate between 1 and $n!$ are summed up with the help of a formal analogy between the considered wave-packet system and an already explored multi-boson plane-wave system. We solve the model analytically in the highly condensed and in the rare gas limiting cases, numerically in the intermediate cases. The relevance of the model to multi-pion production in high energy heavy ion physics as well as to the Bose-Einstein condensation of atomic vapours is discussed. As a by-product, a new class of probability distribution functions is obtained and the multiplicity dependence of single-particle momentum distributions are predicted.