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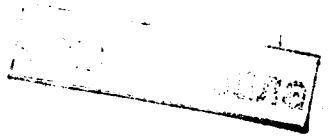

VERY HIGH MULTIPLICITY PHYSICS

International Conference «Hadron Structure 2004»

Smolenice Castle, Slovakia, August 30 – September 3, 2004

Selected Papers of the Conference

Dubna 2005

Where are the thermalized states seen?

J.Manjavidze & A.Sissakian

Joint Institute for Nuclear Research

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- **Introduction**

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- **Thermodynamics** of inelastic collisions

  --- *Necessary and sufficient condition for thermalization*

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  --- *Phase space structure and Multiplicity distribution*

- **Reactions** for which the thermalized state can be achieved

  --- *Ion collisions: NA49*

  --- $e^+e^- \to hadrons : DELPHI, OPAL$

  --- "Thermalization" : *JINR-MSU-IHEP-TSU Coll.*

- **Conclusions**

References

The VHM physics phenomenology:
J.Manjavidze & A.Sissakian, JINR Rap. Comm., P2-88-724, 1988; 5/31 (1988) 5; 2/281 (1988) , *A.Sissakian,* Physics – Uspekhi, 46, (2003) 323

Introduction into the multiple production thermodynamics:
J.Manjavidze & A.Sissakian, Phys. Rep., 346 (2001) 1

Generating functionals for QCD on the invariant-field manifolds:
J.Manjavidze & A.Sissakian, J. Math. Phys., 41 (2000) 5710,
42 (2001) 641, 42 (2001) 4158

Symmetry-constrained dissipation processes:
J.Manjavidze & A.Sissakian, Th. Math. Phys., 123 (2000) 776, 130 (2002) 153

Experiment:
J.Manjavidze & A.Sissakian, JINR Rap. Comm., 4[96] (1999) 45; *J.Manjavidze & A.Sissakian,* Proc. of the ICHEP 2002; *J.Manjavidze & A.Sissakian*, JINR Rap. Comm. , 2001 4[96] (1999) 35; *J.Budagov, G.Chelkov, Y.Kulchitsky, J.Manjavidze, A.Olchevsky, N.Russakovich, A.Sissakian,* Talk at the ATLAS Week, Lund (1999)

See also the collected articles:
Nucl.Phys. (Rus.) 67, #1 (2004); Proc. of VHM physics Workshops (2000-2004),

Necessary and sufficient condition for thermalization

- **The equilibrium thermodynamics assumes:**

--- Boltzmannian energy spectrum for produced particles

--- fluctuations are Gaussian around the mean value of secondaries energy : the higher energy correlators K_l, $l = 3,4,...,$ **are negligible,**

$$|K_l(E,n)| / |K_2(E,n)|^{l/2} << 1,\ l = 3,4,...$$

J.Manjavidze & A.Sissakian (2001)

dispersion of energy fluctuations

- **The "local equilibrium" hypothesis:**

--- The equilibrium can be achieved for a part of the energy spectrum (*this idea is used for ion collisions*).

Why is the thermalization important

1. **Restricts a number of necessary variables →**

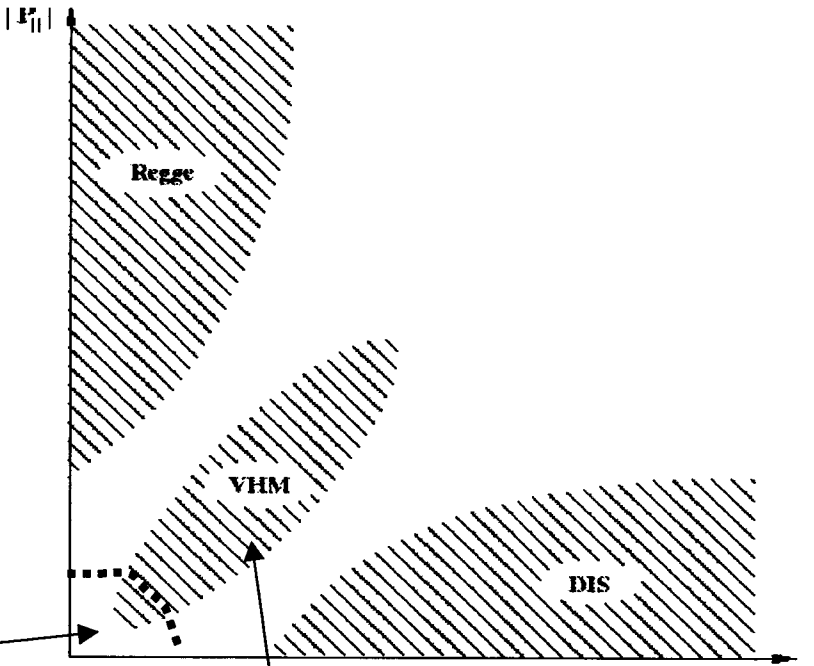
--- ***"inclusive description"*** **("partial description" according to Bogolyubov)**
--- ***fluctuations are Gaussian*** **(equilibrium)**

2. **If the state is equilibrium →**

--- ***the role of hidden constraints*****? (symmetries, etc.)**
--- ***collective phenomena can be investigated*** **(phase transitions, etc.)**

VHM region: The phase space structure

- "Regge" - soft hadron dynamics: (V.Gribov; K.Ter-Martirosyan; A.Kaidalov; P.Landshof; BFKL, ...)
- "DIS" - hard hadron dynamics: (DGLAP;...)
- "VHM" – hard, low-x hadron dynamics (L.Gribov et al.; L.Lipatov; J.Manjavidze & A.Sissakian; L.MacLerran, D.Kharzeev..)

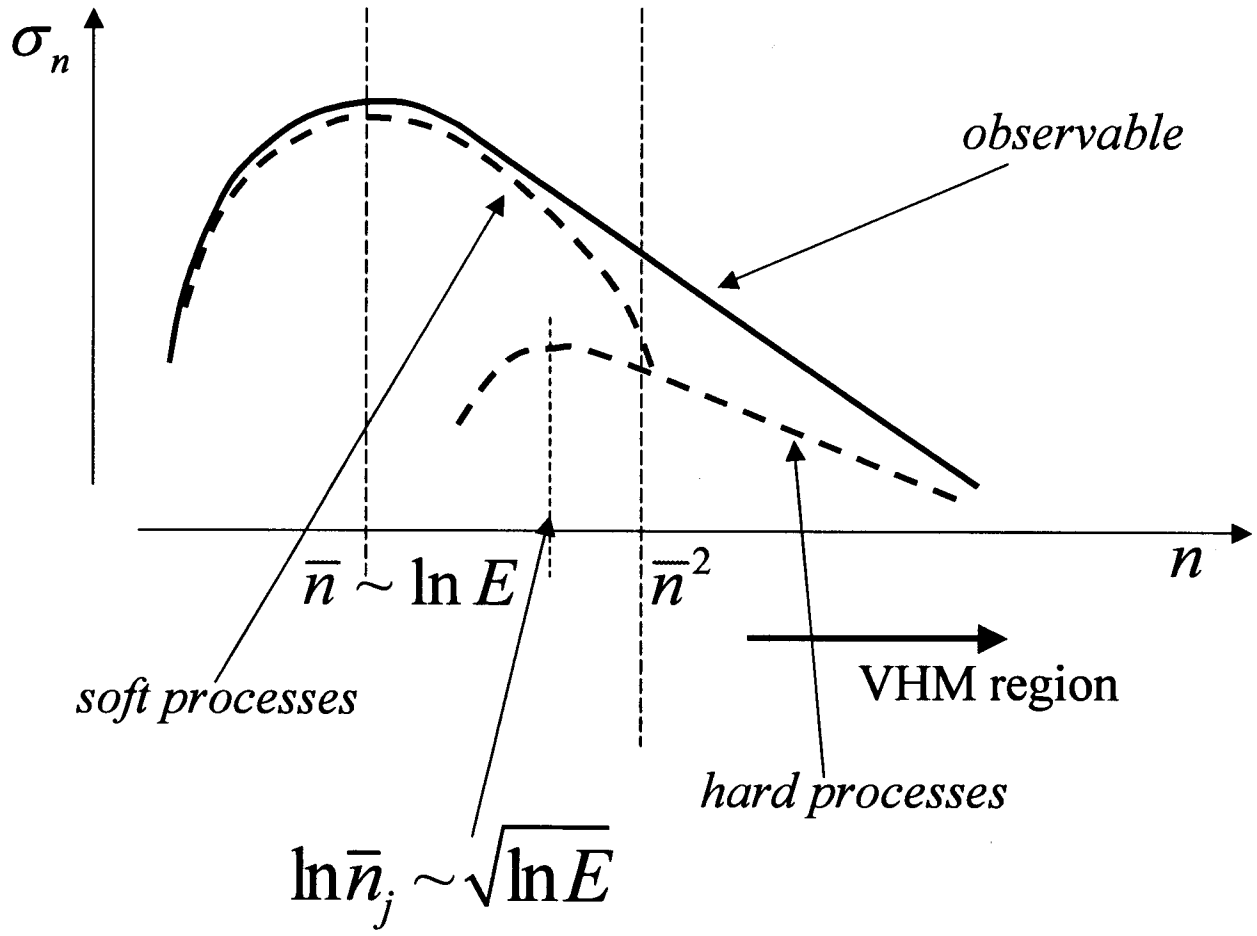


$$|K_3|/|K_2|^{3/2} \sim 1/n$$

VHM region $\rightarrow |K_3|/|K_2|^{3/2} \ll 1$

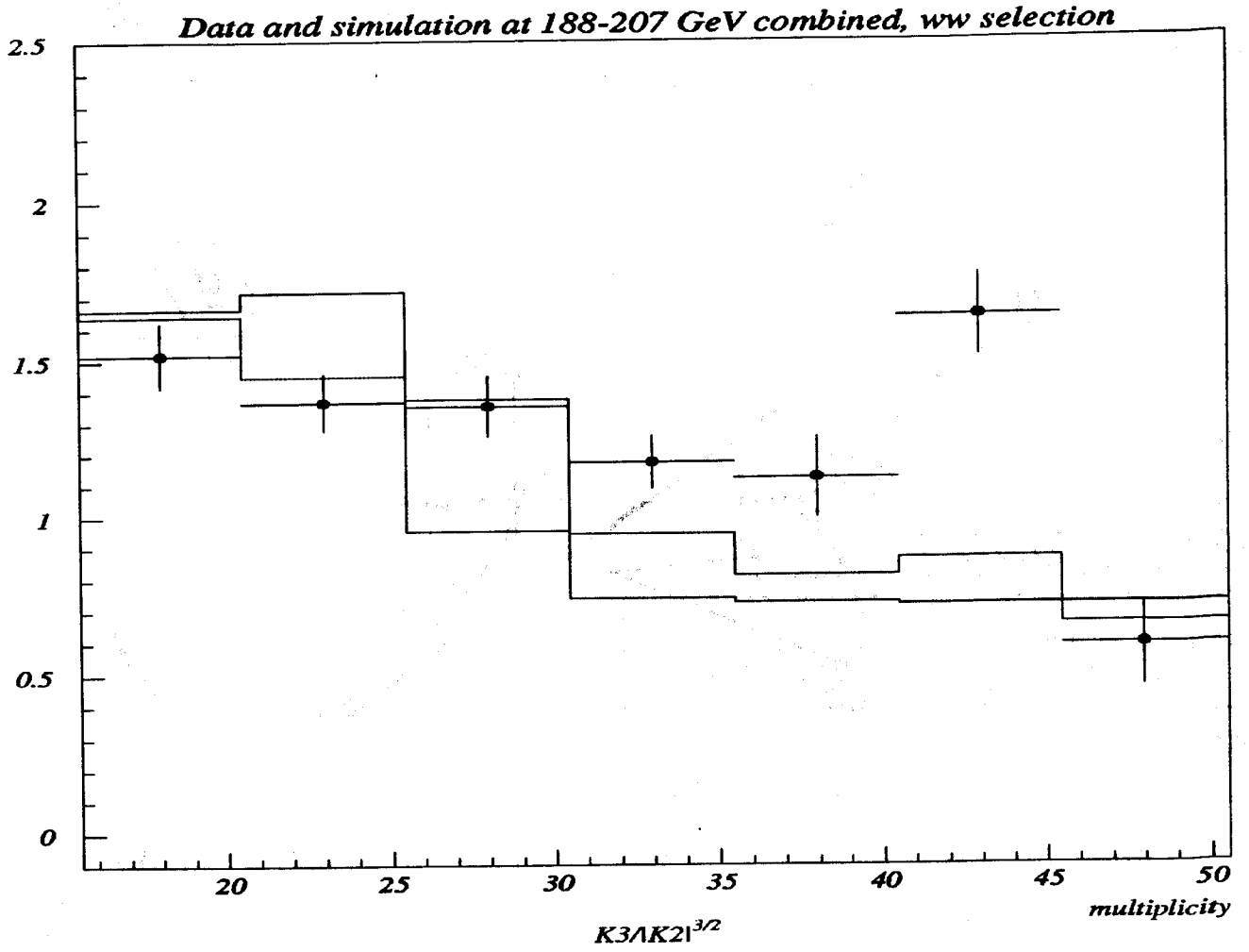
- LLA technique is not effective outside the "DIS" domain
- Strong coupling QCD (J.Manjavidze & A.Sissakian, Theor. Math. Phys. 130 (2002) 153) was built to describe the "VHM" domain
- Symmetry constraints are not important inside "DIS" domain

VHM region: Multiplicity distribution



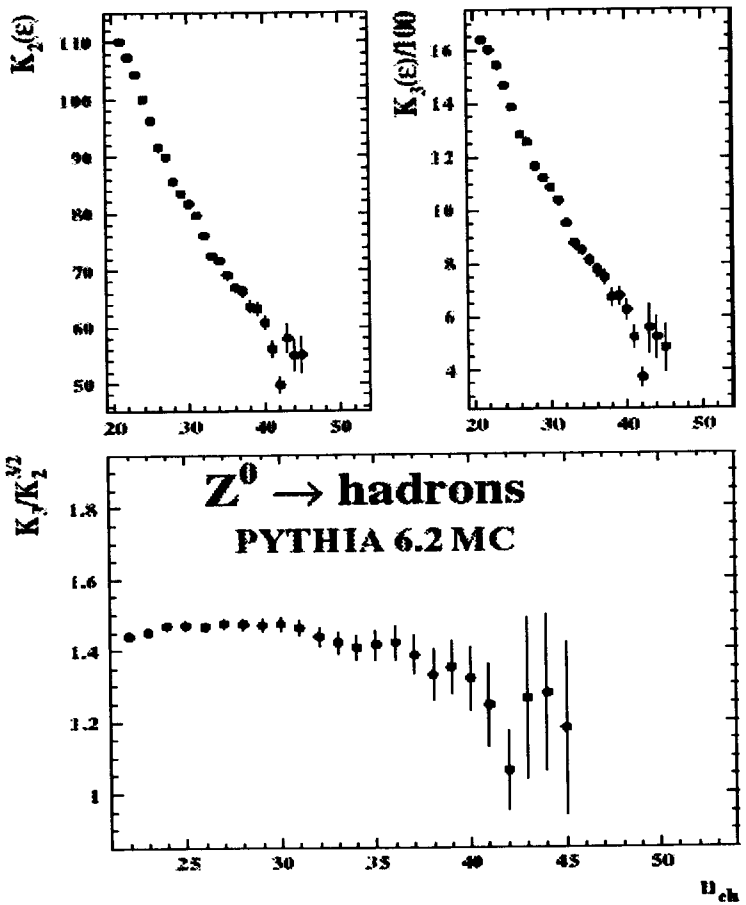
Manjavidze & Sissakian (2000)

DELPHY (preliminary)



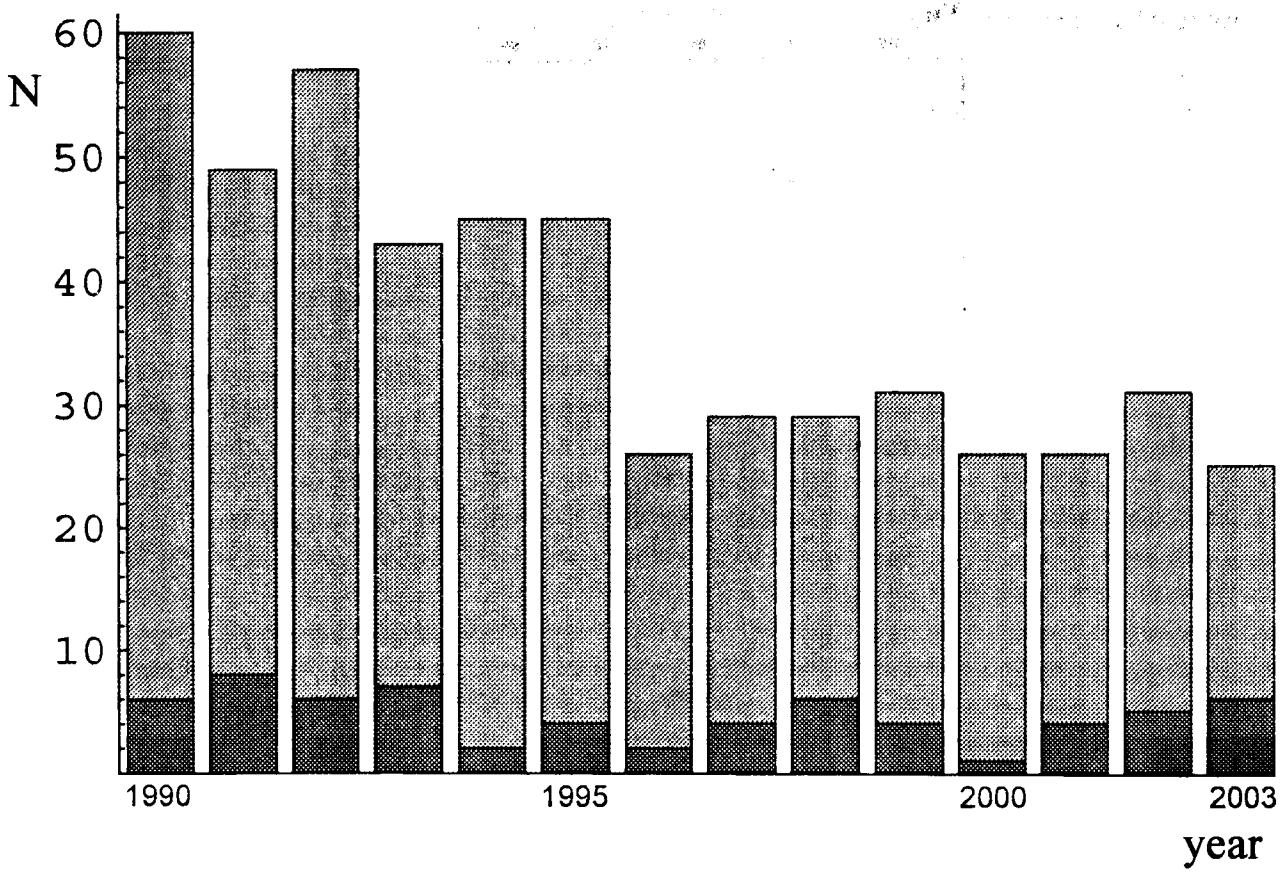
M.Nikolenko, A.Olshevski et al. (2003)

OPAL PYTHIA



E.Sarkisyan-Grinbaum et al. (2004)

SLAC: multi# and production



The number of publications appeared in SLAC data base vs. year

Experiment: NA49(preliminary)

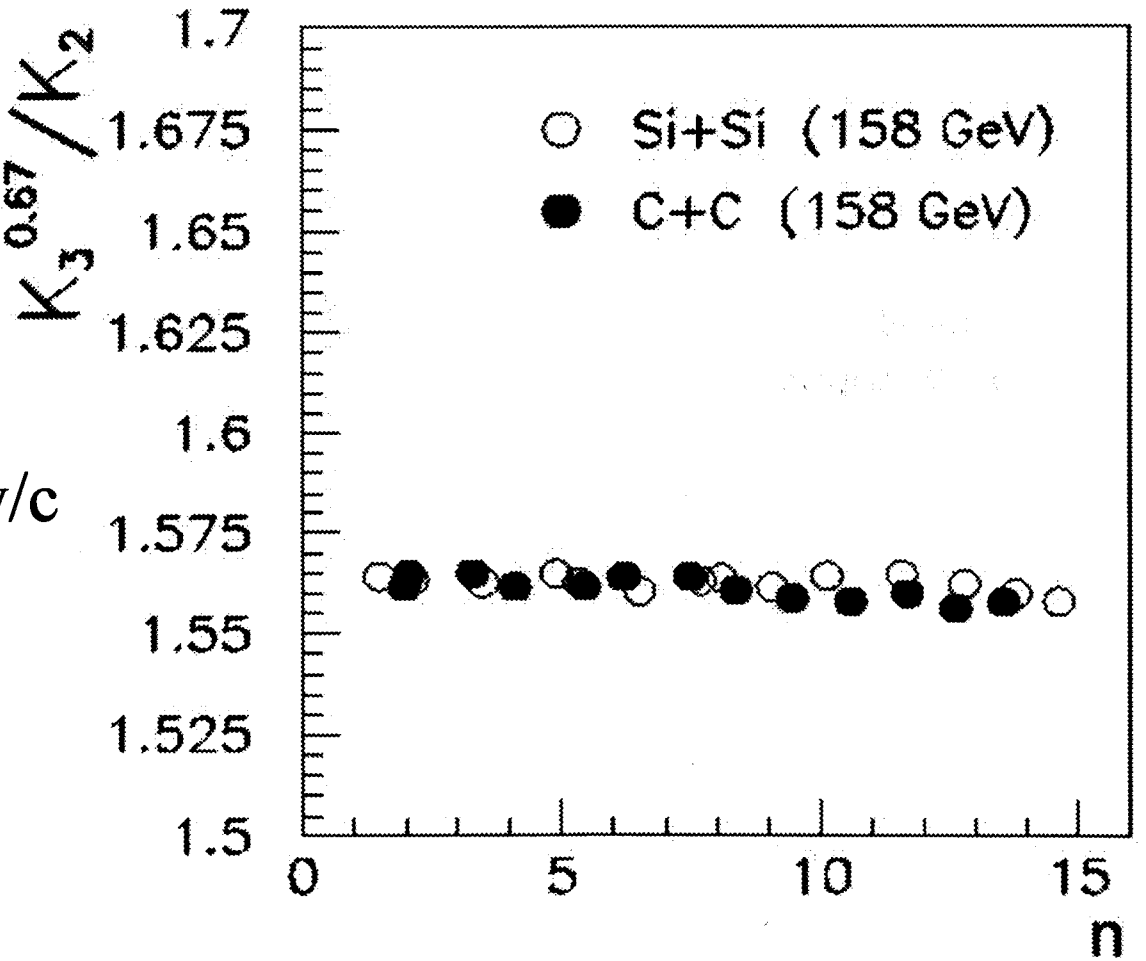
$$\overline{n}_{CC} = 50,$$

$$\overline{n}_{SiSi} = 140$$

$|CM \text{ rap.}| < 2.4 - 5.0$

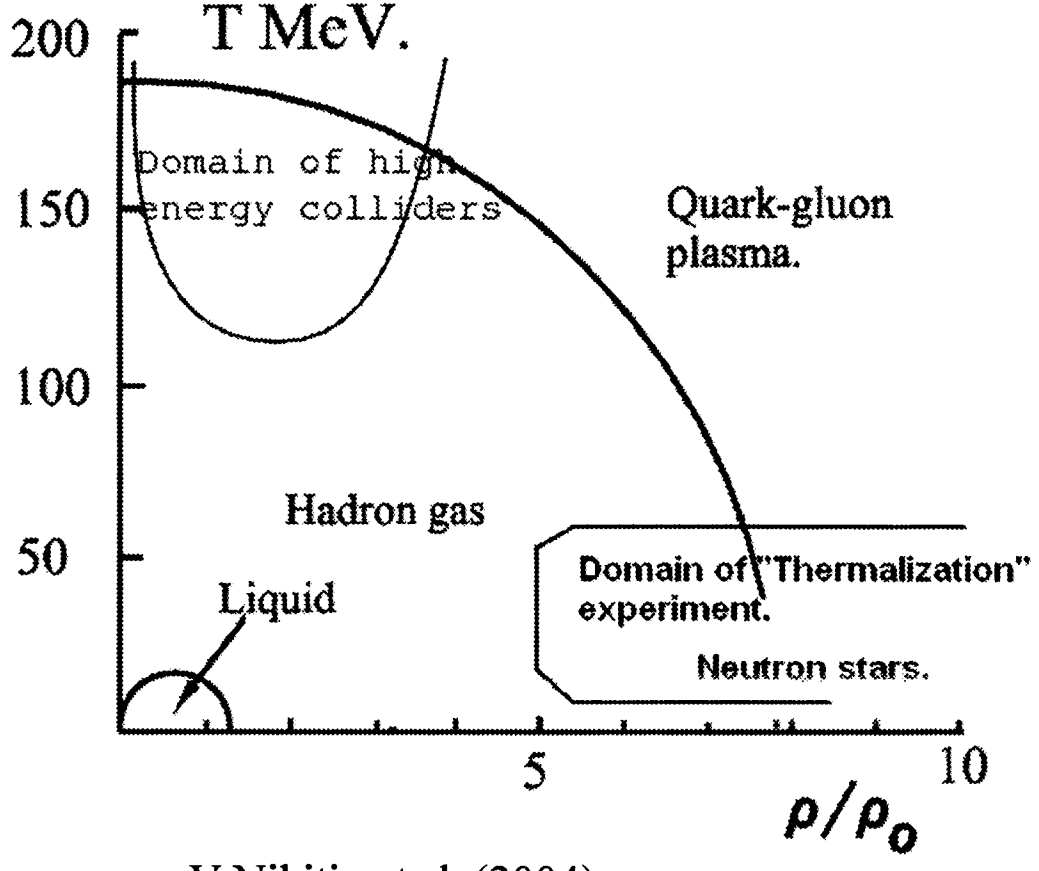
$|\text{trans. mom.}| < 2.5 \text{ Gev/c}$

$$n = \overline{n} + 5x$$



N.Agababian, et al. (2003)

"THERMALIZATION"



V.Nikitin et al. (2004)

- **Production of thermalized state**
- **Cold** and **dense equilibrium** state is favorable for QG plasma production
- **Multiple Bose-Einstein correlations**

Coll. "Thermalization"

JINR(Dubna), MSU(Moscow), IHEP(Prorvino), TSU(Tbilisi)

P.Ermolov, J.Manjavidze, V.Nikitin, A.Sissakian, et. al.

Conclusions

1. **The hard annihilation processes are favorable searching for the thermalized states (Panda, FNAL, J-Parc)**

2. **The low-energy interactions are also interesting ("Thermalization")**

3. **Heavy ion collisions (BNL)**

The necessary and sufficient condition for thermalization is the inequality:

$$|K_l(E,n)|/|K_2(E,n)|^{l/2} << 1,\ \ l = 3,4,...$$