Some Travels with Gena, Some Physics from Kyiv

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I met Gena Zinovjev through Helmut Satz who organized

International Symposium on the Statistical Mechanics of Quarks and Hadrons, Bielefeld 1980

Quark Matter Formation and Heavy Ion Collisions, Bielefeld 1982

Gena organized a meeting in Kyiv, that was to be with heavy participation from the then Soviet Union and Eastern Europe

I had flown to St Petersburg the week before the meeting arriving on May 10, 1986

Unfortunately, on April 26, 1986: Chernobyl

The accident was not widely known at first. I was told that it was first known to scientists at Gatchina (LNPI) because when scientists came to work on the nuclear reactor and tried to pass into the reactor building, they triggerred the radiation detectors. This was scary because there was no news anywhere of a disaster.

For Gena, this was a personal disaster, since he had invested much time and effort to have the meeting in Kyiv.

Gena was my friend, and I was young and foolish, so I considered going to Kyiv not to let Gena down. I was told that it was easy to get a plane ticket to Kyiv. I was also told it would be hard to get a plane ticket to return from Kyiv. I consulted with the US consulate and they told me that if I went to Kyiv, it would be very difficult to leave by any means, and although my own personal safety would not be a problem, my presence would not be helpful for anyone. I stayed in St Petersburg for the week, with the help of the Russian Academy if Sciences

This was only my first adventure with Gena

In 1987, there was the International Symposium on Multiparticle Dynamics held in Tashkent, Uzbekhistan. Gena knew Tashkent well. He took me to the Korean Market for some lunch. He wanted us to have a real adventure while we were there. He suggested we take a few days away from the meeting to go up in the mountains to spend with Kazakh horse breeders and shepherds. Of course this was not on my visa, so there could be big trouble. Gena had a solution: Don't tell any one you are leaving. Do not leave your key with key lady in the hotel. Gena found a driver, who I suspect was responsible for approving my adventure.

This was the time of Gorbachev's anti-alcoholism campaign. This made the job of finding vodka for the trip very easy. In any moderate size town, you could find a long line. This was to make it easy to discover which store had vodka. You simply had to wait a while.

In the mountains where we spent the night, there was a beautiful stream. It was deep in the rocks and had beautiful pools of blue green water. Gena said "Lets go swimming." He said "You go first". When I jumped through the air, my feet hit the water and it was very cold. I thought of yelling "It's too cold." but if I did, the Gena would not be able to enjoy the water. So when I returned to the surface, I yelled to Gena how wonderful the water was. When Gena jumped in, he felt under no civilized constraint to pretend the water temperature was comfortable. He let out a huge Gena scream when he surfaced, that echoed from the mountains many times.

The Kazakh group had several men and one woman. The woman milked the horse for kumis. She had a gentler touch, I guess. The men rode horses in a Kazakh manner unlike anything I had ever seen. It was as if the horse and the rider were one animal.

I learned on the trip that Gena was oftentimes called Gena Crocodile, after the famous Russian cartoon character. I sometimes think of Gena as a tall and elegant crocodile, who sits very silently underneath the water, waiting. But in reality, Gena Crocodile is a jovial good natured fellow just like Gena Zinovjev. Not like the photo.

The attendees at the conference soon discovered I was missing and became very worried when I simply disappeared from the meeting. Unlike years past, it was not so simple to simply disappear in the Soviet Union. But fortunately, they did not inform the police.

When I got back the hotel staff had carefully cleaned my room. They had sprayed it with bug spray, and there was not a living thing in my room. This was a little scary.

Nowadays, if I had gone on such an adventure, and I worked at a national laboratory, there would be hell to pay with national lab officials. Things were simpler then. Thank God.

Gena, me, Yuri Sinukov and Kyril Bugaev

I believe in 1990, Gena invited me to visit Kyiv. There I met many people who became professional friends throughout my career. These include Yuri Sinyukov, Kyril Bugaev and Mark Gorenstein.

Gena took good care of me. I was told that Murray Gell Mann been to the Bogolyubov Institute on a previous visit. Gena took me on a tour of the institute. He showed me the remnants of an old house that had been partially constructed in the western style, complete with a swimming pool. If I remember correctly, Gena told me that they were trying to recruit Dirac to Kyiv after his retirement, and the house was part of the deal. Gena introduced me to Kyiv, and I learned about Bulgakov, and the various different cultures of Ukraine. I ate chicken Kiev.

Gena was still worried surveillance even at this late stage of the Soviet Union. I remember at one point before we had a discussion, he piled pillow on top of my phone, and then we could talk. We always ate hot dogs for breakfast. This is always fun!

He taught me the meaning of the Russian word дикий (дикая)

Gena has always been a pleasant presence, an unusual, and very interesting man.

Some Physics from Kyiv:

Excluded volume theory and why I think it is important.
Based in part on the works of:

Excluded volume effect for the nuclear matter equation of state
Dirk H. Rischke (Frankfurt U.), Mark I. Gorenstein (Frankfurt U.), Horst Stoecker (Frankfurt U.), Walter Greiner (Frankfurt U.)

Excluded volume effect and the quark - hadron phase transition
J. Cleymans (Cape Town U. and Bielefeld U.), Mark I. Gorenstein (Frankfurt U. and BITP, Kiev), J. Stalnacke (Oulu U.), E. Suhonen (Oulu U.)
DOI: 10.1088/0031-8949/48/3/004
Published in: Phys.Scripta 48 (1993), 277-280, Phys. Scr. 48 (1993) 277-280 and Bielefeld Univ. - BI-TP-92-16 (92/07,rec.Aug.) 14 p

Van der Waals excluded volume model of multicomponent hadron gas
Mark I. Gorenstein (Frankfurt U. and BITP, Kiev), A.P. Kostyuk (BITP, Kiev), Ya.D. Krivenko (BITP, Kiev)
e-Print: nucl-th/9906068 [nucl-th]
DOI: 10.1088/0954-3899/25/9/102
Published in: J.Phys.G 25 (1999), L75-L83

Van der Waals excluded volume model for Lorentz contracted rigid spheres
K.A. Bugaev (Frankfurt U. and BITP, Kiev), Mark I. Gorenstein (Frankfurt U. and BITP, Kiev), Horst Stoecker (Frankfurt U.), W. Greiner (Frankfurt U.)
e-Print: nucl-th/0004061 [nucl-th]
DOI: 10.1016/S0370-2693(00)00690-0
Published in: Phys.Lett.B 485 (2000), 121-125

The observed mass radii relations of neutrons stars argue strongly that the sound velocity squared significantly exceed 1/3 at densities only a few times that of nuclear matter. If this is so, then I will argue that at these densities the cores of nucleon begin to strongly overlap, and interaction energies are big. Quark degrees of freedom become important. An essential ingredient in understanding the nuclear matter equations of state is an excluded volume model.

Such concepts were developed in part in Kyiv.

Some facts about matter at nuclear matter density.
I use large number of color to organize thinking

$$k_F \sim 250\ MeV \sim \Lambda_{QCD}$$

$$\rho \sim k_F^3 \sim \Lambda_{QCD}^3$$

$$\epsilon \sim M_N \rho \sim N_c \Lambda_{QCD}^4$$

$$P \sim \frac{k_F^2}{2M}\rho \sim \frac{1}{N_c}\Lambda_{QCD}^4$$

$$v_s^2 \sim \frac{k_F^2}{M^2} \sim \frac{1}{N_c^2}$$

Interactions are weak because of large separation but hard core interaction energy is big

$$V_{cor} \sim N_c \Lambda_{QCD}$$

Is the rapidly rising interaction energy due to the hard core interaction?

Recall that neutron star observations require

$$v_s^2 \sim 1$$

Suppose we have a hard core radius r_0

Corresponding to a density

$$n_0 = \frac{1}{\frac{4}{3}\pi r_0^3}$$

The volume not excluding the cores is

$$V_{ex} = V(1 - n/n_o)$$

The density of the matter in the excluded volume is

$$n_{ex} = \frac{n}{1 - n/n_0} = \frac{2}{(2\pi)^3} \int^{k_F} d^3k$$

The Fermi momentum is singular at the hard core density

$$k_F \sim (1 - n/n_0)^{-1/3}$$

Using thermodynamic identities, one can relate the true chemical potential to the excluded volume fermi momentum to find

$$\mu \sim (1 - n/n_0)^{-5/3}$$

Hagedorn Model:
Limiting T with diverging densities

Excluded volume model:
Limiting density, diverging chemical potential

Limiting T solved by quark gluon plasma

Limiting baryon density solved by quark matter

$$\rho_N \sim (k_F^N)^3$$

$$\rho_Q \sim (k_F^Q)^3$$

$$k_F^Q = \sqrt{E_Q^2 - M_Q^2} \sim \sqrt{E_N^2/N_c^2 - M_N^2/N_c^2} \sim \frac{1}{N_c} k_F^N$$

$$\rho_Q \sim (k_F^N)^3/N_c^3$$

Obtaining reasonable quark densities requires singular nucleon chemical potential

Very Reasonable result:
When cores begin to strongly overlap, quarks become important

There remains a problem:

Nucleons and quarks cannot occupy the same phase space region because of the Fermi exclusion principle

Quarkyonic Matter:

Nucleon degrees of freedom on near Fermi surface and quarks inside.

Density of nucleons becomes fixed because shell gets thinner as overall Fermi momentum increases

$$\rho_N \sim k_F^2 \Delta$$

Δ is the surface thickness

To avoid overcounting of degrees of freedom need a Lagrangian with nucleonic ghosts to cancel modes of nucleons in regions of phase space occupied by quarks

Duarte, Hernandez-Ortiz, Jeong, McLerran

Summary:

When Gena was young, he told me of his dream to build a great group in Kyiv.

He is older now, but that gives him the opportunity to look back and be happy about what he has accomplished.

At the INT, we have a postdoc and RAP with origins in his group. Many first rate scientific institutions have benefitted from the young people from Ukraine.

There are world known contributions for Kyiv to the theory of high density matter and the theory of heavy ion collisions. Making such a scientific insitution in Ukraine is a great accomplishment.

Age can make some people regret the things they have not accomplished.

Gena: Never forget the things you have accomplished

Morituri Salutamas (excerpt)
Henry Wadsworth Longfellow

But why, you ask me, should this tale be told
To men grown old, or who are growing old?
It is too late! Ah, nothing is too late
Till the tired heart shall cease to palpitate.
Cato learned Greek at eighty; Sophocles
Wrote his grand Oedipus, and Simonides
Bore off the prize of verse from his compeers,
When each had numbered more than fourscore years,
And Theophrastus, at fourscore and ten,
Had but begun his “Characters of Men.”
Chaucer, at Woodstock with the nightingales,
At sixty wrote the Canterbury Tales;
Goethe at Weimar, toiling to the last,
Completed Faust when eighty years were past.
These are indeed exceptions; but they show
How far the gulf-stream of our youth may flow
Into the arctic regions of our lives,
Where little else than life itself survives.