Beppe Nardulli Memorial Workshop

Martina Franca, June 20, 2010

Commemoration Talk

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Authorities, ladies and gentlemen, colleagues and dear friends,



this is the fifth workshop of the series QCD@work. A series started by Giuseppe Nardulli (Beppe for friends) back in 2001. As you know Beppe left us two years ago, and today he is not here to open this conference. So, I have been given the sad task of commemorating him and I will try of doing it, also recollecting moments that I have shared with him.

I met Beppe for the first time in December 1991 in Geneva. Our collaboration began from that occasion and we wrote together a paper about some aspects of the physics of the hadron colliders LHC and SSC (the dismissed American project). This first collaboration was somewhat episodic, but later on it became systematic. During the period 1993-1997 we started an extended collaboration about the physics of heavy mesons. Then, from 2000 on we studied together the nuclear matter under extreme conditions of temperature and density. This was also the subject that Beppe continued to investigate until his last days.

An element that probably had some role in the natural sympathy between us was a sort of common formation in physics of elementary particles. In fact, Beppe used to say that Giuliano Preparata was the person with whom he acquired his experience in the field of elementary particles. Preparata moved to Bari around 1977. In the half of the sixties Preparata had been a member of the theory group in Florence. The group was led by Raoul Gatto (the students of Gatto were also known as "gattini", kittens). During those years I was also a "gattino" and this created a kind of common ground between Beppe and me in the way of approaching physics.

The scientific production of Beppe has been very copious (about 200 published papers in the most prestigious physics journals) and with relevant impact in various sectors of elementary particle physics and other disciplines as I will discuss later. Beppe began his scientific activity in 1979 in collaboration with Gianluigi Fogli (now Professor in Bari) and then, in the same year he started a long collaboration with Preparata and Paolo Castorina (now Professor in Catania) about the phenomenological implications of a particular quark model. Giuliano Preparata had a very strong personality and he was also a very good theoretical physicist. Probably, having in mind the example of Gatto in Florence, he worked very hard to grow up a group of young theoreticians.





The papers that Beppe wrote with Preparata had the purpose of understanding the nuclear matter starting from its elementary constituents. The model that they considered was a phenomenological one and not fundamental as QCD. But it was a nice model and produced a good agreement with the experimental data. They worked hard and wrote about ten papers in the period going from 1979 to 1982. Castorina told me that in 1979 Beppe rented a house at the beach in Porto Cesareo where they went together with their wives. The wives were going to the beach and Beppe and Paolo were staying home working and discussing physics.

Beppe was a hard worker with an uncommon capacity of concentration. He was able to perform very complicated calculations in many different situations, for instance travelling. He used to travel with a booklet where he was writing the results of his evaluations. Only lately he started to appreciate automatic means of computations as the ones offered by Mathematica, but whenever it was possible he checked the results by hand.

After his first collaboration with Preparata many other younger people from Bari started to work with Beppe, as Angelini, Cea, Colangelo, Paiano, Rotondi, Scrimieri. Beppe started also some external collaboration with Soffer in Marseille, Grimus and Chiappetta at CERN and Guillet in Lausanne. Also, the scientific interest of Beppe started to slide from quark models to problems of parity violation in nuclei, non-leptonic decays etc. All this activity lasted till the end of the eighties. At that time Beppe was a mature researcher and willing to find new fields of interest. Not necessarily fashionable fields but such to produce good physics and with the possibility of confronting the theoretical results with the experimental data. Beppe did not love particularly the formal aspects of theoretical physics unless they furnished useful techniques to get results to be confronted with the known phenomenology. Most probably this was a consequence of the Gatto school as conveyed by Preparata.

The sector chosen by Beppe was the physics of heavy mesons where new experimental results were beginning to come out. He started this activity with Colangelo (Bari), Paver (Trieste) e Riazuddin (Arabia Saudita). In the same years a new theoretical technique useful to deal with these problems was emerging, the effective lagrangian technique. Since I had worked to applications of this technique to other problems it was natural to start a systematic collaboration on the heavy meson physics. Other members of this collaboration were Gatto (with whom I was working since a long time and was Professor in Geneva), two young PhD Italian students in Geneva, Aldo Deandrea (now in Lyon) and Nicola Di Bartolomeo (that went to economy after his PhD). Part of this collaboration was also Ferruccio Feruglio, at that time postdoc in Geneva and now Professor in Padua. We worked very much on these problems till 1993. Then, due to other involvements, I had to withdraw from the collaboration that Beppe continued with the people in Geneva and in Bari. Among these, many Beppe's students, a point that I will discuss again later on. We worked again on this argument to write a review paper [1] slide] that took us from the end of 1995 to half of 1996. This review is still very popular today. Beppe continued an intense work on this subject until 2000 but he was also involved in other projects that I will now discuss.

In the summer of 2000 I was in DESY and Beppe decided to join me for one month. In that period we started a project on which Beppe has worked until his last days. The project was to study the behaviour of the elementary constituents of matter under extreme conditions (very low temperatures and very high density). This subject is of interest for the physics of neutron stars whose inner core could be made of quarks in such extreme situations. The last paper of Beppe was about these arguments, written when he was already very ill in collaboration with Abuki (a visitor of the Physics Department in Bari), Anglani a Phd student of Beppe, Gatto and Ruggieri (who got his PhD as a student of Beppe). This series of papers has obtained important recognitions at international level.

Beppe was very keen of summarizing the arguments on which he was working and, as a consequence, he has written various reviews in different subjects, as the one mentioned before about heavy mesons. When we started the large density business there were already many papers on the argument. Beppe decided to go over all the relevant literature and then to write a review, still missing at that time. This review appeared in La Rivista del Nuovo Cimento.

> EFFECTIVE DESCRIPTION OF QCD AT VERY HIGH DENSITIES

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Abstract

We describe the effective lagrangian approach to the color superconductivity. Superconductivity in color interactions is due to vacuum instability at T = 0and high densities, which arises because the formation of quark-quark pairs is energetically favored. The true vacuum is therefore populated by a condensate of Cooper pairs breaking color and baryonic number. The effective languagian follows from the Wilson's renormalization group approach and is based on the idea that at T = 0 and $\mu \rightarrow \infty$ the only relevant degrees of froadom are those near the Fermi surface. The effective description that arises if one considers only the lander arows to be 1/w consumers in sarricelarity from the transmitters. only the leading terms in the $1/\mu$ expansion is particularly simple. It is based on a lagrangian whose effective fermion fields are velocity-dependent; moreover on a lagrangtan whose effective formion fields are velocity-dependent; moreover strong interactions do not change quark velocity (Fermi refacety representation reals) and the effective lagrangian does not contain spin matrices. All these features render the effective theory similar to the Heavy Quark Effective Theory, which is the limit of Quantum ChromoDynamics for $m_Q \rightarrow \infty$. For this reason one can refer to the effective lagrangian does the Heavy Quark Effective Theory effective Theory (IBDET). In some cases HDET results in analytical though approximate, relations that are particularly simple to handle. After a pedagogical introduction, several topics are considered. They include the treatment of the Color-Flavor-Locking and the SC model, with evaluation of the gap parameters by the Nambu-Colov equations, approximate color superconductive (LOFF) phase and we give a description of the pinono field related to the breaking of the rotational and translational invariance. Finally a few astrophysical applications of color superconductivity are discussed.

Rivista del Nuovo Cimento 25N. March 2002, **Pages 1-80**

This paper has become a classic on this matter. Beppe had also the honour of being invited to write a review on some aspects of the large density systems common to particle and solid state physics, Reviews of Modern Physics, one of the most prestigious in journals in our field Very generously, he asked me to collaborate in writing this review

PHENOMENOLOGY OF HEAVY MESON CHIRAL LAGRANGIANS

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Figure from our review paper

Beppe liked also to change subject whenever he thought that nothing important could be done any more on that particular argument. Beppe, thanks to his vast knowledge of physics, was exceptionally fast in learning new. For instance, when we started to study systems at large density, he studied the physics of neutron stars. Study that he inserted in his review in La Rivista del Nuovo Cimento. This made his review self-contained and accessible to many readers. Also, when we wrote together the paper for the Reviews of Modern Physics, Beppe took the difficult task of going through the solid state literature with possible connections with our studies in the field of elementary particles.

Beppe had extremely good relations with his students. He was always proposing them problems related to his actual researches and involving them in his work. As an example, during the period 2000-2006, in which we have worked together almost at full time, 7 Beppe students were involved in our publications. Furthermore he was always proposing them new problems once finished the old ones and he worried very much for their future. In total, about 15 students finished their studies under the direction of Beppe, one of these is now full professor of chemistry, two are researchers in the CNR (National Council of Researches), two in the INFN (National Institute of Nuclear Physics), one in the INAF (National Institute of Astrophysics) and two in the University. Just to understand how much Beppe was tied to his students, when he was already seriously ill, being in a bed in the hospital in Brindisi, he was capable of reading the thesis work of two of his students!

Beppe was also a very good organizer. He had money from the Ministry of Research (MIUR) and he decided to use part of it to promote a biennial international conference, the one we are opening today, that, according to his character, was called QCD@work. These conferences were organized with great success and with many prestigious speakers from all over the world, starting in 2001 in Martina Franca, and then in 2003 [2 slides] and 2005 [1 slide] in Conversano and in 2007 [1 slide] once again in Martina Franca. This was also the last occasion in which I saw Beppe.









The thing that always struck me about him was the large variety of his cultural interests. Of course, his first love was physics, but he had also many other interests. For instance, he was very fond of classical music. I remember that, when in Geneva, he used to go to a shop in Rue de la Corraterie where it was possible to find CD's with very rare performances (unfortunately that shop moved to Lausanne). Beppe never went away with empty hands and he played the CD's on a portable CD player that he had always with him. Beppe liked reading books and newspapers both national and international. During a period spent together at CERN he used to send me by e-mail excerpts from the daily press that he found particularly interesting. Furthermore Beppe considered social commitment as a duty for a scientist. In 1982 he contributed, together with other scientists, to establish the USPID (Union of Scientists for Disarmament), an association devoted to inform the public opinion about armament control, nuclear proliferation and disarmament. Beppe has been General Secretary of the USPID during the period 1988-1995 and a member of the Pugwash, the association born in 1957 under the influence of the Einstein-Russell manifest about the risks of the thermonuclear arms. Beppe was a real expert on these subjects that he treated, very characteristically, in a real scientific way. About this point I would like to quote an article that he wrote for the Italian review "Sapere" with the title "Gulf: a difficult peace" in collaboration with Nicola Cufaro Petroni, an extremely accurate analysis of the reasons of the Gulf war in 1991 full of data and extremely accurate in all his details. Always in this field Beppe created the interdepartmental Center of Peace Researches of the Bari University (CIRP-UniBa) and a School in Politics and Technologies of Peace and Disarmament. A school that, during the years, has been followed by a few hundred students.

I would like also remember another of his many interests, precisely the one about neural networks. He started this activity with Guido Pasquariello, a CNR researcher, and with several students that did their thesis work on this subject. Neural networks have many different applications and therefore many projects originated from this activity. For instance the INFN projects about mine clearance in war areas and the pattern recognition of the tracks in the elementary particle detectors. Eventually this led to the development of a center about technologies for the pattern recognition of biomedical images called TIRES (Excellency Center on elaboration and recognition of signals). This center originated from the decision of Beppe to participate in the year 2000 to a national competition for the creation of excellency centers in Italy. Beppe's project was the only one proposed by physicists to be among the winner projects and he got money from the Ministry (MIUR) for a period of three years. Then the University of Bari decided to continue this experience creating an interdepartmental center. In this center physicians, chemists and physicists operate together for a total of about 20 people. In TIRES many PhD students and PostDocs have been involved. Furthermore TIRES has organized in Bari three international conferences about interdisciplinary aspects of physics.

Although Beppe was very taken by all of these many activities, he liked to go around the world visiting institutions and people with whom he could establish new collaborations. He was an exquisite person, very generous but also very shy about his personal problems. For instance, none among his friends, not living in Bari, knew about his illness at the beginning of it. I got this terrible news only when I called him in February 2008, a couple of months after he knew about it, with the intention of discussing physics.

To discuss with Beppe was always a big pleasure due to his intelligence and his knowledge of many different problems. I will always remember our evenings in Geneva in front of a "pizza' discussing about the Italian political situation. Other times we were speaking of physics, and then the discussions were extremely long. Sometimes we were in different localities and we spoke each other through the phone. Very often he was calling me at supper time and I still remember once we had problems on a particular calculation, whereas I was in Hamburg and Beppe at the beach. We were calling each other quite often and sometimes it happened that I would ask to Marina, his wife, to tell him to call me back as soon as he would have been back from swimming.

Beppe had a very good balance, a quality very much appreciated in his participation in various committees. He was a physicist of great value, able to pick up the important aspects of the problems and to use various technical means to solve them. He had a vast culture in physics. He shared this culture with his students writing a very nice book in two volumes about Quantum Mechanics, very useful also to teachers.

Beppe was very enthusiastic of his work and he was able to communicate his enthusiasm to his collaborators. To loose him has been a tragedy for his family for his friends and, I think for all those who knew him. He has been a great collaborator and a friend. My biggest regret is that, due to various activities I have been involved with in the recent past, I was unable to work with him in the last period of his life, namely from 2006 until June 2008 when he left us.

I wish to thank Paolo Castorina, Pietro Colangelo and Nicola Cufaro Petroni for the many informations about Beppe's activities and for the photographic material that they provided to me.