Structure and Dynamics of Elementary Matter

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PREFACE

Ladies and gentlemen,
dear colleagues,
welcome to Kemer to the NATO Advanced Study Institute

Structure and Dynamics of Elementary Matter.

We have chosen Kemer as the place of our NASI because it is located in a beautiful and hospitable surrounding. This part of the Mediterranean at the Turkish Riviera is a historic region where many cultures meet (e.g., the Oriental and the Greek and Roman European cultures) and where you find numerous places which played a role in ancient science and in early Christianity. Moreover, with the hotel Ceylan Inter-Continental we have found a most excellent meeting place, directly located at the beach, equipped with wonderful swimming pools and restaurants – an absolutely first-class location.

Our NASI will deal with the most recent developments in high-energy heavy ion physics and in the search for superheavy nuclei – two rather distinct areas of research. Indeed, we want to bring two very active communities of nuclear and high-energy physics into close contact. The meeting is both a school and has also the character of a conference: A school because there are many advanced students, many of which are themselves already top researchers and who are contributing with their own research in seminars and posters. It is also a conference because new results in the exciting and wonderful fields of low- and high-energy heavy ion physics will be presented. We are mainly focussing on the topics of superheavy elements and of hot and dense nuclear matter.

Here we investigate, how elementary matter may have been formed and what its properties were just fractions of a second after the big bang. We try to reveal how our world was formed, how baryosynthesis and nucleosynthesis may have proceeded, how ordinary or exotic stars (e.g., neutron or quark stars) are built, how supernova explosions occur, and many similar questions. It is believed that hot and/or dense elementary matter displays completely new phases, most notably the famous Quark-Gluon-Plasma predicted by Quantum Chromodynamics (QCD) which most probably is a cluster plasma where strong correlations of hadronic type survive. The most recent experimental data from RHIC

indicate that we are close to the discovery of this new phase of elementary matter. Another intriguing phenomenon are the phases of Color Superconductivity which may exist in the interior of collapsed stars. Other new forms of matter involving strangeness (strangelets, multi- Λ -hypernuclei, multiply strange exotic mesonic objects (Memos)) may be formed in nuclear collisions, as well as clusters of matter and antimatter. The extension of our periodic system into the new directions of strange matter and antimatter leads to exciting prospects. The matter-antimatter clusters, furthermore, open the door for a new form of cold compression of elementary matter. This would stand in contrast to the compression by nuclear shock waves which automatically also heats up the matter (Rankine-Hugoniot equations). We want to create dense nuclear matter and this up to now was achieved through the shock wave mechanism in its various forms. When nuclei collide at high energies they compress and heat up tremendously. On the other hand, in matter-antimatter clusters the heating should be much less (Mishustin, Satarov, ...).

Another tremendously rich and exciting field is the search for superheavy nuclei. The theoretical predictions by the Lund and Frankfurt groups now are 35 years old. Experiments at GSI (S. Hofmann, Münzenberg, and collaborators) and at Dubna (Oganessian and his group) have brought great progress. Short-living superheavy nuclei along the proton drip line were found and their α -decay has been observed. The fusion of these superheavy nuclei discovered so far occurs if the projectile and target are chosen such that they approach through a *cold valley* in the potential energy surface. In this case no push and also no 'extra push' is necessary. The fused elements are produced rather cold.

Also quasifission processes (Itkis) of various nuclear systems are seen. The theory has been better founded over the years, using, e.g., the framework of meson field theory, and new magic numbers occur. The extension of the periodic system is a challenge!

We want to bring both research communities together. It is important to understand each other, to talk to each other and to learn from each other! This is why in this NASI we have mixed the talks evenly, so that there is little possibility to escape each other.

We will have plenty of discussions, I hope, both here in the lecture hall as well as outside in the surroundings and at the beach side. The wonderful hotel Ceylan will provide an ideal setting for our conference and we will spend nearly two weeks in a most agreeable confinement.

As it turned out, we had far too many applications, many of which had to be turned down, and also the number of accepted participants lies somewhat above the normal quota for a NATO Advanced Studies Institute. Not surprisingly, quite a number of spouses and companions have joined their husbands and friends.

Let me finally make a number of remarks concerning the organization of the meeting.

The idea for such a NASI down here in Turkey has been suggested to me by A. V. Ramayya (Vanderbilt University) and I took it up with pleasure. My colleagues and friends Dr. Joachim Reinhardt from Goethe University, Frankfurt, and Prof. Çem Güçlü from Istanbul Technical University were helping tremendously in the organization. I thank them cordially. NATO's scientific program has been very generous in providing the main support for this school, deserving our warmest thanks. The German Ministry for Science (BMBF), in particular Dr. D. Müller, and the Gesellschaft für Schwerionenforschung (GSI, Prof. Walter Henning) have also been very helpful with their support. The same is true for the Institut National de Physique Nucléaires et de Physique Particules (IN2P3), for Vanderbilt University, Nashville TN (Prof. J. Hamilton) and for the Turkish Atomic Energy Agency, Ankara. All of them deserve our "thank you" for their support, without which this meeting could not take place in this form. Travel support for students was granted by the Scientific and Technical Research Council of Turkey (Tübitak) and by the National Science Foundation, Washington.

Special acknowledgments go once more to Dr. Joachim Reinhardt who keeps contact with all the speakers and will be organizing most of the editorial work for the Proceedings volume.

The next eleven days will be time filled with hard work, but I am confident that it will also be a fruitful, memorable, and enjoyable period.

I wish us all a very pleasant, interesting and successful NASI. Let us get to work now!

Walter Greiner

NATO ADVANCED STUDIES INSTITUTE
"Structure and Dynamics of Elementary Matter"

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