

The surface of a crystal, apart from acting as a defect for phase transitions of the bulk, is also the site for interesting two-dimensional phase-transition-like phenomena including order-disorder transitions (melting) of adsorbate films, surface segregation and related ordering effects, reconstruction of semiconductor surfaces, surface magnetism, etc. Two combined sessions of the Phase Transitions Symposium and the Surface Physics Symposium, with a number of invited talks, will be devoted to this important topic.

New and exciting developments are taking place in the area of phase-transition-like phenomena in systems far from thermo-dynamic equilibrium. La-

asers, hydrodynamic flows, current flows in semiconductors, chemical reactions, all exhibit instabilities with bifurcation into new phases of broken symmetry. Breaking of time translation symmetry leads to dynamical structures such as oscillatory states or solitary travelling-wave states. A highly important discovery is the possibility of bifurcation into strongly non-periodic states with pseudo-ergodic properties, which is expected to lead to an improved understanding of turbulence. Some aspects of this area will be reviewed in two invited lectures on hydrodynamic instabilities.

*H. Thomas*

## **Symposium C 2: Hot Plasma in Space and Laboratory**

The physics of hot plasma has been growing at an appreciable rate during the last decades, due to the challenge of both its possible application in energy generation through thermonuclear fusion and the role it plays in space and astrophysics. It is a consequence of this growth that specialization has become considerable. Even for a plasma physicist it becomes increasingly difficult to keep up with the rapid development in the different fields, and there are not many opportunities to overcome the barriers of specialization. The Symposium on Hot Plasma in Space and Laboratory has been conceived to offer just such an opportunity. It is intended to give an overview, accessible also to non-specialists, over a number of selected topics in which relevant progress has been made during the past years. At the same time, an attempt will be made to characterize and display the place plasma physics has in the frame of physics as a whole: plasma physics is concerned with the description of the behaviour of a large number of charged particles interacting with each other. The great richness in phenomena appearing in plasmas and at the same time the difficulties and the appeal of the discipline are directly due to this fact.

Taking this viewpoint, it is evident that putting the accent of the Symposium on collective phenomena in hot plasmas is rather a way of presentation than a selection criterion. As far as laboratory plasmas are concerned, some aspects of three very different types of plasma of thermonuclear interest will be examined, namely: ma-

gnetically confined toroidal plasmas; plasmas generated by intense laser light beams impinging on matter; plasmas produced in a magnetic field by relativistic electron beams. These three topics offer an opportunity to show how important collective effects are, both in plasma formation and heating, and in imposing limitations on the existence of certain plasma states, due to the appearance of gross instabilities or to transport induced by turbulence. In many cases heating and transport phenomena can, in fact, be visualized as a consequence of plasma particles interacting with wave fields which are self-consistently generated in the plasma. Effects of this same kind are also responsible for most of the energy transfer phenomena appearing in astrophysical plasmas, and some examples of this kind will be discussed at the Symposium too. On the other hand, it is gross instability and again turbulence-induced transport effects determining essential limitations on plasma confinement, which impose important constraints on the way to utilizing plasmas in energy production by fusion of light nuclei.

Somewhat apart from these questions, examples of recent important developments in plasma diagnostics will be presented at the Symposium. Here again, the leitmotiv of the Symposium becomes apparent as plasma diagnostics is largely concerned with making evident, collective phenomena.

*F. Engelmann*

## **Symposium C 1:**

For the purpose of this short introduction to the C1 Symposium, Nuclear Astrophysics may be defined as that peculiar marriage of physics and astronomy which seeks to explain how, why, when, where and in what quantity the elements and their isotopes were produced and are being produced today. These may seem to be extraordinarily ambitious questions for such a young science to answer and, in all their details, they are. However, today we do have a firm basis of observational evidence supplied by the solar system, cosmic rays, gas clouds, stars and distant galaxies; experimental data obtained from laboratories across the world concerning reaction cross sections and the like; and the theoretical knowledge (sometimes) to put it all together in a coherent form so that we do have some confidence in the general picture that is emerging and which we hope to see coloured-in more during our symposium.

Some of the most profound statements modern science makes about the Universe are embodied in the words "Hot Big Bang". The success of the simplest cosmological model of the Hot Big Bang, based on the observed highly isotropic 2.9K microwave background radiation and the density of visible matter in the Universe, in accounting for the observed overall level of the hydrogen and helium abundance and of their isotopes, is remarkable and is widely

## **Symposium D:**

The investigation of interactions between heavy particles i.e. atoms and complex nuclei is an exciting field of physics that has been steadily growing during the past few years. A wide range of new physical phenomena and submicroscopic behaviour has been discovered. It is the goal of this Symposium to present in a selection of review talks first results on nuclear, atomic and solid state physics.

Many projects have burgeoned in European laboratories that operate tandem Van de Graaff accelerators, the first accelerators for heavy ions. One of the leading heavy ion laboratories has been established at the Joint Institute for Nuclear Research at Dubna, from where a large number of

## Nuclear Astrophysics

held to be strong evidence in its favour, especially in view of the predicted deuterium abundance. The results are so important that we devote some time in our symposium to looking deeper into the simple picture and ask what it is that determines, in the very early stages of the Universe, the values of the baryon number, the lepton numbers and the temperature, and to what extent the simple picture may be altered, yet still retain the essential features of the nucleosynthesis era.

Paradoxically, because there is only one Universe and despite the central position of the Hot Big Bang picture, we also look seriously at alternative models of the Universe which seek to explain the origin of the light elements etc. in other ways. For example there is some current interest in cold or tepid universes in which neutrino degeneracy, black holes and super-massive stars all play a role. There are also indications today that there is a lot of matter in the Universe that is only visible in the X-ray region. This might upset the simple Hot Big Bang picture and it could be that the Universe is playing cat and mouse with us in our attempts to explain it — but that only makes the game more exciting.

*A. Edwards*

## Heavy Ion Physics

important contributions to the investigation of transuranium elements have come as well as fundamental results in nuclear and atomic reaction studies.

At present much activity is under way at the new heavy ion accelerator UNILAC of the GSI near Darmstadt which has been in operation since early 1976. New facilities in Europe will be in operation in the near future, such as the GANIL project near Caen (France), the VICKSI project at Berlin, and the 30 MV tandem Van de Graaff accelerator at the Daresbury Laboratory in England. A review of the present state of these facilities and their comparison will be given at the Conference.

The production of elements beyond

uranium is one of the most interesting aims in the whole field because its study should reveal the criteria of nuclear stability and the construction principles of nuclei. Unfortunately, progress so far has been slow and the nuclear physics community has been trying hard to find new ways to reach this goal. The nuclear reaction mechanisms ruling the interactions of complex nuclei have to be studied and proved at already known nuclei which are presently very thoroughly investigated to find a feasible way for the production of superheavy elements. In particular, the behaviour of nuclei with high angular momenta and the Coulomb interactions are being studied extensively.

Heavy ion atomic physics is very closely related to the fundamental test of quantum electro-dynamics of very strong fields. Those fields can be produced in the interpenetration of heavy-particle atomic-shell systems giving rise to the formation of an atomic shell system of the combined atom  $Z_1 + Z_2$ . During the collision,

vacancies in the strong bound K-shells can be produced which dive into the negative energy continuum. There the spontaneous production of positrons has been observed. Furthermore, X-ray transitions of these so-called quasi-molecules have already been observed which belong to the united atom. During these interactions also, atomic systems of superheavy atoms can be formed. The transitions in such a system reveal features of superheavy elements and their atomic properties. The well-known Coulomb interaction allows also the development of theoretical models and thus predictions which could be tested experimentally. However, a great number of detailed problems also have to be solved before a consistent picture can be drawn. A number of reviews will be devoted to these problems.

The implantation of heavy particles into solid material opens new aspects of applied physics and technology.

*K. Bethge*

## Symposium E 2: Quarks

The notion of "Quarks" dominates today the field of High Energy and Particle Physics. Under the impulse of the very simple idea (Gell-Mann and Zweig, 1964) that hadrons are made out of much smaller constituents, high energy physics has explored vast new domains which have disclosed very fascinating structures.

This Symposium intends to focus on those areas of High Energy physics where the quark idea has found its most fruitful applications and has led to in-depth experimentation. Today we know a vast number of particles with different charges, spins and parities and all can be classified according to the idea that they are constituted from a quark-antiquark pair (mesons) and three quarks (baryons). The recent discovery of the J/psi has only strengthened our belief in the relevance of quarks, for it has become clear that their spectrum too could be understood according to the simple quark model.

Another very important area, where quarks play a central role is the field of high energy neutrino and electron scattering on a nuclear target. The results of many different experiments can be explained by thinking of hadronic matter as made out of a number of pointlike constituents: the par-

tons (Feynman 1969), which scatter electromagnetic and weak probes in a way similar to the well known leptons (electrons and muons). What is amazing is that partons and quarks seem to show a great deal of properties.

This fact, however, brings us to a very critical situation. If matter is made out of such simple objects, we should be able to see them under appropriate experimental conditions (i.e. in deep inelastic or high  $p_T$  scattering). But so far the hadronic constituents have eluded the most ingenious and tenacious searches. It is this paradoxical situation that has induced many theorists to think that quarks are basically "confined", and has encouraged a great deal of theoretical effort on the quark-"confinement" problem, which is the really central problem of modern high energy theoretical physics.

The Symposium on Quarks will deal with all these problems, in order to make the point about the status of our understanding of this puzzling and fascinating idea.

*G. Preparata*