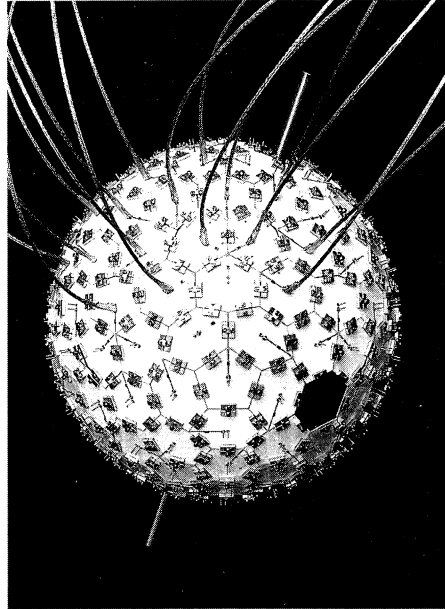
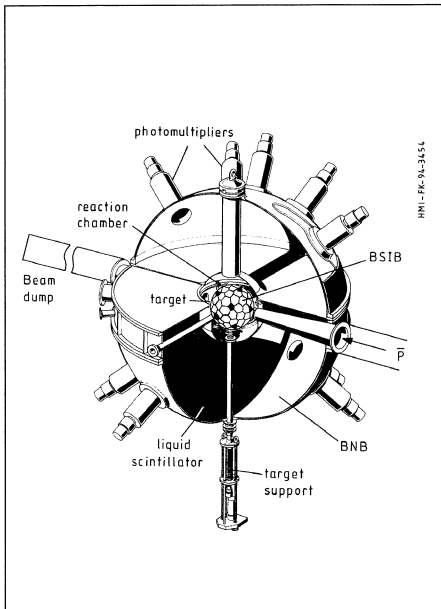


Full solid angle detectors for the PS208 experiment at CERN's LEAR low energy antiproton ring - neutron ball (BNB) with silicon ball (BSIB).

Close-up of the PS208 silicon ball, composed of 158 pentagons and hexagons.



This can be accomplished by the annihilation of an antiproton with one nucleon in a nucleus, resulting in about five pions. Antiprotons at low energies annihilate outside the surface - in the nuclear 'stratosphere'. Thus only a small fraction of the produced pions can be absorbed by the nucleus. At high antiproton energies of about 1 GeV the annihilation site is much closer to or even inside the nuclear surface (an 'underground' explosion) with absorption of several pions and production of very hot nuclei with excitation energies of up to 1 GeV. This method of antiprotonic heating is exploited at CERN's LEAR low energy antiproton ring by the PS208 collaboration: HMI-Berlin, GANIL-Caen, TU-Munich, Warsaw, FZ-Rosendorf, IPN-Orsay, IPN-Moscow, and CERN.

Studying the properties of these hot nuclei needs measurement of all nuclear decay products such as neutrons, protons, alphas and heavier particles up to fission fragments. This is done with two full solid angle detectors: the Berlin Neutron Ball

(BNB) and the Berlin Silicon Ball (BSIB) installed at LEAR.

The neutron ball is a spherical shell with an outer diameter 160 cm, filled with a liquid scintillator doped with gadolinium. This scintillator counts all emitted neutrons by registering the capture gamma-rays of delayed neutrons. Inside the shell 158 silicon detectors are arranged on the inside of a 20 cm diameter sphere. The silicon ball measures the energy, particle species and angular correlations of all charged nuclear particles.

The decay of hot nuclei with antiprotons is studied up to the maximum LEAR energy of 1.25 GeV. Initial results show the expected highly efficient antiprotonic heating of nuclei. Ongoing analysis will reveal decay characteristics near the critical point of the nuclear liquid-gas phase instability.

DESY Theory Workshop 1994

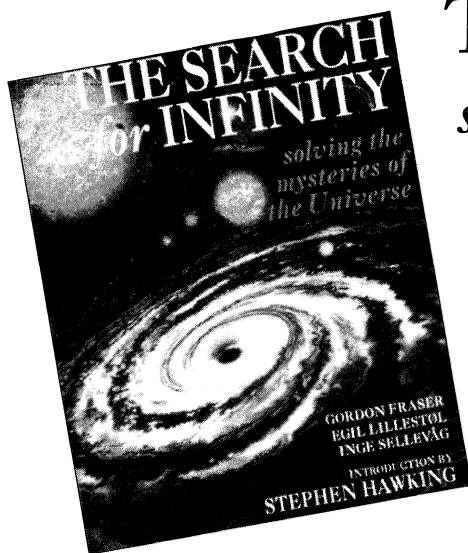
For 1994, the traditional annual DESY Theory Workshop was devoted to supersymmetry. This is a novel symmetry relating bosons (normally force-carrying particles) and fermions (which normally feel the forces).

In supersymmetry, bosons could have fermion counterparts, and vice versa.

Although this subject is still largely a theorist's playground, many of the particles and phenomena predicted by models of low energy supersymmetry now seem within reach of present and planned future accelerator experiments, and this was one of the main reasons for choosing a more speculative theme after more phenomenological orientations in recent DESY Theory Workshops.

After the welcome by DESY Director General Bjorn Wiik, attention was immediately focused on experimental aspects. P. Steffen (DESY) presented the latest results from HERA. In the following talks, K. Honscheid (Ohio), S. Lammel (Fermilab) and S. Komamiya (CERN and Tokyo) reviewed the experimental situation at electron-proton, hadron and electron-positron colliders, respectively. They discussed the most recent limits for supersymmetric particles (still none in sight!), as well as precision experiments where deviations from the standard model might show up.

The workshop was treated to a first rate introduction to the MSSM ("minimal supersymmetric standard model") by F. Zwirner (CERN), who clearly explained the motivation for going supersymmetric and reviewed the basic structure of the MSSM, its

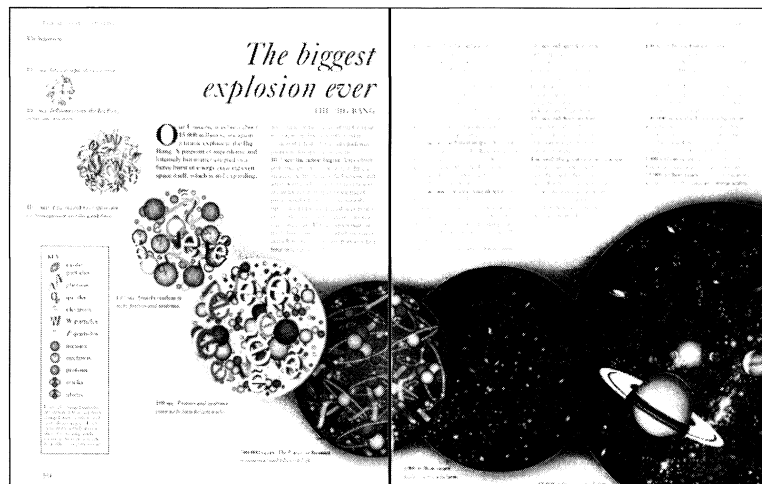


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DESY Director Bjorn Wiik (left) with supersymmetry pioneer Julius Wess at the traditional annual DESY Theory Workshop, which for 1994 was devoted to supersymmetry.

particle content and couplings, as well as the soft breaking terms necessary to avoid immediate conflict with experiment.

This was followed by a systematic discussion of the Higgs sector by H. Haber (Santa Cruz), where the first hints of new physics could appear. However, he also made clear that it may not be easy to distinguish standard and non-standard Higgs bosons. Symmetries beyond the standard model, and in particular supersymmetric grand unification were treated in detail by G. Ross (Oxford) and S. Raby (Ohio), who capitalized on the recent precision data from CERN showing that coupling constant unification is compatible with supersymmetric grand unification (the original non-supersymmetric unification already having been ruled out). They also discussed more specific predictions of these models for gauge couplings and fermion masses.

The second day started with discussions of "non-standard supersymmetric standard models" by U. Ellwanger (Orsay) and R-parity violating models by J. Bagger (Baltimore). R-parity distinguishes, roughly speaking, known particles from their (as yet unseen) superpartners. Conservation of R-parity means that SUSY particles can only be pair-produced, hence the lightest supersymmetric particle ("LSP") is stable.

These talks emphasized that, although the MSSM is the simplest realization of supersymmetry in the standard model, many other possibilities remain. Especially for models where R-parity is broken, the relevant experimental signatures might be very different from the missing energy signals commonly assumed to be the most direct experimental manifestation of low energy supersymmetry. Experimentalists were



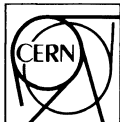
thus advised to keep an open mind for new and unconventional models while looking for supersymmetry. Next, A. Masiero (Padova) showed the way beyond terrestrial experiments in his overview of supersymmetric astroparticle physics, stressing that supersymmetry provides plenty of candidates for the invisible 'dark matter' of cosmology, independently of whether one prefers the hot or the cold dark matter scenario.

After this excursion into outer space, P. West (London) brought the audience back down to earth in his review of non-renormalization theorems (i.e. the most general statements about cancellation of divergences between boson and fermion loops in supersymmetric theories), reminding everyone that these still provide the main motivation for introducing supersymmetry, offering a possible resolution to the hierarchy problem (explaining "unnaturally" large ratios such as that between top and up quark masses). Finally, the status of and the difficulties with supersymmetry breaking were

reviewed by H.P. Nilles (Munich); despite a number of proposed breaking mechanisms (spontaneous, "soft", "stringy", or by gravitino condensates), no satisfactory solution of this important problem has yet been found.

More theoretical aspects of supersymmetry were discussed on the last day, when attention turned to 'superstrings' - supersymmetric versions of a theory of one-dimensional extended objects, the "strings". In a spirited review of superstring unification, L. Ibanez (Madrid) reviewed the state of the art in superstring model building, a more demanding task than the construction of "superstring inspired" field theory models that were once fashionable.

The replacement of point particles by strings as fundamental entities is believed to be necessary in order to cure the ultraviolet divergences of perturbative quantum gravity. He especially mentioned new possibilities for constructing 'stringy' grand unified theories (necessitating the use of higher level representations of



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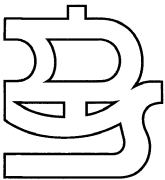
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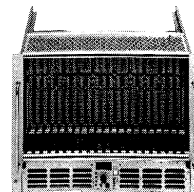
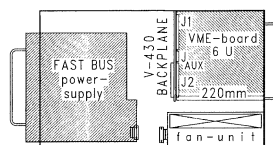
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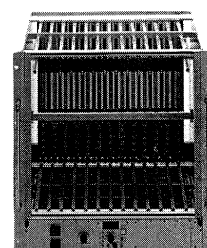
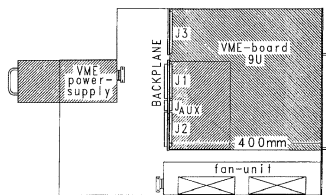
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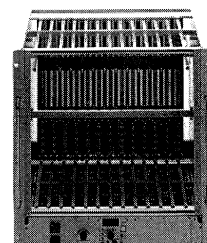
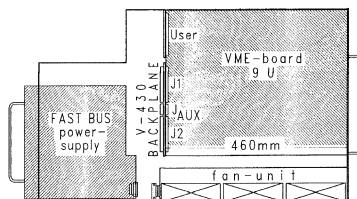


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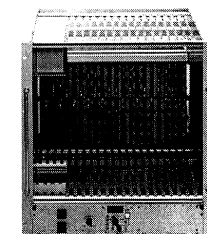
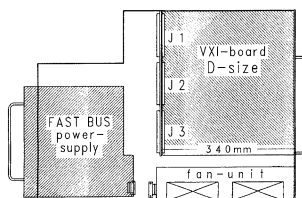
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Kac Moody algebras). J. Louis (Munich) presented the latest results on how to compute gauge couplings from superstring theory (using such advanced mathematical tools as the theory of modular forms) as well as new non-perturbative mechanisms of supersymmetry breaking. While superstring theory has greatly added to our understanding of perturbative quantum gravity, key questions of a conceptual nature remain unresolved (or are not even asked by many superstring practitioners).

These issues were addressed by E. Verlinde (CERN), who proposed to use black holes as a "probe" to investigate the fate of space and time in a superstring theory of quantum gravity. He also turned attention to the question of what the fundamental gauge symmetry of superstring theory might be, citing recent progress on "duality symmetries". In the final talk and in lieu of a conference summary, supersymmetry pioneer J. Wess (Munich) opened new horizons beyond supersymmetry, introducing the notion of "quantum space". These have coordinates which are not ordinary commuting (nor anti-commuting) numbers, but more abstract mathematical entities called "q-numbers".

The workshop showed that there is still quite a way to go until we know which is the correct (supersymmetric?) model of particle physics. Nonetheless, even after 20 years of supersymmetry, theorists (and many experimentalists!) remain enthusiastic and convinced that supersymmetry is too beautiful a concept not to be used by Nature.

H. Nicolai

Books received

The CERN Courier has received an impressive consignment of new books from World Scientific Publishing, and hopes to include reviews in coming months.

Lectures in Particle Physics by Dan Green of Fermilab (ISBN 9810216823 HC £63, 9810216831 SC £35), imaginatively presented, *World Scientific Lecture Notes - Vol.55*;

Instantons in Gauge Theories, edited by M. Shifman (ISBN 9810216815 HC £62, 9810218265 SC £35), a collection of reprinted papers;

Development of Perturbative QCD by Guido Altarelli of CERN (ISBN 9810217021 HC £58, 981021703X SC £35), a collection of review articles, talks, and lecture notes;

Salam Festschrift edited by A. Ali, J. Ellis and S. Randjbar-Daemi (ISBN 9810214219 HC £80, 9810214227 SC £39), talks from a conference to honour Abdus Salam, held at ICTP, Trieste, in March 1993, and Volume 4 in *World Scientific's Series in 20th Century Physics*;

Selected Papers of Abdus Salam (with commentary), edited by A. Ali, C. Isham, T. Kibble and Riazuddin (ISBN 9810216629 HC £64, 9810216637 SC £31), a fine volume for Salam admirers, Volume 5 in *World Scientific's Series in 20th Century Physics*;

B decays (Revised, 2nd edition) edited by Sheldon Stone of Syracuse (ISBN 9810218362 HC £64,

9810218974 SC £25), a collection of contributions;

A Career in Theoretical Physics by Philip W. Anderson (ISBN 981021717X HC £58, 9810217188 SC £28), a collection of articles and papers, Volume 7 in *World Scientific's Series in 20th Century Physics*;

Knots and Physics (2nd edition) by Louis H. Kauffman of Illinois, Chicago (ISBN 9810218564 HC £64, 9810216580 SC £40), fascinating.