

Spin time in Italy

The SPIN 2004 symposium in Trieste provided a showcase for the latest developments in this key area of particle and nuclear physics.



Participants relax around a table at the conference banquet at SPIN 2004, which was held in Trieste, Italy.

Spin is a key element in particle and nuclear physics, and has always played a paramount role in the study of fundamental symmetries, static-particle properties and the structure of fundamental interactions. Moreover, during the past 15 years, spin physics has enjoyed a true renaissance, with many enthusiastic young people – both theoreticians and experimentalists – entering the field, attracted by new ideas and experimental opportunities.

Last year, around 300 physicists attended the 16th International Spin Physics Symposium, SPIN 2004, which was held on 10–16 October in Trieste, Italy. The event was organized by the Trieste section of the Istituto Nazionale di Fisica Nucleare (INFN) and was hosted by the Abdus Salam International Centre for Theoretical Physics (ICTP) on the beautiful Miramare campus. The symposium also benefited from the support and infrastructure of the nearby International School for Advanced Studies (SISSA).

Participation at SPIN 2004 was highly diverse, with 29 different countries represented. A unique feature was the large contingent from developing countries, made possible thanks to logistic support from the ICTP and sponsorship from the International Union of Pure and Applied Physics. Additional support from the Central European Initiative allowed significant participation from the initiative's 17 member countries. The symposium was also sponsored

by the International Spin Physics Committee, the town of Trieste, the Friuli-Venezia Giulia region and a few other local institutions.

SPIN 2004 was structured with plenary and parallel sessions, but no poster session. Instead, more than 160 presentations were accommodated in short communications in the parallel sessions, allowing everybody, in particular the young participants, the opportunity to stand up and present their work. The 20 plenary talks, half of which were given by excellent young physicists, were followed by interesting discussions. In addition, four rapporteurs were asked to give plenary talks to summarize the contributions of corresponding parallel sessions. The plenary sessions included short reports on the specialized workshops supported by the International Committee that had taken place during the previous two years: "SPIN 2003" in Dubna, "Polarized Sources and Targets" in Novosibirsk, "Symmetries and Spin" in Prague, "Polarized Solid Target Materials and Targets" in Bad Honnef, and "Polarized Electron Sources and Polarimeters (PESP 2004)" in Mainz. Following tradition, this last workshop took place the week before SPIN 2004.

It is impossible to summarize in a few pages the large amount of information presented in Trieste. In the following, we give some highlights that are bound to reflect our personal bias. However, all the talks have immediately been put on the web and are accessible to ▷



Abhay Deshpande of Stony Brook talked on future facilities and also gave a tribute to Abdus Salam, who founded the ICTP in Trieste – the host institution for SPIN 2004.

everybody until the time when proceedings become available.

Two of the parallel sessions were dedicated to technical developments in the fields of polarized sources, polarized targets, polarized beams and polarimetry – the essential tools of spin physics. In the session on “Polarized Sources, Targets, and Polarimetry”, summarized in the last plenary session by Thomas Wise from Wisconsin, contributions described all of the ongoing activities in the field: polarized electron sources; various aspects of thermal velocity atomic H and D sources, used either as jets or to feed storage cells; new ion sources; polarimetry for a ^3He gas target; and solid targets.

Further impressive work was presented in the session on “Acceleration, Storage and Polarimetry of Polarized Beams”. In this plenary talk, William McKay from Brookhaven illustrated the enormous progress made there with the Relativistic Heavy-Ion Collider (RHIC). Thanks to the insertion of a partial Siberian snake in the Alternating Gradient Synchrotron, polarization at extraction is now 50% and can be preserved during acceleration in RHIC at 40% (compared with 27% last year). After changing the betatron-tune working point, average luminosity is now $4 \times 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$ at $\sqrt{s} = 200 \text{ GeV}$. The presentations in this parallel session spelled out the activity at various existing accelerators (AGS, RHIC, COSY, Nuclotron and BATES), as well as the plans for future facilities (JPARC, FAIR, eRHIC), all of which were skilfully summarized by Andreas Lehrach of Jülich. Importantly, a polarized-hydrogen jet target has been installed at Brookhaven and, during the course of 2004, was successfully used to calibrate the polarization of the RHIC proton beam.

Spin physics began in 1921 with the pioneering work of Otto Stern, who discovered the spin of the electron and showed that it has a gyromagnetic ratio, g_e , of about 2. Since then, the study of dipole moments of elementary particles has provided a wealth of information about subatomic physics, and the measurement of the electron and muon anomaly $a = (g-2)/2$ has reached impressive sensitivities. Lee Roberts of Boston described Brookhaven’s $g-2$ experiment, which yields a final result of $a_\mu = 11\,659\,208(6) \times 10^{-10} (\pm 0.5 \text{ ppm})$. This is 2.7 standard deviations from the Standard Model value and is a possible indication for new physics (*CERN Courier* November 2004 p6).

In an equally impressive talk, Klaus Jungmann of KVI Goningen reviewed current searches for permanent electric dipole moments, which could also provide an excellent sign of new physics. In this context, Emlyn Hughes of Caltech reported on the past, present and future measurements of parity violation in electron scattering as a means of making precision measurements of the weak mixing angle, θ_w , far from the Z mass, and possibly detecting signals of new physics. Preliminary results from the full data sample of the E158 experiment at SLAC were given out to attendees for the first time as $\sin^2\theta_w = 0.2330 \pm 0.0011 (\text{stat}) \pm 0.0010 (\text{syst})$, a result that pushes any new four-fermion interaction to a scale of $\Lambda_{\text{LL}} \sim 10 \text{ TeV}$ (95% confidence level). In addition to these three plenary talks, contributions were presented in the parallel sessions on “Spin and Fundamental Symmetries” and “Spin Beyond the Standard Model”. These spanned topics from “Graviton Exchange Effects at High-Energy Colliders” to “New Approaches to Unify Spin and Charge”, which were well summarized by Oleg Teryaev from Dubna at the end of the symposium.

The quantum chromodynamics (QCD) spin structure of the nucleon was a central issue at the symposium. Plenary talks and parallel sessions covered the present understanding, experimental status, recent developments and future perspectives of the field. In the opening talk of the symposium, Andreas Metz of Bochum gave a comprehensive review of the present knowledge of quark and gluon helicity distributions, generalized parton distributions (GPDs), single-spin asymmetries and transverse-spin effects. In his plenary talk, Vincenzo Barone of Piemonte Orientale discussed transversity and stressed the differences between transversity and helicity distributions, the difficulties related to the measurement of transversity and the importance of intrinsic quark momentum-dependent distributions.

There was a wealth of new results from the major experiments presented in the plenary talks of Delia Hasch from Frascati (talking on HERMES at DESY), Andrea Bressan from Trieste (COMPASS at CERN), Naohito Saito from Kyoto (experiments at RHIC) and Michel Garçon from SPhN-Saclay (experiments at the Jefferson Laboratory), and also in many other parallel sessions, of which we cite only a few.

There is now high-precision data on the structure function g_1 at small x for the deuteron (from COMPASS) and at large x for the proton and neutron (from CLAS at the Jefferson Laboratory). The first measurements of the Sivers and Collins asymmetries have been made on transversely polarized protons, by HERMES, and on deuterons, by COMPASS. Both HERMES and experiments at the Jefferson Laboratory have results (and projections) for deeply virtual Compton-scattering measurements. There are measurements of the gluon polarization $\Delta G/G$ from high p_T hadron pairs (COMPASS) and A_{LL} for π^0 production (the PHOENIX experiment at RHIC). Experiments at RHIC have also made measurements of the cross-section for prompt photon and π^0 production, as well as precision measurements of A_N for proton–proton and proton–carbon elastic-scattering in the Coulomb–nuclear interference region. In a nutshell, the latest results indicate that $\Delta G/G$ seems to be small, hinting at a larger angular momentum contribution to the nucleon helicity; transversity signals definitely seem to be there. Needless to say, it was not an easy job for Gerhard Mallot of CERN to summarize in his rapporteur talk 16 hours of parallel sessions

with highly compressed contributions.

The bridge to hadronic physics was represented by the session on "Soft Spin Physics with Photons and Leptons". Plenary talks here were dedicated to the Gerasimov–Drell–Hearn (GDH) sum rule, to nucleon form factors and to other activity at Jefferson Laboratory in "soft physics". As Hans Arends of Mainz explained, with the recent data from the MAMI machine at Mainz and ELSA in Bonn, the GDH sum rule is now verified at the 10% level for the proton, while the situation for the neutron is not clear and more theoretical work is needed.

The hot issue of the discrepancy between results of G_E^p/G_M^p with the Rosenbluth techniques and with polarization transfer was discussed by Kees de Jager of Jefferson Laboratory. This now seems to be understood, thanks to recent advances in the calculations of the two-photon exchange contributions. The subjects of the third plenary talk of this session, by Raffaella de Vita of Genoa, were the high-precision measurements of g_1 and g_2 at low Q^2 , and the study of polarization observables in exclusive and semi-inclusive meson production.

The SPIN 2004 symposium also covered most recent developments in spin physics at intermediate energies and in nuclear physics. Jean-Marc Richard of ISN Grenoble gave a particularly lively talk in which he revisited hadron spectroscopy, summarizing and discussing the dramatic revival of the field that has occurred over the past few months. Barbara von Przewoski of Indiana reviewed the nucleon–nucleon scattering experiments in hadron storage rings with a polarized beam and a polarized internal target at the Indiana Cooler and at COSY in Jülich, and described their impact on phase-shift analysis, meson-exchange models, chiral-perturbation theory and the role of the three-nucleon forces (3NF).

Many other data from ITEP, Protvino and other laboratories were discussed in the parallel session on "Spin in Soft Hadronic Reactions". Kichiji Hatanaka of Osaka reported on the high-precision systematic work that is ongoing at lower energies to establish the theory of the modification of the NN interaction in a medium and, in general, to find evidence for the 3NF in nuclear matter. He also reviewed the contributions presented in the parallel session dedicated to "Spin Physics in Nuclear Interactions".

The symposium could not end without looking to the future. In the last plenary session, Abhay Deshpande of Stony Brook illustrated the physics potential and the machine concept of the eRHIC project at Brookhaven – an electron–proton/nuclei collider that could be operational 10 years from now – as well as the alternative ELIC project at Jefferson Laboratory. Frank Rathmann of Jülich described the polarized antiproton facility at GSI, focusing particularly on the new ideas of measuring transversity in polarized antiproton–proton Drell–Yan processes. With a completely different scenario, and on a much longer timescale, Stefano Forte of Milan communicated to the audience his enthusiasm for the huge physics potential of a future neutrino factory.

During the symposium, tributes were paid to two distinguished members of the International Committee who have passed away since SPIN 2002: Vernon Hughes and Lev Soloviev. Both Myriam Hughes and Tatiana Solovieva attended the symposium and accepted the friendship and gratitude of many of their husbands' colleagues.

• The 17th International Spin Physics Symposium will be held in Kyoto in September 2006.



The future measurement of transversity at the FAIR facility at GSI was a hot matter of discussion, in particular between Raimondo Bertini (left) and Mauro Anselmino of INFN Torino.

Further reading

Proceedings from SPIN 2004 will be published by World Scientific, Singapore, and will include the PESP2004 contributions. See the SPIN 2004 Web page: www.ts.infn.it/events/SPIN2004.

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