Participant Number 1 : INFN-LNF Laboratori Nazionali di Frascati

SCIENTIFIC STAFF

Giulia Pancheri, J. Lee-Franzini, S. Bellucci, G. Isidori, G.o Colangelo - 48 pm/y - LNF; E. Franco, P. Franzini, L. Maiani, A. Pugliese - Rome1 (5pm/y); R. Petronzio - Rome2 (3pm/y); M. Greco, V. Lubicz (12 pm/year) - Rome3 ; G. D'Ambrosio, J. Portoles (24 pm/year) - Naples ; W. Alberico, A. Molinari - Torino (4 pm/y); P. Gensini, O. Panella, Y. Srivastava -Perugia (24 pm/y); L. Trentadue - Parma (3 pm/y); G. Montagna, O.e Nicrosini and F. Piccinini - Pavia(3 pm/y) Tot. 126 pm/y

ROLE OF THE TEAM

The INFN team will provide the overall coordination of the network activity, linking together various expertises and monitoring progress between theory and experimental data. It will be the leading team for 2 crucial areas for DAΦNE physics, CP violation and CPT symmetries in the $K\bar{K}$ system, and higher order QED processes. It will collaborate with other teams on rare Kaon decays and other light pseudoscalar meson decays, and on hypernuclear physics issues.

RESEARCH LINKS

There exist working collaborations between this team and teams from Barcelona, Bern, Wien, Orsay and Helsinki. Collaboration is planned with DESY-Zeuthen teams.

CP AND CPT

CP and CPT have been explored in depth by the theoretical group from University of Rome, up through the recent next-to-leading estimates of the ratio ϵ'/ϵ, as well as studies of the time evolution of the C-odd $K^0\bar{K}^0$ system and implications for CP violation, T and CPT symmetries. Due to its recognized leadership of this group and close interaction with the EURODAPHNE Collaboration (through a number of joint publications and two *DAΦNE Handbooks*), this group, which includes the spokesman and the analysis coordinator of the "K-zero Long Experiment "(KLOE) at DAΦNE, has the fundamental **task** of extracting the CP violating parameters and CPT symmetry observation.

QED RADIATIVE CORRECTIONS

The second **task** of the INFN team concerns high precision QED calculations, for luminosity monitoring, detector calibration and tagged studies for $\gamma\gamma$ physics. The INFN Frascati group has a long standing reputation in QED radiative corrections and, together with the Pavia and Parma groups, the **task** will be to produce reliable higher order corrections to the processes of interest with the required one per mille precision. Collaboration with Paris (for QED calibration processes) will be continued, and with Zeuthen groups (for high precision measurements of $e^+e^- \to hadrons$) is planned.

CHIRAL PERTURBATION THEORY

The INFN team will also contribute to studies in ChPT theory, where the Naples and Frascati group have a well recognized competence, acquired through fruitful collaboration with the Vienna and Bern group during the last 5 years. In particular, **tasks** to which the Frascati and Naples group can contribute are : $\pi\pi$ scattering; Quenched ChPT; radiative η decays; isospin violations in non–leptonic decays; rare kaon decays and estimate of the $O(p^4)$ low–energy constants of the nonleptonic lagrangian; calculation of the scalar and vector pion form factors to two loops; pion and nucleon polarizabilities ; $\overline{K}N$ interactions.

HYPERNUCLEI

This team also includes hypernuclear physics experts, who will join the newly established task force on Hypernuclei.

RECENT RELEVANT PUBLICATIONS

1. M. Lusignoli, L. Maiani, G. Martinelli and L. Reina, *Mixing and CP Violation in K and B-mesons, a Lattice QCD Point of View* Nucl. Phys. B369 (1992) 139.
2. *The Second DAΦNE Physics Handbook*, **Edited by L. Maiani, G. Pancheri and N. Paver**, ISBN 88-86409-02-8. Frascati Publications 1995. And references therein.

Participant Number 2 : UKRAL Rutherford Appleton Laboratory

SCIENTIFIC STAFF

Frank Close (12 m/year) RAL, D Morgan (1 m/year) RAL , R Dalitz (12 m/year) Oxford, A Donnachie (12 m/year) Manchester, M R Pennington (6 m/year) M Boglione (6 m/y) P Watson (6 m/y) Durham, G. J. Gounaris, J.E. Paschalis, N.D. Vlachos, University of Thessaloniki (9 pm/y) Tot. 64 pm/y

ROLE OF THE TEAM

This will be the core team for spectroscopy and will provide the theoretical background to the DAΦNE program.The UK team will investigate low energy hadronic interactions in three key areas of DAΦNE physics, i.e. spectroscopy up to 2 GeV, dynamics of $\pi\pi$ scattering at threshold , and hypernuclear structure, in which subject it will provide the theoretical background to the DAΦNE program.

RESEARCH LINKS

The research will be collaborative between RAL, Durham, Manchester, Paris and Thessaloniki, together with consultation with Bramon (Barcelona), Greco (INFN), Tornqvist (Helsinki) and Barnes (Oak Ridge).

K_{e4} & QUARK CONDENSATE

The KLOE detector will provide high statistics information on K_{e4} decays. These will allow the determination of low energy $\pi\pi$ scattering. The details of this basic process are uniquely connected to the mechanism of spontaneous chiral symmetry breaking, in particular to the size of the $q\overline{q}$–condensate. The aim of the Durham group, in collaboration with Bern and Orsay, will be to determine this with optimal precision.

f_0 AND a_0

The Durham and RAL groups will continue their collaborative studies of ϕ–radiative decays to learn about the structure of the f_0 and a_0 mesons and the role of isospin breaking. Past experience by M. Pennington in dynamical calculations of meson decays will be applied to the case of the ϕ to learn about the non-perturbative structure of the strange quark propagator and its interactions.

DYNAMICS & SPECTROSCOPY

GLUEBALL

It now seems probable that the lightest scalar glueball is being manifested around 1.5 GeV (Crystal Barrel at LEAR and Lattice QCD predictions). Close (RAL) and Pennington (Durham) have been central in the phenomenological work that has clarified the status of scalar mesons and the glueball candidate $f_0(1500)$. This also shows that hybrid mesons, where gluonic degrees of freedom are excited in the presence of $q\bar{q}$, may be within reach of DAΦNE in its second phase.

ρ' ω' ϕ'

Preliminary studies will also be made of the opportunities available if DAΦNE is operated up to 2 GeV, its maximum after modifications. A. Donnachie's analysis of the isovector meson states produced in e^+e^- annihilation below 2 GeV and in τ-decay has provided definite evidence for at least two ρ' mesons, $\rho(1465)$ and $\rho(1700)$. Production of ρ' ω' and ϕ' in the 1.7 – 1.9 GeV range, quantifying their decay modes and isolating $J^{PC} = 0^{++}$ and 0^{-+} in these decays can add significant information on possible gluonic excitations. Unravelling the emerging complex structure will be a primary goal of the UK team, consulting with Bramon (Barcelona), Greco (INFN), Oliver (Paris) and Törnqvist (Heksinki).

KN SYSTEM

The UK team includes one of today's foremost experts in hypernuclear physics, R. Dalitz, who will provide theoretical expertise on open problems, like the decay of Λ-Hypernuclei, the $A = 1, 2$ systems of type KN and heavier K^-–nucleus "atoms", for all of which more experimental and theoretical studies are needed before one can claim an understanding in terms of the known properties of nuclear matter.

RECENT RELEVANT PUBLICATIONS

1. C. Amsler and F.E.Close, *Evidence for a Scalar Glueball, Phys Lett* **B353** *385 (1995)*; Phys Rev **D53** 295 (1996)
2. R. Dalitz , *Is bound ${}^4_\Sigma He$ formed in K^-–meson capture from rest in liquid helium?* - II, Nucl. Phys. **A585** (1995) 303c-306c.

Participant Number 3 : IN2P3-CNRS Orsay, Paris

J.Stern , L.Girlanda, B.Moussallam (24 m/year) DPT- IPN Université Paris-Sud-IN2P3/CNRS.
André Courau (10 m/year) LAL Université Paris-Sud- IN2P3/CNRS.
Luis Oliver (8 m/year) LPTHE Université Paris Sud-CNRS.
C. Carimalo, P. Kessler, J. Parisi, S. Ong (16 m/year) Université Paris VI-IN2P3/CNRS.

Tot. 58 pm/y

SCIENTIFIC STAFF

ROLE OF THE TEAM

This team is mainly involved in the QED program, scalar meson spectroscopy and the question of Spontaneous Symmetry Breaking in QCD. The different subjects of work for this team reflect its composite expertise and the fact that its various components have long standing collaborations with other network partners on the specific subjects.

QED

$\gamma\gamma$

LUMINOSITY CALIBRATION

The Work Program of the Paris and LAL group is essentially related to simulation and analytical computation of QED processes at DAΦNE . While the theory group in Paris is mainly concerned about the study of azimuthal correlations and radiative corrections in the muons and pions pairs produced in $\gamma\gamma$ collisions, A. Courau, from LAL, will be concerned with simulations of $\gamma\gamma$ collisions for various models and the preparation of analysis. This also implies the simulation of quasi-real compton and the study of its ability for luminosity measurement and Kloe calibration . The widely recognized experience gained with H1 detector at HERA and previously with other lower energy e^+e^- machines will assure a successful outcome of this fondamental part of the DAΦNE physics. It obviously needs a close connection and collaboration with the theorists concerned in Italy, United Kingdom and France, as well as with experimentalists at Frascati.

CP VIOLATION IN K MESONS

0^+ MESONS

The group of LPTHE at Orsay is interested in two topics: 1)Weak interactions of kaons and their relation to the weak interactions of heavy quarks. In particular CP violation in K mesons and its implications for the predictions of CP violation in the B meson case.
2) Low mass 0^+ meson spectroscopy. These states are still subject to controversy, whether they are pure $q\bar{q}$ states or have more or less important diquonium or gluonium components that the study of the spectrum and decays can clarify.

GCHPT

$q-\bar{q}$ CONDENSATION TESTS

The IPN group (in collaboration with Marc Knecht from the Marseille node) is involved in the study of the mechanism of spontaneous chiral symmetry breaking in QCD using the generalysed chiral perturbation theory developped by this group. The main effort will be concentrated to the preparation and interpretation of experimental tests of the quark-antiquark condensation in the vacuum, which will be performed at DAPHNE : i) in low energy $\pi\pi$ scattering, ii) K_{l4} form-factors, iii) in $\gamma\gamma \to \pi\pi$ near threshold.In addition the Sensitivity of the prediction for ϵ'/ϵ and light quark masses on the amount of quark condensation will be studied. This research completes and generalizes the analysis of the above processes performed under the assumption of a strong quark condensation by the Bern, Copenhagen, Helsinki and Vienna nodes.

RESEARCH LINKS

Research linkages exist with the network teams in Frascati, Marseille, and Rutherford Laboratory.

RECENT RELEVANT PUBLICATIONS

1. **A. Courau and G. Pancheri** *Quasi Real Compton Scattering at DAΦNE* , Phys. Lett. B (submitted).
2. **M. Knecht, B. Moussallam, J. Stern and N.H. Fuchs**,*The low energy $\pi\pi$ amplitude to one and two loops*, Nucl. Physics B457 (1995) 513.

Participant Number 4 : CNRS-CPT Marseille-Luminy

SCIENTIFIC STAFF

Eduardo de Rafael (9 m/y), Pierre Chiappetta (2 m/y), Marc Knecht (9 m/y), Laurent Lellouch (4 m/y), Michel Perrottet (9m/y). Tot. 33 pm/y

ROLE OF THE TEAM

The main activities of the CPT team concern several non-perturbative aspects of the Standard Model at low energies, including CP violating K decays, lattice calculations, QCD Sum Rules, large N_c and (Generalized) Chiral Perturbation Theory.

CP VIOLATION AND K DECAYS

A. Pich, J. Prades and E. de Rafael are presently pursuing various phenomenological analyses in the field of CP violating K decays, concerning in particular the decay $K_L \to \pi^0 e^+ e^-$, and testing new approximation methods based on a simultaneous expansion in chiral and $1/N_c$ powers. L. Lellouch, with members of the UKQCD Collaboration, is planning to undertake a new lattice determination of $K_0 - \overline{K}_0$ mixing parameter B_K using a tadpole-improved S-W action for Wilson fermions to eliminate the leading discretization errors, and chiral Ward identity techniques to correct for the explicit chiral symmetry breaking.

LIGHT QUARK MASSES

The u, d, and s quark masses are fundamental parameters of the Standard Model. Their accurate determination is urgently needed in many instances (ϵ'/ϵ, ...). Some recent results from lattice QCD suggest values sensibly smaller than those obtained by various determinations based on QCD sum rules. L. Lellouch, E. de Rafael, and J. Tarón are working on the optimal lower bounds for the light quark masses which can be obtained by combining the known hadronic experimental information with the general properties of analyticity of form factors and positivity of spectral functions.

MUON $g-2$

The expected uncertainty of $\pm 40 \times 10^{-11}$ in the measurement of the muon $g-2$ at BNL demands a refined analysis of the usual hadronic vacuum polarization contribution, but also of the hadronic light–by–light scattering, and of the hadronic Z–γ–γ contributions. These interesting effects, which are a new challenge to progress towards a better understanding of non-perturbative QCD, require a matching of long– and short– distance contributions. M. Perrottet, S. Peris and E. de Rafael have been analyzing this question in quantities like the Adler function, the hadronic vacuum polarization contribution to the muon $g-2$, and the electromagnetic $\pi^+ - \pi^0$ mass difference. The aim here is to obtain a systematic methodology which could be applied to more complicated situations, like the hadronic light–by–light scattering contribution to the muon $g-2$.

LOW ENERGY EFFECTIVE ACTION OF QCD

Most of the low-energy constants which govern several physical processes measurable at DAPHNE are at present unknown. In order to obtain reliable estimates for them, the aim is to find well defined approximations of QCD within the framework of combined $1/N_c$ and chiral expansions. An original line of research, based on the properties of UV-renormalons and started by S. Peris and E. de Rafael, provides a new perspective within QCD into the phenomenologically successful ENJL model and is at present under active investigation.

CHIRAL STRUCTURE OF THE QCD VACUUM

The possibility of a dynamical pattern of spontaneous chiral symmetry breaking in QCD different to the conventional one has been vigorously explored by J. Stern and M. Knecht (further activities of M. Knecht in this respect are described in the Orsay contribution). This is an important issue not only in QCD, but also with reference to possible vector–like gauge theories beyond the Standard Model. In this connection, and within the framework of the large–N_c limit, we propose to investigate the phenomenological constraints which follow from the various types of Weinberg–like sum rules implied by different patterns of spontaneous chiral symmetry breaking in vector–like gauge theories.

RESEARCH LINKS

Working collaborations already exist between this team and the teams of Barcelona, Bern, Lund, Orsay, Valencia, Vienna and Zürich.

RECENT RELEVANT PUBLICATIONS

1. **J. Bijnens, J. Prades, and E. de Rafael**, *Light Quark Masses in QCD*, Phys. Lett. B348 (1995) 226.
2. **A. Pich and E. de Rafael**, *Weak K–amplitudes in the chiral and $1/N_c$–expansions*, Phys. Lett. B374 (1996) 186.

Participant Number 5 : UAB Universitat Autònoma de Barcelona

SCIENTIFIC STAFF

Albert Bramon , Lluis Ametller, Emili Bagan, Santiago Peris, Rafel Escribano and Marek Nowakowski at Universitat Autònoma de Barcelona, UAB, 60 pm/y.
Pere Pascual, Rolf Tarrach, Domènec Espriu, Josep I. Latorre, Angels Ramos and Josep Taron at Universitat de Barcelona, UB, 58 pm/y.
Inés Grau and Ramon Muñoz Tapia at Universidad de Granada, UGR, 24 pm/y.

TOT. 142 PM/Y

ROLE OF THE TEAM

The UAB and UGR research groups, in close collaboration with the Frascati (LNF) node, will be mainly involved in the spectroscopy of vector mesons, their role in chiral Lagrangians, and applications of ChPT. The recent incorporation of the UB group —a group with well-established senior experts in field theory and with strong connections to the Marseilles node— is expected to greatly enhance the efficiency and capabilities of the whole network.

RESEARCH LINKS

There exist established working collaborations between this node and teams from the INFN-LNF, Marseilles, Helsinki, UKRAL and Valencia nodes.

CHIRAL PERTURBATION THEORY

The UB group has good expertise in the construction of models linking QCD and ChPT (see, e.g., the well-known paper [1] below). More recently, the team has discussed the possibility of extending ChPT to account for the ninth pseudoscalar meson. Applying ChPT to the $\eta\prime$ and establishing a firm basis for NJL-like models based on renormalization-group ideas are presently being explored. ChPT is also a field of interest for the UAB group. Further applications of ChPT to processes to be measured at DAΦNE, such as η and $\eta\prime$ decays and $\gamma\gamma$ reactions, will become an important **task** of the team.

SPECTROSCOPY

Another **task** of the team concerns the physics of vector mesons. The copious production of ϕ mesons at DAΦNE will be matched by a considerable production of ω- and ρ-resonances, and highly accurate measurements of their properties will be available. Recurrences of these states (see section on ρ', ω', ϕ' in UKRAL node) are also expected to be found and their properties established.

VMD

Further studies on conventional VMD and on recent developments concerning the inclusion of vector mesons in effective chiral Lagrangians will be required. In the UAB and UGR groups there are well-known senior experts in this field, as well as promising young researchers, planning to deal with all these issues.

HYPERNUCLEI

The theoretical **tasks** at UB concerning hypernuclei will be closely connected to the FINUDA experiments. With the UVEG node, we plan to test both our one-meson-exchange model and the validity of the $\Delta I = 1/2$ rule in non-mesonic decays, as well as to study the exclusive reaction ${}^6_\Lambda\mathrm{He} \to {}^4\mathrm{He} + n + n$.

RECENT RELEVANT PUBLICATIONS

1. **D.Espriu, E. de Rafael and J.Taron**, *The QCD Effective Action at Long Distances*, Nucl. Phys. B345 (1990) 22.
2. **A.Bramon, I.Grau and G.Pancheri**, *Effective chiral lagrangians with an SU(3)-broken vector-meson sector*, Phys. Lett. B345 (1995) 263.

Participant Number 6 : UVEG University of Valencia

Scientific staff

Antonio Pich (8 m/y), , F.J. Botella (6 m/y), E. Oset (4 m/y), J. Prades (12 m/y), M. Vicente (4 m/y) Tot. 35 pm/y
F. Guerrero (12 m/y), J.A. Oller (12 m/y), O. Vives (12 m/y) – PhD Students –

Role of the team

The UVEG team has a well–known expertise in many of the topics covered by this proposal. Most of its activity is centered on the dynamics of the lightest meson states, which are going to be copiously produced at DAΦNE . The research includes both electroweak (K decays, CP violation) and strong (vector mesons, low–energy effects of QCD) interaction aspects; indeed, the main interest is in the important interplay between both interactions at low energies. The physics of hypernuclei is another area where this team will have a leading contribution.

Research Links

There exist working collaborations between this team and teams from Barcelona, Bern, Helsinki, Marseille and Wien. The team expects to incorporate soon (next fall) Dr. J. Portoles, who has been working (for the last 4 years) at the INFN–LNF and UKRAL nodes; thus, an active collaboration with these two nodes is also planned.

CP

CP violation is one of the favourite research topics of our team, which has made important contributions in this field (determination of the relevant non-perturbative parameters, time evolution of the C–odd K^0-$\bar{K}^0$ system, quark–mixings, ...). We will continue our investigation of CP phenomena in the kaon system, trying to improve the theoretical predictions (mainly to control the unavoidable long–distance effects). There is a close collaboration with the Marseille and Wien teams in this area.

Chiral Perturbation Theory

The UVEG team has a good expertise in Chiral Perturbation Theory, acquired through a fruitful collaboration with the Bern, Helsinki, Marseille and Vienna groups during the last 10 years. Some specific **tasks** to which the UVEG group will contribute are: Dynamical estimates of the Chiral perturbation Theory couplings; Isospin and $SU(3)$ violations in non–leptonic decays; η and η' physics; Rare K decays; Extrapolation of the Effective Lagrangian results at higher energies and inclusion of heavier hadrons.

Hypernuclei

Our team will play a leading role in the field of hypernuclei, where some of our members are well recognized experts. The aplicability of meson–exchange models to the weak decays of hypernuclei will be investigated in close collaboration with the Barcelona group.

$(g-2)_\mu$

At present, there is an active collaboration of our team with the Marseille and Helsinki groups on the field of hadronic contributions to the muon $(g-2)$. We plan to use the $e^+e^- \to$ hadrons data collected at DAΦNE to improve the present theoretical predictions for $(g-2)$ and other interesting quantities. Moreover, we want to combine the DAΦNE data with the measurements of hadronic τ decays.

Recent Relevant Publications

1. A. Pich, *Chiral Perturbation Theory*, Rep. Prog. Phys. 58 (1995) 563.
2. **J. Bijnens, E. Pallante and J. Prades**, *Hadronic Light–by–Light Contributions to the Muon $g-2$ in the Large N_C Limit*, Phys. Rev. Lett. 75 (1995) 1447.

Participant Number 7 : UWIEN Inst. Theor. Physics, Univ. Vienna

Gerhard Ecker, Helmut Neufeld, Heinz Rupertsberger – 16 pm/y SCIENTIFIC STAFF

ROLE OF THE TEAM

The Vienna team will be one of the leading teams in the field of ChPT. Its long standing joint research program with other European experts in studying various aspects of the Standard Model at low energies, is central to this project. In particular, this team will have a leading role in studying the meson–baryon sector.

RESEARCH LINKS

The tasks to be understaken will be pursued in collaboration with teams from Bern (Zürich), Frascati, Helsinki (Lund), Marseille and Valencia. As described in detail below, with all these groups there exist previous collaborations.

Some time ago, a systematic program for nonleptonic kaon decays was started in collaboration with A. Pich (Valencia) and E. de Rafael (Marseille), both of whom are now joining the EURODAΦNE project. This program was later continued and extended together with J. Bijnens (Copenhagen/Lund), J. Kambor (Zürich), G. D'Ambrosio (Naples) and G. Isidori (Frascati), all members of EURODAΦNE either from the very start or joining at this time. This team has also been involved in other aspects of the effective field theory of the Standard Model at low energies (chiral perturbation theory), such as semileptonic kaon decays and elastic pion–pion scattering at the two–loop level (with J. Bijnens, G. Colangelo(Frascati), J. Gasser (Bern) and M.E. Sainio (Helsinki)). Members of the team have clarified the structure of isospin violation in chiral perturbation theory, independently of similar work in Bern and Zürich.

CHIRAL PERTURBATION THEORY

The ChPT program for nonleptonic kaon decays will be completed to $O(p^4)$ in the low–energy expansion and updated in several cases. For many channels, it will be necessary to determine at least the dominant $O(p^6)$ contributions for meaningful comparisons with the data. We also intend to contribute to investigations of η decays, both on more theoretical and on phenomenological issues (systematics of weak and radiative decays). Another project involves estimates of low–energy coupling constants of $O(p^6)$ in the strong sector, extending previous work on resonance exchange at $O(p^4)$. This work has already been started for the pion–pion scattering amplitude to $O(p^6)$ and will be extended to other processes of interest. In the same spirit of a systematic attack on two–loop amplitudes, we plan to calculate the two–loop divergence functional to determine the scale dependence of the relevant coupling constants of $O(p^6)$. Standard methods of chiral perturbation theory will be applied to investigate the effect of isospin violation in processes accessible at DAΦNE. This includes in particular elastic $\pi\pi$ scattering and K_{l3} decays to allow for a precise determination of the $\pi\pi$ scattering amplitude near threshold. Chiral perturbation theory can also be applied to processes involving baryons. This field could profit very much from the physics potential available at DAΦNE for low–energy K–nucleon scattering. The low–energy expansion in the pion–nucleon sector will be reformulated to include the dominant Δ resonance explicitly in the chiral Lagrangian. As part of this project, the divergent part of the one–loop functional will be calculated to set the stage for a systematic renormalization procedure.

RECENT RELEVANT PUBLICATIONS

1. **J. Bijnens, G. Colangelo, G. Ecker, J. Gasser and M.E. Sainio**, *Elastic $\pi\pi$ scattering to two loops*, Phys. Lett. B374 (1996) 210.

2. G. D'Ambrosio, G. Ecker, G. Isidori and H. Neufeld, *Radiative four–meson amplitudes in chiral perturbation theory*, Phys. Lett. B380 (1996) 165.

Participant Number 8 : DESY-ZEU DESY-IfH Zeuthen

SCIENTIFIC STAFF

Friedrich Jegerlehner, Oleg Tarasov (each 6 m/year), Johannes Blümlein, Tord Riemann (each 3 m/year) - DESY Zeuthen;
Wolfgang Kluge, Gabriela Cataldi, Res Urech (each 12 m/year), Achim Denig, Uwe v. Hagel (each 9 m/year), Siegfried Wesler (6 m/year) Johann Kühn, Erwin Mirkes (each 4 m/year) - Univ. Karlsruhe Tot. 86 pm/y

ROLE OF THE TEAM

The DESY-Zeuthen/Karlsruhe team will be the leading team in the investigation of the implications of the determinations of hadronic cross sections at low energy electron-positron colliders with particular emphasis on possible efforts at DAΦNE both from the experimental and theoretical point of view.

RESEARCH LINKS

The experimental group at Karlsruhe (part of the DESY team) is a member of the KLOE Collaboration from Frascati. Further close collaborations are planned between the DESY-Zeuthen and Karlsruhe groups and the INFN team.

TOTAL HADRONIC CROSS SECTION

Hadronic cross sections in electron-positron annihilation are of crucial importance for two problems:

- the interpretation of the future measurement of the muon anomalous magnetic moment planned in Brookhaven
- for the precise determination of the fine structure constant α at the Z^0 resonance. The uncertainty of $\alpha(M_{Z^0})$ is one of the limiting factors of precision tests of the Standard Model.

RADIATIVE CORRECTIONS

One **task** will be the calculation of radiative corrections for low-energy, low-multiplicity hadron production in e^+e^-–annihilation at DAΦNE and the estimate of the theoretical uncertainties. Both the DESY-Zeuthen and the Karlsruhe groups have long standing expertise in calculating higher order corrections. Of particular interest is the study of the total hadronic cross section measurements, initial-state radiation and its impact on R measurements, QED corrections to hadronic reactions and form-factor extractions. The connections between form-factor measurements at DAΦNE and tau-lepton decays as well as isospin and SU(3) relations between multi-pion final states will be analyzed. Furthermore, the interplay between cross section measurements at DAΦNE and electroweak precision physics, in particular, the $(g-2)_\mu$ experiment performed at Brookhaven and precision measurements of the weak mixing parameter $\sin^2\Theta_W$ and the W–mass will be investigated.

RELATIONSHIP TO τ–PHYSICS

EXPERIMENTAL QUESTIONS

Measurements of hadronic cross sections (electron-positron annihilation into two or more pions or kaons) with the detector KLOE at DAΦNE is planned. Research objectives of the experimental group are the feasibility study of the measurements of hadronic cross sections, the preparation of a detailed proposal with realistic Monte Carlo simulations of the detector KLOE including advanced theoretical input, e.g. radiative corrections, higher-order electroweak corrections, etc. and the measurements of hadronic cross sections with a center of mass energy between 0.5 and 1.5 GeV and data analysis.

RECENT RELEVANT PUBLICATIONS

1. S. Eidelman and F. Jegerlehner, *Hadronic contributions to $g-2$ of the leptons and to the effective fine structure constant $\alpha(M_Z^2)$*, Z. Phys. C67 (1995) 585.
2. J.H. Kühn and E. Mirkes, *Structure functions in tau decays*, Z. Phys. C56 (1992) 661.

Participant Number 9 : UHELS University of Helsinki

SCIENTIFIC STAFF

Nils Törnqvist, Mikko Sainio (each 7 pm/y=) 14 pm/y - Helsinki
Johan Bijnens (7 pm/y) - Lund, Sweden 21 pm/y

ROLE OF THE TEAM

A special role of the Helsinki group will be to link the DAΦNE results in meson spectroscopy with the Particle Data Group. The Helsinki team has by now a long experience in chiral perturbation theory, and it has contributed from early on to the DAΦNE project participating to the writing of the *Handbooks*, and later to the training of one of the post-doctoral EURODAPHNE fellows. The Helsinki team has also a long-standing expertise in light meson spectroscopy. In collaboration with other teams it will study specific problems on mesonic interactions, decays and spectroscopy.

RESEARCH LINKS

Existing research linkages: Barcelona, Bern, Durham, Frascati, Granada, Marseille, LPTHE Orsay, Rutherford, Rome 2, Vienna.

CHIRAL PERTURBATION THEORY

As to the scientific **tasks**, we contribute to the understanding of $\pi\pi$ *scattering* in the framework of ChPT, where we have shown that the standard picture of chiral symmetry breakdown allows one to predict the two S–wave scattering lengths with high precision. The Lund subnode has in addition a large experience in the calculation of nonleptonic matrix elements and other aspects of nonleptonic decays. It also has experience in the study of models to cover the region between ChPT and perturbative QCD. For instance, it has been shown that the pattern of higher order parameters in the nonleptonic sector can be different from simple expectations. This was important for B_K and will probably be important in ϵ'/ϵ. We will also contribute to the study of Quenched ChPT. Chiral symmetry breaking will be studied in the context of the intermediate quark models. We will also contribute to the study of K and η decays.

MESON SPECTROSCOPY

The second **task** of the Helsinki node is to analyze data and construct better models for meson resonances and meson-meson scattering in an S-matrix, flavour symmetric framework above the threshold region. An especially important question is the nature of the lightest scalar mesons, the $\sigma(\simeq 500)$, $f_0(980)$, $a_0(980)$, $f_0(1300)$ etc.. Whether they are $q\bar{q}$, $K\bar{K}$ or glueball states, will be studied in detail. With the help of the anticipated DAΦNE data these questions most likely will be understood much better during the time span of the project. Further clarification of the role of the controversial broad σ meson near 500 MeV, often called "the Higgs boson of strong interactions", in nonperturbative QCD and in mechanisms of spontaneous symmetry breaking is of great importance. The expertise of the Helsinki team in light meson spectroscopy is also used in the Particle Data Group, to which N. Törnqvist belongs, and which biannually publishes the well known Review of Particle Physics.

PARTICLE DATA GROUP

RECENT RELEVANT PUBLICATIONS

1. **J. Bijnens and J. Prades**, *The B_K parameter in the $1/N_c$ Expansion*, Nucl. Phys. B444 (1995) 523.
2. N.A. Törnqvist and M. Roos, *Confirmation of the sigma meson*, Phys. Rev. Lett. 76 (1996) 1575.

Participant Number 10 : UBERN University of Bern

This team participates on a project-by-project basis

SCIENTIFIC STAFF

J. Gasser (6 m/y), V. Antonelli (12), H. Leutwyler (2), E. Pallante (12) (University of Bern)
R. Baur (12), S. Dürr (6), J. Kambor (6), D. Wyler (3) (University of Zürich) 59 pm/y
Doctoral students: Th. Becher (12), A. Gall (12), D. Toublan (12) (University of Bern)
One Postdoctoral researcher (24 m in 2 years) (to be financed by the Swiss Government)

ROLE OF THE TEAM

The team will work on specific applications of ChPT and contribute to the project with its knowledge on this technique.

CHIRAL PERTURBATION THEORY

Our research team has a long experience in chiral perturbation theory. We have written two basic articles on the subject some time ago – these works are among the first twenty in the *List of Top-cited HEP articles*. Since then, we have concentrated much of our work both to the deepening of the method and to its application to specific processes, gaining in this manner a thorough understanding of this and related topics. Our specific **tasks** will be to prepare the extraction of $\pi\pi$ scattering amplitude form K_{e4} decays measured at DAΦNE in collaboration with the Helsinki, Paris and Marseille group, and to work on isospin violations (with the Vienna team), final state interactions (with the Marseille team) and to set up an effective lagrangian framework for quenched lattice calculations (with the Frascati team).

RESEARCH LINKS

Frascati, Helsinki, Marseille, Paris, Vienna

RECENT RELEVANT PUBLICATIONS

1. J. Gasser and H. Leutwyler, *Chiral perturbation Theory to One Loop*, Ann. Phys. (N.Y.) 158 (1984) 142;
2. H. Leutwyler, *On the Foundations of Chiral perturbation Theory*, Ann. Phys. (N.Y.) 235 (1994) 165;