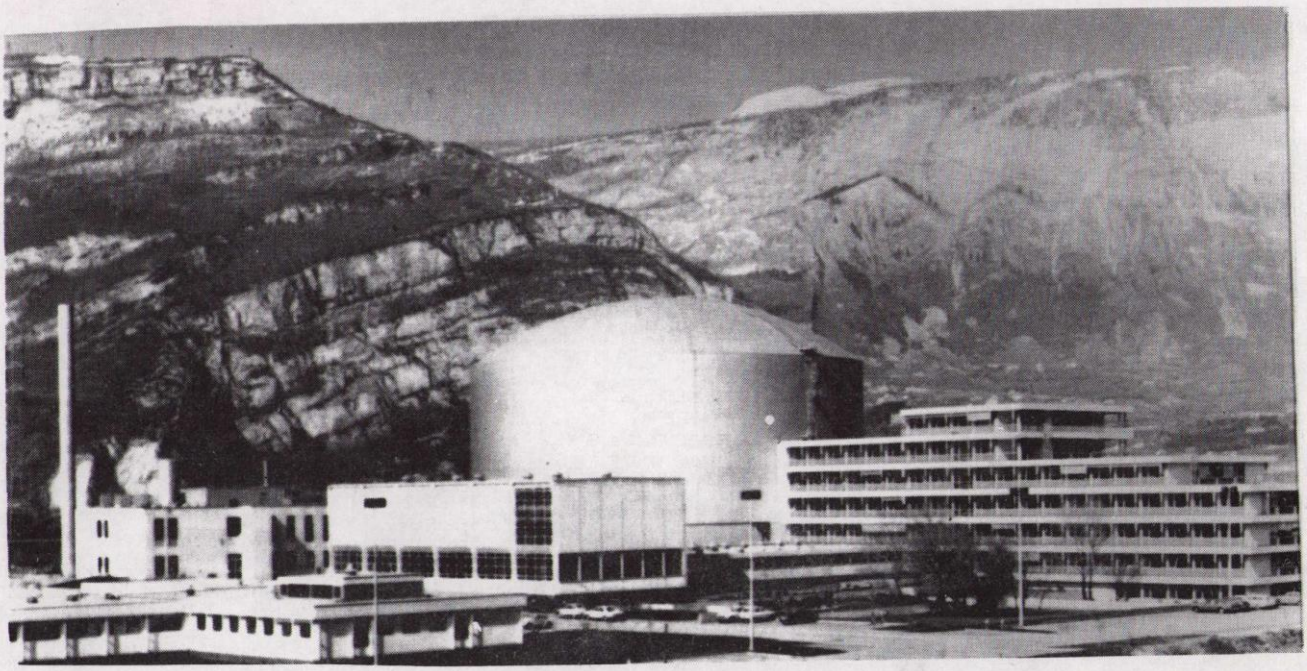
Rutherford Laboratory

29 July-12 August 1974

bulletin 15



INSTITUT MAX VON LAUE-PAUL LANGEVIN (ILL)

Ministers from Britain, France and Germany met at the Préfecture in Grenoble last Friday, I9 July to sign the formal agreement whereby Britain becomes a member of ILL. Amongst those present at the ceremony were Sir Brian Flowers and Professor S F Edwards, the past and present Chairmen of the SRC, Dr Stafford, Dr Hobbis and a number of other emminent scientists and officials from all three countries. A contract between the Associates of the ILL, a Society governed by French Civil Law, and the Statutes of the Society were signed on behalf of the SRC by Professor Edwards. The present Director of ILL, Professor R L Mössbauer (Nobel Prizewinner for physics in I96I) in his speech before the signing ceremony had some nice things to say about the British contributions in the field of neutron research and their extensive research programme which has so quickly and smoothly been incorporated into the work of ILL. With the signing of the agreement last Friday it is an appropriate time to take a look at the Rutherford Laboratory's contributions in this field and the Editor is grateful to Dave Salter for the following report.

Over a year ago, an article in the Bulletin No 3/73 outlined the progress being made in, what was then, the new collaboration of the SRC with the Institut Laue-Langevin, Grenoble (ILL) and indicated how the Neutron Beam Research Unit (NBRU) at the Rutherford Laboratory was involved in this new project.

Many things have happened in the last I8 months ranging from the sublime (over 50 UK experiments having had time on the various facilities at Grenoble) to the ridiculous (the efforts of NBRU members struggling with French irregular verbs at classes in Abingdon and Newbury). One of the areas of the Unit's work is to provide an interface on technical matters with the ILL and to support users from UK Universities to carry out approved experiments there. The Institut has a formal bi-annual procedure for selecting new proposals for experiments. So far I55 proposals involving UK scientists have been submitted and of these I02 have been approved and accepted on to the experimental programme. A total of 32 UK experiments has already been completed.

The Unit is responsible for looking after the UK proposal from the initial submission, through the necessary technical and scheduling discussions, to assisting scientists and samples to be at Grenoble at the appropriate time. Over I20 visits have now been made by SRC sponsored users.

Some features of the Unit's involvement with ILL can be seen much nearer home, however, as readers who work in R25 will know. There, an unusual (for the Rutherford Laboratory, that is) piece of apparatus has been built up over the last few months. This is the

contd. on page 4

INTERNAL EVENTS

NIMROD LECTURE SERIES AND HEP SEMINARS

As mentioned in the last issue lectures in both these series may be arranged at very short notice. Please watch the small portable notice boards for details.

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TELEPHONE DIRECTORY AMENDMENTS

ALTERATIONS

	Delete	Add
BEATY Miss I L	BEATTY Miss I L	COWARD Mrs I L
CASTLE F J	Ext. 216	Ext. 392
EAGLE R	Ext. 486 RI2 Rm 154 HEP VIS	Ext. 254 R25 Rm 1.14 ENG DESC.
FRY Miss M E	Ext. 575 Rm 70	Ext. 550 Rm 48
GODFREY M/S P M	Ext. 391	Ext. 319
MCLOUGHLIN Mrs B	Rm 19	Rm 54
PETT Dr T G	Ext 533 Rm 1.40 CACS	Ext 6189 Rm 2.84 CA CA
TEMPLEMAN K H	Ext 216	Ext 392
DUNK P	Ext 307	

ADDITIONS

CARR F S	Ext 254 R25	Rm 1.13	ENG DIV
CUTLER P M F	" 570 R20	Rm 19	ADM GA
CHERRY S	" 6144 R20	" 54	ADM FA
DAVIES J K	" 6245 RI	" 1.82	HEP CGA
DUMN P A	" 493 RI	" 1.6A	HEP CGA
NEWBOND Mrs G M	" 367 R32		ADM GA
PAYNE Mrs F	" 6163 R20		ADM SCI
QUINTON S P H	" 6240 R36	" 6	HEP EL
ROBERTS Dr B L	" 431 R12		HEP NP
RICE R M	" 360 RI		CA CO
WEST J R	" 360 RI	Rm 1.95	CA CO

NIMROD SCHEDULE

CYCLE 6 30.7.74 - 20.8.74

MACHINE PHYSICS

HIGH ENERGY PHYSICS

Team	Beam	Experiment	State
CERN/ORSAY/OXFORD	P8I	Hadron-Proton Spin	Data
RUTHERFORD LABORATORY	πII	Beam Measurements	Tests
IMPERIAL COLLEGE/RL	π8A	Experiments on Narrow Bosons X^{O} (958) S* and Cross-Section Measurements	Data
BEAM DETECTOR GROUP	KI5A	Parasitic Running	Tests
COUNTER GROUP B/ CAMBRIDGE UNIVERSITY	πI2	$\pi^{-}p \rightarrow K^{O}\Lambda^{O}$ in the Range 1.4 - 2.0 GeV/c	Setting up
RUTHERFORD LABORATORY	π9	Polarisation in $\pi^{-}p \rightarrow \pi^{O}n$, nn	Setting up
BIRMINGHAM/SURREY/RL	KI7	Stopping Kaons	Data

RUTHERFORD LABORATORY BULLETIN *Published by the Scientific Administration Group*

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Deadline for Insertions	GENERAL & SOCIAL NEWS	INTERNAL & EXTERNAL EVENTS
	Tuesday 1600	Wednesday 1200

XVII INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS 1974

Like all other conferences, the seventeenth in the Rochester series has come and gone. Many words were spoken, many papers were submitted (around 1000 were on display) and many people from over 40 countries were subjected to the uncertainties of the British climate. In these days of rapid news communication, the presentation of startling new results could not be expected. However very interesting and in some instances, exciting results were announced, in particular from the Fermi National Accelerator Laboratory. Summarising a ten-day conference is at best a compromise so this report will be given in two parts (readers are warned in advance that both are unavoidably technical). The Editor is grateful to Wilbur Venus, Gordon Walker and Bill Toner, all of whom acted as scientific secretaries at the conference for these reports. Part 1 on 'neutrino physics' is by Wilbur Venus; Part 2 to be published in the next issue will include a report on 'strong interactions' by Gordon Walker and Bill Toner has promised something about the SPEAR results

The main topic of interest in neutrino physics during the past year has been the question of the existence of neutral currents. Neutral current reactions are reactions whose existence, on an intermediate vector W-boson model of weak processes , would require the existence of a neutral W-boson in addition to the charged ones mediating the well-known charged current reactions. The absence of neutral currents in strangeness-changing processes such as kaon decay is exceedingly well established. This had led to a common expectation that no weak neutral currents existed. But the new gauge theories unifying the weak and electromagnetic interactions required the existence of neutral currents or heavy leptons (or both) in order to maintain renormalisability.

The Weinberg model is unique in requiring neutral currents but no heavy leptons, for which no experimental evidence exists. The experimental observation of neutral current reactions due to neutrinos was first reported a year ago by the Gargamelle collaboration working at CERN and the Harvard-Pennsylvania-Wisconsin collaboration working at FNAL.

At the London Conference, there were seven contributions reporting the experimental observation of weak neutral currents.

Three of these were concerned with the inclusive process $\nu+N\rightarrow\nu+$hadrons. The CERN-Gargamelle collaboration reported further analyses of their experiment showing that the neutral current events are qualitatively different from the background events due to neutron interactions, and in particular that the π^o multiplicities are quite different in the two classes of event. They also reported preliminary data, confirming that the neutron background is indeed well understood, coming from a subsidiary experiment in which nearly half the neutrino shielding was torn down in order to get large numbers of protons and neutrons into the chamber. The Harvard-Pennsylvania-Wisconsin collaboration, who earlier this year were rumoured to be obtaining negative results after improving their experimental configuration, reported a positive result after a detailed study of their muon detection efficiency and hadron "punch-through" corrections. The CALTECH group, who took a lot of data at FNAL a few months ago expressly to search for neutral currents, also reported a positive result based on a study of the penetration depths of their events. All these three experiments reported unambiguous signals and similar values for the ratio of neutral to charged current events, despite very different sources of background and systematic error.

The CERN-Gargamelle collaboration also reported seeing two candidates so far for the purely leptonic neutral current process $\nu_\mu e^-\rightarrow\nu_\mu e^-$ compared with an expectation of 0.18 ± 0.12 events from background processes. The corresponding limit on the Weinberg angle was reported as $\sin^2\theta_W < 0.45$ (90% c.l.) This remains the cleanest neutral current process for theoretical interpretation since hadrons are not involved but the cross section is so low ($\sim 10^{-42}$cm^2) that events are hard to come by. More film will be obtained.

There were also three contributions reporting the observation of single pion production via neutral currents. In two of these experiments, (i) a further analysis of the 1967 CERN neutrino experiment in the 1.2m propane bubble chamber indicating that the upper limit originally given probably corresponds to a clear signal, and (ii) a stop-press result from the new Columbia-Brookhaven spark chamber experiment, the production process occurs in complex nuclei. Consequently the observed cross section is difficult to interpret theoretically because of charge exchange and reabsorption effects inside the parent nucleus. The third is a beautiful experiment by the Argonne group using the 12 ft bubble chamber in which all backgrounds are convincingly evaluated using data internal to the experiment combined with a special exposure to neutrons. The observed cross sections are substantially higher than predicted by the Weinberg model but the latter is not yet excluded because the statistics are limited. The $p\pi^-$ mass plot for events of the kind $\nu n\rightarrow\nu p\pi^-$ (in deuterium) reveals a surprisingly large non-resonant contribution to the cross section.

The absence of neutral currents only in strangeness-changing reactions presumably requires an explanation in terms of hadron structure. The simplest explanation requires the existence of a fourth type of quark (in addition to the three required to explain the spectrum of presently known hadrons) carrying an additional additive quantum number ("charm"). This explanation requires the existence of charmed hadrons decaying only via the weak interaction somewhere in the 2-10 GeV/c^2 mass range. The search for these now seems certain to become a fashionable area for experimental investigation.

The striking feature of the data on charged-current neutrino reactions presented to the Conference was the lack of surprises. The total cross sections rise linearly with neutrino energy from 1 GeV to 100 GeV, the proportionality constant being measured as $.76\pm.08$ at CERN and $.80\pm.10$ at FNAL for neutrinos and $.28\pm.03$ at CERN and $.28\pm.04$ at FNAL for antineutrinos, in appropriate units. An attempted evaluation of the Gross-Llewellyn-Smith sum rule in the CERN experiment yielded the value 3.2 ± 0.6 compared with the prediction of 3.1 at asymptotic energies by the quark-parton model. And within experimental errors the π^+/π^- ratio in neutrino processes was found equal to the π^-/π^+ ratio in antineutrino processes and furthermore equal to the value predicted via the quark-parton model from electroproduction data. In fact the major theoretical mystery is why the quark-parton model appears to work so well where it should not, in the CERN neutrino experiment, and to fail so badly where it should work, in the SPEAR experiments.

However, two possible portents of future surprises were reported by the Harvard-Pennsylvania-Wisconsin collaboration. The observed inelasticity (y) distribution in antineutrino events is in gross disagreement with the $\sim (1-y)^2$ distribution observed at CERN and rather similar to that observed for neutrino events. A partial explanation may be that, because of the finite angular acceptance of the apparatus, the observed events with large y values necessarily have small values of x; and at small values of x one expects comparable numbers of quarks and anti-quarks and therefore comparable neutrino and antineutrino cross sections. However it seems unlikely that this can explain the whole observed effect. An alternative explanation is that a threshold for (for example) charmed particle production has been crossed. Such threshold effects will first appear precisely in this large-y small-x region of the kinematics. The other possible portent is that two two-muon events were observed in the neutrino run among 300 charged current events; both events have very high energy ($\sim$150 GeV). The obvious interpretation is that while one muon presumably came directly from the neutrino in the normal way, the other presumably came from the prompt weak decay of one of the created particles. One immediately thinks of the intermediate vector W boson and of a charmed particle, neither of which has yet been observed, as possible candidates (the background expected from π and K decay is very small). But speculation as to their origin is premature, particularly since the μ^+/μ^- momentum ratios are the inverse of what one would expect, particularly for W production.

first of two neutron scattering diffractometers which are being built at the Laboratory for use on the reactor at ILL (Since this article was written the Diffractometer, D3, has arrived at ILL and within two days ran successfully under full computer control. An article on D3 will be published in the next edition of the Bulletin - Ed)

The ILL collaboration is only one aspect of the Unit's work. In addition to providing technical secretarial support for SRC Committees and for providing support for approved neutron beam experiments in the UK on reactors at Harwell and Aldermaston, the Unit also has a thriving development programme of its own. This includes amongst other things, the construction of a polarisation filter, development of position sensitive neutron detectors and devices for bending neutron beams, and work on pressure cells and magnetic neutron guides.

Members of the Unit are also involved in running their own experimental programmes both on the reactor in Grenoble and on reactors in the UK.

FILM BADGE NOTICE Period 8 commenced Monday, 15 July. Colour Strip - ORANGE for βγ films and neutron packs. Please make sure you are wearing the correct dosimeters and that all old ones are returned.

Six monthly TLD change for people with surnames commencing C D E and F.

Please note - the Film Service now operates from Room G4A, Building R2. Telephone Ext. 430.

LOST Anyone finding a large key in the BLUE car park is asked to contact Mrs North, Building R2, Ext. 430.

TRAINING CONCESSIONS 1974-75 Employees of the Rutherford and Atlas Laboratories may now apply for training concessions for courses at local Technical Colleges and application forms for this purpose are available from Local Admin Officers and from the Training Section, Building R20. College prospectuses will be distributed to Local Admin Offices as soon as they are available and they can also be seen in the Library and the Training Section.

It would be appreciated if all completed and countersigned applications could be in the hands of the Training Officer not later than Friday 16 August. If exam results are still outstanding by this date, a conditional concession will be given. Employees seeking advice on training matters should make an appointment on Ext 555 to see the Training Officer, Mr T F Gubbins.

Enrolment details will be given in a later issue.

NATIONAL SAVINGS CERTIFICATES SALARY CYCLE ENDING 31 JULY 1974 Certificates can be collected from the Cash Office, Building R12 from the 1 August onwards. New members wishing to join the scheme can obtain enrolment forms from the Cash Office.

ALEXANDRA ROSE DAY 1974 The total amount collected in the Rutherford Laboratory was £29. 33½p. The organisers wish to express their thanks for the efforts of collectors and to those who contributed for this Charity.

SOCIAL NEWS

SRC SPORTS DAY - SIX-A-SIDE-FOOTBALL

In many ways the star attraction of the tournament was the RHEL 1 team, affectionately known as the 'Silver Threads' due to their average age being well over 40! (In several cases well over!). The squad, consisting of Les Patton, Bob McClure, Bob Blowfield, Artnur Bell, Dave Lucas, Mick Ryan, John Whittaker and Steve Brazier, played intelligently and ran continuously for 5 matches to qualify for the semi finals at the expense of the much more fancied Daresbury 1st team and RHEL 2. Unfortunately, they found the eventual winners RHEL 3, a little too strong in their semi final but nevertheless maintained a good standard of football and spirit to the end.

The RHEL 4 team also made the semi final, but after an apparently horrifying injury to one of their players (who was carried off with two suspected broken legs - but re-appeared a few hours later complete with stick and beer mug), succumbed 1-2 to R.G.O.

The competition was won, in the end relatively easily, by the well organised RHEL 3 team who triumphed 7-1 in their semi final and then beat R.G.O. 6-2 in the final. The squad, consisting of Bob Bryne, Malcolm Edwards, Martin Guest, Peter Hemmings, Jeremy Ireson, Ron Lawes and Jim Taylor, recorded 28 goals against 8 in 6 matches with Jim Taylor as the competitions top goal scorer (13 goals). As is appropriate in these days of "total football", the entire team (except the goalkeeper) scored in the final. That may be rectified next year!

TABLE TENNIS Although the new season does not start until the middle of September, we have to give details of our teams by 7 August. Would all those interested in playing for a team contact Eric Thomas, Ext. 6219 or Martin Fowler, Ext. 6105 by 1 August please.

CHRISTIAN FELLOWSHIP All are welcome to join in a time of prayer led by Ben Kingdom of Building R20 at 1230 on Friday 2 August in the Conference Room, R12.

On 9 August, Graham Turner of Surrey University will be reviewing some books he has recently read. As usual the meeting will be held in the Conference Room, R12 at 1230.

FAREWELL Sue Watts writes to say - "I would like to say goodbye to my colleagues at the Laboratory and thank them for making my five year stay an enjoyable one".

And thank you Sue, for the many Bulletins you typed for me in the early part of your stay - Ed.