

Supplementary catalogue of the papers and
correspondence of

Herbert Fröhlich FRS

(1905-1991)

by Peter Harper and Timothy E. Powell
NCUACS catalogue no. 168/11/08

Title: Supplementary catalogue of the papers and correspondence of
Herbert Fröhlich (1905-1991), physicist

Compiled by: Peter Harper and Timothy E. Powell

Description level: Fonds

Date of material: 1930-2005

Extent of material: ca 300 items

Deposited in: Special Collections and Archives, Liverpool University Library

Reference code: GB 0141 D.56

© 2008 National Cataloguing Unit for the Archives of Contemporary Scientists,
University of Bath.

NCUACS catalogue no. 168/11/08

The work of the National Cataloguing Unit for the
Archives of Contemporary Scientists in the
production of this catalogue is made possible
by the support of the



Arts & Humanities
Research Council

NOT ALL THE MATERIAL IN THIS COLLECTION
MAY YET BE AVAILABLE FOR CONSULTATION.
ENQUIRIES SHOULD BE ADDRESSED IN THE
FIRST INSTANCE TO:

THE UNIVERSITY ARCHIVIST
SPECIAL COLLECTIONS AND ARCHIVES
SYDNEY JONES LIBRARY
UNIVERSITY OF LIVERPOOL

LIST OF CONTENTS

	Items	Page
GENERAL INTRODUCTION		5
SECTION A BIOGRAPHICAL	A.5-A.41	7
SECTION B RESEARCH	B.367 -B.605	11
SECTION C PUBLICATIONS	C.22, C.23	31
SECTION D LECTURES	D.70-D.93	32
SECTION F CORRESPONDENCE	F.337-F.354	35

GENERAL INTRODUCTION

PROVENANCE

These papers were received from Professor G.J. Hyland, a former colleague of Fröhlich, in January 2008.

DESCRIPTION OF THE COLLECTION

This catalogue of papers of Professor Fröhlich is a supplement to that compiled as NCUACS no. 159/2/08. There are additional biographical, research, publications and lectures papers and correspondence. They have been arranged and numbered to follow the sequence of the previous catalogue, which should therefore be consulted in conjunction with this catalogue. The papers cover the period 1930-2005.

Biographical papers include obituaries and tributes, interviews, curricula vitae and lists of publications. Careers, honours and awards material includes documentation of activity after Fröhlich's formal retirement from his Liverpool Chair in 1973 such as the appointment to the Chair of Solid State Electronics at Salford University and as a Visiting Professorship at the Dublin Institute of Advanced Studies. Miscellaneous biographical items include correspondence and papers relating to a proposed 'Matter and Anti-matter' ballet for fundamental physics particles. The idea arose from discussions with his wife who produced the sketch of the ballet

Research papers form by far the largest component. The material, which comprises correspondence, manuscript and typescript notes and drafts, preprints and offprints by Fröhlich and others, is presented in an alphabetical sequence of broad subject areas: biology, condensed matter physics, dielectrics, electrodynamics, non-local Dirac field theory, nuclear physics/elementary particles, and solid state physics/superconductivity. The papers cover an extended period 1937-1990 though much of the material is undated, especially Fröhlich's manuscript notes and calculations in electrodynamics and non-local Dirac field theory.

Publications material is slight, comprising correspondence, 1960, with the Royal Society about the publication of two of his papers in the Society's proceedings and an invitation, 1970, to write an article for *Bild der Wissenschaft*. Lectures material is more significant including notebooks used to record courses given at the University of Bristol from 1939-1940 on such topics as 'Atomic Theory for Chemists' and 'Statistical Mechanics'. The enclosure of University of Liverpool examination papers in one of the notebooks suggests continued use after his move there from Bristol in 1948. There are also duplicated typescripts of lectures given at Purdue University on statistical mechanics in 1950 and

electrons in crystals in 1953 and duplicated and photocopied typescript of lectures given at the University of Stuttgart in 1966, 1969 and 1971.

There is also a little scientific correspondence, 1973-1990.

ACKNOWLEDGEMENTS

We are very grateful to Dr G.J. Hyland for help and advice.

Peter Harper
Bath 2008

SECTION A	BIOGRAPHICAL, A.5-A.41	1930-2005
------------------	-------------------------------	------------------

A.5-A.9	OBITUARIES AND TRIBUTES	
A.10-A.20	INTERVIEWS	
A.21-A.34	CAREER, HONOURS AND AWARDS	
A.35-A.41	MISCELLANEOUS BIOGRAPHICAL ITEMS	

A.5-A.9	OBITUARIES AND TRIBUTES	1992-2005
----------------	--------------------------------	------------------

See also A.1 of the previous catalogue NCUACS no.159/2/08.

A.5	Obituary by G.R. Alcock, <i>University of Liverpool Recorder</i> , February 1992	1992
A.6	'Herbert Fröhlich FRS, 1905-1991' by G.J. Hyland	ca 1992
A.7	'Herbert Fröhlich', by N.F. Mott, <i>Biographical Memoirs of the Royal Society</i> , 38	1992
A.8	Fröhlich Memorial Lecture' by G.J. Hyland, IGD VSP, 1995	1995
A.9	'Herbert Fröhlich, FRS (1905-1991) - Physicist Ahead of His Time' by G.J. Hyland, <i>Electromagnetic Biology and Medicine</i> , 24, 161-182, 2005	2005

A.10-A.20	INTERVIEWS	1983-1988, n.d.
------------------	-------------------	----------------------------

A.10-A.15	'HF Interviews (Stuttgart)'	n.d.
	Contents of ring binder so labelled by G.J. Hyland divided	

Biographical, A.5-A.41

into six for ease of reference: transcripts of interviews in English and German, recollections of Fröhlich, biographical articles, etc.

A.16	'Interview mit Prof. Fröhlich 4 März, 1988 & 9 März 1988' In German.	1988
A.17	Transcripts with manuscript corrections In German.	n.d.
A.18	Manuscript notes relating to interviews	N.d.
A.19	'Moving on: Experiences of a Scientist in Exile' Article published in <i>University of Liverpool Recorder</i> , October 1983, based on an interview with Fröhlich.	1983
A.20	Brief correspondence <i>re</i> interviews	1986
A.21-A.34	CAREER, HONOURS AND AWARDS	1930-1981
A.21, A.21A	Curriculum vitae and entries in biographical directories 2 folders. Includes a little correspondence found with the biographical information.	1970-1978
A.22-A.26	Lists of publications 5 folders.	

Biographical, A.5-A.41

A.27	D.Phil., University of Munich Photocopy of award certificate.	1930
A.28	Dublin Institute of Advanced Studies Correspondence and papers <i>re</i> possible move to Dublin in preparation for his retirement from Liverpool in 1973.	1970-1971
A.29	Max Planck Medal Telegram (photocopy) and letter <i>re</i> award to Fröhlich.	1972
A.30	University of Salford Correspondence and papers <i>re</i> Fröhlich's appointment to the Chair of Solid State Electronics at Salford on his retirement from Liverpool in 1973.	1973-1976
A.31	Dublin Institute of Advanced Studies Correspondence <i>re</i> Visiting Professorship 1974.	1972-1973
A.32	Possible Visit to China Correspondence with Chinese colleague <i>re</i> possible visit '1974/5'.	1973
A.33	Wolf Prize nomination Correspondence and papers <i>re</i> nomination of Fröhlich.	1980
A.34	Nobel Prize nomination Correspondence and papers <i>re</i> nomination of Fröhlich.	1981

Biographical, A.5-A.41

A.35-A.41	MISCELLANEOUS BIOGRAPHICAL ITEMS	1970-1991, n.d.
A.35-A.38	'Ballet also Kermode - Liverpool Great Georges etc' Contents of folder so inscribed	1970-1971
A.35-A.37	Correspondence and papers <i>re</i> 'Matter and Anti-matter' ballet for fundamental physics particles 3 folders. Fröhlich explained that the suggestion of a ballet based on properties of fundamental physical particles and processes arose in discussions with his wife who produced the sketch of the ballet. Correspondents include Jacques Rueff, Institut de France and John Tooley, General Administrator, Royal Opera House, Covent Garden.	1970-1971
A.38	Correspondence <i>re</i> support for Great Georges Arts Project in Liverpool	1971
A.39	Notes on relativity written by Fröhlich for his wife (information from G.J. Hyland) Parts 3 - 7 only.	n.d.
A.40	Drawing of Fröhlich	n.d.
A.41	Correspondence Includes letter from Fröhlich <i>re</i> history of solid state physics and the role of the British Electrical Industries.	1983, 1991

SECTION B	RESEARCH, B.367-B.605	1937-1990
------------------	------------------------------	------------------

References to Fröhlich's books in the form Fi, Fii, Fiii and Fiv and published papers in the form F1, F2, F3, etc relate to the 'Complete Bibliography (1930-1990)' prepared by G.J. Hyland at A.22.

B.367-B.442	BIOLOGY	
B.443-B.459	CONDENSED MATTER PHYSICS	
B.460, B.461	DIELECTRICS	
B.462-B.493	ELECTRODYNAMICS	
B.494-B.569	NON-LOCAL DIRAC FIELD THEORY	
B.570-B.601	NUCLEAR PHYSICS/ELEMENTARY PARTICLES	
B.602-B.605	SOLID STATE PHYSICS/SUPERCONDUCTIVITY	

B.367-B.442	BIOLOGY	1937-1988
--------------------	----------------	------------------

B.367-B.421	Alphabetical sequence of topic folders	1953-1988
--------------------	---	------------------

B.367	'Bio current'	1985
-------	---------------	------

Contents of folder so inscribed: correspondence with K.J. Blinowska, University of Warsaw; offprint; manuscript notes.

B.368-B.371	'Cummings Pinel Relativité en Biologie'.	1972-1978
-------------	--	-----------

Contents of folder so inscribed divided into four for ease of reference: correspondence, 'rough' draft of paper by F.W. Cummings and J.W. Prothero, copy of E. Pinel's 'La Relativité en Biologie', offprints.

Research, B.367-B.605

B.372-B.374	<p>'Enzymes, current'</p> <p>Contents of plastic folder so labelled divided into three for ease of reference: manuscript notes, correspondence, offprints, etc.</p>	1977-1979
B.375-B.380	<p>'Fatt - Pike Experiment on frog's eye'</p> <p>Contents of folder so inscribed divided into six for ease of reference: correspondence, manuscript notes, offprints, etc.</p> <p>Correspondents are E.R. Pike, Paul Fatt and P.E.R. Tatham.</p>	1965-1973
B.381-B.382	<p>'Lifshitz etc.'</p> <p>Contents of folder so inscribed divided into two for ease of reference: correspondence, manuscript notes, offprints.</p> <p>The material relates to H. Fröhlich, 'Coherent Excitations in Biological Systems', <i>Biofizika</i>, 22, 777-778, 1977 (Information from G.J. Hyland).</p>	1977
B.383-B.388	<p>'Limit cycle etc'</p> <p>Contents of folder so inscribed divided into six for ease of reference: typescript drafts, correspondence, manuscript notes, etc.</p> <p>Material & workings relating to 'Biological Control through Long-Range Coherence'. In <i>Synergetics</i> (ed H. Haken), pp241-246. 1977 (Information from G.J. Hyland).</p>	1974-1982
B.389-B.391	<p>'Maharishi'</p> <p>Contents of two folders so inscribed divided into three for ease of reference: correspondence and papers re meeting at Maharishi European Research University, Weggis, Switzerland, December 1975.</p> <p>Includes background papers on brain wave coherence in transcendental meditation.</p>	1975-1976

Research, B.367-B.605

B.392-B.395	'Mills'	1977-1982
Contents of folder so inscribed divided into four for ease of reference: correspondence, preprints etc.		
Relates to Biophysics / Ramifications by R.E. Mills of Fröhlich's paper 'Long-Range Coherence and Energy Storage in Biological Systems', <i>Intern. J. Quantum Chem.</i> 2, 641-649, 1968. (Information from G.J. Hyland).		
B.396-B.404	[Neuroscience]	1966-1984
Contents of Fröhlich's folder: two folders and loose papers.		
B.396-B.397	'Neuroscience Boston'	1974
Contents of folder so inscribed divided into two for ease of reference: correspondence and papers <i>re</i> MIT Neurosciences Research Program work session on 'Brain Interactions with Weak Electric and Magnetic Fields', Boston, Massachusetts, 10-12 November 1974.		
Fröhlich talked on the 'Possibilities of Long- and Short-Range Electric Interactions of Biological Systems'.		
B.398-B.400	'Neuro'	1974-1984
Contents of folder so inscribed divided into three for ease of reference: correspondence, manuscript notes, and background papers.		
B.401-B.404	Offprints, etc found loose in principal folder	1966-1977
4 folders.		
B.405-B.407	'Papers ...'	1972-1977
Contents of folder so inscribed divided into three for ease of reference: photocopies of Fröhlich's papers and related manuscript notes		
B.408-B.409	Photosynthesis Correspondence Various Papers'	1967-1983
Contents of folder so inscribed: correspondence,		

Research, B.367-B.605

photocopies of published papers, offprint, manuscript notes.

B.410-B.420 'Rouleaux formation' 1970-1988

Contents of folder labelled by G.J. Hyland 'Application of F150 to understanding of Rouleaux formation' divided into eleven for ease of reference: correspondence, preprints, offprints, etc.

F150 is 'Selective Long-Range Dispersion Forces between Large Systems', *Phys. Letters*, Ser. A 39, 153-154. 1972.

B.421 'Schaich etc contains F[röhlich] & [R.L.] Platzman'. 1953-1984

Contents of folder so inscribed: correspondence, offprints, photocopied papers, manuscript notes.

Fröhlich & Platzman is F86 'Energy Loss of Moving Electrons to Dipolar Relaxation', *Phys. Rev.* 92, 1152-1154. 1953.

B.422-B.436 Unlabelled folders 1937-1986

B.422-B.433 1977-1986

Contents of unlabelled plastic folder divided into twelve for ease of reference: correspondence, photocopies of published papers, typescript copies of papers, etc.

Includes correspondence and papers *re* cancer research.

B.434 Contents of unlabelled plastic folder: manuscript notes by Fröhlich, typescript draft paper by P. Lal, etc. n.d.

Includes manuscript notes titled 'Bio Theoretical Problems'.

Latest bibliographical reference (Lal's paper), 1981.

B.435 Contents of unlabelled plastic folder: manuscript notes, offprint of 1937 paper by F. London 1937, n.d.

Found with biophysical papers.

Research, B.367-B.605

B.436	<p>Contents of unlabelled plastic folder: correspondence and papers.</p> <p>Includes preprints of work on Raman spectroscopy of metabolically active bacteria sent to Fröhlich by S.P. Layne, Los Alamos National Laboratory.</p> <p>Relates to F171: (with S.J. Webb and M.E. Stoneham) 'Evidence for Non-thermal excitation of Energy Levels in Active Biological Systems', <i>Phys. Letters Ser. A</i> 63, 407-408. 1977. (Information from G.J. Hyland).</p>	1985-1986
B.437-B.442	Miscellaneous	1971-1988
B.437, B.438	'Self Organization of Matter and the Evolution of Biological Macromolecules' by M. Eigen	1971, 1973
B.437	Preprint of Eigen's paper submitted to <i>Naturwissenschaften</i> .	1971
B.438	<p>Papers found enclosed in preprint</p> <p>Manuscript notes and carbon of letter from Fröhlich to H. Matsuda, 16 May 1973, sending 'the remarks I promised you in connection with Eigens work'.</p>	1973
B.439	<p>Correspondence with E.G.D. Cohen and offprint by Cohen and colleagues</p> <p>Relates to Fröhlich's paper 'Collective Behaviour of Non-linearly Coupled Oscillating Fields with Applications to Biological Systems', <i>Collect. Phenom.</i> 1, 101-109. 1973. (Information from G.J. Hyland).</p>	1984-1986
B.440	<p>'Coherent Vibrations'</p> <p>Manuscript notes so titled.</p> <p>Relates to Fröhlich's paper 'Collective Behaviour of Non-linearly Coupled Oscillating Fields with Applications to Biological Systems', <i>Collect. Phenom.</i> 1, 1973. (Information from G.J. Hyland).</p>	n.d.

Research, B.367-B.605

- | | | |
|--------------------|---|------------------|
| B.441 | Note on the history of Fröhlich's paper 'Long-range coherence and energy storage in biological systems' (<i>Int. J. Quant</i> 2, 641-649. 1968) for Institute for Scientific Information | 1981, 1988 |
| B.442 | 'Possibility for Photosynthetic Membrane Witt'

1p manuscript note. | n.d. |
| B.443-B.459 | CONDENSED MATTER PHYSICS

Contents of bundle with note by G.J. Hyland 'Miscellaneous work in Condensed Matter Physics / Superfluids/Superconductors Flux quantization etc' | 1957-1971 |
| B.443 | 'Proposal for Measurement of Helium-II Condensate by F.W. Cummings, Queen Mary College, London and G.J. Hyland and G. Rowlands, University of Warwick

The proposal is stapled in University of Warwick School of Physics covers and labelled on front cover by Hyland 'Work relating to superfluidity & superconductivity within context of Reduced Density matrix approach F.139, 141, 142'.

Latest bibliographical reference, 1970.

Cummings was visiting from the University of California, Riverside. | n.d. |
| B.444-B.447 | Correspondence and papers found loose inside 'Proposal' at B.443

Includes typescript notes by Fröhlich headed 'Cummings; Hyland & Rowlands; Haug & Weiss; Lal & Terreaux', 20 May 1971; typescript papers 'A proposal for an experimental determination of the equilibrium condensate fraction in superfluid helium' by Hyland, Rowlands and Cummings, latest bibliographical reference 1970 and 'Hydrodynamics of a Superfluid Condensate' by Hylands and Rowlands, latest bibliographical reference 1970; correspondence with Hyland, J. Chela-Flores, Rowlands, 1970-1971; offprint of paper by Fröhlich 'The Macroscopic Wave Equations of Superfluids', <i>Phys. Kondens. Materie</i> 9 | 1969-1971 |

Research, B.367-B.605

(1969) and photocopied manuscript notes by Fröhlich 'Hydrodynamics of Superfluids' found enclosed within offprint.

4 folders.

B.448-B.449 'Electron-Phonon Taylor'. 1963-1965

Contents of folder so inscribed divided into two for ease of reference: manuscript notes, correspondence with J. Hadju, offprints by Hadju.

Relates to 'The Boltzmann Equations in Electron-Phonon Systems' (with A.W.B. Taylor), *Proc. Phys. Soc. (London)* 83, 1964. (Information from G.J. Hyland).

B.450-B.452 'Mass' 1957-1961

Contents of folder so inscribed divided into three for ease of reference: offprints by Fröhlich and others, typescript draft by Fröhlich 'Some Properties of Elementary Particles', latest bibliographical reference, 1957, manuscript notes.

Relates to 'Speculations on the Masses of Particles', *Nucl. Phys.* 7, 1958. (Information from G.J. Hyland).

At B.452 are manuscript notes found in folder (within principal folder) inscribed 'Odd Remarks / Magnitudes'.

B.453-B.456 'Rothwarf' 1965-1971

Contents of folder so inscribed divided into four for ease of reference: offprints by Fröhlich and others including A. Rothwarf, correspondence, manuscript notes.

At B.456 are offprints, manuscript notes found in folder (within principal folder), inscribed ? 'Stability & Super cond.'

'Workings & correspondence re F130, 132, 144, 149'. (Information from G.J. Hyland).

B.457 'Flux Bloch' n.d.

Contents of folder so inscribed: manuscript notes and photocopies of published papers by F. Bloch.

'Flux Quantiz. Eventually appeared in Fiv'. (Information

Research, B.367-B.605

from G.J. Hyland).

B.458-B.459	Manuscript notes, typescript drafts found loose in bundle. 2 folders.	n.d.
-------------	--	------

Includes material related to F126 and F139. (Information from G.J. Hyland).

B.460, B.461	DIELECTRICS	1957-1968
---------------------	--------------------	------------------

Correspondence, manuscript notes, offprints., etc.

2 folders.

B.462-B.493	ELECTRODYNAMICS	1965-1980
--------------------	------------------------	------------------

Manuscript notes, offprints by Fröhlich and others, etc.

Most of the material is in fact undated.

B.462-B.463	'Lorentz force etc'	1965-1976
-------------	---------------------	-----------

Contents of folder so inscribed divided into two for ease of reference: variously titled and paginated manuscript notes, letter from G.J. Hyland, 12 November 1975, photocopied papers, 1965-1976, etc.

'Bilocal Maxwell'. (Information from G.J. Hyland).

B.464	'Various old incl SU3 Keep Screw'	1965-1975
-------	-----------------------------------	-----------

Contents of folder so inscribed: variously titled and paginated manuscript notes, offprints including F121, letter from G.J. Hyland, 22 July 1975. Includes manuscript notes with note by Hyland dating them to 1968 'when HF was in Kyoto at the Res. Institute for Fund. Physics'.

'Novel Maxwell (2 component neutrino-like equations)'. (Information from G.J. Hyland).

Research, B.367-B.605

B.465-B.468	<p>'Nonlocal Maxwell Detailed write-up F_5 etc!'</p> <p>Contents of folder so labelled by G.J. Hyland divided into four for ease of reference: variously titled and paginated sequences of notes.</p>	n.d.
B.469-B.471	<p>'Soln for F_5 in nonlocal E/D'</p> <p>Contents of folder so labelled by G.J. Hyland divided into three for ease of reference: manuscript notes; letter from Hyland, 28 September 1978 enclosing typescript of his investigations on 'the "finite" electron'; offprint, 1980.</p>	n.d., 1978, 1980
B.472-B.474	<p>'Equations of Motion'</p> <p>Contents of folder so inscribed divided into three for ease of reference: manuscript notes.</p>	n.d.
B.475-B.476	<p>'Early but keep'</p> <p>Contents of folder so inscribed divided into two for ease of reference: manuscript notes. Includes notes on back of headed notepaper of Max-Planck-Institut für Festkörperforschung, Stuttgart.</p> <p>'E/D Stress Tensor'. (Information from G.J. Hyland).</p>	n.d.
B.477	<p>'Nonlocal Maxwell'</p> <p>Contents of folder so labelled by G.J. Hyland: manuscript notes.</p>	n.d.
B.478-B.485	<p>'Old / Keep' and 'Maxwell'</p> <p>Contents of folder so inscribed: 4 folders and loose papers.</p>	n.d.
B.478	<p>'Maxwell 16-Component'</p> <p>Contents of folder so inscribed: manuscript notes.</p>	n.d.

Research, B.367-B.605

B.479-B.481	'Space'	n.d.
	<p>Contents of folder so inscribed divided into three for ease of reference: manuscript notes, photocopy of paper by F. Kottler on 'Maxwell'sche Gleichungen und Metrik', 1922.</p> <p>'N/L E/D' (Information from G.J. Hyland).</p>	
B.482-B.483	'Gauge Generating Functions'	n.d.
	<p>Contents of folder so inscribed divided into two for ease of reference: manuscript notes.</p> <p>Includes notes on back of University of Liverpool 'From the Professor of Theoretical Physics' headed notepaper and notes on back of duplicated typescript note on International Conference on 'Collective Phenomena', Moscow, 27-29 December 1978.</p>	
B.484	'[?] / problems'	n.d.
	<p>Contents of folder so inscribed: manuscript notes.</p>	
B.485	Loose papers found in principal folder	n.d.
	<p>Manuscript notes.</p>	
B.486-B.488	'Space' and 'F ₅ '	n.d., 1976
	<p>Contents of folder so inscribed divided into three for ease of reference: manuscript notes, photocopy of published paper by A.S. Goldhaber 'Connection of Spin and Statistics for Charge-Monopole Composites', 1976.</p>	
B.489-B.490	'Non local E.D. 1969'	1965-1972
	<p>Contents of folder so inscribed divided into two for ease of reference: manuscript notes including 'New Remarks 1972'.</p> <p>At B.490 is offprint of Fröhlich's paper 'Geometrical Interpretation of Electrodynamics. An Analysis', <i>Progress of Theoretical Physics Supplement</i> (1965). F.121</p>	

Research, B.367-B.605

B.491	'Space - Screw - SU3' Contents of folder so inscribed: manuscript notes.	n.d.
B.492-B.493	'Old Calculations' Contents of folder so inscribed divided into two for ease of reference: manuscript notes and calculations, and typescript draft of paper by E.A. Remler 'Some Connections between Relativistic Classical Mechanics, Statistical Mechanics and Quantum Field Theory', February 1977. 'Old Maxwell'. (Information from G.J. Hyland).	n.d., 1977
B.494-B.569	NON-LOCAL DIRAC FIELD THEORY Most papers undated.	1979-1989
B.494-B.563	'Tetrad' Contents of box so inscribed	1979-1989
B.494	'Magnetic Currents in the Dirac Theory' 8pp typescript of unpublished paper by Fröhlich with date '1986' in pencil at the top of the first page. See also B.568.	1986
B.495	'Magnetic Currents in Dirac' 1p manuscript notes so titled, also headed 'Given to Bill Fairbank'.	n.d.
B.496-B.497	'Magnetic currents ... E-case' Contents of folder so inscribed divided into two for ease of reference: calculations.	n.d.

Research, B.367-B.605

B.498	'H-case'	n.d.
	Contents of folder so inscribed: calculations	
B.499-B.500	'Mass Reflexions ...'	n.d.
	Contents of folder so labelled by G.J. Hyland divided into two for ease of reference: manuscript notes.	
B.501-B.503	'blue and yellow, etc.'	n.d.
	Contents of folder so inscribed divided into three for ease of reference: manuscript notes.	
	Notes at B.501 were found in blue tinted plastic folder, those at B.502 in yellow tinted plastic folder.	
B.504-B.507	Contents of untitled folder divided into four for ease of reference: manuscript notes	n.d.
	Notes at B.507 were found in a folder within the principal folder.	
B.508-B.514	'Tetrad etc / 1988 / contains Yukawa'	1988-1989, n.d.
	Contents of folder so inscribed divided into seven for ease of reference: manuscript notes, calculations.	
	At B.511 is letter from G.J. Hyland, 6 November 1989 and at B.513 are calculations dated '8.1.88'. Most papers are undated.	
B.515-B.518	'SU4 [mathematical symbol for less than or equal to] 1985'	1979-c.1985
	Contents of folder so labelled divided into four for ease of reference: manuscript notes, photocopies of published papers by others.	
	Includes notes on back of University of Liverpool and University of Salford headed notepaper, on back of proofs of 'Coherent Excitations in Active Biological Systems' (ed Fröhlich and H. Kremer) 1983 and on back of typescript draft of paper 'Magnetic Currents in the Dirac Theory'.	

Research, B.367-B.605

At B.517 are notes on back of copy of letter from Fröhlich to F.H.C. Crick, 19 November 1984.

B.519	<p>'Space' and 'Vector Meson etc Hyland'</p> <p>Contents of folder so inscribed, also labelled by G.J. Hyland '1979 / 'Dirac/Kemmer Ord Lorentz Eq derivation': manuscript notes.</p> <p>Includes notes headed 'September 1979', most of the notes are undated.</p>	1979
B.520-B.521	<p>'... Dirac/Kemmer ... Gordon decomposition'</p> <p>Contents of folder so labelled by G.J. Hyland divided into two for ease of reference: manuscript notes and calculations.</p> <p>Includes manuscript working on University of Liverpool and 'Max-Planck-Institut für Fesetkörperforschung' headed notepaper.</p>	n.d.
B.522-B.526	<p>'Space'</p> <p>Contents of folder so inscribed divided into five for ease of reference: manuscript notes and calculations.</p> <p>Includes working on back of University of Liverpool and University of Salford headed notepaper</p>	n.d.
B.527-B.528	<p>Contents of untitled folder divided into two for ease of reference: manuscript notes and calculations</p> <p>Includes manuscript working on back of University of Liverpool and University of Salford headed notepaper</p>	n.d.
B.529-B.531	<p>'Space'</p> <p>Contents of folder so inscribed divided into three for ease of reference: variously paginated and titled manuscript notes including 'Bilinear Relations in the Dirac Equation', correspondence with G.J. Hyland, January - April 1981.</p>	n.d., 1981

Research, B.367-B.605

B.532	Contents of unlabelled plastic folder: variously paginated and titled manuscript notes including 'The 2-dimensional hyperbolic space' and 'Gauge and Gauge Invariant Fields'	n.d.
B.533	Contents of unlabelled plastic folder: manuscript notes and calculations including '8-space' and 'Lorentz example'	n.d.
B.534	'Null Tetrad etc' and '1987' Contents of folder so inscribed, also labelled 'Tetrad & masses': manuscript notes headed 'Principal Axes Transforms' and 'Principal Axes'.	1987
B.535	'... Articles, Masses'. Contents of folder so inscribed: manuscript notes, photocopies of published papers by others.	n.d.
B.536-B.541	'Mass reflexion' Contents of folder so labelled by G.J. Hyland divided into six for ease of reference: manuscript notes and calculations.	n.d.
B.542-B.545	Contents of folder with various inscriptions by Fröhlich including 'Current Space', '1987 contains Tetrads', 'Yukawa References ...' and 'in 1988', also labelled 'SU4 ...' by G.J. Hyland, divided into four for ease of reference: manuscript notes and calculations etc At B.543 are contents of plastic folder labelled 'SU3/4'. At B.544 are contents of unlabelled plastic folder found within labelled plastic folder at B.543. Includes notes on back of University of Salford headed notepaper.	n.d., 1987-1988
B.546	'Equation of Motions' Contents of folder so inscribed, also labelled by G.J. Hyland '... Importance of non local even locally / Summary of bilocal equations': manuscript notes	n.d.

Research, B.367-B.605

B.547-B.551	<p>Contents of untitled folder divided into five for ease of reference: variously titled and paginated manuscript notes including 'Equations of motion', 'Conservation Laws', etc.</p> <p>At B.547 is sheet with label attached which may relate to the contents of the folder: 'Early Tetrad use of R & A to get Eq of Motion'. Papers at B.548, B.549 and B.550 were found in three unlabelled plastic folders.</p>	n.d.
B.552-B.554	<p>'Space'</p> <p>Contents of folder so inscribed divided into three for ease of reference: variously titled and paginated manuscript notes including 'Equations of Motions: General Remarks', 'Equations of Motion', 'Dirac eqn - Non relativistic Pauli limit' and 'Dirac & Pauli eqns'.</p> <p>'Pauli limit of non local Dirac equation and spin current'. (Information from G.J. Hyland).</p>	n.d.
B.555-B.557	<p>'... Superconductor Expt'</p> <p>Contents of folder so labelled by G.J. Hyland divided into three for ease of reference: variously titled and paginated manuscript notes including 'Very important', 'Relations', 'Plane Wave' 'p+p- Relations' and 'Equation of Motion'.</p>	n.d.
B.558-B.559	<p>'Space'</p> <p>Contents of folder so inscribed, also labelled by G.J. Hyland 'Elaborations on ...' divided into two for ease of reference: variously titled and paginated manuscript notes.</p>	n.d.
B.560	<p>'Mass operator! ...'</p> <p>Contents of folder so labelled by G.J. Hyland: manuscript working found in labelled plastic folder within principal folder.</p>	n.d.
B.561-B.562	<p>'Bilinear ...'</p> <p>Contents of folder so labelled by G.J. Hyland divided into two for ease of reference: manuscript working.</p>	n.d.

Research, B.367-B.605

B.563	Papers found loose in 'Tetrad' box Includes manuscript notes 'On bilocal space'.	n.d.
B.564-B.569	Papers related to contents of the 'Tetrad' box but not found within it	n.d., 1979-1985
B.564-B.567	'Kemmer' Contents of folder so inscribed: correspondence and papers with explanatory notes by G.J. Hyland which are used in the catalogue entries.	n.d., 1979, 1984
B.564	'Correspondence relating to Kemmer Symposium' This was the symposium held at Edinburgh, 1 October 1979, in honour of Nicholas Kemmer on the occasion of his retirement.	1979
B.565	'Summary of Dirac Tetrad work, 5 years after Kemmer's Retirement Symposium in Edinburgh. The first two pages contain results reported at the Symposium. The second 2 pages report on findings subsequent to Edinburgh'	1984
B.566	'Extension to Kemmer meson theory of Dirac Tetrad work, which he [Fröhlich] spoke about at K's retirement Symposium in Edinburgh 1st Oct 1979' Includes transparencies.	n.d.
B.567	'Working & Sketches' for the preceding	n.d.
B.568	'Magnetic Currents in the Dirac Theory' Manuscript draft labelled by G.J. Hyland 'Manuscript original of the typed (unpublished) paper in TETRAD box'. See B.494.	n.d.

Research, B.367-B.605

B.569	Letter from M. Fierz-Biber, 15 October 1985 Photocopy. Labelled by G.J. Hyland 'Reply to an enquiry by HF (of Markus Fierz) concerning Dirac Bilinear Covariant ('TETRAD' Box)'.	1985
B.570-B.601	NUCLEAR PHYSICS/ELEMENTARY PARTICLES	c.1939-1989
B.570	'Chain-reactions in Uranium' Photocopy of early unpublished paper by Fröhlich and W. Heitler so titled with related later correspondence.	c.1939-1940, 1987, n.d.
B.571	'Fission produced by Cosmic Ray Neutrons' Photocopy of early unpublished paper by Fröhlich and W. Heitler.	n.d.
B.572-B.585	Contents of bundle with note 'Workings & attempted developments of F.106, 108, 110 & 116' by G.J. Hyland	1963-1966, n.d.
B.572	'A' Contents of folder so inscribed: manuscript working and offprint of Fröhlich's paper 'On Isobaric Spin Space'. Nucl. Phys. 45, 609-631. 1963. F116.	1963, n.d.
B.573	' α -A Algebras' Contents of folder so inscribed: manuscript working.	n.d.
B.574	'Current' Contents of folder: manuscript working and offprint of H. Fröhlich 'On isobaric spin space', Nucl. Phys., 45 (1963). F.116.	1963, n.d.

Research, B.367-B.605

B.575-B.577	<p>'Space Algebra / $A_3^{\text{superscript}}=A$'</p> <p>Contents of folder so inscribed divided into three for ease of reference: manuscript working.</p>	n.d.
B.578-B.580	<p>Contents of folder divided into three for ease of reference: manuscript working.</p>	n.d.
B.581-B.582	<p>'Development of F.121'</p> <p>Contents of folder so labelled by G.J. Hyland divided into two for ease of reference: offprint of H. Fröhlich 'Geometrical Interpretation of Electrodynamics An Analysis', <i>Progress Theoretical Physics</i> (Supplement) 1965 (F.121), correspondence, 1966, manuscript working.</p>	1965-1966, n.d.
B.583-B.585	<p>'Devel[opments]s of F116'</p> <p>Contents of folder so labelled by G.J. Hyland divided into three for ease of reference: manuscript working.</p>	n.d.
B.586-B.594	<p>Contents of bundle with note by G.J. Hyland 'Miscellaneous unpublished attempts in Particle Physics & extended space'</p>	n.d., 1963-1973
B.586-B.588	<p>'Generators [?] / 1969' and 'Important Formulas'</p> <p>Contents of folder so inscribed, also labelled 'Conformal Group & SU(3)' by G.J. Hyland, divided into three for ease of reference: manuscript working, variously titled and paginated manuscript notes, offprints of Fröhlich and C. Terreaux's paper 'Isobaric Spin Algebra' <i>Nucl. Phys.</i> 42, 21-26 (1963) F115 and Fröhlich's paper 'On Isobaric Spin Space', <i>Nucl. Phys.</i> 45, 609-631 (1963) F116.</p>	1963-1969, n.d.
B.589-B.592	<p>'Screw up to [?] 1972'</p> <p>Contents of folder so inscribed, also labelled 'Work on Twisted Space - never published' by G.J. Hyland, divided into four for ease of reference : manuscript working, variously titled and paginated manuscript notes, photocopied papers by others.</p> <p>Papers at B.592 were found in folder (within principal</p>	n.d., 1972

Research, B.367-B.605

folder) inscribed 'Twisted Space in General Relativity'.

B.593 'Complex Space' n.d., 1973

Contents of folder so labelled: 2 papers by J. Sarfatt, Collective Phenomena, 1973; manuscript working.

B.594 'Measure' and 'Dirac Electron' n.d.

Contents of folder so inscribed, also labelled 'Early Dirac' by G.J. Hyland: variously titled and paginated manuscript notes.

B.595-B.598 'SU3 Also Kamal modification continuous representation' n.d., c.1970

Contents of folder so inscribed, also labelled by G.J. Hyland 'Unpublished work on SU(3)', divided into four for ease of reference: typescript draft by Fröhlich titled 'SU(3)' with manuscript inscription 'not for publication'; variously titled and paginated manuscript notes; typescript draft titled 'U(2) and SU(2)' with manuscript inscription 'Kamal'; and typescript draft by F.A. Kaempffer 'A model of neutral mesons based on invariance under duality rotations' with manuscript inscription by the author 'Not for publication', latest bibliographical reference 1970.

B.599-B.601 Contents of unlabelled plastic folder divided into three for ease of reference: manuscript notes, correspondence, two offprints of H. Fröhlich's paper 'On Isobaric Spin Space', *Nuclear Physics* 45 (1963) F.116 with manuscript notes enclosed 1963-1989

B.602-B.605 SOLID STATE PHYSICS/SUPERCONDUCTIVITY n.d., 1960-1990

B.602 Manuscript notes headed 'Jumping General', 'Approximations', 'Sewell' found clipped together N.d.

Relates to F101, F104, F.117, F.118. (Information from G.J. Hyland).

Research, B.367-B.605

B.603	'Superconductivity' by P.W. Anderson and B.T. Matthias, Bell Telephone System Monograph 4824. 1964; correspondence found enclosed within publication, 1960-1990	1960-1990
B.604	Manuscript draft by Fröhlich beginning 'In the discussion between P.W. Anderson & B.T. Matthias, amusing as it sounds, certain very general questions concerning Physics as a whole are touched'. May relate to publication by Anderson and Matthias at B.603.	n.d.
B.605	Manuscript notes Possible connexion with F122, F130 and F138. (Information from G.J. Hyland).	N.d.

SECTION C	PUBLICATIONS, C.122, C.123	1960, 1970
C.122	<p>'Space-time reflections, isobaric spin and the mass ration of bosons', <i>Proc. Roy. Soc. (London)</i>, Ser. A 257, 147-164 (F106) and 'Light quanta and heavy bosons', <i>Proc. Roy. Soc. (London)</i>, Ser. A 257, 283-290 (F107)</p> <p>Correspondence with the Royal Society re publication.</p>	1960
C.123	<p>'Wohinführt die Physik?', <i>Bild der Wissenschaft</i> 8(1), 64-70 1971 (F148)</p> <p>Invitation to write article.</p>	1970

SECTION D	LECTURES, D.70-D.93	1939-1976
D.70	<p>University of Bristol hardback notebook used from the front for lecture courses '1939/40 Atomic Theory for Chemists', '1940/41', '1942 (-43)' and '1943 I. Statistical Mechanics' and from the back for problems in statistical mechanics, n.d. and '1940/41'</p> <p>Enclosed at front are University of Bristol chemistry examination papers, 1939-1941.</p>	1939-1943
D.71	<p>Hardback notebook used from the front for lecture course 'Introduction to Theoretical Physics 1944/45' and from the back for lectures on 'Theory of Radiation 1944', 'Statistical Mechanics 1944', 'Electro-Dynamics 1944', 'Electrodynamics 1946/47', 'Relativity 1947' and 'Relativity 1948'.</p> <p>See also D.72.</p>	1944-1948
D.72	<p>Printed, duplicated and typescript University of Bristol and University of Liverpool examination papers and questions found enclosed in notebook D.71</p>	1942-1949
D.73	<p>Hardback notebook used from the back for lectures on 'Meson Field Theory 1945/46' and 'Nuclear Theory 1946/7'</p> <p>At front is ?transcript of paper by W. Pauli 'Pauli Solvay Report', and notes on papers by Eddington and Rarita and Schwinger and research notes on pseudo-scalar meson theory, vector meson theory and magnetic moment of proton.</p>	n.d., 1945-1947
D.74	<p>University of Bristol hardback notebook used for mathematical formulae</p> <p>? re teaching.</p>	N.d.
D.75-D.79	<p>'Statistical Mechanics' lectures given by Fröhlich at Purdue University, West Lafayette, Indiana, Spring Semester</p> <p>Title page, index and 129pp duplicated typescript.</p> <p>5 folders</p>	1950 /...

Lectures, D.70-D.93

- /... This record of Fröhlich's lectures was 'based on notes taken by R.M. Baum and E. Strick'.
- Fröhlich is quoted on the title page: 'Unfortunately I did not have the time to look very carefully through the manuscript'.
- cf D.65-D.69 of the previous catalogue NCUACS 159/2/08.
- D.80 'Electrons in Crystals' lectures given by Fröhlich at Purdue University, West Lafayette, Indianan, Spring Semester 1953
- Bound volume of duplicated typescript.
- With note on title page 'These notes on Professor Fröhlich's lectures were taken by Dr P. Feuer and M. Freiser. Professor Fröhlich examined the manuscript only briefly and is not responsible for any errors that may appear here'.
- D.81-D.86 'Stuttgart Lectures (1966)' 1966
- Contents of plastic folder so labelled by G.J. Hyland divided into six for ease of reference: manuscript notes and sequence of five duplicated typescript lectures headed '1. Vorlesung', '2. Vorlesung' and so on. In German.
- cf. D.28-D.32 in previous catalogue NCUACS 159/2/08.
- D.87-D.90 Lectures given by Fröhlich at University of Stuttgart, West Germany, Summer Semester 1969
- Manuscript notes and 67pp duplicated typescript of four lectures. In German.
- 4 folders.
- cf D.18-D.21 in previous catalogue NCUACS 159/2/08.
- D.91, D.92 Lectures given by Fröhlich at the University of Stuttgart, West Germany, Summer Semester, 1971 1971
- 'Lecture Notes on the Many-body problem (Density matrices)'. Contents of plastic folder so labelled by Hyland divided into two for ease of reference: 15pp photocopied typescript and transparencies. In German.

/...

Lectures, D.70-D.93

/... cf D.22 in previous catalogue NCUACS 159/2/08.

D.93

'Order and organisation in Physics and Biology'

1976

20 pp typescript of lecture by Fröhlich 'arranged by C. Terreaux from the tape recording of a [University of Liverpool] Faculty Lecture delivered on 15th January, 1976'.

SECTION F	CORRESPONDENCE, F.337-F.354	1954-1990
------------------	------------------------------------	------------------

F.337	SCIENTIFIC CORRESPONDENCE	1973-1990
--------------	----------------------------------	------------------

Scientific correspondence.

F.338-F.354	REFERENCES AND RECOMMENDATIONS	1954-1989
--------------------	---------------------------------------	------------------

F.338-F.351A	Max Planck Medal	1972-1989
---------------------	-------------------------	------------------

Nominations.

Unindexed.

F.338	1972
-------	------

F.339	1973
-------	------

F.340	1974
-------	------

F.341	1975
-------	------

F.342	1976
-------	------

F.343	1977
-------	------

F.344	1978-1979
-------	-----------

F.345	1980
-------	------

Correspondence, F.337-F.354

F.346 1981-1982

F.347 1983

F.348 1984

F.349 1985-1986

F.350 1987

F.351 1988

F.351A 1989

F.352-F.354 Nobel Committee for Physics 1954-1971

Nominations.

Unindexed.

F.352 1954

F.353 1968

F.354 1971