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22 December, 1983

Professor D.S. Mathewson,
Director,
MOUNT STROMLO

Thank you for your letter of 20 December and for sending me a copy of your Annual Report. You must win the all time record for getting the annual report out promptly, that is at least 12 days before the earliest possible due date.

I am delighted to see that Starlab and the 2.3 metre telescope are going so well.

With best wishes,

Yours sincerely,

PETER KARMEL

Mount Stromlo and Siding Spring Observatories

Director: Professor D.S. Mathewson

Research School of Physical Science
The Australian National University

Private Bag
Woden Post Office, ACT 2606
Canberra, Australia
Telegrams CANOPUS Telex AA 62270
Telephone 062-88-1111

20 December 1983

Professor P H Karmel
Vice-Chancellor
Australian National University

Dear Professor Karmel:

Thank you for your support for the 2.3-m telescope. It is very much appreciated by all of us here at MSSSO.

I have enclosed our Annual Report which demonstrates that in return for this support, we attempt to raise our output to the highest possible level of excellence.

Yours sincerely,

Don

D S Mathewson

Encls

MOUNT STROMLO AND SIDING SPRING OBSERVATORIES

ANNUAL REPORT 1983

STAFF

Professor and Director of the Observatories	D.S. Mathewson, MSc Qld., PhD Manc.
Professorial Fellows	K.C. Freeman, BSc W.Aust., PhD Camb., FAA
	A.W. Rodgers, BSc Syd., PhD
Senior Fellows	M.S. Bessell, BSc Tas., PhD
	D.J. Faulkner, MSc Qld., PhD
	A.R. Hyland, BSc Qld., PhD
	A.J. Kalnajs, SB MIT, PhD Harv.
	J.E. Norris, BSc, PhD
	N. Visvanathan, BSc Madras, PhD
	M.A. Dopita, MA Oxf., MSc PhD Manc.
Senior Research Fellows	E.B. Newell, MSc Melb., PhD (to 21 September 1983)
	B.A. Peterson, ScB MIT, MS PhD Caltech.
	I.R. Tuohy, BSc PhD Adel.
	P.R. Wood, BSc Qld., PhD
Research Fellows	G.V. Bicknell, MSc PhD Syd.
	R.A. Gingold, BSc Monash, PhD
	K. Kawara, DSc Kyoto (from 12 May 1983)
	W.L.M. Peters, BS Loyola, New Orleans, PhD Texas
	D. Carter, BA Oxf., PhD Camb.
Postdoctoral Fellows	E.M. Green, BS Stanford, MS PhD Texas
	N.A. Sharp, BA PhD Camb.
Visiting Fellows	W.N. Christiansen, DSc Melb., Hon DSc Eng Syd., FAA
	P.J. Edwards, BSc PhD Tas.
	S.C.B. Gascoigne, MSc NZ, PhD Brist., FAA

Visiting Fellows - cont'd	M.L. McCall, BSc Victoria, MA PhD Texas
	P. Seal, MSc Jadavpur, PhD Calcutta (to 31 December 1983)
	P.C. van der Kruit, PhD Leiden (left August 1983)
	C. Alcock, BSc Auckland, PhD Caltech.
	P.L. Cottrell, BSc Adel., PhD
	M. Bottema, PhD Groningen
	E.B. Jenkins, AB Univ Calif. Davis, PhD Cornell
	H.C. Ford, BS Oklahoma, PhD Wisconsin
	M. Scholz, Phys Diploma PhD Hamburg
	J.A. Thomas, BSc Adel., PhD Qld., DSc Melb.
Research Officer	V.L. Ford, B.App.Sc. CCAE.
Research Assistant	P. Harding, B.App.Sc. CCAE.
Librarian	D. Gerlach, BSc Adel., ALAA
Students	M.C.B. Ashley, BSc ANU, MSc Caltech.
	J.M. Brett, BSc Murdoch
	D.A.H. Buckley, BSc MSc Canterbury
	R.A. Cameron, BSc BE Adel.
	C.S. Coleman, BSc Syd.
	I.N. Evans, BSc W. Aust.
	M.W. Fox, BSc Melb.
	I.R. Hercus, BSc
	D.J. Hillier, BSc Melb.
	N.E.B. Killeen, BSc Adel.
	A. Kulessa, BSc
	C.M. Lance, BSc Univ. of London
	J.R. Lewis, BA Virginia
	H.L. Morrison, BA BSc Melb.
	G. Paltoglou, BSc Melb.

Students - cont'd	A.J. Pickles, BSc Birmingham, MSc Sussex
	K.U. Ratnatunga, BSc Ceylon, MSc Pittsburg
	G. Rowley, BSc Qld.
	R.A. Ruelas Mayorga, MSc Manc.
	R.M. Smith, BSc St Andrews
	S.M. Straw, BSc N'castle-upon-Tyne
	P.F. Teague, BSc Adel.
	R.J. Wainscoat, BSc W. Aust.
	G.A. Wilson, BSc Newcastle
	D.M. Zarro, BSc Syd.
The Administrator	E.B. Newell, MSc Melb., PhD (commenced 22 September 1983)
Executive Officer	N.R. Stokes, MSc (left 18 March 1983)
Assistant to Executive Officer	W. Flynn
Clerks	G.F. Benzin
	M.C.C. Lees
	L. Farrell (commenced 3 March 1983)
	P. Hill (commenced 14 March 1983)
Cleaners	M. Angelic
	M. Gagulic
Driver/Cleaner	A.W. Trounson
Driver	H. Norgrove
Fire and Security Officer	N.J. Cunynghame
Secretaries	S.G. Khouri
	M. Sharr (left 18 February 1983)
	A.E. Strudwicke, BA CCAE.
Publications Officer	S.O. Parkes
Photographer	K. Smith, Photo Technician's Cert., SAIT

Night Assistants	J. McKinlay
	D.J. Manuel
	J.H. Wach, BSc Vic.
<u>Mechanical Engineering</u>	
Chief Engineer	J.A. Hart, BE Mech NSW.
<u>Design Office</u>	
Engineer	H. Wehner, Cert. Eng. Munich, M.I.E. (Aust.)
Senior Technical Officers	P.C. Linstead, O N Cert Lond., de Havilland Aeronautical Tech. Coll. Cert.
	P.G. Conroy, Cert. Mech. Eng. CTC.
Senior Draftsmen	G.J. Koci, Cert. Prec. Mech. & Opt. Czech.
	F.R. Johnson, Mech. Eng. Cert. C TC, Assoc. Dip. Appl. Sc. CCAE.
<u>Mechanical Workshop</u>	
Workshop Manager	J.D. Irons, Cert. Mech Eng. UK
Leading Hand	N.H. Banham
Senior Laboratory Craftsmen	H.L. Gebauer, Cert. Mech. Eng.
	R.J. Miles
	H.E. Pennefather, Cert. Mech. Eng. Belfast Col. Tech.
	L. Jaquier
	L.E. Parkes
	C. Vest
Carpenter	P. Mackin
Attendant	D. Mitchell
<u>Optical Workshop</u>	
Senior Technical Officer	G. Bloxham, Dip. App. Phys. Gordon Inst. Tech.
Technical Officer	T.F. Waller
<u>Electronics</u>	
Acting Chief Engineer	J. van Harmelen, Drs Delft

Electronics - cont'd

Engineers	G.R. Hovey, BSc Monash, PhD
	M.D. Downing, B.App.Sc. M.App. Sc. Melb.
	H.A. Lewis, BSc Capetown
	R. Gorham, BE (Qld), Dip Comp Sc. (Qld) (left 8 April 1983)
	T.I. Hobbs, BSc (Hons), PhD (Adel) (left 8 July 1983)
	D.J. King, BE (Hons) NSW, (commenced 21 November 1983)
Head Technical Officer	R.E. Moon, E & C Cert CTC, B.App.Sc. CCAE.
Senior Technical Officers	J.C. Findlay, O N Cert. Elec. Eng. UK.
	M.A. Szuszkiewics, E & C Cert. Nth Syd. TC.
Technical Officers	D.L. Bullock
	G.R. Hausler
	A. Lagos
	D.T. May
	A.R. Roberts
	D.E. Andriolo

Computing Laboratory

Senior Programmer	B.C. Cogan, BA Coll of Wooster, MS PhD Mich.
Programmers	B. Durnota, BSc La Trobe (left 30 April 1983)
	P.J. Keogh
	P. Morris Kennedy
	H. Matić, BSc Zagreb (commenced 1 June 1983)
Yale Columbia Observers	P.A. Ianna, BA MA Swarthmore, PhD Ohio State
	D. Saunders

STARLAB PROJECT

SIP Project Manager	T.E. Stapinski, BE Qld., M. Eng. Sc. NSW.

STARLAB PROJECT - cont'd

SIP Technical Manager	P. Rollier, Diploma from Ecole Nationale Superieure de l'Aéronautique et de l'Espace Paris/Toulouse
SIP Project Controller	D. Harris, BE Elec. Melb., MBA NSW.
Consultant from Ball Aerospace	M. Bottema, PhD Groningen
SIP Systems and Interface Manager	D. Dubet, Diploma from Ecole Centrale Paris
Software Team Leader	P. Brown, BSc (Hons) London
Consultant from CSA	S. Gardiner, BSc (Hons), PhD Glasgow
Detector Team Leader	E. Roberts, BE Elec. (Hons), BSc NSW.
Detector Engineer	D. Carden, B.App.Sc. CCAE.
Product Assurance Manager	D. Henry, BSc (Hons)
SIP Technical Manager	J-N Rolland, Diploma from Ecole Nationale Superieure d'Electricite et de Mecanique, Nancy (left August 1983)
Secretary	J. Gerhardy, BA ANU, Grad. Dip. Sec. Studies CCAE.
Typist and Clerical Assistant	H. Clothier
Part-time Typist	V. Baas-Becking

Siding Spring Observatory

Superintendent	R. Roberts, Cert. Mech. & Prod. Eng. UK.

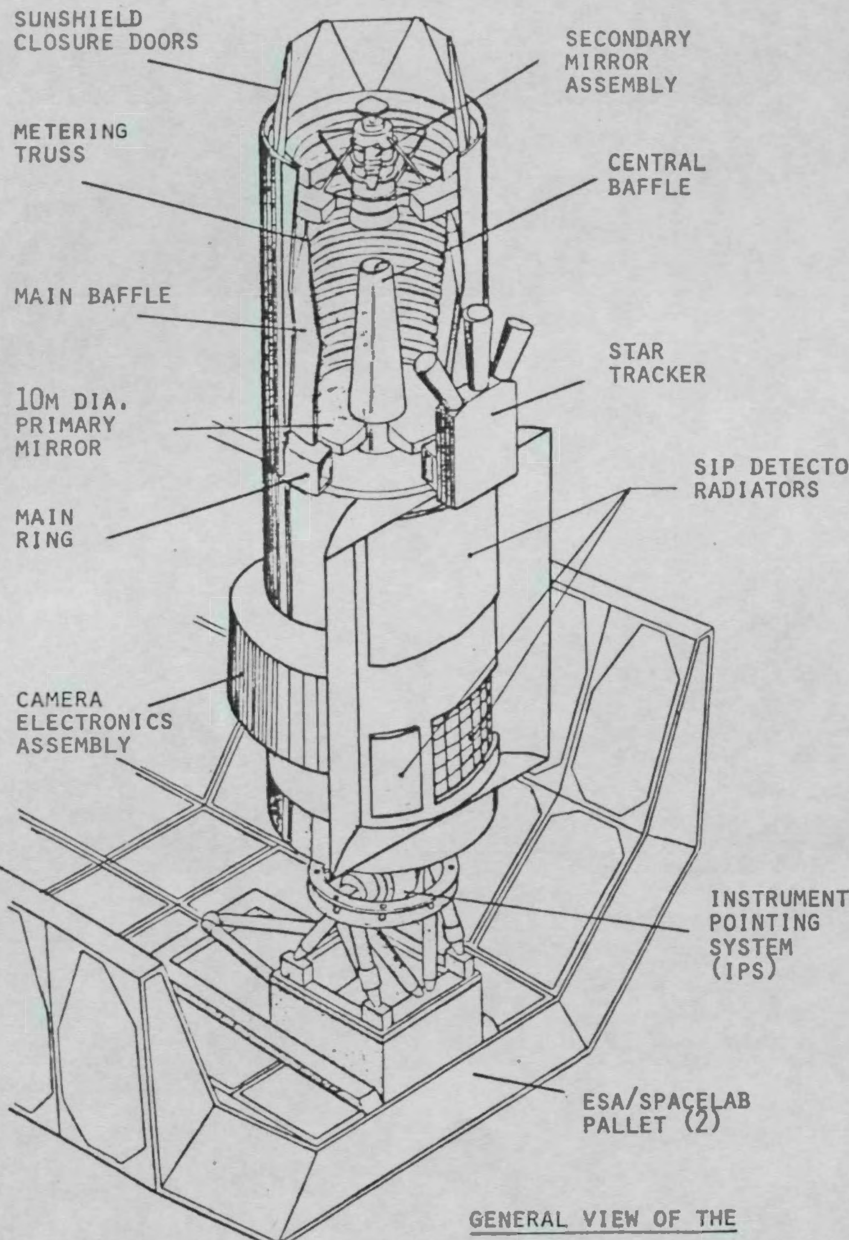
Administration

Clerk	M.L. Gillingham
Forester/Fire Officer	R.A. Fenwick
Groundsman	P.M. Burns

Mechanical Engineering

Workshop Foreman	G.B. Bradshaw, Mech. Eng. Cert. TAFE Canberra
Technical Officers	E.D. Coyte
	A.W. Green

<u>Mechanical Engineering</u> cont'd	
Technical Officers	P.S.G. Bakker
Laboratory Craftsmen	B.E. Emmott (retired 19 July 1983)
	A.R. Bacon (commenced 2 May 1983)
Carpenter	T.R. Jackson
<u>Electronics</u>	
Senior Technical Officer	J.L. Atkin
Technical Officer	A. Arms
<u>Siding Spring Lodge</u>	
Manageress	M. Ciempka
Domestic Staff	C. Irvin
	M.D. Noy
	E.R. Rafferty, BA Armidale
<u>Siding Spring Exhibition</u>	
Custodian	S.M. Dicks



GENERAL VIEW OF THE
STARLAB FACILITY

OVERSEAS VISITS AND CONFERENCES

M.S. Bessell, University College London, June, Observatoire de Paris, Meudon, July.

D. Carden, SPIE Instrumentation in Astronomy V Conference, London, September.

D. Carter, Canada-France-Hawaii Telescope, Hawaii, April; Institute for Astronomy, University of Hawaii, April; Physics Department, Durham University, July; Institute for Astronomy, University of Cambridge, August; Royal Greenwich Observatory, August; Royal Observatory Edinburgh, August; Astrophysics Department, University of Oxford, August; Toulouse Observatory, France, September.

W.N. Christiansen, Board Meeting of URSI, Brussels, September.

B.C. Cogan, Anglo-Australian Observatory Computer Working Group meeting in the UK, September.

M.A. Dopita, Cerro Tololo Interamerican Observatory, Chile; STARLAB Scientific Sub-committee meetings, Royal Greenwich Observatory, Sussex, September.

K.C. Freeman, STARLAB Imager Sub-committee meeting, NASA Goddard Space Flight Center, Maryland, January 31 - February 2; STARLAB Joint Sub-committee meeting, Royal Greenwich Observatory, September; Landsdowne Visitor, University of Victoria, BC, February; ACIAAT and AAT Computer Working Group meetings, UK, September; Lectures at MIT and Yale, May; Spring Lecture series at Princeton University, May.

E.M. Green, Kitt Peak National Observatory; Steward Observatory; University of Texas Astronomy Department; Yale University Observatory; Dominion Astrophysical Observatory, June - July.

A.R. Hyland, Mauna Kea Observatory, Hawaii, June.

M.L. McCall, York University, Downsview, Ontario, October.

J.E. Norris, Outside Studies program, Steward Observatory, Tucson, and Dominion Astrophysical Observatory, Victoria, August 1982 - August 1983.

W.L.W. Peters, American Astronomical Society Meeting, Minneapolis, June.

B.A. Peterson, STARLAB Imaging Sub-committe, NASA Goddard Space Flight Center, Maryland, February; Space Telescope Science Institute, Baltimore, February; STARLAB Grism Study Group, Dominion Astrophysical Observatory, Victoria, June; University of British Columbia, Vancouver, June.

I.R. Tuohy, STARLAB Data and Operations Sub-committee meeting, Goddard Space Flight Center, Maryland, September 20 - October 3.

T. Hobbs, Visit manufacturers of possible STARLAB components, USA, April-May.

E. Roberts, Visit manufacturers of possible STARLAB components, UK and USA, September.

P. Brown, Data and Operations Sub-committee meeting, Goddard Space Flight Center, Maryland, September.

T.E. Stapinski, STARLAB Project Management meeting, Canada, April.

J-N. Rolland, STARLAB Project Management meeting, Canada, April.

D. Dubet, STARLAB Project Management meeting, Canada, April.

STARLAB Joint Science Working Group, NASA Goddard Space Flight Center, Maryland, April
D.S. Mathewson, A.R. Rodgers, T.E. Stapinski, I.R. Tuohy.

Overseas Conferences

IAU Symposium 78, 'Schmidt Type Telescopes', Asiago, August 28 - September 1
D. Carter, "Elliptical Galaxies with Shells".

IAU Symposium 80, 'Double Stars, Physical Properties and Generic Relations', Bandung, June
D.A.H. Buckley, "Observations and Models of Some Neglected Southern Eclipsing Binaries".

IAU Symposium 105, 'Observational Tests of the Stellar Evolution Theory', Geneva, September
P.R. Wood and D.J. Faulkner, "On the Termination of Asymptotic Giant Branch Evolution".

IAU Symposium 108, 'Structure and Evolution of the Magellanic Clouds', Tübingen, September (the underlined presented the paper)
D.S. Mathewson and V.L. Ford, "HI Surveys of the Magellanic System".
K.C. Freeman, Review Lecture "Kinematics and Dynamics of the Magellanic Clouds".
M.A. Dopita, "Supernova Remnants in the Magellanic Clouds".
P.R. Wood, M.S. Bessell, G. Paltoglou and K. Ratnatunga, "A Search for Red Variable Stars in the LMC".
M.S. Bessell, "Spectroscopy of Red Variables and Other Upper AGB Stars".

European Physical Society Meeting, Trieste, September,
D. Carter, "Fibre Optic spectra and the dynamics of Sersic 40/6".

COSPAR/IAU Symposium, 'Advances in High Energy Astrophysics and Cosmology', Rogen Bulgaria, July
N. Visvanathan, "Global Value of the Hubble Constant".

10th International Conference, 'General Relativity and Gravitation', Padova, July
G.V. Bicknell and R.A. Gingold, "Tidal Detonation of Black Holes".

Overseas Conferences - continued

24th Liege Astrophysical Conference, 'QSOs and gravitational lenses', Liege, June

B.A. Peterson, "QSO Absorption Lines".

Herstmonceux Conference on 'Observational Cosmology', Herstmonceux Castle, Sussex, June

M.S. Bessell

Summer Workshop on 'Globular Clusters: Aspen, Colorado, June - July

E.M. Green

Workshop on 'Cool Giants and Supergiants', Kitt Peak National Observatory, Tucson, January

J.E. Norris

Local Conferences

STARLAB Joint Science Working Group Meeting, Mount Stromlo Observatory, November

D.S. Mathewson, A.R. Rodgers, T.E. Stapinski, M.A. Dopita.

17th Annual General Meeting of the Astronomical Society of Australia held at University of New South Wales, Sydney, in May 1983

M.S. Bessell, "The Space Density of Hot White Dwarfs".
G.V. Bicknell, "The Morphology and Surface Brightness of Extragalactic Jets".
D.J. Faulkner and R.R. Shobbrook, "1981-82 Observations of Beat Cepheids U Trianguli Australis".
A.R. Hyland, "The Search for Protostars in the Magellanic Clouds".
D.S. Mathewson, "STARLAB".
W.L.W. Peters, "CO Emission vs. HI Self-Absorption".
P. Seal and A.R. Hyland, "The Stellar Population in the SMC Region N76B.

Local Conferences - continued

AAT Research Symposium, Epping, March

P.R. Wood, "Shell Ejection from the Variable Carbon Star HV2379".

A.R. Hyland, "The late stellar population in the bar of the LMC".

N. Visvanathan, "Global value of the Hubble Constant".

"The Gascoigne Research Symposium" was held November 21 and 22. A total of 44 papers were presented by astronomers and students. Each paper concerned their "best result" for the year.

The following attended conferences at -

W.L.W. Peters, "Entropy and Images", CSIRO Division of Radiophysics, Epping, February. IAU/URSI Symposium on Indirect Imaging, CSIRO Division of Radiophysics, Epping, August.

A.R. Hyland spent two weeks at Richmond, NSW, to take part in four flights on the Kuiper Airborne Observatory.

B.C. Cogan, P. Keogh, R. Vallak, Decus VAX Programmers Workshop, Monash University, May.

B.C. Cogan and P. Keogh, Decus Australia Symposium, University of Auckland, August.

HONOURS

J.E. Norris received a Fulbright Travel Grant from the Australian American Education Foundation to facilitate his Outside Studies Program.

W.N. Christiansen was awarded Honorary degree of Doctor of Engineering by the University of Melbourne.

M.A. Dopita was awarded the Pawsey Medal of the Academy of Science for his work in astrophysics.

MEMBERSHIP OF COMMITTEES

D.S. Mathewson,	STARLAB Joint Science Working Group STARLAB Program Management Committee Australia Telescope Advisory Committee Faculty Board, Research School of Physical Sciences National Committee for Solar-Terrerstrial and Space Physics Chairman, Space Research Sub-committee of the Australian Academy of Science.
I.R. Tuohy,	STARLAB Data and Operations Sub-committee (Chairman) Australian STARLAB Science Advisory Committee Time Assignment Committee for the Parkes Telescope Space Research Sub-committee of the Australian Academy of Science.
G.V. Bicknell,	Australia Telescope Scientific Objectives Committee
M.S. Bessell,	A Secretary of the Astronomical Society of Australia Accreditation Panel for Astronomy courses in ACT Colleges Representative for Astronomy in organizing panel for Physics in 1984 ANZAAS meeting.
A.R. Rodgers,	Member of ANU Council Anglo-Australian Telescope Time Assignment Committee STARLAB Joint Science Working Group.
M.A. Dopita,	STARLAB Joint Science Working Group STARLAB Project Management Group

Membership of Committees - continued

M.L. McCall, Australian STARLAB Science Advisory Committee

R.A. Gingold, Working Party on Computing Graphics
Computer Centre Users Committee.

W.N. Christiansen, "Overview Committee" on International Scientific Exchanges of the Department of Science and Technology.

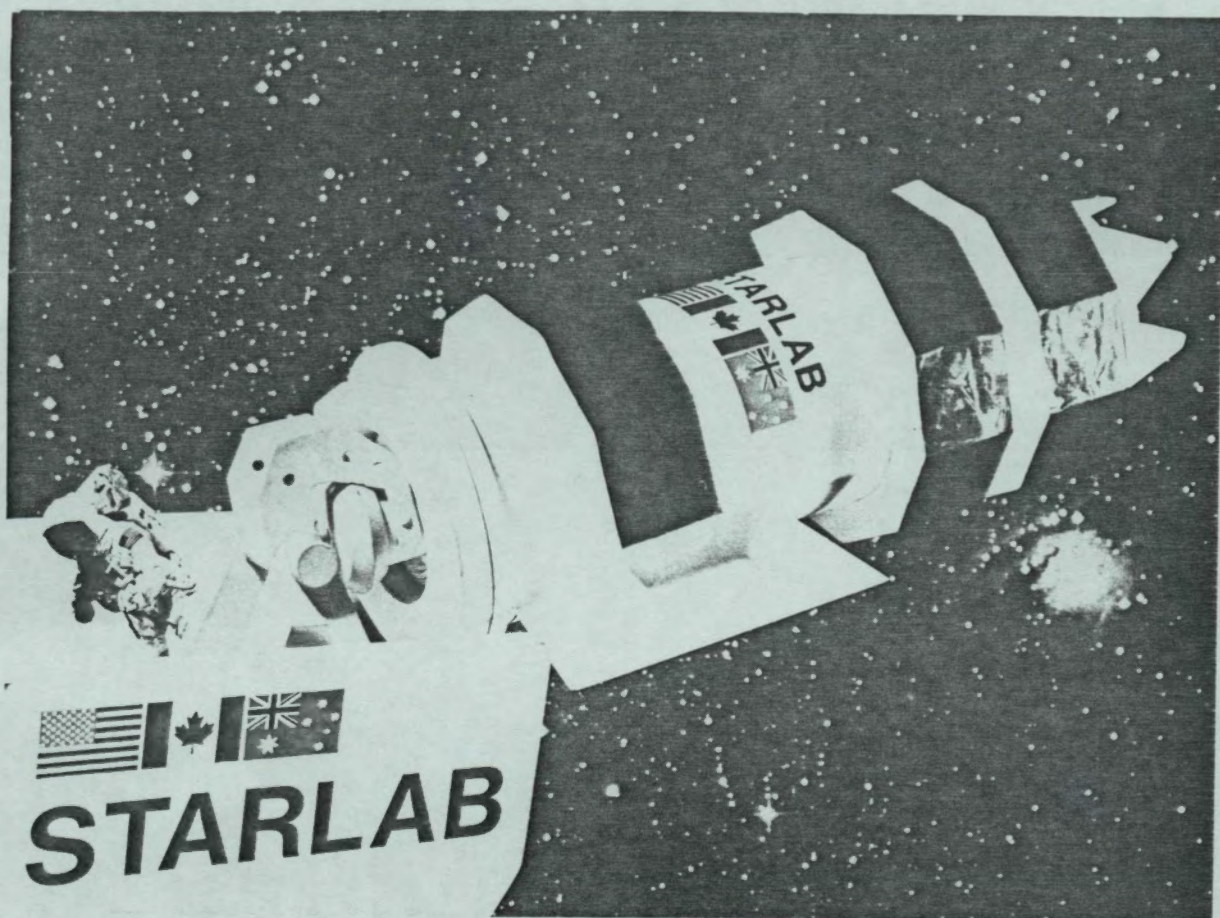
K.C. Freeman, STARLAB Imager Sub-committee
STARLAB Calibration and Performance Sub-committee
Australia Telescope Science Objective Committee
Advisory Committee for Instrumentation for the AAT (ACIAAT): Chairman
Faculty Board, Research School of Physical Sciences
President, IAU Commission 37 (Star Clusters).

T.E. Stapinski, STARLAB Project Management Group

N. Visvanathan, STARLAB Polarization Study Group (Chairman)

B.C. Cogan, Member of AAO's Computer Working Group
Member of the University's Computer Requirements

P. Keogh, Chairman, DECUS Special Interest Group on Structural Languages.



STARLAB - A UV-optical space telescope. A collaborative project between Australia, Canada and the USA. MSSSO has received $4.2 million from the Department of Science and Technology to conduct the Phase B studies of the Instrument Package. These will be completed by June 1984. The lead industrial contractor is AUSPACE. Other Australian companies heavily involved in these studies are Hawker de Havilland, British Aerospace (Australia), Commonwealth Aircraft Corporation, Computer Sciences of Australia and James Optics.

Assistance is also being given by Division of Chemical Physics and Division of Radiophysics, CSIRO, University of Tasmania, and Defence Research Centre, Salisbury.

1. OVERVIEW OF MAJOR INITIATIVES

1.1 THE STARLAB PROJECT

The ability to place large telescopes into orbit using NASA's Space Shuttle Transportation System offers the greatest single leap in our capability of observing the distant universe since the days of Galileo. Astronomy will be progressing into a totally new and unexplored regime well beyond the capabilities of ground based instrumentation and the Shuttle will be the focus of the world's most exciting astronomical research for the remainder of this century.

By participation in STARLAB, a one metre free flying UV-optical space telescope, Australia will be able to maintain its world reputation as a leader in astronomy. Discoveries in astronomy have a major impact on all branches of the physical sciences and studies of cosmic events have allowed us to formulate and test many of the physical laws which form the basis of modern technology. For example, Kepler's measurements of the motions of planets and Newton's subsequent formulation of his laws of motion and gravitation led to the Industrial Revolution. It is from such quantum jumps in knowledge that new phases in our civilization have emerged.

STARLAB's contributions, unique and unmatched by any other existing or proposed installation, will be in two areas:

- very high spatial resolution, large bandwidth imagery over a large field of view; and
- high efficiency, high spatial resolution spectroscopy of extended or point sources in applications where large spectral or spatial multiplex gains are required.

The ultraviolet/optical region which will be STARLAB's domain is one of the richest of all spectral regions in terms of the sheer density of astrophysical information therein. Its exploration is essential in interpreting the many unexpected - and as yet unexplained - phenomena which have been revealed in other spectral regions. In almost all cases, this interpretation would be impossible without optical observations.

A unique feature of STARLAB resides in the ability to service, refurbish and upgrade the facility at regular intervals, using the Space Shuttle. This will allow STARLAB to carry the most advanced instrumentation available at a given time so as to keep pace with the changing requirements and technology of frontier astrophysics.

STARLAB is being developed under a tripartite agreement among Canada, the United States and Australia. The overall division of responsibilities has been defined by a Letter of Intent signed by the three national agencies, the National Research Council of Canada (NRCC), the National Aeronautics and Space Administration (NASA), and the Australian Department of Science and Technology (DST).

The division of responsibilities is:

- Canada to construct the telescope;
- Australia to build the science instruments comprising camera, spectrographs and detectors; and
- the United States to provide the space platform and bear the cost of the first two launches and flights on the platform. This involves all services connected with launch, integration with the platform, operation in orbit, retrieval and the ground data system.

It is planned to launch STARLAB in 1990. Each mission will be of 6-12 months duration and a total of about 10 missions is envisaged over a 20 year period. The division of observing time between Australia, Canada and the USA is 1/3: 1/3: 1/3.

The science instruments, entirely Australian in concept, will represent the ultimate in advanced technology in the electronic, optical and mechanical areas. They comprise:

- Two Direct Imagers (or cameras) - one will image in the ultraviolet, the other in the visible.

- A multi-mode panoramic echelle spectrograph. This instrument will be unique, offering a slit length of 400 arc seconds at moderate resolutions. Each exposure makes 2300 independent spectral measurements. At high resolution, the slit length is still 30 arc seconds and the spectral and spatial elements are 60,000 and 100 respectively. STARLAB can obtain high resolution spectroscopy of extended sources at rates over one thousand times faster than Space Telescope.

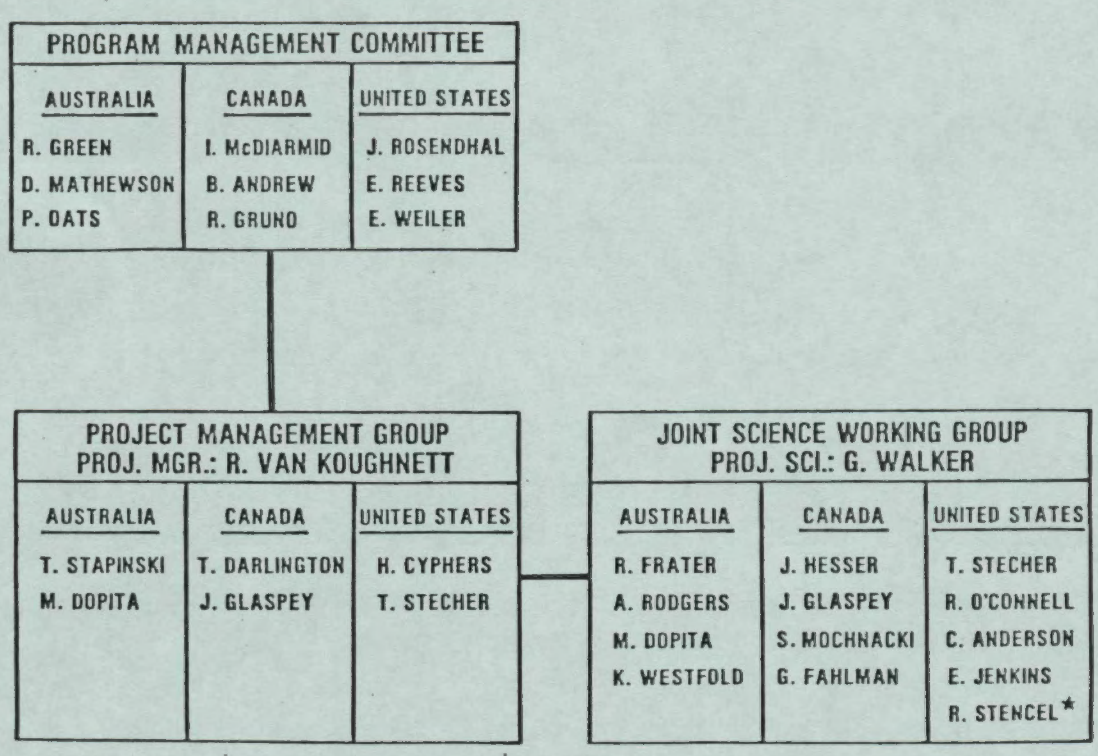
- Detectors - there will be 4 ultra large area photon counting arrays and associated electronics. Each detector uses a microchannel plate image intensifier to amplify the photon pulses by a factor of a million. It then conducts them down coherent fibre-optic boules to charge-coupled devices (CCDs) which detect the pulses in real time. Electronic circuitry measures the position of the pulses of light and stores them, thus building up a picture of about 100 million elements. Sophisticated image processing techniques are used to produce the final ultra-high resolution picture of the cosmos.

The project definition stage of STARLAB has been completed and the design stage is underway. Canada has funded Phase B studies in critical areas of telescope and interface design from the Space Sciences budget through the Canada Centre for Space Science (CCSS). The Australian Government has funded Phase B development studies of the

Science Instruments. The United States has examined the various concepts of free flyers, platforms and space stations, has provided STS/platform interface requirements and has performed definition studies establishing ground system requirements.

The management of the STARLAB project is unique, given the complexity of the facility and the tripartite nature of the program. A Program Management Committee (PMC) with representatives from each participating country provides overall management. Responsibility for implementing the STARLAB project resides with a Project Management Group (PMG) appointed by the PMC and consisting of two representatives from each country. A Joint Science Working Group (JSWG) acts as an advisory body to the PMG on matters related to the scientific objectives of the STARLAB project.

STARLAB PROGRAM ORGANISATION



Formal meetings of the three groups were held in April at Goddard Space Flight Center and in November at Mount Stromlo Observatory. At the last meeting a draft Memorandum of Understanding and its two attachments, the Science Requirements Document and the Project Plan, were drawn up.

The Data and Operation Sub-committee (Chairman, Dr I Tuohy, MSSSO) has defined the scientific requirements for the operational support of STARLAB in orbit and the reduction of scientific data on the ground. A key activity has been the preparation of two Mission Profile Studies which have addressed STARLAB operations on the Space Platform. The Committee has worked closely with NASA to produce a STARLAB Ground System Guidelines Document which identifies the required capabilities of the STARLAB ground segment beginning with the initial scheduling of observations through to the analysis of scientific data. Other topics addressed by the DOS include Real-time Operations, Orbital Avoidance Angles, Pixel Sub-stepping, the special applications of the PCA Accumulating Memory.

The Optics system group is now well established headed by Dr Murk Bottema, optical systems engineer from Ball Aerospace. Considerable help is provided on the spectrograph design by Dr Clyde Mitchell from CSIRO's Division of Chemical Physics and Dr Michael Waterworth of the University of Tasmania.

The Australian STARLAB Science Advisory Committee (ASSAC) continued to provide input into the STARLAB Project Group via its Chairman, Dr Michael Dopita, Project Scientist for the Instrument Package, of the needs of Australian astronomers.

The Phase B Studies of the Instrument Package (the ANU is prime contractor) should be completed by June 1984. The ANU will be seeking funds for Phases C and D in next year's Budget.

The STARLAB Project Office at Mount Stromlo Observatory became fully operational in January with Mr T Stapinski as Project Manager. M. J-N Rolland (later replaced by M. Pierre Rollier) of MATRA Espace, was made Deputy Project Manager. The ANU appointed AUSPACE (a new Australian space company having as member companies, Hawker de Havilland and MATRA) as the lead contractor. Subcontracts were awarded as follows:

Structures, Mechanisms, Thermal: Hawker de Havilland and Commonwealth Aircraft Corporation.

Electronics: British Aerospace (Australia).

Optics : James Optics.

Software : Computer Sciences of Australia.

Product Assurance: Hawker de Havilland and MATRA.

The Initial Design Review of the Instrument Package was held in June and attended by the Project Managers and the Project Scientists of the three countries. The Australian Studies were given strong endorsement by the group although the need for additional space qualification tests of the detector was stressed.

In September, the Minister for Science and Technology, Mr Barry Jones, approved additional funding of $863,000 for the Phase B Studies requested by the STARLAB Steering Committee chaired by Mr Frank Montgomery of the Department of Science and Technology. $600,000 is an inflation and devaluation update of the original grant and 263,000 is for these additional tests. Mr M J Kern, Section Head of optical and mechanical systems design, from TRW (Redondo Beach) will join the STARLAB Group in December to lead the space qualification tests.

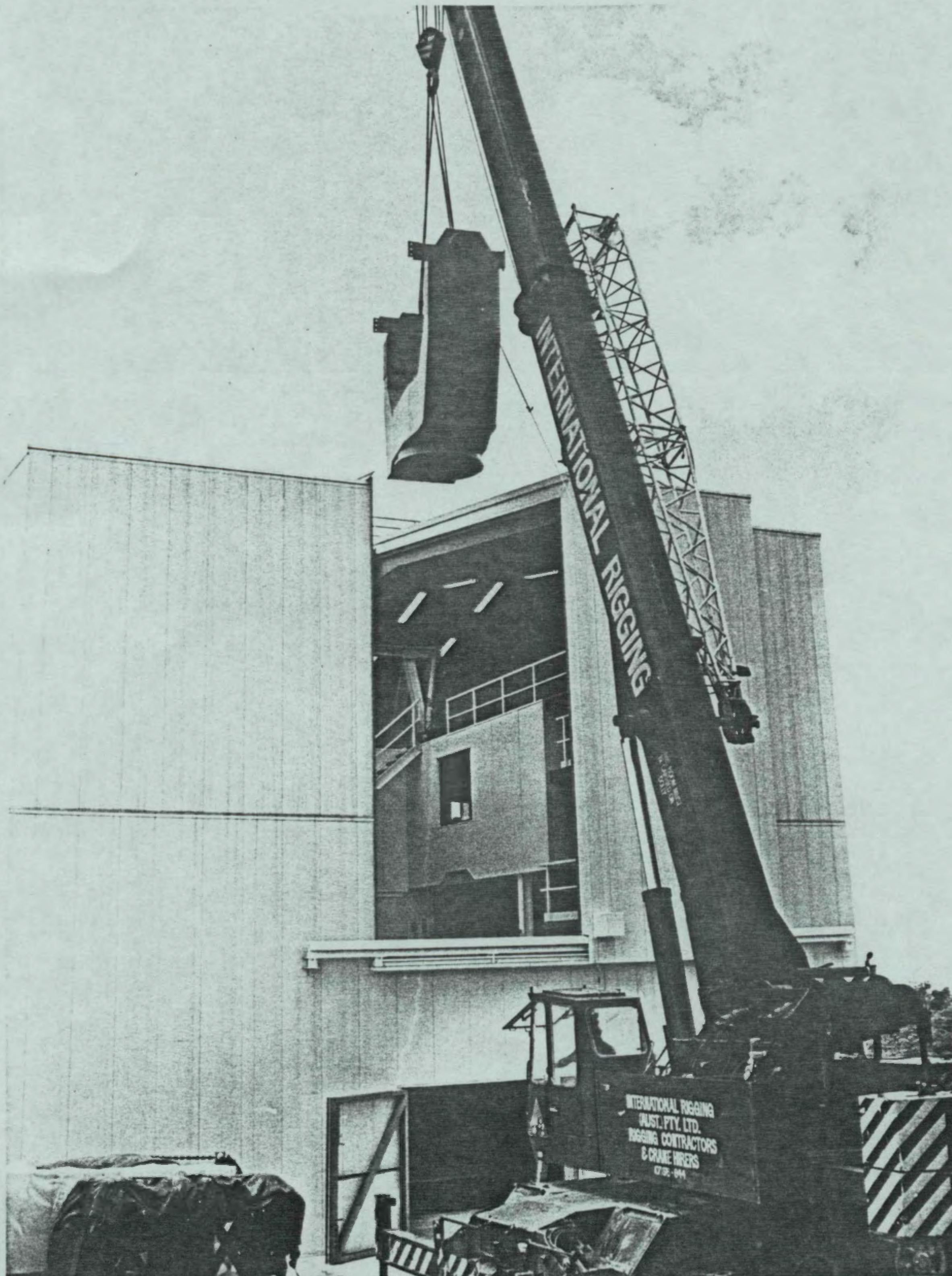
The ANU awarded the contract for the STARLAB Aerospace Industrial Study to McLennan Magasanik Associates, Stanford Research Institute and Australian Mineral Development Laboratories. The overall objective of this study is to identify, assess and document the economics, social and other benefits likely to accrue to the community if Australia participates in the two remaining phases (C and D) of the STARLAB Project. An ANU steering committee chaired by Professor Ian Ross (members: Dr Susan Bambrick, Professor Allan Barton, Mr Max Smythe, Mr Rein Mere, Mr Ted Stapinski and Professor Don Mathewson) met with the management consultants five times throughout the study. It is planned to present the study to the Department of Science and Technology on December 23.

1.2 The 2.3-m Advanced Technology Telescope

The program is on schedule, commissioning tests will commence March 1 and the dedication ceremony will take place at Siding Spring Observatory on May 16.

The Building

The site Engineer, Mr E W Simmonds, left site on 4 February to take up another position and construction supervision was taken over by Wehner. Fitting out of the building continued during the first half of the year. This comprised mainly carpentry and the installation of the ventilation and air-conditioning system. During February the building drive components were mounted to the two driven bogie wheels and electrically connected to the drive control system. The building was then successfully rotated via controls in the drive cubicle on level 2. The contractor installed the building crane during the first week of March. The installation of the air-conditioning and ventilation equipment was completed by Haden Engineering during June. Commissioning took place during



The mount of the 2.3-m telescope being lifted into the building at Siding Spring Observatory.

October. After discussions with Barry Webb and Associates, Consulting Engineers, and site measurements of earth resistivity the lightning protection system originally proposed by Wehner was adopted. Stainless steel air terminations were manufactured and installed. Landscaping and road works in the vicinity of the building were discussed with Buildings and Grounds. Mr J Weir was made available to design and supervise this work. Kerbs, gutters, retaining walls and improved drainage facilities were constructed. The final road bed was formed during October. Final sealing which had been deferred until the heavy machinery required for the installation of the main telescope components had left site is now underway.

The Optics

Work on improving the performance of the primary mirror continued during January when the contractor, Mr N Cole, reported test results well within specifications. Wehner travelled to Tucson, Arizona, in February to participate during final interferometric and double star tests conducted at the Optical Sciences Center, University of Arizona. The mirror was accepted on 13 February. Wehner remained at Tucson to supervise packing and dispatch. The mirror arrived at Siding Spring Observatory on 7 April. The contractor continued work on the two secondary mirrors and the Nasmyth flat. The Nasmyth optics are scheduled to arrive at Mount Stromlo at the end of November for acceptance tests whilst the infra-red secondary mirror will follow in January 1984.

The Telescope

The contract for construction of the mount structure was completed by the State Dockyard, Newcastle during February after which time the fork was sent to John

Grout Pty Ltd, a machine tool re-conditioning company in Sydney, where the main azimuth bearing flange was hand scraped to a flatness of 3 micrometres. This program involved the alternate measuring of the surface flatness errors to extremely small limits by Hart, and the selective scraping of high spots by the scraping contractor. A similar program had been undertaken for the corresponding face of the telescope base some months earlier, as reported previously.

After completion of this work, the fork was sent to the workshop of the Research School of Physical Sciences where other components of the mount had already been received. These included the bearings manufactured by Rothe Erde in West Germany and the drive system manufactured by Maag in Switzerland. A trial assembly of the mount was commenced during June in the HPC pit using the large 30 tonne overhead crane installed there. After this had been completed during August, the assembled mount was fitted-out with detailed components such as lubrication pipes and electrical ducts. The mount was then dis-assembled during September, transported to SSO in several stages, and finally assembled in its building during November.

During the last two months of the year, work was concentrated on completing the primary reflector support system in the Physics workshop in preparation for the assembly of the superstructure. This is expected to be done in the new year. Some additional work remains to be done on various peripheral assemblies such as the mirror cover and the instrument rotators.

Electronics and Control System

A substantial portion of the electrical, electronics and computer equipment necessary for the control of the telescope has been constructed (or procured) and installed in the building on site. Accurate time-keeping and data transmission systems have been designed by Downing, a flexible control console (from which the observer operates the telescope) and the Auxiliary Systems cubicle (responsible for the electrical control of the building shutter and many of the telescope functions) by van Harmelen and detailed design of the axis servos is progressing under the supervision of Hovey. The team effort to fabricate, test and install the subsystems listed above has involved Findlay, Andriolo, Hausler, May, Roberts and Sawa of the Mount Stromlo electronics section and Atkin, Arms, Bradshaw, Green and Bakker on site.

A VAX 11/780 computer programmed in PASCAL and assembly language will control the telescope, and the important task of designing, writing and testing this large, flexible and ergonomic software package is being carried out by Lewis with assistance in some areas from Downing, Hovey and Keogh. Lewis, together with Rodgers and van Harmelen are making good progress in procuring and developing an advanced TV acquisition system based upon Fairchild CCD cameras and a high performance image processing system by by Integrated Imaging Systems Inc.

Hovey has supervised the integration of the electrical/electronic systems with the building and the telescope mount mechanics and has studied the telescope and building dynamics.

2. INSTRUMENT DEVELOPMENT

A red-blue Nasmyth spectrograph for the 2.3-m telescope has been designed and is being built in the Observatory shops. It has a 150mm beam diameter and 225mm f/1 cameras. An aperture of 85mm (5 arc mins) passes unvignetted through the spectrograph. All optics are optimally coated, and 2-D Photon Counting Array detectors with S-20 (blue) and Ga-As (red) cathodes are to be used. A suite of gratings gives dispersions from 260 to 17 Å/mm.

Development of the 2-D Photon Counting Array in 1983 consisted of (i) implementation of higher CCD clock rates leading to improved upper count rate levels; (ii) switch to Fairchild 222 CCDs with greater dynamic range; (iii) use of single stage fiber-coupled MCP intensifiers in tandem fashion, instead of multistage tubes (this provides greater tube life); (iv) initial testing of Generation III, III-IV Negative Electron Affinity MCP tubes, to provide high Q.E. (> 20%) out to 900 nm.

The rebuild of the 50-inch telescope commenced in the early part of 1983. Major assembly of R.A. and DEC axis, along with counter balance and tube, has been completed. All major mechanical components for drives etc have been machined and are awaiting assembly. Some machining effort on the instrument rotator is being provided by Professor J.A. Thomas of RAAF Academy, Melbourne, who is also designing and building a chopping secondary mirror system similar to that of the 2.3-m telescope.

Steady progress was made this year on the Fabry-Perot Infrared Grating Spectrograph which MSSSO is building under contract to the Anglo-Australian Observatory. The monocrystal silicon wedges manufactured by Franck Cooke Optical Ltd arrived from the USA in June, and after testing were returned to the USA to be multilayer coated by the Optical Coating Laboratories Inc to form the Fabry-Perot etalons. The CAMAC Module which drives all mechanical functions is nearing completion in our workshops and, with the addition of some detector electronics and the return of the etalons form the USA, will allow the final testing of the instrument to begin.

The 3-channel infrared photometer will be in operation shortly. It will enable simultaneous photometry in three infrared bands, resulting in improved efficiency and the ability to make accurate photometry when atmospheric conditions are marginal.

The pressure scanned Fabry-Perot interferometer has been modified for use as a narrow (1-5 Å) tunable filter for high magnification imaging, as a speckle interferometer. It is intended for use at the coudé focus of the AAT, and at the 2.3-m telescope, with the IPCS and the 2-D PCA as detectors.

Equipment acquisitions in the Computing Laboratory emphasized an increased ability to provide access to the computer outside of the central computing area. A conduit was laid to the Duffield Building and all offices wired for terminal communications to the VAX. In addition several terminal lines were also established to the STARLAB building and to the Electronics Section. A 9600 network link was established with the control computer for the 2.3-m VAX (currently sited at Mount Stromlo), and will be re-established via a Telecom land line when that machine moves to Siding Spring early in 1984. The functionality of the Laboratory's VAX was enhanced by the NAG subroutine package, a Pascal compiler, and the Word-11 processing system. At the end of the year there were 24 interactive terminals connected to the system.

3. SCIENTIFIC HIGHLIGHTS

- The Hubble constant and the age of the Universe

The Hubble constant gives the rate of expansion of the Universe. To measure it, reliable distances to distant galaxies are needed. New photometry, in visual, red and near infrared light, has been made for 52 spiral galaxies in three distant clusters, with redshifts up to 6000 km s^{-1}.

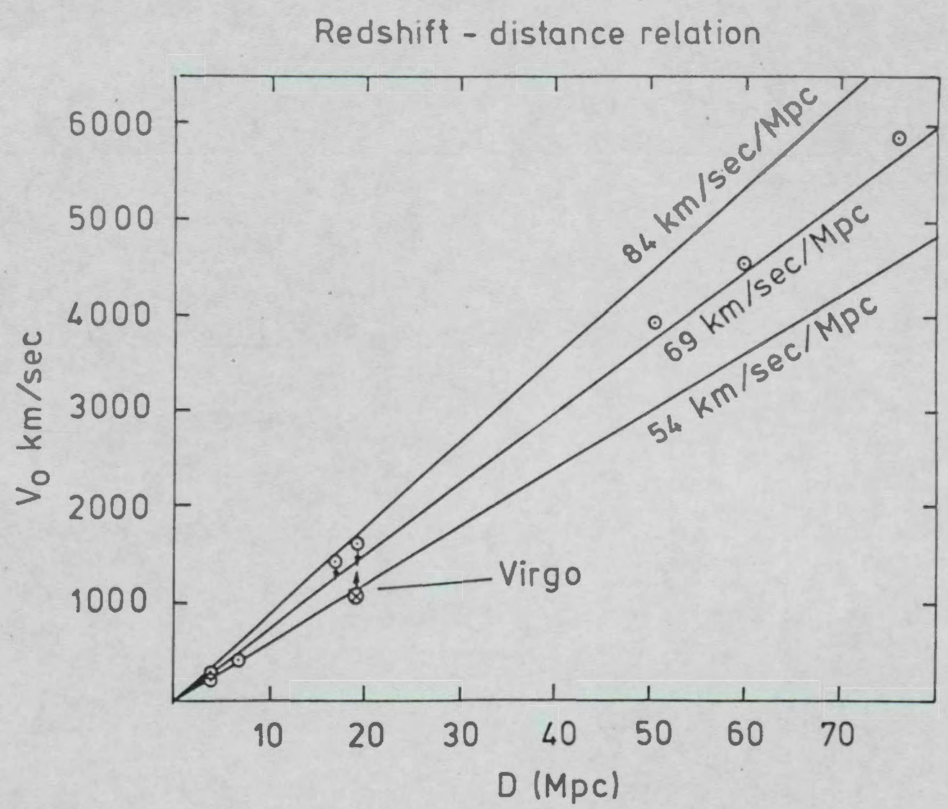


Figure 1. Velocity-distance relation for the nine clusters. The solid lines correspond to $H = 54$, 69 and 84 km s^{-1} Mpc^{-1}. Note how the distant clusters give the global value of the Hubble constant, while the nearby clusters, like Virgo, give a larger scatter due to our infall velocity component towards Virgo.

Combined with neutral hydrogen profile widths, this gives three independent distance estimates for each galaxy. The new data leads to a Hubble constant value of 68 km s^{-1} Mpc^{-1} (see Fig. 1); the corresponding age of the Universe is 15 billion years, (assuming $\Lambda = 0$ and $q_o = 0$).

- The evolution of the Universe

The contribution to the mean mass density of the Universe, of matter that is clustered like galaxies, has been calculated by analysing the peculiar velocities between galaxy pairs in a new galaxy redshift catalogue. The mass density is only 14 percent of that needed to close the Universe: the Universe will expand forever.

- Gas in radio galaxies

A complete survey for emission lines in over 200 E and SO galaxies has shown that they occur in 50% of the total, as opposed to the 15-25% hitherto believed to be emission objects. There is a good correlation between stellar luminosity of the galaxies and its associated emission luminosity, and also between the full width half maximum and the equivalent width of the emission. Furthermore, over 80% of galaxies with radio emission also show emission lines, and there appears to be a correlation between [NII]/Hα ratio and radio power. These facts are consistent with a process of thermal instability operating preferentially in more massive galaxies, where the hot supernova ejecta is more tightly bound in the potential well of the galaxy and cooling times are shorter. This gas then collapses into a disk near the nucleus, where some is able to feed the active core of the galaxy.

- Jets in radio galaxies

Multifrequency VLA radio observations of the nearby radio galaxy PKS 1333-33 show that this source consists of a flat spectrum ($\alpha \sim .3$) unresolved core

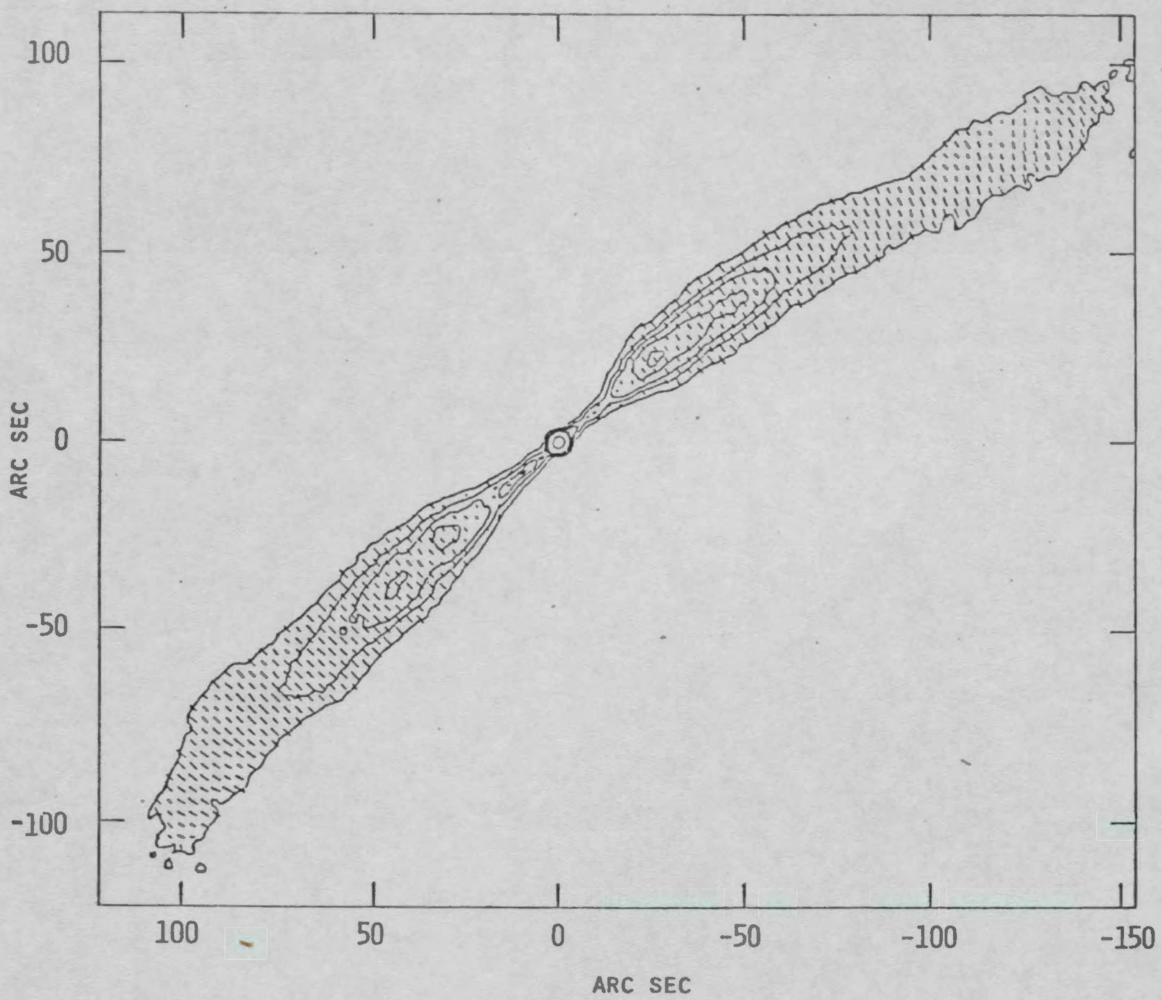


Figure 2. The radio source PKS 1333-33, observed at 20cm with the VLA. The short lines show the direction of polarization in the jets.

source from which issue two symmetric jets; the jets terminate in edge brightened lobes. The overall source extent is ~ 380 kpc. These observations show several important features: (1) The jets are initially unresolved but flare rapidly at ~ 3 kpc from the core (see Fig 2), followed by continued but less rapid expansion. (2) The spectral index is steep ($\alpha \sim -1$) in the unresolved regions, but flattens with increasing distance from the core. This is the first jet to show such behaviour, which indicates an increase in the electron distribution function at high energies. It is the first indication that jets turn on some distance from the core, when they produce shocks due to rapid expansion. (3) The jets display a number of knots, some of which show a flattening of spectral index, possibly indicating shocks. The brightest knots follow the rapid widening of the jets. (4) Transverse oscillations are recognizable beyond ~ 11 kpc from the core. Their 3-dimensional structure is likely to be helical and is analogous to that observed in laboratory fluid jets. (5) Polarization data show a remarkably uniform projected magnetic field (see Fig 2). The field is initially longitudinal, but rapidly becomes transverse in the region where the jets flare rapidly. The jets are strongly polarized and values of 40% are typical in the main body of each jet.

In a new model of radio jets, the spreading of the jet is due to the turbulent shear stress associated with entrainment of the surrounding interstellar medium. Entrainment decelerates the jet, compressing plasma in the jet direction, partially compensating for its lateral expansion. The component of magnetic field perpendicular to the jet direction is also compressed. These two effects combine to give a slower rate of decrease of surface brightness than that implied by laminar jet models. If the pressure of the confining atmosphere varies as

$R^{-\beta}$ (R = distance from core), then the observed variation of surface brightness gives $1 \lesssim \beta \lesssim 1.5$. This is precisely the range of the parameter β inferred from the X-ray observations of the atmospheres of giant ellipticals. A model fit to the surface brightness of the jet of the northern radio galaxy 3C31 gives $\beta \approx 1.2$, indicative of a temperature of approximately 3×10^7K for the confining atmosphere. Considerations of the energy balance in this jet imply a velocity of the order of 10,000 km s^{-1} with a Mach number around unity.

- <u>The peculiar galaxy Arp 144</u>

Arp 144 is a peculiar galaxy, showing little of the symmetry of elliptical or spiral galaxies. According to one theory, it was formed by an intergalactic cloud which is now passing through the disk of a spiral, stripping the interstellar matter from the spiral but leaving the stars unaffected. The 'nucleus' of the galaxy (bottom left on Fig 3) looks like that of an SO galaxy; the bright gas above and to the right of the nucleus could consist of undisturbed disk material plus some gas which has been stripped off, and is starting to fall down towards the disk again, due to the gravitational attraction of the stars in the disk.

Alternatively, we could be seeing two galaxies in a binary system: an SO galaxy with a Magellanic spiral sitting at one end of its disk.

Radial velocity measurements on the AAT have shown that the top component is moving in a regular fashion, similar to the velocity field of a Magellanic spiral. However, the SO component has an unusual spectrum, indicating relatively recent star formation - hard to explain for a binary system. A gas cloud stripping the gas from the nuclear regions could terminate star formation by removing the material from which new stars form.

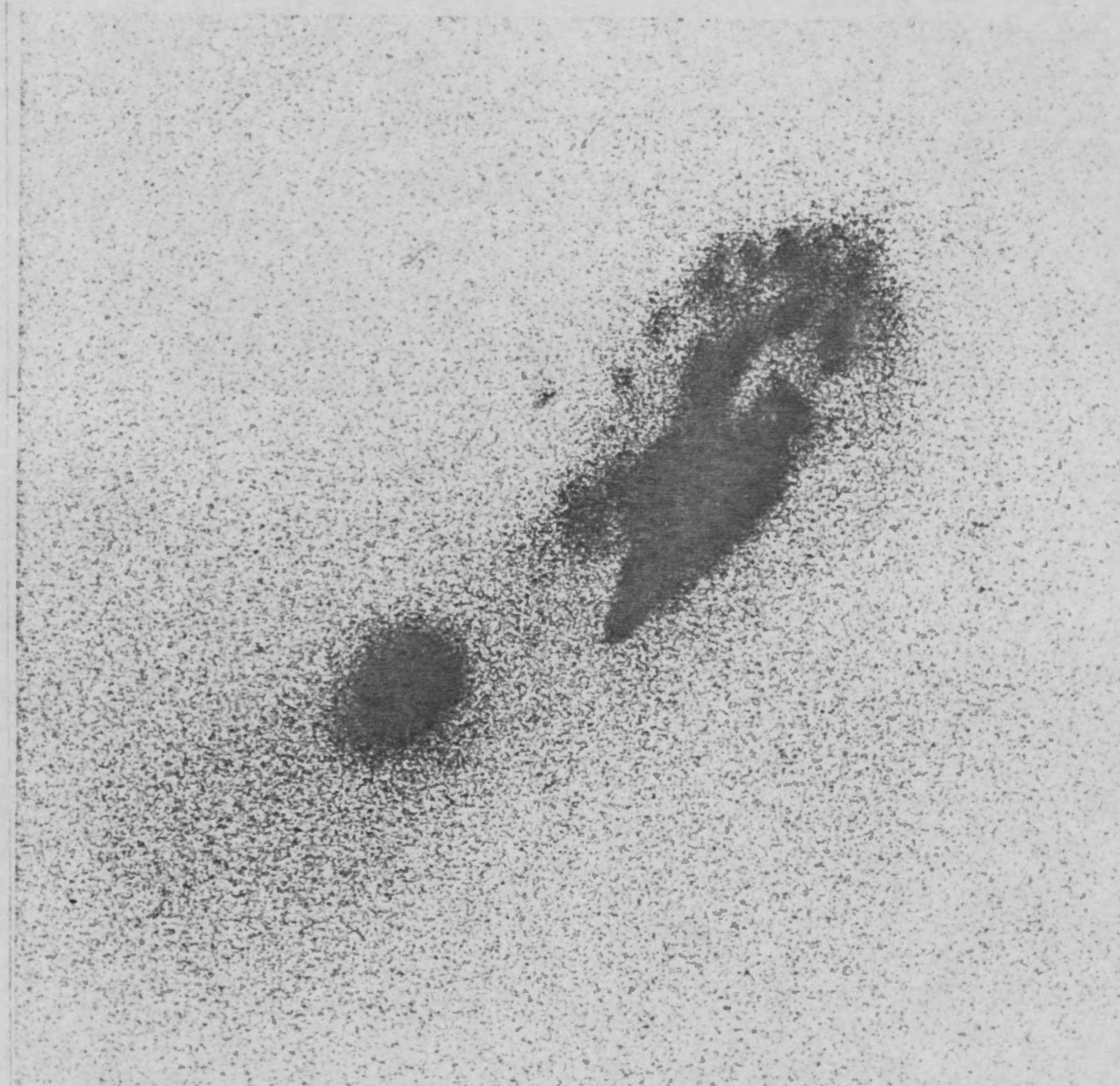


Figure 3. The peculiar galaxy Arp 144.

Thus the radial velocity measurements support the 'binary system' theory, but the nucleus spectrum is more in line with the 'gas stripping' theory ... if Arp 144 is a binary system, it is an unusual one.

- Low mass stars in elliptical galaxies

Galaxies are composed of a mixture of stars of a variety of stellar types. Because red dwarf stars, which could be very numerous in other galaxies, have extremely low luminosity, they can influence the dynamics of a galaxy greatly without contributing very much luminosity. Fortunately the spectra of red dwarfs have two strong absorption lines, of Sodium at 819nm; and of Iron Hydride at 991nm, which are characteristic of these stars; they do not appear in the spectra of red giants at all. The Sodium line is characteristic of moderatly cool dwarf stars of spectral type around MO; the Iron Hydride line occurs only in the coolest stars, of type M3 to M6. To quantify the population of dwarf stars in galaxies, strengths of these lines were measured with the red sensitive Charge Coupled Device on the Anglo-Australian Telescope. Figure 4 shows the spectrum of the giant elliptical galaxy NGC 1399. The Sodium line is quite strong, indicating the presence of substantial numbers of moderately cool dwarfs, but the Iron Hydride line is absent, ruling out large numbers of very cool dwarfs. The spectrum can be synthesised with a model of the stellar population in the galaxy; the solution for NGC 1399 has a mass to light ratio of twelve times that of the sun, very similar to that inferred from dynamical observations.

- Dark matter in spiral galaxies

From the rotation curves of spiral galaxies, it seems that these systems contain a large fraction of non-luminous gravitating matter. However, the analysis is not straightforward, and the result is still contentious. As

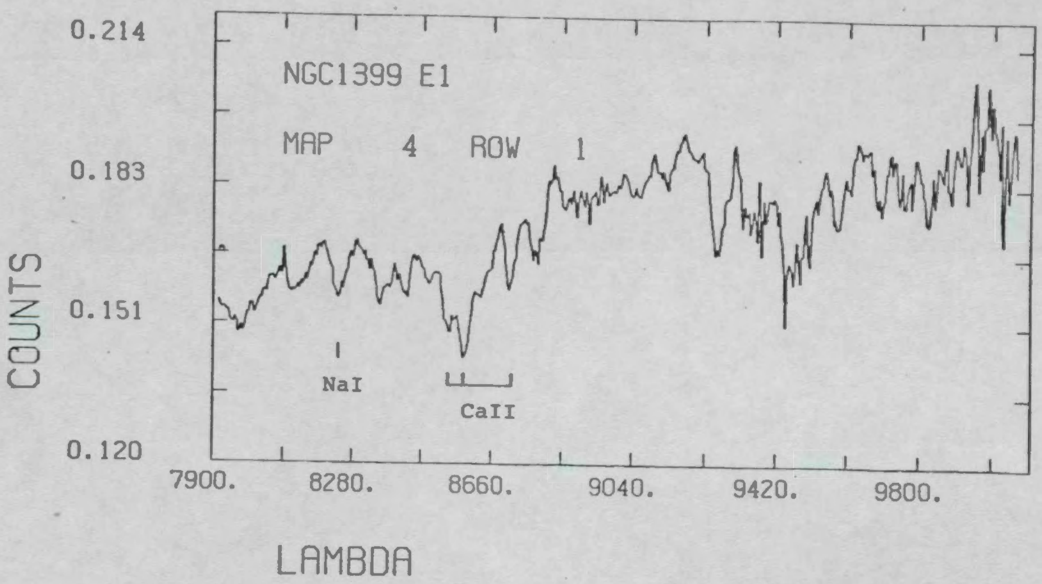


Figure 4. The spectrum of the elliptical galaxy NGC 1399. The NaI line shows that this galaxy contains substantial numbers of moderately cool dwarf stars.

an independent check, the vertical velocity dispersion of the old disk stars has been measured in two nearly face-on spiral galaxies. This gives a direct measure of the amount of self-gravitating matter in the disk, independent of the rotation data. It turns out that the disks alone are not massive enough to account for the amplitude of the rotating curves, and that more than half of the galactic mass within the optical radius must reside outside of the disk, in a dark halo.

- The outermost parts of our Galaxy

An automated objective prism survey, covering 60 square degrees in 3 high latitude fields, has discovered more than 100 metal weak K giant stars in the outer galactic halo, between 10 and 40 kpc from the sun. This discovery has now opened the outer regions of the galactic halo for detailed investigations. Spectroscopic observations of these giants, with the AAT and the 74-inch telescope, show a decrease in mean metal abundance for the most distant stars. Also, the anisotropy of the velocity dispersion, seen for halo stars near the sun, extends into the outer galactic halo. This is an unexpected result, of great importance for understanding the formation and dynamics of the galactic halo.

- The ultra metal deficient red giant CD-38°245

With an iron abundance some 30,000 times less than that of the sun, this star is the most metal deficient astronomical object currently known in the Universe. An example of the extreme line weakening in its spectrum is shown in figure 5. CD-38°245 has the potential to shed light on the type of objects in which the first heavy elements were synthesised. Perhaps the most interesting result is that the ratio N/Fe is ten times higher than in the sun. One possible explanation is that the nitrogen was produced in 500 solar mass , zero heavy element objects;

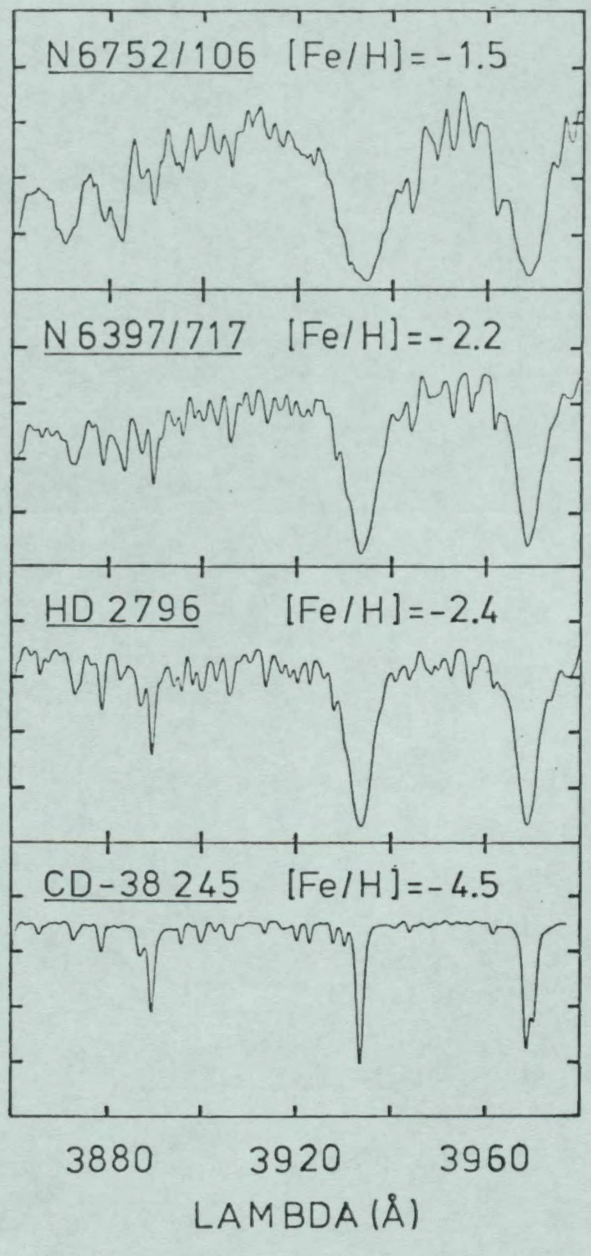


Figure 5. A comparison of the spectrum of the ultra metal deficient red giant CD-38°245 with those of 3 other stars of similar effective temperature, but higher metal abundances. The metal abundance decreases from top to bottom going from an object deficient by a factor 30 relative to the sun, through two objects deficient by 100-250, to CD-38°245 which (with a deficiency of 30,000) is the most metal deficient astronomical object currently known in the Universe.

a second possibility is that it was produced in the interior of the star itself (in the CNO cycle) and mixed to its surface. Calcium and titanium are also more abundant, relative to iron, than in the sun and other stars more metal rich than CD-38°245. This suggests that at very low metal abundance, the production of relatively more massive stars (10-100 times the mass of the sun) is favoured over that of objects of lower mass. Finally, roughly solar values of Sr/Fe and Ba/Fe imply that the nucleosynthetic "r"-process (as opposed to the "s"-process) has occurred in the first stellar generations.

- Formation of globular clusters

The globular clusters are among the oldest objects in the Galaxy, and their mode of formation is not understood. There is now evidence that they may have formed long ago in a few satellite galaxies which were then captured by the Galaxy, and coalesced to form the galactic halo. Among the clusters of intermediate chemical abundance, the 8 which show the strongest retrograde motions have very similar chemical properties and horizontal branch morphology. It seems likely that these 8 clusters can all be associated with the one parent galaxy.

- The distances of supernovae

Distances to supernovae derived by the Baade method are extremely valuable to the determination of the extragalactic distance scale, because they are completely independent of all other distance calibrations. However, the accuracy of these distances depends upon the assumption that supernovae are round. Spectral lines with P Cygni profiles produced by resonance scattering in an expanding atmosphere with noncircular isophotes should show a linear polarization in excess of that in the continuum. Thus, spectropolarimetry offered a means of testing the roundness of supernovae and assessing the reliability of supernovae distances. With these aims, the world's first spectropolarimetry of a supernova has been made, using the Anglo-Australian Telescope. No change in polarization through the P Cygni profiles was observed, indicating that the apparent axis ratio of the expanding atmosphere was greater thant 0.5. The Baade method would overestimate the distance by at most a factor of 1.4 if spherical symmetry were assumed. The clash between supernova and conventional pyramidal distances to Virgo cluster galaxies remains unexplained.

- Ejection of planetary nebulae shells

How are the shells of planetary nebulae formed ? Are they ejected at the helium shell flashes that occur during the late stages of evolution of red giant stars, or is the normal quiescent stellar wind responsible for the envelope loss and nebula formation. The main effect of ejection at a helium shell flash, rather than in the quiescent interflash phase, is to prolong considerably the evolution of planetary nebula nuclei at high luminosities, even if there is no hydrogen left on the nucleus. Theoretical models of pulsating white dwarfs show that all white dwarfs (and presumably all planetary nebular nuclei) have hydrogen envelopes $\leq 10^{-6}\ M_{\odot}$; in this case planetary nebula nuclei could only remain luminous for the time required by observations if ejection occurs at a shell flash.

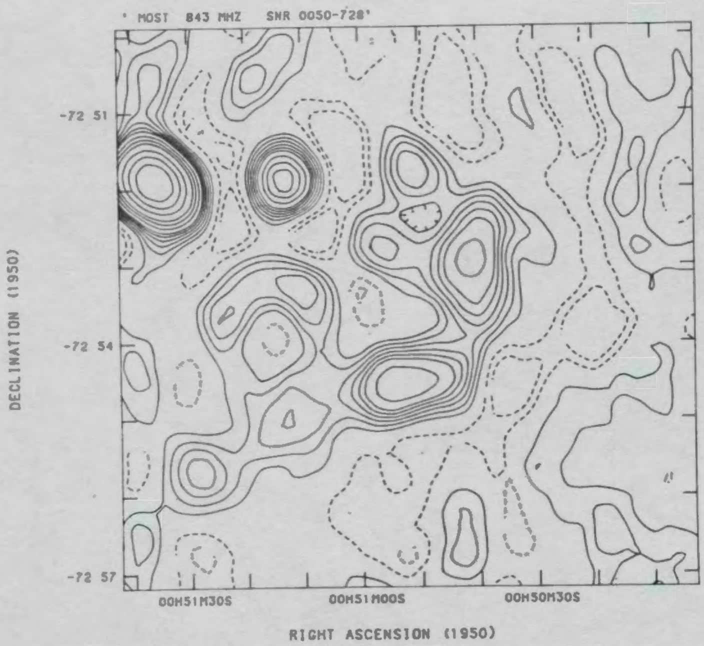
- Discovery of protostars in 30 Doradus

The 30 Doradus nebula in the Large Magellanic Cloud is a region of particular interest. Among its features are a high degree of emission nebulosity, indicative of widespread excited gas, hgih nebular and gas velocities, a notable concentration of Wolf-Rayet stars, and the presence of two, very distinct, stellar populations - a collection of bright, young stars, which are markedly clustered around the central object R136 (itself an enigma), and a population of older M Supergiants which are dispersed throughout the peripheries of the region. A third very young age group has recently been discovered: these are very red objects which ahve been confirmed as protostars (young objects in the throes of formation) by observations made with the AAT. The presence of this third stellar age group is important for theories of stellar formation processes. One of these, that of sequential formation in sub-groups proposed by Elmegreen and Lada, seems to be particularly pertinent to the 30 Dor complex. In this picture, shock and ionisation fronts produced by associations of OB stars are driven into nearby molecular clouds, thereby initiating the formation of other star associations. This model's application to 30 Dor lies in picturing the sizeable stellar wind, emitted by the central group of Wolf-Rayets, propagating into the adjacent gas regions, causing the instability and turbulence that leads to the formation of protostars.

- New advances in numerical hydrodynamics

A large increase in resolution attainable by the Smoothed Particle Hydrodynamics (SPH) technique has been achieved. This will allow the study of 3-dimensional convection under astrophysical conditions, which is the area of outstanding uncertainty in our understanding of stellar structure. Investigations have also been completed into the treatment of shocks in particle hydrodynamical methods. Techniques have been developed that give results as good as the best standard finite difference methods. The SPH technique has now been developed to the stage where it can handle a wide range of astrophysical and other problems involving multidimensional hydrodynamics.

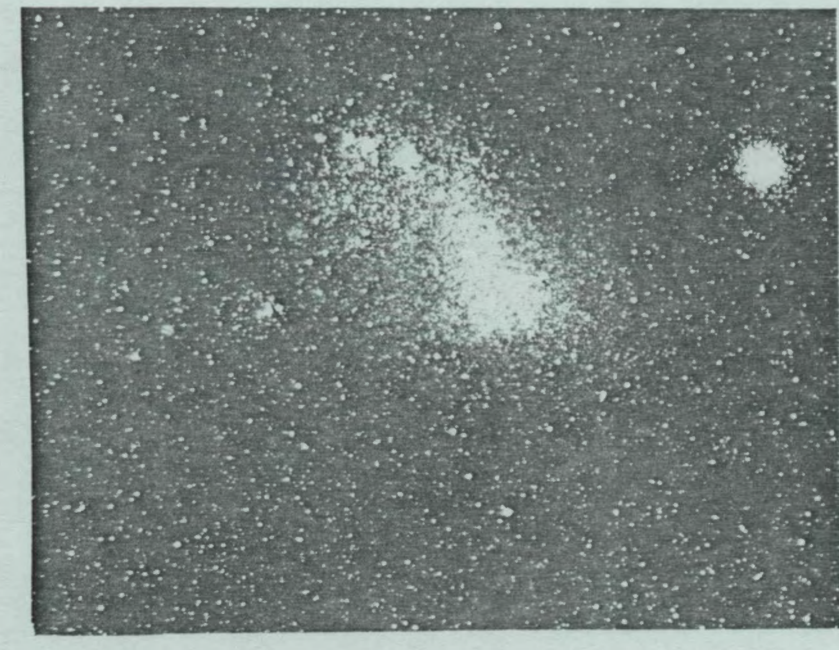
Hα photograph of SNR 0050-728 taken using the AAT.



843MHz contours of SNR 0050-728 obtained using MOST.

- Discovery of 5 New Supernova Remnants in the SMC

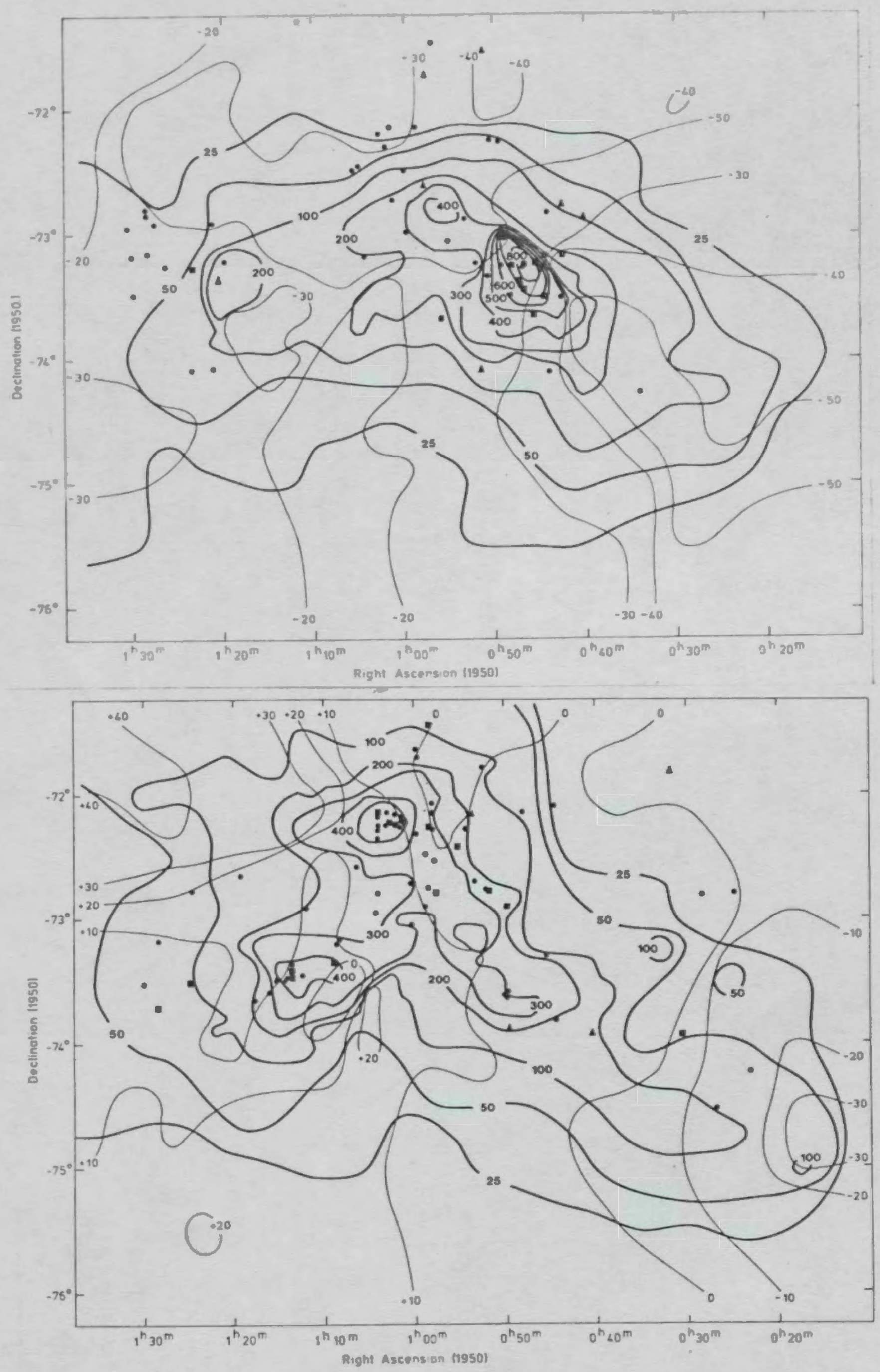
The number of known supernova remnants in the Small Magellanic Cloud has been almost doubled as a result of a collaborative program between MSSSO and the University of Sydney. Narrow band optical maging using the AAT combined with radio observations using MOST has led to the identification of 5 new SNRs in the SMC.



The Small Magellanic Cloud in red light taken with the 8-inch Schmidt Telescope at Siding Spring Observatory.

• The Small Magellanic Cloud is Two Galaxies

It has been shown that the Small Magellanic Cloud (SMC) is two galaxies (the Small Magellanic Cloud Remnant, SMCR, and the Mini-Magellanic Cloud, MMC) superimposed along the line of sight. This follows from analysis of the bimodality of the radial velocities of the neutral hydrogen in the SMC. The SMCR is delineated by the lower velocity gas whilst the MMC is delineated by the higher velocity gas. The mass of gas in the SMCR and MMC is 1.8×10^8 $M_\odot$ and 2.4×10^8 $M_\odot$, respectively. The stars, emission nebulae and planetary nebulae also display the same dichotomy in their radial velocities as the gas. Thus the two radial velocity components of the neutral hydrogen in the SMC define quite separate entities each with their own nebular and stellar populations. It is concluded that the SMC was badly torn during its near collision with the LMC 2×10^8 years ago and a large fragment, the MMC is now separating from the SMCR at about 30 km s^{-1}. They are about 6 kpc apart. CaII absorption line observations indicate that the



The Small Magellanic Cloud Remnant (top panel) and the Mini-Magellanic Cloud (bottom panel). The thick contours show the structure of the neutral hydrogen in the two galaxies. The contour numbers are in units of 10^{19} atoms cm^{-2}. The thin contours show the radial velocity distribution in km s^{-1} of gas. These maps were constructed by plotting the lower velocity component (top panel) and the higher velocity component (bottom panel) of the bimodal radial velocity distribution of neutral hydrogen in the Small Magellanic Cloud. The stars (circles), the emission nebulae (squares) and the planetary nebulae (triangles) whose radial velocities are similar to the neutral hydrogen are marked.

SMCR is in front of the MMC. The splitting of the SMC into two galaxies separated in space provides a simple expalantion for the puzzling stellar observations of a number of investigators which showed that the SMC had a much greater depth than expected for a single galaxy.

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Note for file re 1983 Annual Reports (for presentation to Council)

M. Behncke, secretary to the Director RSPhysS, rang to request that the School's annual report be scheduled for presentation at the Council meeting on 13 July 1984.

M. Steele
1 December 1983