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APPLETON LABORATORY
NEWSLETTER

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SATELLITE DATA PROCESSING AND CONTROL AT THE APPLETON LABORATORY

Part II

For the control aspect of the Ariel V project spacecraft command operations are conducted using the Spacecraft Command Encoder (SCE) at the NASA ground stations at Quito or Ascension Island. These encoders are designed around Honeywell 316 computers and are interfaced to a 7.2 kb/sec data link circuit which enables us to access them from Slough. Message interchange is by means of 1200 bit blocks error protected by a 24 bit polynomial detection system. Commands to the spacecraft are computed at Slough and relayed to Quito about 15 minutes prior to each pass, when they reside in the Honeywell machine. The control loop used during a pass is shown in figure 1. The ground station operator sends the commands to the satellite, where they are stored in a command register. The Slough operator is able to inspect the commands on a VDU in the control centre, as the command register settings are included in the real time telemetry. If the settings are correct he tells the ground station operator to issue a "command enable" message.

A manoeuvre takes several passes to complete. On pass 1 the attitude is carefully checked to determine the current pointing position as accurately as possible. On pass 2 the manoeuvre command is sent. Pass 3 data cannot be used for checking the manoeuvre, as the attitude sensor data is not sufficiently accurate. The manoeuvre is therefore checked at pass 4, and if necessary a small trim manoeuvre issued on pass 5. In our experience trim commands have only been required for very large manoeuvres.

There is a large degree of redundancy in the control centre, and this has proved to be entirely necessary. PDP8/I no. 2 can be regarded as a spare computer which can be substituted for either of the other small machines. There are a number of tasks which can be carried out on all three machines. The 1904A computer is backed up by the 1906A at the Atlas Laboratory and also by the 1906S at British Airways. The Atlas machine is used regularly on Wednesday mornings when our own machine undergoes maintenance, and frequently in a fault situation. The 1906S has also been used on a number of occasions, but we have never been without a machine to handle live passes.

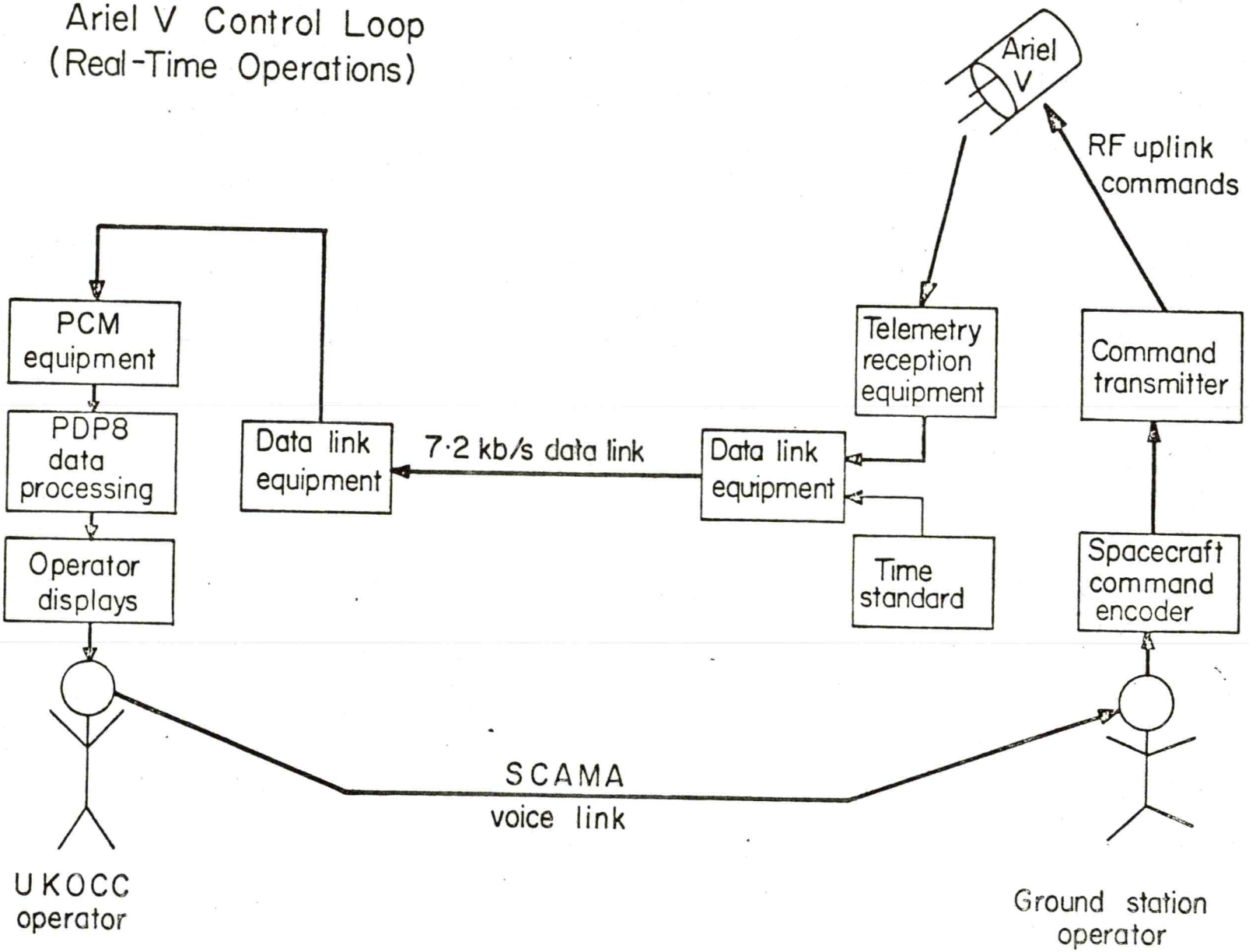
Ariel V Control Loop
(Real-Time Operations)
Ariel V
RF uplink commands
PCM equipment
PDP8 data processing
Operator displays
Data link equipment
7·2 kb/s data link
Data link equipment
Telemetry reception equipment
Time standard
Command transmitter
Spacecraft command encoder
SCAMA
voice link
UKOCC operator
Ground station operator

Figure 1

This project is nearly 9 months old now and would seem to be the most successful of all the Ariel projects to date. There have already been 3 major discoveries and many minor ones. The ASR Board has recently decided to extend the lifetime of the satellite from 2 to 3 years, and this is very much due to the success of the observing programme in economising on gas usage. It could go on for even longer, for when the gas runs out it will be possible to carry out limited manoeuvres using the magnetic torquing system which is currently used for correcting for magnetic drift.

This leads me to UK-6. This satellite, which will be launched in October 1977, will have 3 experiments on board. The prime experiment is from Bristol University, and will investigate cosmic rays. The satellite will however also carry 2 X-ray experiments; one from Leicester University and a joint experiment from MSSL and Birmingham. Both MSSL and Bristol are hoping to carry out their major data analysis on the 370/195. It is intended to adapt the UK-5 control centre to handle both Ariel 5 and UK-6 and many operations will be similar. The main differences are:-

1. UK-6 will have an on-board tape recorder instead of a core store, and there will be a much larger volume of data to deal with.

2. The ground station involved will be Winkfield, near Windsor, so that the whole project will be contained in this country.

3. All the manoeuvring will be carried out by a magnetic torquing system.

4. There will be many more possible commands, and hence, instead of the semi-manual control system used for Ariel 5, we will have to employ a completely automatic system for sending and enabling commands.

We have already started work on this project and things are going very well so far.

The final satellite project I want to refer to is the International Ultraviolet Explorer (IUE). This is a collaborative project involving the Goddard Space Flight Centre, ESA, University College London and ourselves. The aim of the project is to carry out ultra-violet astronomy, and to this end the satellite will carry a spectrograph camera and the data received will be in the form of echelle spectra.

With regard to the data processing we have two main tasks; the first is to carry out the calibration of the camera system prior to launch, the second is to write the post-launch data reduction package which will be incorporated by the Goddard Space Flight Centre into the final data handling system, and used in Washington and Madrid. The two tasks have a great deal in common, and our prime aim is to "clean up" the images received from the satellite. There are 4 main areas we have to study, and these are:

1. Geometric distortion correction.

2. Photometric correction.

3. Resolution enhancement, and

4. Removal of noise.

The software we have written is nested in the VICAR system (Video Image Correction And Retrieval) which was initially developed at the Jet Propulsion Laboratories in California. This is essentially an Image Processing operating system superimposed on the IBM operating system OS, which is why we are developing our software at Rutherford.

With regard to the future, there are several possibilities currently under discussion and we should know, towards the end of this year what will be our next major project.

B.R. Martin.

SCIENCE AND THINGS THAT GO 'BUMP' IN THE NIGHT

A report in a 'flying saucer' enthusiasts' magazine described how a number of people had witnessed several bright lights 'below cloud cover', of approximate magnitude -1 or -2, on 17 June 1973 between 0230 BST and 0250 BST. A five-minute check by Philip Jordan and myself with the satellite predictions experts at Appleton established that the objects reported were almost certainly Skylab and associated orbiting satellites. This rapid success in eliminating one of the many thousands of 'unidentified flying object' (UFO) reports brought home to us how usefully the talents and resources of the staff of the Appleton Laboratory could be employed in a serious study of UFO reports.

Of course, most UFO reports have completely trivial explanations, like the one described above. However, after careful analysis it does seem that there remain a number of reports which stubbornly defy explanation in terms of natural phenomena. These are the reports which present a problem to the scientific community - a problem which it has unfortunately very much ignored because of the journalistic connotations of UFOs with 'little green men' and similar 'extraterrestrial visitors'.

The most comprehensive scientific study of UFO phenomena to date was the USAF-funded investigation at the University of Colorado, under Professor E.U.Condon[1]. Unfortunately, the Colorado investigation addressed itself to what I consider the wrong problem namely the validity or otherwise of the 'extraterrestrial hypothesis' (ETH) of UFOs, whereas surely a better approach would have been the study of UFO reports to establish whether or not they contained an inexplicable residue, and then to examine any such residue on its own merits with no pro- or anti-ETH bias.

However, a by-product of the study was that a very clear residue of reports showed up. One of several such reports came from USAF bases in different parts of East Anglia. These sightings, on 13 & 14 August 1956, included several simultaneous air and ground sightings, both radar and visual, of rapidly and erratically manoeuvring luminous phenomena, and culminated in an interceptor jet actually being chased by one unidentified phenomenon![2] The conclusions of the Colorado Committee were:

'In conclusion, although conventional or natural explanations certainly cannot be ruled out, the probability of such seems low in this case, and the probability that at least one genuine UFO was involved appears to be fairly high. ... In summary, this is the most puzzling and unusual case in the radar-visual files. The apparently rational, intelligent behaviour of the UFO suggests a mechanical device of unknown origin as the most probable explanation of this sighting. ...'

It is reports such as this that suggest to me that the probability is fairly high that a few UFO reports may well be representative of a new phenomenon, or perhaps of several different types.

Intrigue about whether this is the case, and, if so, about what the phenomena may be, has led several colleagues in the scientific community and myself to the suggestion that a conference might be held within the next couple of years to discuss little-understood aerial phenomena. In the meantime, scientists in various research establishments and university departments are exchanging a good deal of correspondence on this topic, and we are circulating an informal newsletter. In addition, the co-operation of establishments such as the Ministry of Defence which keep UFO files is being sought.

We are also naturally interested in phenomena such as 'ball lightning' which fall on the fringes of scientific acceptance or understanding.

Should anyone at the Appleton Laboratory be interested in these phenomena, I should be very pleased to hear from them and to put them in touch with other scientists interested in these and related topics. We are naturally aware that many scientists are sensitive about becoming associated with 'way-out' phenomena such as 'flying saucers', and so requests for anonymity and confidentiality will be strictly observed. So I shall be pleased if contact can be established with me direct, or via Mr Philip Jordan at the Appleton Lab.

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References:

(1) Scientific Study of Unidentified Flying Objects, edited by E.U. Condon, published by Bantam, 1971.

(2) ibid pp 164 and 256.

NEWS FROM MEASUREMENTS LABORATORY

To further the cause of Scientific investigation it is proposed in future to provide information on selected items that are available for immediate issue and specialised test equipment that has been installed in the Measurements Laboratory for general use by staff.

The following serviceable items are available for immediate issue:

RRS No.	DESCRIPTION	
4677	Tektronix Oscilloscope	Type 585A
6081	Tektronix Oscilloscope	Type 547
5060	Tektronix Oscilloscope	Type 556
4678	Tektronix Plug-in	Type 82

RRS NO.	DESCRIPTION	
5908	Tektronix Plug-in	Type 1A1
4945	Tektronix Plug-in	Type 1A2
4915	Marconi Oscilloscope	Type TF2200A
5985	Telford Oscilloscope Camera	Type A510
5661	Advance Pulse Generator	Type PG52
2958	Racal Receiver	Type RA17
6758) 7058)	DISA Battery operated Anemometer	Type 55D05

MISSING ITEMS

Will the persons who borrowed the reference copies of the 1975 Signetics Data Book and the Texas Instruments Semiconductor Design Manuals from Measurements Laboratory several weeks ago please return them.

THE CHANGING SEASONS

September! the month of Summer's end is with us again, gone the clunk of bat on ball echoing on village greens, the splash of casting fly onto rivers' murmuring flow, a skylark's song on wing, perfumes of stock, regal rose and new mown hay, sandy shores and castles built, are but a token of Summer's splendour, now but a memory.

Reflecting on the season's passing, perchance you will recall that lack of the cuckoo's call, a nightingale's serenade, the wise owl's whooing cry, even the common old frog's croak, to mention but a few.

One can reason they are part of the casualties of this technical and scientific advance for a better world, sacrificed in manmade pollutions, poisoned by chemicals that now saturate the Earth, Sea and Atmosphere in man's accomplishment for a fast dollar.

What will you tell a child whom may enquire thus, "Daddy whatever became of these little creatures shown in my picture book"?

WHAT WILL YOU TELL THAT CHILD?

Off hand, I could only mutter in reply, "Darling look after your picture book,
only within those pages will you ever know such life swam in the waters,
soared into the heavens and gambolled on the good good earth,
now don't touch that, I've just sprayed that plant with D.D.T."

Conserving nature is our shared responsibility, unity in thought and action can move mountains, but I despair, viewing the appalling mess we have allowed bureaucracy to impose on our lives, in our NAME.....

Rembrandt

STAFF NEWS

Congratulations to :

Barbara Okolotowicz and John Rathbone who were married at St. Ethelbert's Church, Slough, on 9th August.

Ann Regan and Anthony Boakes who were married at St. Ethelbert's Church, Slough, on 16th August.

Barbara Dorman and Alan Buck who were married at St. Peter's Church, Staines, on 1st September.

Welcome to :

Dews, B.J.	P.T.O.II	
Stanley, D.J.	S.C.S.	
Ewing, A.	"	
Laycock, R.W.	Vac. Wkr.	
Spalding, G.H.	H.S.O.	
Davis, J.M.	S.C.S.	
Bramley, N.G.	Vac. Wkr.	
Paterson, A.	C.A. (Casual)	
Paterson, Miss C.	C.A. (Casual)	
Cross, Mrs. P.A.	C.A. P/T	
Beere, C.J.	S.C.S.	
Dundas, D.T.	"	
Tipper, P.	"	
Pennell, D.R.	M.O.	
Ward, A.K.	H.S.O.	
Deviny, Mrs.J.	C.A. P/T	
McAra, D.A.	Apprentice	
Weidner, Mrs.A.Y.	S/H Typ.I.	(Culham)

Resignations, etc. :

Daniels, G.R.	S.C.S.	
Lane, Miss C.F.	C.O. (Casual)	
Westbrook, E.G.	H.E.O.	
Coulson, A.P.	Vac. Wkr.	
Whittington, A.R.	A.S.O.	
Galpin, Mrs. A.M.	S/H.Typ.I.	Returned to UKAEA after period of secondment at Culham
Sparkes, M.E.	S.C.S.	
Mercer, I.R.	S.C.S.	
Prevost, E.R.	S.C.S.	
Sweatman, M.P.L.	Vac. Wkr.	

Other Changes :

White, P.A.G.	H.Ex.O.	Transf. from Finance/Accounts to support for Div. I and III.
Sandcraft, D.	H.Ex.O.	Now H.E.O. for Finance, Accounts and Stores.
Long, D.H.	S.S.O.	Changed from Group VI to Group I in Div. VI.
Wright, J.A.	S.O. (Perm.)	F.T. appt. ended 3.8.75. Commenced perm.appt. at A.L. 4.8.75.
Thomas, G.R.	S.S.O.	On detached duty at G.S.F.C. (U.S.A.) w.e.f. 18.7.75 for 1-2 years.

CRICKET CLUB

The culmination to what has been a good season for the club was a match between the "lads and lasses" played on Wednesday, 17th September. Whether it was due to underestimating their opponents, or chivalry on the part of the umpires no one is sure, but the lads almost lost a very enjoyable match finally settling for a draw with honours about even.

The end of season party held in the canteen was a great success. This was due in no small measure to the production of Mrs Loudensack of an excellent buffet, unstinting efforts on the part of the bar stewards to cope with the crowd and an excellent disco - the cricket club's sincere thanks to all concerned. It is hoped we can commence next season with just such an occasion.

For those interested in results, we played 33 matches during the season, of which 7 were normal afternoon affairs and the remaining 26 limited to 20 overs each side, played mainly in the evenings.

	Played	Won	Drawn	Lost
Afternoons	7	3	1	3
Limited over matches	26	19	1	6

For cricket club members who are interested, the batting and bowling averages are on the notice board.

The results of the final 10 matches of the season are summarised below:

30 July v MET. OFFICE (Won)

Met. Office 79 - 7 — Appleton 80 - 3
Buck 3 - 11 — Porter 30 N.O.

31 July v ACO (Won)

ACO 38 - 2 (in 13 overs) — Appleton 117 - 3
Bevan 2 - 5 — Paterson 42, Roger 38

6 August v DE LA RUE (Won)

De la Rue 55 - 8 — Appleton 57 - 4
Paterson 4 - 2 — Dunford 13 N.O.

7 August v BEACONSFIELD DC (Won)

Beaconsfield 92 - 8 — Appleton 91 - 7
Wrench 4 - 8 — Sandal V. 30

13 August v WILKINSON SWORD (Won)

Wilkinson 61 — Appleton 62 - 2
Paterson 3 - 10 — Hassan 32 N.O.

14 August v PRUDENTIAL (Won)

Prudential 50 — Appleton 101 - 2
Wrench 2 - 2 — Martin 60 N.O.

20 August v ICI (Lost)

ICI 75 - 4 — Appleton 73 - 9
Buck 13 N.O.

21 August v BEACONSFIELD DC (Won)

Beaconsfield 37 — Appleton 41 - 7
Paterson 4 - 2 — Roger 14 N.O.

3 September v BAC (STEVENAGE) (Drew)

BAC 163 - 8 — Appleton 130 - 9
Evans 48
Hassan 22

4 September v TREASURY & CSD (Lost)

Treasury 156 - 8 — Appleton 97
Sandal K. 37.

LETTER TO THE OUTSTATIONS

Dear Colleagues

Times change and we with them, so said some classical character or other. (If you want it in latin look it up yourself). However, having taken the trouble to be born about twenty centuries before Newton, he had but an imperfect grasp of the concept of rates of change. We are not always in tune with events and from time-to-time (apt phrase) there is this need to know ourselves and remedy, so far as can be, the temporal out-of-jointedness.

We fortunates who work for the SRC have lately been given help in this hard task. It has come in the form of a pictorial aide-memoire masquerading as a staff pass, complete with likeness. Likeness did I say - none doubts the skill of our photographers so it must needs be so. This glimpse of ourselves as others see us may give rise to indignation, understandably enough; narcissism - watch it, you are far gone in self-deception; or, for some, a gloomy confirmation of our worst fears, appearances are literally against us.

Still, this shock is doubtless therapeutic, and a great help in overcoming crises of identity and possible resulting disturbances of personality. The treatment is tactfully administered by authority, cloaked in the guise of security precautions, backed-up with much artistic verisimilitude in the form of a gate-house, barriers, and all the trappings of gentle but firm exclusion. From time to time a uniformed security officer halts the morning stream of cars and asks, civilly enough, to see our passes. All very quiet and caring.

In truth, though, it isn't that he wants to see the things, its just a ploy to ensure that we shall perforce catch a glimpse of ourselves. A chastening experience; and for one, at least it comes hard to acknowledge that scowling impatience is less hidden than had been hoped by the veneer of mildness and diffidence so long assumed as suitable to the role of

Yours sincerely

The Editor

AUGUST/SEPTEMBER REPRINT LIST

A.1091	B.N. Harden D.T. Llewellyn-Jones A.M. Zavody	Investigations of attenuation by rainfall at 110 GHz in South-East England	Proc. IEE	1975 Vol.122 No.6	600-6
A.1124	R. Holdaway	Satellite ephemeris prediction and orbit manoeuvrability by low thrust	American Inst. of Aeronautics Inc.	1975	1-8
A.1053	D.A. Bryant M.J. Smith G.M. Courtier	Distant modulation of electron intensity during the expansion phase of an auroral substorm	Planet. Space Sci.	1975	867-8
A.1073	H. Rishbeth	F-region storms and thermospheric circulation	JATP Vol.37	1975	1055-1064
A.1103	B.C. Fawcett R.D. Cowan	The identification of solar flare Fe XVIII to Fe XXIII emission lines from $2s^n2p^k$ - $2s^{n-1}2p^{k+1}$ transitions	Mon. Nat. R. Astr. Soc.	1975 Vol.171	1-7
A.1105	J.W. King E. Hurst A.J. Slater B. Tamkin	Agriculture and sunspots	Nature	1975 Vol.252 No.5478	2-3
A.1128	J.W. King	Sun-weather relationships	Astronautics & Aeronautics	1975 (April)	10-19
A.1097	J.W. King	Geomagnetism and the tropospheric circulation	Nature	1974 Vol.252 No.5482	343 and 363-3
A.1111	B.C. Fawcett R.W. Hayes	Spectra in the period between copper and bromine produced with the aid of a 4 GW laser	Journal of the Optical Soc. of America	1975 June Vol.65 No.6	623-6
A.1089	B.C. BOLAND E.P. DYER, J.G. FIRTH A.H. GABRIEL BB. JONES C. JORDAN R.W.P. McWHIRTER P. MONK R.F. TURNER	Further measurements of emission line profiles in the solar ultra-violet spectrum	Mon. Not. R. Astr. Soc.	1975 Vol.171	697-724
A.1130	C.B. BHALLA A.H. GABRIEL L.P. PRESNYAKOV	Dielectronic satellite spectra for highly-charged helium-like ions	Mon. Not. R. Astr. Soc.	1975 Vol.172	359-375

INTERNAL MEMORANDA

I.M. 367	H.P. Summers	Tables & Graphs of Collisional Dielectronic Recombination and Ionisation Coefficients and Ionisation Equilibria of H-Like and A-Like Ions of Elements.
I.M. 368	L.P. Presnyakov	Comments on ionization rate coefficient calculations for highly charged ions.
I.M. 369	L.P. Presnyakov	Inner shell excitation for highly charged ions; the case of Li-Like ions.