



APPLETON LABORATORY

NEWSLETTER

No. 182/3

September/October 1976

Ariel V Two Years in Orbit Part I

Ariel V was the first of the second-generation X-ray satellites. Its predecessor, the NASA satellite UHURU, launched four years earlier, produced a catalogue of X-ray sources. Ariel V was to update that catalogue, and to study in detail many of the 162 sources in it.

On 15th October this year the satellite successfully completed its second year in orbit. The occasion was marked at Ditton Park by a reception for members of the press, at which the experimenters told of the progress that had been made in the field of X-ray astronomy.

Normally, the satellite is either pointed at a different source at the beginning of each day, or otherwise adjusted to a new position from which to take further observations of the same source as on the previous day. A complete sequence of observations on a source will usually take between two days and perhaps three weeks. Since launch, the pointing axis has been scanned completely around the plane of the Milky Way once, and twice more through the region of the Milky Way in the direction of the centre of the Galaxy as this part of the sky is particularly rich in X-ray sources. In addition, the spin axis has been pointed at a large number of individual sources, many of them believed to be external galaxies. Finally, there have been three extended periods - from 10 to 26 days each in duration - when the spin axis has been so pointed that the Sky Survey Experiment can monitor the behaviour of the Milky Way sources.

All of the experiments have produced outstanding results. However, one of the striking features of Ariel V has been the way in which the different experiments have complemented one another to produce results unrivalled elsewhere. On five occasions since launch, results from 3-5 experiments have been simultaneously published in Nature, all dealing with different observations of the same object. The outstanding

observations of this character are those of the transient X-ray sources. These turn on rapidly and within a few days reach a peak in brightness. They then decay over a few hours, days or weeks. One of these transients (A0620-00), first observed by the Sky Survey Experiment in August 1975, became for 6 weeks the brightest X-ray source in the sky. Only four transients had been detected prior to the launch of Ariel V, and observations of these were sketchy, but Ariel V has observed no less than 14. Two further transients (A1118-61 and A0535+26) were found by MSSL and Birmingham to be modulated with periods of 6.75 min. and 1.73 min. respectively. This caused considerable excitement, because those modulated X-ray sources which had previously been found, varied either with periods of hours, the modulation arising from the orbital motion of the X-ray star about an ordinary star, or seconds, the modulation then arising from a spinning neutron star. A periodicity of minutes might arise alternatively from an extraordinarily close pair of orbiting stars, or from a very slow rotator. For some months the explanation was uncertain; then it became clear that a slowly rotating neutron star was involved. Subsequently, with their experiment on the Copernicus satellite, MSSL found no less than 6 slow rotators amongst the ordinary X-ray sources.

During the last year, the most exciting observations have been of the so-called "burst sources". These were first discovered by the Dutch satellite ANS, which found a source emitting isolated bursts of X-rays lasting 10 seconds. A number of these sources have been found, typically emitting bursts at intervals of several hours, which makes them difficult to observe. A remarkable burst source is the so-called rapid burster, MXB1730-335. MSSL found the bursts to come in groups with a rough periodicity of 15-20 sec. Imperial College showed them to occur also in very energetic X-rays, whilst Birmingham produced the first accurate position which combined with optical observations suggested that the source lay in a distant, massive cluster of stars on the opposite side of the Galaxy (such clusters are believed to be the oldest objects in the Galaxy). The most likely, though not certain, explanation of the burst sources is that material emitted by the companion star in a binary system in which that star orbits a neutron star, collects in the atmosphere of the neutron star. It is held there by the enormous magnetic field of the neutron star (10^{12} x greater than that of the Earth) until it can be supported no longer, when it cascades down on the surface of the neutron star, producing a brilliant flash of X-rays. Then material begins again to collect in the atmosphere in preparation for the next burst.

Many observations which demonstrate the extreme variability of X-ray sources have been made by all the experiments, but particularly by the All-Sky Monitor and Sky Survey Experiment. These variations - which usually are little understood - range from periodic or quasi-periodic modulation to irregular flaring. The Imperial College group have studied these for high energy X-rays. The particular interest of their observations is that usually the X-rays are envisaged as being produced in a swirling disc of extremely hot gas orbiting close around a neutron star or a black hole. The high energy X-rays are emitted from the innermost part of the disc, closest to the compact star, and so allow us to probe deepest into the X-ray source. The Goddard group have been particularly interested in studying the long term behaviour of bright sources and more particularly in the search for binary periodicities.

All the results so far mentioned refer to sources within our Galaxy. However, many important results have been obtained on sources outside the Galaxy, though not all the experiments can make good observations on these sources as they appear much fainter on account of their greater distance. There are believed to be two main

classes of extra-galactic source. One is associated with clusters of galaxies which typically contain hundreds of individual galaxies. The X-rays come from the region around the galaxies as well as, or perhaps rather than, the galaxies themselves. This is attributed to a vast cloud of extremely hot gas surrounding the galaxies, rather like a huge atmosphere. In one of these sources, the Perseus cluster, MSSL have demonstrated the existence in the spectrum of lines of highly ionised iron (i.e. iron atoms with many orbital electrons stripped off, indicative of the high temperature of the gas), the first indication of the spectrum lines of any element in any extra-galactic X-ray source. This result is potentially significant, since the origin of the gas between the cluster galaxies is not known - it could be primeval, from the time of the formation of the galaxies in the cluster, or it could originate from the galaxies themselves. Since elements like iron are synthesised in stars, the observation of their spectrum lines appears to suggest the latter explanation. However, the lines may very well come from a galaxy in the cluster, and until this is clarified, no definite conclusion is possible.

The other type of extra-galactic source is thought to lie within the nucleus of other galaxies. Galactic nuclei often contain great concentrations of stars and indeed in the nucleus of our own Galaxy, the Birmingham group have noticed that transient X-ray sources are common. Some other galaxies have nuclei which appear to be very powerful X-ray sources. MSSL, together with Leicester, have demonstrated for the first time that some galaxies may vary in X-ray brightness over a period of months. The significance is that the whole galaxy could not vary in brightness so rapidly so the X-ray emission must be concentrated in one small region of the galaxy, presumably the nucleus.

The 1976/77 High Latitude Campaign

During November and December the first part of the 1976/77 High Latitude Campaign will take place at the Andøya Rocket Range, Norway. (The second part is scheduled for autumn next year.) It is planned to launch two pairs of rockets, each pair consisting of a Skylark 12 and a Fulmar. Experiments from the Universities of Southampton and Sussex, the Mullard Space Science Laboratory, University College London, the Appleton Laboratory, Goddard Space Flight Center and the Norwegian Defence Research Establishment will be flown. In addition ground based observations will be made by a group from the Ulster College, Northern Ireland and a number of the groups mentioned above. Nearly 50 UK personnel will be taking part, including thirteen from the Appleton Laboratory.

Skylark 12 is the first 3-stage vehicle in the Skylark family of sounding rockets. The third stage, which burns outside the atmosphere, pushes the payload to much greater heights than hitherto attainable. Currently the highest altitude reached by a Skylark is 318 km, achieved in 1969 by a very light payload. The predicted apogee for SL1422, the first Skylark 12 scheduled to be launched, is 808 km (approximately 500 miles). Fulmar is the SRC version of the 10 inch diameter Flamenco rocket, developed by Bristol Aerojet for Spain. It is capable of carrying a 55 kg payload to 300 km.

Dr. Bryant is the project scientist for the first pair of rockets scheduled to be launched. They will be fired within a few seconds of each other, so that one

rocket will be flying above the other, enabling simultaneous measurements of auroral phenomena to be made at different altitudes connected by the Earth's magnetic field lines. The second pair, for which Dr. Rees of UCL is the project scientist, will study time variations of auroral phenomena. The Fulmar will be launched a half to two hours after the Skylark.

There is considerable Appleton Laboratory involvement in this campaign : Dr. Bryant's group are providing instruments for 3 of the 4 payloads; Tony Hall's group, telemetry for all four rockets and a considerable amount of ground equipment for Andøya; Dr. Thomas's Lidar will track the sodium clouds to be released from the second pair of rockets; and many of the contracts and the coordination of the whole campaign is managed by Mr. Delury's division.

GORDON BENNETT

Staff News

Congratulations to :

Alan and Barbara Buck on the birth of their son, Christopher Martin, on Tuesday 5th October.

Jim Braby and Rosemary Quinton who were married on July 3rd.

Richard Brazier and Anne Homfray who were married at St. Mary's Sunbury-on-Thames on 9th October.

D. Collerton, Now Craftsman II

Miss V. Williams now Assistant Scientific Officer

Mrs. H. Young, now Shift Leader

D. R. Pennell now Deputy Shift Leader

Welcome to :

Miss S. Yip	S.C.S. (Culham)
C. M. Brown	D.P.
S. J. Brewer	Cft. I (Chilbolton)

Resignations, etc. :

R. A. Buckland	S.S.O.
P. Woodcock	S.C.S.
N. C. Thompson	S.C.S.
Miss O. J. Gripp	S.C.S.
Miss H. D. R. Young	S.C.S.
J. Burnett	S.C.S.
N. Woodall	P.T.O. IV
K. Ayers	A.S.O.

Resignations, etc. (contd.)

C. Nelson	H.S.O.
P. Tipper	S.C.S.
C. J. Beere	S.C.S.
A. Ewing	S.C.S.
S. G. Drinkwater	S.C.S.
T. R. Eyre	S.C.S.

Other Changes :

B. J. P. T. Warburton S.O. to Group 5 in Division 2

Eric Acton, P.S.O., now moved to London Office, Joined S.R.C. in 1968 after work with E.S.R.O. (now E.S.A.) on satellites E.S.R.O. 2 and H.E.O.S. A. He is now concerned with liaison duties with the experimenters on Spacelab packages and Spacelab/ESA matters in general.

Institutions' Premium Awards to Staff

The Institution of Electronic and Radio Engineers recently awarded the Rediffusion Television Premium to Peter Bradley for his paper 'Long-term H.F. Propagation Predictions for Radio Circuit Planning'.

This was adjudged to be the outstanding contribution on communication or broadcast engineering published in the Institution's Journal in 1975.

The Institution of Electrical Engineers has awarded Don Mackinnon the Mather Premium for his contribution, as joint author, of two papers; 'Design of a Digital Self-alignment Controller for a Ship's inertial navigation at Sea' and 'Design of a Digital Stability Augmentation and Control System with Gust Alleviation and Modal Suppression'.

We congratulate our two colleagues on their having received this approbation from their Professional Institutions.

Obituary

Professor John Hollingworth

We are sorry to learn of the death, at Devizes, at the age of 90, earlier this year, of Professor John Hollingworth, a member of our staff in the 1920's. Though not perhaps so well-known to later generations, his work, in conjunction with the late Robert Naismith, on the interference pattern between the ground and sky wave emanating from a radio transmitter in France, provided valuable supporting evidence at the time of Appleton's crucial experiments to verify the existence of the ionosphere.

Despite this considerable research, Hollingworth felt that his true vocation lay in teaching and, when the opportunity came to succeed Miles Walker, at Manchester, he left Ditton Park to devote himself to those academic matters in which he maintained a deep interest throughout his long life.

External Lectures to Appleton Staff

The following lectures have been arranged.

AUTOMOTIVE POWER SYSTEM

Dr. M. T. G. Hughes

Wednesday 1 December 1976

CLIMATE

Dr. H. T. Mörth

Wednesday 16 February 1977

Further details will be announced in due course.

Sports and Social Club News

Appleton Laboratory Sailing Club

With the aid of a loan from the Sports and Social Club we have now purchased a secondhand fast racing dinghy, Fireball 1178, called 'Lotus Eater'. She is in very good condition, and with a full inventory including trailer, trolley, trapeze, seven sails and a few spares.

Our initial test drives at Datchet were in a strong gusty wind giving a very exciting ride, including the first capsize, from which we recovered easily, giving us some good trapeze practise. The second outing was in very light winds giving us the opportunity to try out both spinnakers.

At present the boat is being kept in the Laboratory grounds, but it may be moved to the Reservoir later.

Eight members hope to make their own wetsuits from kits within the next few weeks, enabling sailing to continue through the winter.

Sailing the hired Wayfarers has continued on every Sunday since July, and several members who have not previously sailed, are now taking boats out without supervision.

Thirty members have now joined the Civil Service Sailing Association, and a Committee of nine with four Officers was elected at our first General Meeting on the 15th September. The Officers are Commodore - Paul Dickinson, Vice Commodore - Brian Warburton, Treasurer - John Macdougall and Secretary - Ken Pavitt.

All members of staff are welcome to a series of talks, on sailing subjects, which are being organised for Tuesday evenings. These will continue until the end of the year.

New members, with or without sailing experience, are welcome. Full details of Club activities are available from the Secretary.

KEN PAVITT

Bar-B-Q (18 September)

Once again a very successful social function, even more so this year as the elements were on our side. Spotlights in the branches lit up the merry scene of bonfire, barbecue and sizzling sausages (well, at least we managed to keep the chill off them).

The pleasant evening air allowed folk not too keen on prancing around to the disco to group around the smouldering bonfire and make small talk before the raffle was drawn (a bottle of Bells to Brian Benson).

The gaiety continued into the small hours and finally came to a halt when the disco was persuaded to "shut up shop" by the Chairman (who shall remain nameless) who wanted to go home.

Many thanks to all helpers and here's hoping for similar weather conditions on November 5. (See Linda Chipperfield, Mary Thrift, Mike Farman, Hari Shah for tickets.)

CHAIRMAN
Sports and Social Club

Appleton Cricket Club

The Cricket Club finished a reasonably successful season with its Annual match against the 'lassies'. This ended, in heavy rain, in another tie, with the 'lads' stretched to the limit to find the last run to equalise. Perhaps our fortunes will turn next year.

The season's results indicate that while we seem to have some aptitude for the 20 over evening cricket, our standard in afternoon games is not quite of the same quality.

Our record for the season, which included 7 afternoon games, was Won 14 Drawn 2 Tied 2 Lost 10; of the afternoon matches we could only manage 2 draws.

The batting performances generally were quite good, but the bowling lacked penetration on the many batting wickets we played on. Terry Paterson headed the batting averages with 476 runs average 43 runs, and Alan Buck bowled most overs 118 and took 32 wickets in the process.

The Club purchased a great deal of equipment during the season, including a reconditioned motor lawn mower, and were able to pay for most of this out of the proceeds from two very successful Discos held to mark the beginning and end of the season. Our thanks as always to Mrs. Loudonsack and the bar staff for their efforts in making these events so successful.

It is proposed to hold the Annual General Meeting of the Club one evening during the first week of December and follow this with a night out at a local restaurant and bar. Nominations for Captain, Treasurer, and Fixture Secretary for the coming season, duly proposed and seconded, should be made on the form to be found on the Social Club Notice Board.

Bridge Club

The bridge season has started again and this year we have entered 3 teams of 4 in the Great West Road Bridge League. Our results to date have been encouraging. The first team have still to lose a match, the second team are above average, and the third team, made up of newcomers to the Club, although losing their first 2 matches have not been disgraced - some good results will come its way shortly.

Letter to the Outstations

Dear Colleagues

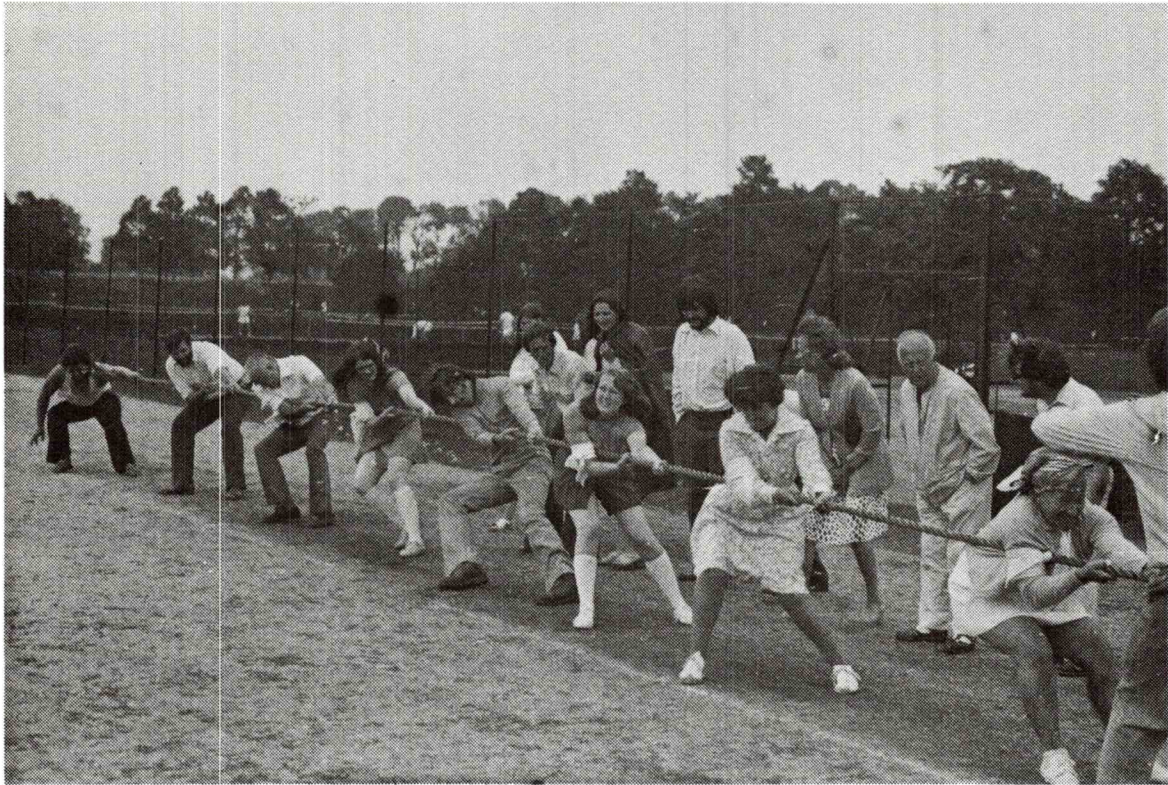
Well then, the rains came at last. Walks are muddied in a decent English fashion and seemingly burnt-up grass revived with an ostentation bordering upon the vulgar. The moat is once more strictly for the fishes, such as have survived, though the occasional glimpse, beneath its ripples, of meadow plants, like remnants of a drowned orchard, recall the curious climate of summer '76.

Our own peculiar seasonal signs are not wanting. The autumnal pre-migration patterns of the Greater Arctic Particle Catcher are clearly to be seen; the gathering up of useful containers, boots, etc. accompanied by a demanding cry most nearly rendered as 'IMM-PRRESST' is a sure sign of coming departure from our shores.

Nor do we lack incoming visitors. The Wave Scatterer whose activities were thought to be centred on the Malvern Hills has, it seems, been completely absorbed by a European form of the species emanating from a number of nesting-places on the Continent. Characteristics so far noted are a variety of individual calls but, in general, a group goal or purpose and, most striking of all, the recently remarked Hidden Set Sociability display. This consists of the gathering together of, for the most part, the same individuals of the species, often at feeding time, but - presumably to guard against predators - each occasion is identified by variations in group call, though it usually has the 'KOM-MIT-TEE' suffix well known to even comparatively inexperienced watchers such as,

Yours sincerely,

THE EDITOR



SUMMER RECALLED

Staff, fully stretched, at
the Tug of War

Reprint List for September/October

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A magnetic model of the solar transition region
Phil. Trans. R. Soc. Lond., 1976, Vol. 281, pp 339-352.
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First European Solar Meeting, 1976, pp 3-6.
- DAVIES, P G A 1167
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Proc. I.E.E., 1976, Vol. 123, No. 8, pp 765-769.
- LLEWELLYN-JONES, D T, R J KNIGHT & H A GEBBIE A 1066
Millimetre wave spectroscopy of water vapour using
harmonics from IMPATT diode oscillators
Scientific Instruments, 1976, Vol. 9, pp 690-692.
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Spectrum of CaX and spectral observations of calcium,
scandium, and titanium
J. Opt. Soc..Am., 1976, Vol. 66, pp 632-633.
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EISCAT: A new project for studying the high latitude
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Contemp. Phys., 1976, Vol. 17, No. 5, pp 483-489.
- RISHBETH, H & H KOHL A 1194
Topical questions of ionospheric physics: A working
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J.A.T.P., 1976, Vol. 38, pp 775-780.
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The energetics of sun-weather relationships:
magnetospheric processes
J.A.T.P., 1976, Vol. 38, pp 685-698.
- GIMMESTAD, G G, D T LLEWELLYN-JONES & H A GEBBIE A 1184
Millimetre wave oxygen attenuation measurements
J. Quant. Radiat. Transfer, 1976, Vol. 16, pp 899-900.
- THOMAS, L, A J GIBSON, & S K BHATTACHARYYA A 1197
Spatial and temporal variations of the atmospheric sodium
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Nature, 1976, Vol. 263, No. 5573, pp 115-116.

Internal Memoranda

NIL