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Spaceflight

The International Magazine of Space and Astronautics

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- *TDRS-E is Geosynch' After STS-43 Launch*
- *Pegasus No.2 Success*
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- *24 New Launches Listed*

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No.9

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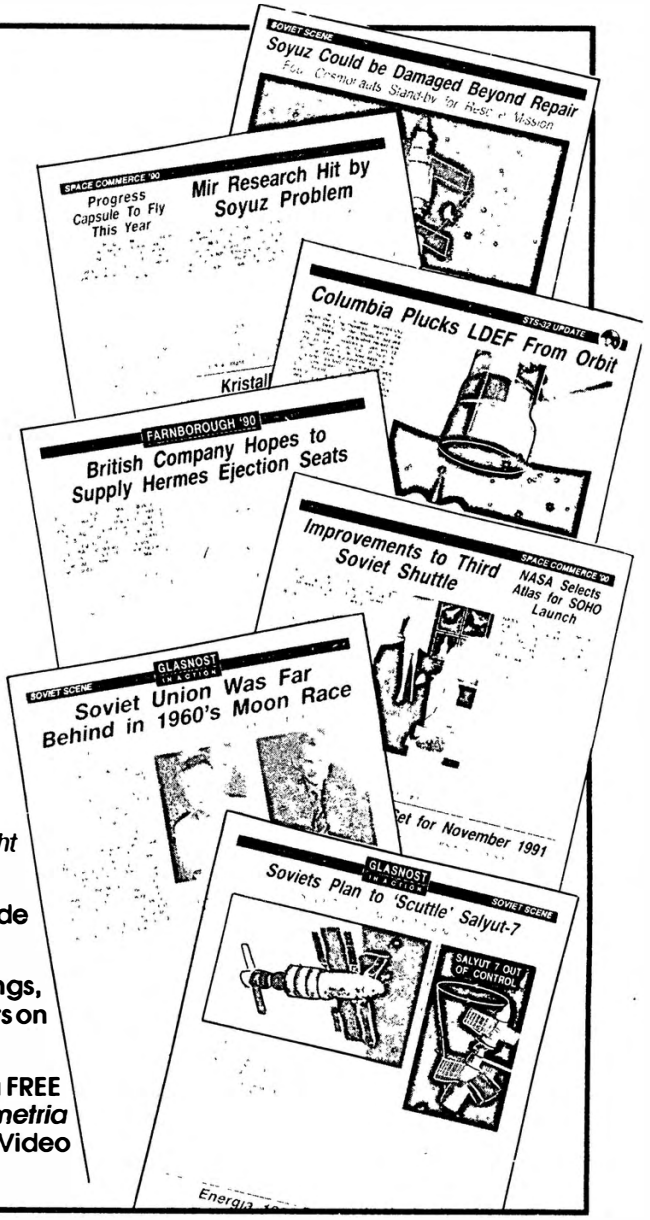

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DISTRIBUTION DETAILS

Spaceflight may be received worldwide by mail through membership of the British Interplanetary Society. Details from the above address. Library subscription details are also available on request.

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Spaceflight is distributed in the UK and overseas through newsagents by Magnum Distribution Ltd, Cloister Court, 22-26 Farringdon Lane, London, EC1R 3AU. Tel: 071-253 3135 Fax: 071-608 0646

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Back issues of ***Spaceflight*** are supplied at £2.00 (US$4.00) each, inclusive of surface mail delivery. ***Spaceflight*** binders (holding 12 issues) are available at £7.00 (US$14.00), inclusive of surface mail delivery.

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Published monthly by the **British Interplanetary Society Ltd.**, 27/29 South Lambeth Road, London, SW8 1SZ, England. Printed by JWL Ltd, Aylesbury, Buckinghamshire, England.

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Spaceflight
The International Magazine of Space and Astronautics

Vol. 33 No. 9 **September 1991**

FRONT COVER: The 204th Delta rocket carries the ASC-2 communications satellite into orbit on April 13. The satellite is just one of many listed in this month's Satellite Digest.
McDonnell Douglas

Super Powers Agree on Astronaut/Cosmonaut Exchange

President Bush and President Gorbachev have signed an agreement under which a Soviet cosmonaut will fly on the American Space Shuttle and a US astronaut will spend several months aboard the Soviet Mir space station. The agreement also covers other areas of cooperation.

The agreement was signed during the recent super power summit in Moscow on July 31. No timetable for the cooperative venture was given but is widely expected a Soviet cosmonaut will fly aboard the Space Shuttle Columbia in May 1993 for the second Spacelab Life Sciences mission, scheduled to last 13-days. Probably in the same year, an American astronaut would fly to Mir in a Soyuz TM capsule. The astronaut could spend up to six months working aboard the Soviet space station before returning to Earth.

The proposal for the exchange was developed on the US side by the National Space Council, under the chairmanship of Vice-President Dan Quayle.

According to a NASA statement, the purpose of the exchange flights is to conduct life sciences research of mutual interest. "It would advance current efforts to standardize in-flight medical procedures which would improve comparability of data taken by each side," the statement says.

The exchange would involve the training of two or three astronauts at Star City, near Moscow, and a similar number of cosmonauts at the Johnson Space Center in Houston.

The two sides plan to exchange medical equipment for flight on the missions and establish a communications link between the two countries for use during the missions.

A new joint working group on manned space flight will be established as an annex to the 1987 US/USSR space science agreement to implement the exchange flight project. The manned space flight JWG will work with the existing JWG on Space Biology and Medicine, which will be responsible for implementing the life sciences research.

The agreement also calls for expanded cooperation in the monitoring of the global environment. Both sides will exchange information on their respective plans for Earth observation programmes and develop cooperation where joint action could improve Earth science research and environmental monitoring on a global scale and allow the free and open international exchange of data from those programmes. This cooperation will be carried out by the US/USSR Earth Sciences JWG.

It was also agreed to hold annual meetings between the two governments on civil space issues and cooperative activities.

The JWGs are coordinated on the US side by NASA and the Department of State-led 'Interagency Working Group on US/Soviet Space Cooperation', under the guidance of the National Space Council.

US to Build No New Space Shuttles

Quayle Announces New Space Launch Policy

Under the new US National Space Launch Policy no new Space Shuttle orbiters will be built. The policy calls for the use of surplus military missiles for civilian satellite launches and the development of a new family of unmanned, expendable rockets.

"In all probability, we have purchased the last Space Shuttle," Vice President Dan Quayle said, unveiling the new policy at Vandenberg Air Force Base in California on July 24.

"The Space Launch Policy proposes to extend the life span of the Shuttle fleet, to maintain the capacity to produce spare parts and to operate the system conservatively," Quayle said.

"The Space Shuttle, with its precious human lives, is just too valuable to use on missions that don't need its unique capabilities," he added.

The decision to build no more orbiters does not mean the Shuttle is being phased out, the Administration says.

"As far as manned space flight is concerned, the Shuttle will be crucial for some time to come," Quayle said.

The policy rejects a NASA request to build a sixth Shuttle orbiter but space agency chief Dick Truly said he was pleased with the policy.

"It is a thoughtful plan that lays out important priorities for a new launch system, while still maintaining the inherent capacity for Shuttle support or production in the event of an orbiter loss or other demonstrable need," he said.

The policy calls for surplus military missiles to be released for civilian use as space launch vehicles. Recent arms reduction agreements have freed a large number of ballistic missiles for other applications.

However, the policy aims to protect the fledgling US private launch industry from a flood of cheap ex-military rockets. It states that "due regard to economic impact on the commercial space sector" must be considered.

Under the policy a new family of launch vehicles will be developed to carry medium and heavy payloads into orbit. NASA, the Department of Defense and the Department of Energy are to deliver a ten-year plan for implementing the strategy by December 1. The new series of rockets will not be man-rated but could be qualified for manned flights at a later date. The vehicles should reduce launch costs by a tenth to about $300 a pound.

Second Pegasus Orbits 'Micro-Satellites'

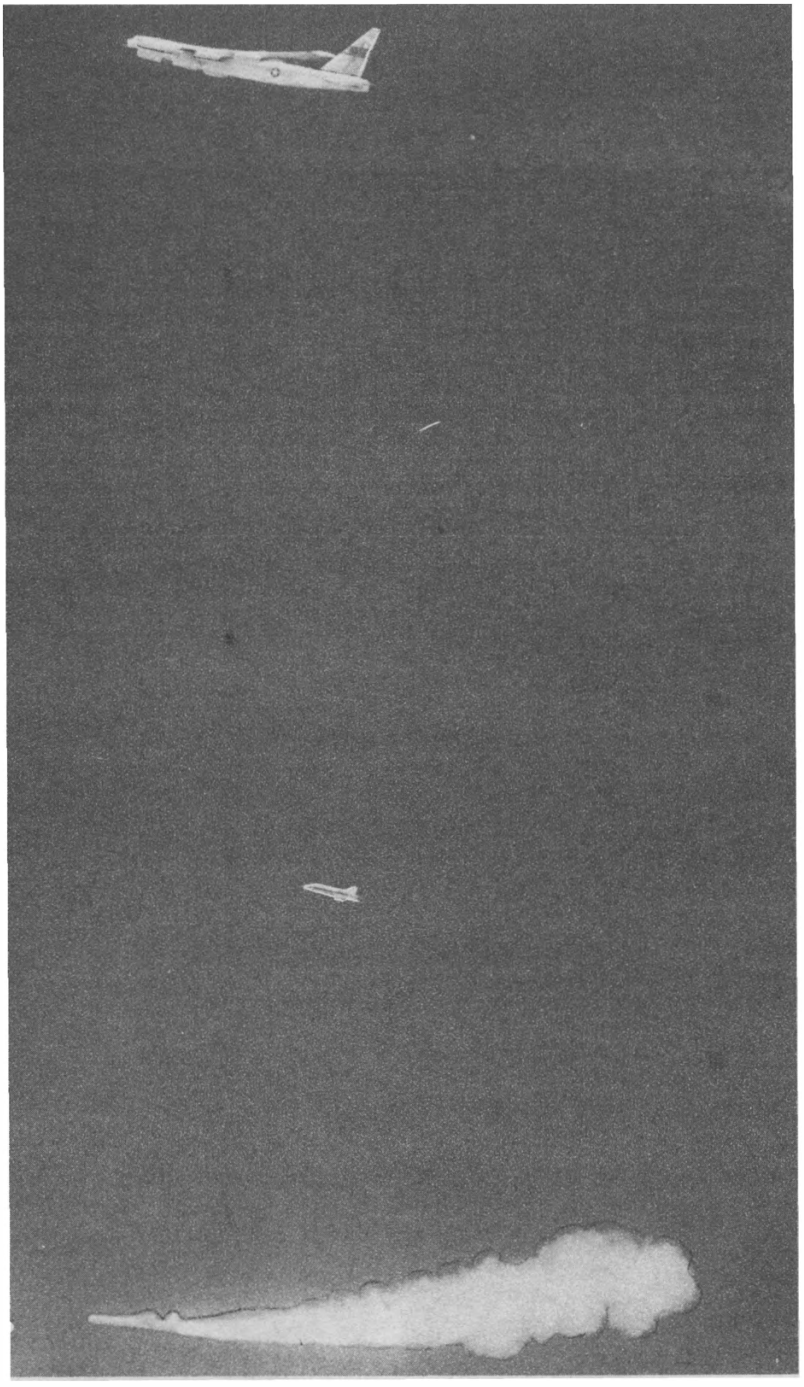
First Stage Glitch Mars Otherwise Successful Mission

The Orbital Sciences Corporation Pegasus booster has successfully completed its second test flight. The air-launched rocket orbited seven tiny 'Microsat' research satellites for DARPA, the Defense Advanced Research Projects Agency. An otherwise successful mission was marred by a problem at first stage separation that caused the Pegasus to veer off course. As a result the satellites were placed in a lower orbit than planned, but one that should be sufficient for them to accomplish their mission.

The second Pegasus differed in two major ways from its predecessor. It was fitted with an additional liquid-fuelled fourth stage called HAPS - the Hydrazine Auxiliary Propulsion System. The stage, with its three 50lb thrusters, increases vehicle performance and should provide a more precise delivery of the payload into orbit. The first three Pegasus stages use solid propellant.

The second new feature is the use of a Global Positioning System (GPS) satellite navigation receiver. Mounted on the avionics deck as part of the vehicle's guidance and navigation system, the GPS receiver aids the accurate tracking of the vehicle during flight. It is planned to incorporate GPS receivers on all future Pegasus missions.

"HAPS is Orbital's first liquid propellant rocket stage and it performed superbly," said Robert R. Lovell, President of Orbital's Space Systems Division. "Pegasus also broke new ground with the operation of a GPS receiver, the first time one has been flown on a space launch vehicle."



The second Pegasus booster ignites after being dropped from beneath the wing of a NASA B52 aircraft (top). A chase plane is visible above the rocket. *NASA via OSC*

The Pegasus booster was released from the right wing of a NASA modified B-52 bomber at 10:33 PDT on July 17 as the aircraft flew due south, 43,100 feet over the Pacific Ocean about 60 miles off the coast of California. The B-52 had taken off from Edwards Air Force Base about an hour before.

Five seconds after release, the Pegasus first stage ignited and the winged-rocket arced skyward. At the end of the 84-second burn an anomaly of some sort occurred at first stage separation causing the booster to veer off course.

Fortunately, the rocket's guidance system was able to compensate for the loss, said US Army Major Robert Bonometti, the mission director for DARPA.

As ground controllers waited for the Pegasus fourth stage to inject the satellites into orbit, telemetry was lost because a USAF tracking aircraft was grounded by bad weather over Antarctica.

It was nine hours after launch when ground controllers finally made contact with the seven tiny satellites. Due to the first stage separation problem the Microsats were not in the planned 389 nautical mile circular orbit but a 245 x 192 nm elliptical orbit. According to Bonometti, the satellites can perform their mission in the lower orbit but will probably reenter the atmosphere in a year, instead of the planned three year lifetime.

The seven microsats were constructed for DARPA by Defense Systems Inc. of Virginia. The 12-sided satellites, 19 centimetres high and 48 centimetres in diameter, each weighed 22 kilograms. They were designed to provide push-to-talk 'bent pipe' tactical communications. They contain a 'store and forward' capability and are compatible with existing military radios. Tactical applications also include the relay of data, facsimile and low data rate imagery.

Orbital Sciences Corporation and Hercules Aerospace developed the Pegasus launch vehicle under contract to DARPA. The winged-rocket made its maiden flight on April 5, 1990. Orbital Sciences now has contracts for 15 firm and over 45 optional launches. These include contracts for NASA, the US Air Force and Sweden.

The next Pegasus launch is scheduled for the Autumn, carrying a US Air Force payload.

Additional Material by Curtis Peebles

Crippen Shelves Plans for MMU Flight

Management and Astronauts Differ on Spacewalks

Shuttle Director Bob Crippen told *Spaceflight* he has shelved plans for a reflight of the Manned Maneuvering Unit (MMU). Earlier in the Shuttle programme, the backpack was used by spacewalking astronauts to fly untethered in orbit. The decision highlights a difference between NASA management and the astronaut corps on the frequency of spacewalks.

The two MMUs were taken out of storage in 1990 with the intention of flying them at the end of this year. Supporters of the MMU wanted a flight every 18 months to demonstrate its different capabilities. They pointed out that although at the present there are no specific tasks for the MMU it was important to keep it flight ready and obtain further experience in its use.

It was proposed to use the MMU to photograph from a distance Shuttle manoeuvres and water dumps. IMAX and infrared cameras could have studied heat leaks and collected engineering data about the condition of the Shuttle's thermal insulation tiles.

However, Bob Crippen told ***Spaceflight*** the plans have been rejected.

"At this time I cannot find a reason to use the MMU so I've had them put it back in storage," he said. "It will be available if we come up with a reason to use it."

Crippen said that because of the MMU's limited propellant supplies its uses were rather limited.

"It's a neat device," he said, "but it really doesn't have enough flight time to make it useful. Maybe someday we will build a better one."

Martin Marietta, the builders of the MMU, recognise this drawback and have proposed fitting the unit with additional nitrogen propellant tanks to double its existing capacity.

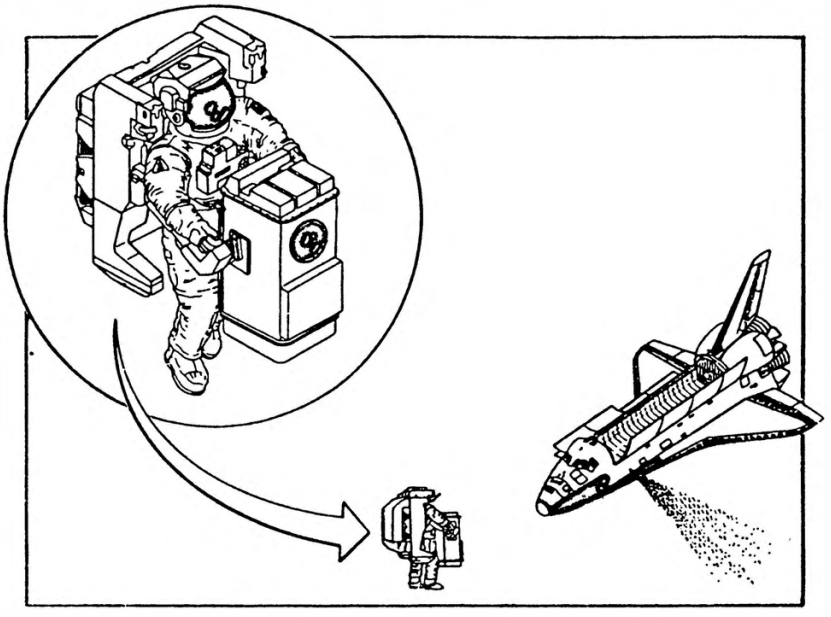
The space agency spent about $20 million building the two MMUs and millions more on their development.

"It was developed mainly to look at the concept," Crippen said. "Could you build something that would fly like that? Would the control system work? What could people physically do with it? And I believe it demonstrated all that. So it was a demonstration tool."

The MMU made its maiden flight in February 1984, when astronaut Bruce McCandless became the first human satellite as he ventured, untethered, out of the payload bay.

McCandless lobbied for further flights with the MMU before he left NASA. Also he and other astronauts have called for more frequent EVAs to gain experience for Space Station Freedom. However, the safety conscious NASA management shied away from spacewalks just for the sake of gaining experience.

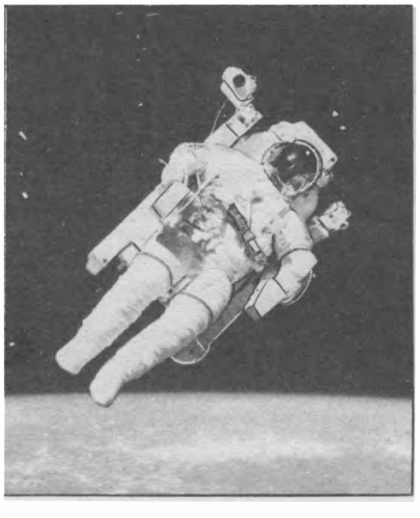
Spaceflight understands NASA management turned down a request for a planned spacewalk on STS-31, the mission to deploy the Hubble Space Telescope. In the flight plan astronauts Bruce McCandless and Kathy Sullivan were to be ready to perform an emergency spacewalk to deploy the telescope's solar arrays or antenna if problems were encountered. During the deployment they wore their cooling garments, so at a moment's notice they could don the rest of their space suits and leave the airlock. With a highly trained and experienced crew it was proposed the astronauts should perform a spacewalk during the flight but Bob Crippen is believed to have rejected the plan.



Plans to photograph water dumps with an IMAX camera mounted on an MMU have been shelved by Shuttle Director Bob Crippen. *Martin Marietta*

By Steven Young
At the Kennedy Space Center, USA

The Manned Maneuvering Unit has probably made its last flight. *NASA*



The first American spacewalk since November 1985 finally took place on Shuttle mission STS-37, in April. In addition to their planned spacewalk Jerry Ross and Jay Apt had to make an emergency EVA to deploy a stuck antenna on the Gamma Ray Observatory.

In the three years prior to the Challenger accident, US astronauts performed 13 spacewalks and chalked up a total of 68 hours 41 minutes outside the orbiter. However, in the three years since Shuttle flights resumed, there have been just two EVAs, totalling 10 hours 49 minutes.

In the same three-year period Soviet cosmonauts have performed 20 spacewalks, spending more than 90 hours outside the Mir space station. The current Mir crew has made six spacewalks in five weeks.

The space agency's management and its astronauts agree more experience is necessary before construction of Space Station Freedom can begin. However, they differ when it comes to the number and frequency of EVA's required.

"We picked a rate of one EVA per year as a means of keeping the team familiar with how to do them," said Crippen. "One a year should be adequate to do that."

However, speaking before STS-37 Jerry Ross said he felt spacewalks should be performed at least every six months.

"There are of course differences of opinion about how often you have to do them," said Crippen. "If we find out through the next EVAs that we are having

Soviets Cancel Mir Mission

Soviet space authorities have cancelled a launch to the Mir space station that was not even known to have existed until the announcement came that it had been called off. The change in plans will mean an extended mission for cosmonaut Sergei Krikalev.

The Soviet State Commission on Space decided on July 17 to cancel the launch of Soyuz TM-14, apparently scheduled for November. The flight will be combined with the planned October 2 launch of Soyuz TM-13, officials said. The announcement was a double surprise because the November flight was unknown in the West.

The Red Star newspaper said "the current economic situation made it impossible" to carry out the original plans.

The scrapped November mission was to have carried the first Kazakh cosmonaut to the Mir station. The Kazakh, Takhtar Aubakirov, now replaces flight engineer Aleksandr Kaleri on the Soyuz TM-13 crew consisting of Aleksandr Volkov and Austrian astronaut Franz Viehböck.

At the end of the eight-day mission the present Mir commander, Anatoli Artsebarski, will return to Earth in the Soyuz TM-12 capsule with Aubakirov and Viehböck. Artsebarski's engineer, Krikalev, will remain on board Mir with Volkov, who coincidentally commanded his previous mission.

Ironically, this is the second time Krikalev has taken Kaleri's place on a mission. Kaleri had been assigned to the Soviet-French mission in 1988 but due to illness was replaced by Krikalev.

According to Tass, the back-up crew for TM-13 are commander Aleksandr Viktorenko, Kazakh Talget Musabayev and Austrian Klemens Lotaller.

Cooling Fails to Release Jammed Galileo Antenna

Controllers at the Jet Propulsion Laboratory in California report that an attempt to free the Galileo probe's stuck antenna has been unsuccessful. The spacecraft's high gain antenna only partially deployed when it was commanded to open in April.

Ground tests have confirmed that three to five of the 18 ribs on the umbrella-like antenna are stuck in the closed position.

It is hoped that by cooling the antenna parts the stuck ribs may come free. On July 10 controllers turned Galileo so its high gain antenna was shaded from the Sun for about 32 hours. The temperature of the antenna dropped by 100 degrees C but subsequent testing has shown no evidence that the ribs were released.

The antenna was cooled again on August 12-15. Galileo turned 165 degrees away from the Sun to put the entire high-gain antenna behind the large sun shield. The antenna stayed in the shade longer and, in addition, some electrical power loads were turned off and shifted away from the antenna. These differences will permit the antenna to cool further than it did before. As this issue of ***Spaceflight*** went to press the results of the test were still being analysed.

On August 7, the Galileo spacecraft was about 146 million miles from Earth, and 182.4 million miles from the Sun. The probe is speeding towards a flyby of the asteroid Gaspra at 41,500 mph. The spacecraft should pass about 1,000 miles from the rocky body on October 29. Because of the loss of the high gain antenna, Galileo will record its images and data from the flyby for later transmission on the low gain antenna.

MMU Continued...

any problems that seem to be driven by how often you are doing them we would reconsider. But at this time we consider that probably doing them annually would be satisfactory."

Crippen says that since the restructuring of Space Station Freedom the EVA requirements for the assembly flights have been dramatically reduced.

"It is not nearly as dependent on EVA," he said. "You used to have to go out and assemble the truss structure. Now we are putting up these pre-integrated structures and all you have to do is connect the things together and you can do that with the [robot] arm as opposed to doing EVA."

Previously three EVAs were required on many of the station assembly flights. With the new design only two walks per mission will be necessary.

Despite this NASA intends to perform three back-to-back spacewalks next April on the maiden flight of the Space Shuttle Endeavour. One spacewalk will be made to attach a new booster to the stranded Intelsat satellite and two more will evaluate construction techniques for Space Station Freedom.

The next spacewalks are planned for late-1993/early-1994 when three EVAs will be required to repair the Hubble Space Telescope.

In 1995 construction of Space Station Freedom will begin. In the ten years prior to this event the US will have performed eight spacewalks on three missions.

NEWS IN BRIEF

Ariane Success

The 45th Ariane rocket has successfully placed the Intelsat VI F5 telecommunications satellite into geostationary transfer orbit. The Ariane 44L equipped with four liquid strap-on motors — the most powerful version in the Ariane series — blasted-off from Kourou in French Guiana at 12:15:33am BST on August 15. Positioned at 14.5 degrees west, over the east Atlantic Ocean, Intelsat VI F5 will relay 24,000 telephone circuits and three television channels. The next Ariane launch is scheduled for September 26 when an Ariane 44P — equipped with four solid propellant strap-on boosters — will orbit the second Anik E telecommunications satellite for Canada's Telesat.

Soviets Launch NASA Ozone Instrument

NASA's Total Ozone Mapping Spectrometer (TOMS) is in orbit on a Soviet Meteor-3 weather satellite after launch by Tysklon from Plesetsk at 10:14 am BST on August 15. Since the first TOMS was launched aboard NASA's Nimbus-7 satellite in 1978, the instrument has provided reliable, high-resolution daily mapping of global total ozone. The Meteor-3/TOMS instrument is identical to the Nimbus-7 instrument in terms of optics and performance. By launching in August, Meteor-3/TOMS will be in place to observe the formation of the Antarctic ozone "hole" in September and October. The ozone "hole" is a large area of intense ozone depletion over the Antarctic continent that typically occurs between late August and early October and usually breaks up in mid-November.

Astronaut Irwin Dies

Former astronaut Jim Irwin died of a heart attack on August 8 at Glenwood Springs, Colorado. He had a long history of heart trouble. Irwin was the lunar module pilot on Apollo 15. His death came almost exactly 20 years to the day after he returned from the mission. Of the 12 men to walk on the Moon he is the first to die. An interview with Irwin appeared in the August issue of ***Spaceflight*** (p.284-287).

US-Argentine Agreement

NASA and Argentina have agreed to cooperate on a solar physics and astrophysics satellite. The Satelite de Aplicaciones Cientificas-B (SAC-B) will be built by the newly formed Argentine National Commission of Space Activities (CONAE) and the Institute of Astronomy and Space Physics will provide a solar X-ray instrument. NASA will provide an X-ray cosmic background instrument built by Penn State University and X-ray spectrometers provided by the Goddard Space Flight Center. The spacecraft will be launched on a US expendable rocket.

The BIS Video Collection

The British Interplanetary Society is proud to offer a stunning record of man's exploration of space brought to your home by *The BIS Video Collection.* Three new cassettes in this exciting collection are now available.

STS-26

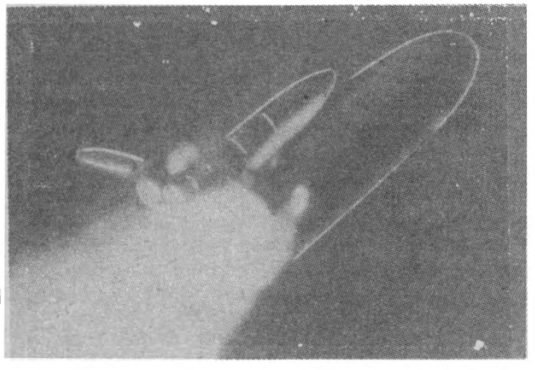
The Return to Flight

On September 29, 1988 Discovery blasted-off from the Kennedy Space Center it was the first Shuttle launch since the Challenger accident.

This video depicts the highlights of the STS-26 four-day mission. During the flight, the five-man crew deployed a Tracking and Data Relay Satellite and performed a series of microgravity experiments. It concludes with the successful landing at Edwards Air Force Base in California on October 3.

There is no commentary on STS-26 Mission Highlights, apart from the astronauts' transmissions and occasional announcements from the NASA Public Affairs Officer. The tape is accompanied by a FREE mission guide.

Running Time: 57 minutes



CHALLENGER

Accident Investigation

On January 28, 1986, the Space Shuttle Challenger exploded 73 seconds after blast-off from the Kennedy Space Center. All seven STS 51-L crew members died.

This video, prepared by the Photo and TV Support Team of the 51-L Data and Design Analysis Task Force, documents task force activities and findings. It also provides a concise, technical explanation of the cause of the Challenger accident.

Running Time: 29 minutes

A COLLECTION OF "THE MOVIES"
LA, Earth, Mars and Miranda

plus

VOYAGER 2 NEPTUNE ENCOUNTER

Created by the Jet Propulsion Laboratory, this video, features four short productions which use satellite/space probe images and supercomputer graphic animation. In 'L.A. - The Movie' the Los Angeles area is seen from space, then the view moves downward to provide a point-of-view tour around the animated city. 'Earth - The Movie' begins with animation of the entire planet as it is rotating in space. It continues with a point-of-view movement down to the surface and past the continents. "Mars - The Movie' features point-of-view movement around one geologic area on the planet. A simulated excursion over the Uranian moon, Miranda, is showcased on 'Miranda - The Movie'.

Running Time: 17.5 mins

At the start of this tape is an additional feature, 'Voyager 2 Neptune Encounter'. Containing 17 individual segments, this production illustrates the various aspects of Voyager's encounter with Neptune. The segments progress from computer animation of the Voyager mission to actual photographs of Neptune and Triton.

Running Time: 29 mins

Also available: **STS-32** Video Highlights, **STS-31** Video Highlights, **The Eagle Has Landed:** The Flight of Apollo 11 and **STS 41-C** Video Highlights

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Hubble May Need Early Repair After Problems with Third Gyro

NASA officials are studying options for an emergency Shuttle mission to repair the Hubble Space Telescope after a third gyro on the observatory showed signs of failure. The space agency was not planning to visit the telescope until late-1993/early 1994, when new optics will be installed to correct for the telescope's misshapen primary mirror.

On July 26, ground controllers detected something strange in the telescope's No.5 gyroscope or 'gyro'. Although the gyro is performing well, it is drawing a higher-than-normal electrical current, possibly because of dirt or dust in its rotor mechanism. Project officials believe the gyro will probably only operate for another year or so.

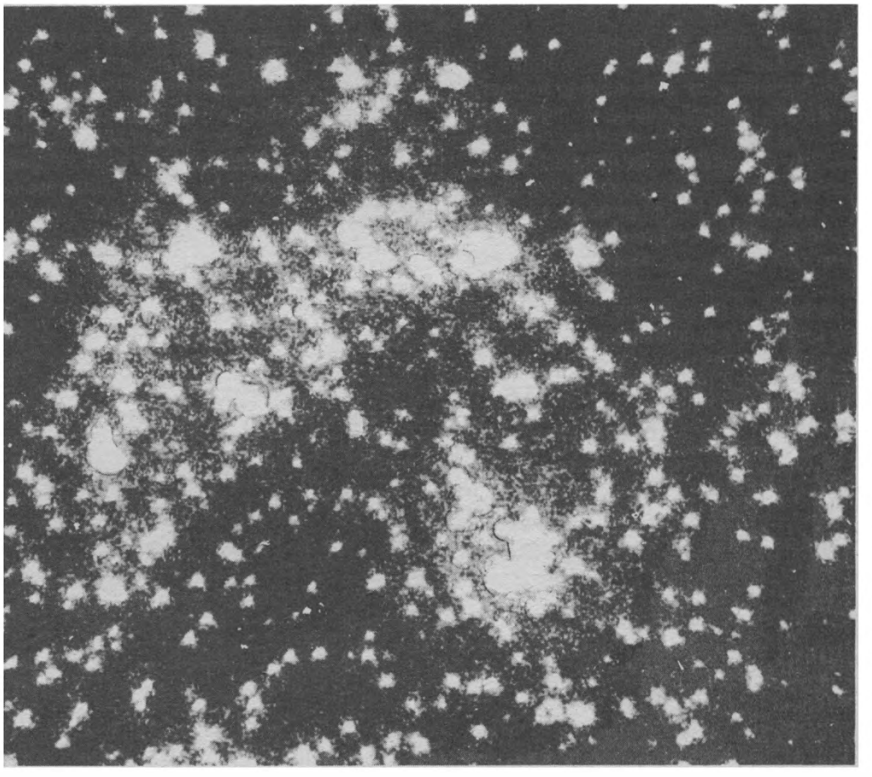
The gyros are used to control the spacecraft's pitch, roll and yaw so the telescope can be pointed at specific targets. At least three gyros are required to position the 11.5 tonne observatory. If two or more of the four remaining gyros fail the telescope would activate its 'Retrieval Mode Gyro Package' which would place it in a safe mode for 15 to 18 months, hopefully enough time for a repair mission to be mounted. Without accurate pointing, science operations would have to be suspended.

Two of the telescope's six gyros have already failed — gyro No.6 in December 1990 and gyro No.4 in July this year. The recent problem with gyro No.5 appears different from the previous two failures, which are thought to have been caused by radiation damage. Project officials are concerned because the gyros, built by Bendix Corp., are designed to operate for 14 years before failing.

The telescope was originally designed to operate on four gyros but after the second gyro failed ground controllers used just three gyros, keeping the fourth in reserve. To their surprise the telescope operated more smoothly than before. However, after gyro No.5 showed signs of failure, the controllers had to operate with all four gyros.

On July 31, the Washington Post reported NASA was considering an emergency spacewalk as early as next year to replace the faulty gyros.

The Washington Post also reported there was growing concern about the continuing jitter in the telescope's ESA-built solar arrays. Some engineers believe the arrays' support booms may suffer from metal fatigue because of the repeated flexing as Hubble passes from night to day and vice versa. If the booms were to snap, the spacecraft would be left without power and its instruments would be ruined.



Hubble Finds "Blue Straggler" Stars

ABOVE: The core of the globular cluster 47 Tucanae, as imaged by the European Space Agency's Faint Object Camera (FOC) onboard the Hubble Space Telescope. The telescope's high spatial resolution and ultraviolet sensitivity make it a powerful tool for probing the centres of globular clusters. The FOC resolves several hundred stars where ground-based images only yield a few dozen stars. At least 21 of these stars are exceptionally bright in ultraviolet light. HST's UV sensitivity and high resolution allow it to easily separate these so-called "blue straggler" stars from the red giant stars which dominate the cluster.

Blue stragglers may evolve from "old age" back to a hotter and brighter youth through stellar collisions and mergers. This high concentration of blue stragglers towards the core of 47 Tucanae suggests they are significantly more massive than most of the cluster's stars. Some of blue stragglers could be massive because they are really double star systems. Such binary systems may influence the motions of thousands of other stars within the cluster. *NASA/ESA*

A new set of solar arrays is currently under construction at British Aerospace in Bristol, England. NASA was planning to install the pair of 12-metre long panels during the planned 1993/94 repair mission. A British Aerospace spokeswoman said the new arrays would not be ready for delivery until late-1992.

In a statement space agency said no specific request for an earlier servicing mission has been made, but space science officials planned to ask the Shuttle programme "to help evaluate alternative servicing strategies."

An agreement laid down before the telescope's launch, allows the Hubble project to request an emergency servicing mission at a year's notice. Programme officials are expected to decide by September whether they need an early repair mission.

Unfortunately, the COSTAR device to correct the telescope's spherical aberration will not be ready in time for a Shuttle mission next year and NASA is unlikely to have the funds to stage two rescue mission.

Meanwhile, despite its problems, the space telescope continues to make exciting discoveries. A recently released image from ESA's Faint Object Camera, shows a cluster of 'blue straggler' stars.

Cosmonaut Grechko Visits London

Georgy Grechko was in London recently to address an audience of schoolchildren at the London Planetarium on the Soviet Space Programme and his three space missions. It was part of the programme to launch the "Space Trail" which opened in June. He was accompanied by Piet Smolders, a well known writer on the Soviet Space Programme.

During his talk Grechko confirmed his participation as a member of the Lunar programme on the third crew. He also stated his support for space stations, although he said he preferred man-tended stations as they seemed to offer greater scientific potential. He also admired the concept of the AN-225-HOTOL launch combination.

When answering questions, Grechko said that the work load was hard and that many cosmonauts got very tired in orbit - both physically and emotionally. Many cosmonauts initially suffered some sickness but soon recovered. Also on arrival crews felt very cold and had to turn up the temperature to 24-25 degrees C but after a week they turned down the thermometer to 20-22 degrees C. He also said soft landings were not so soft. All of his were hard.

In an interview with ***Spaceflight*** after the talk Grechko said that after taking his initial medical in 1964 he waited two years before joining the cosmonaut team. He was immediately assigned to the Lunar Programme but broke his leg soon after, which delayed his chance to fly in space. He was involved in the civilian Salyut programme during 1973. He was on the second or third crew but could not remember which. The first crew were Leonov and Lubasov who were assigned to ASTP.

Georgi Grechko

Currently Grechko is head of a Laboratory at the Institute of Atmospheric Physics run by the USSR Academy of Sciences. His laboratory has designed some experiments which are currently on board the Mir space station. They will be operated by Sergei Krikalev, who trained to operate the equipment in Grechko's Laboratory. He added that putting experiments on Mir was expensive and the Academy of Sciences did not have much money.

Rex Hall

Shuttle Engine Damaged in Test

A developmental space shuttle main engine sustained extensive internal damage while it was undergoing ground testing on July 24 at Stennis Space Center.

Despite the accident, senior NASA officials gave the go-ahead to launch Atlantis on mission STS-43, saying that the development engine was configured differently from engines used in the shuttle flight programme.

"All three of Atlantis' main engines have significantly less run time than components on the development engine that experienced the failure," said Shuttle Program Director Bob Crippen, "and the fabrication, inspection and repair histories of these units are well within our experience base for shuttle engines."

Post-test analysis of the development engine pointed to a failure in the high pressure fuel turbine, which had been modified for the test. Shuttle main engines are routinely tested at Stennis Space Center to expand NASA's data base on high time components and to test and certify new or modified components for later use on flight engines.

The test failure occurred about four seconds after engine start when sensors detected abnormal operating conditions. Ground-control systems terminated the test immediately and there was no apparent damage to the test stand on which the engine was mounted.

Investigation of the exact nature and extent of damage to the engine, as well as the cause of the incident, is continuing.

"Failures such as this do occur from time to time in the aggressive ground-test programme that we've always maintained, and especially when we're testing advanced-design components," said Jerry Smelser, manager of the Space Shuttle Main Engine Projects Office at Marshall Space Flight Center. "However, it has been over two years since we've had such an incident and during that time, we've accumulated over 100,000 seconds of engine operation, with 257 engine starts."

Smelser said the engine, number 0215, had been tested extensively in the past. It had been run 15 times prior to the aborted test, with an accumulated run time of about 87.6 minutes."

NEWS IN BRIEF

Zenit Launch Aborted

The Red Star newspaper reports the countdown for a Zenit launch was aborted at the 'last minute' on July 27. No reason was given. The paper said the Zenit was to have launched a 'military technical satellite to verify the fulfilment of disarmament treaties.' According to Philip Clark, a Soviet space analyst, the payload was probably an Electronics Intelligence (ELINT) satellite destined for a 850 km circular orbit, with an inclination of 71 degrees. The last Zenit launch attempt ended in failure on October 4, when the rocket's first stage engine exploded shortly after takeoff.

Kosmos Launch Fails

A Kosmos booster failed to place its payload in orbit after the failure of its second stage. The rocket blasted off from Plesetsk at 13:20 GMT on June 25. The first stage burned correctly and the first of two burns by the second stage was normal. However, 30 minutes into the flight the second stage did not re-ignite as planned. According to Philip Clark, the rocket followed a ballistic trajectory over the Antarctic and headed north across the Atlantic before burning up in the atmosphere near the Canary Islands. The payload was probably an ELINT satellite intended to orbit 500 km above the Earth at an inclination of 74 degrees, said Clark.

1990 Astronauts Fit to Fly

The Astronaut Candidate Class of 1990 became full-fledged astronauts on July 29. The 23 new astronauts were presented a letter from chief of the Astronaut Office Dan Brandenstein recognizing the completion of their one-year training and evaluation period and making them eligible for future flight assignments. The group includes 7 pilots and 16 mission specialists, 11 of them civilians and 12 are military officers. Among the 5 women in the group, 3 are military officers, including the first woman pilot.

Solid Rocket Test Fired

NASA engineers at the Marshall Space Flight Center fired a 26-foot long, solid rocket motor for a duration of approximately 30 seconds on July 2. The primary purpose for the test was to evaluate the performance of non-asbestos insulation candidate materials for NASA's solid rocket motors which fly on the Space Shuttle. Currently NASA has asbestos insulation in its solid rocket motors. However, the future for the Shuttle Solid Rocket Motors lies with an asbestos-free insulator, project officials said.

Married Couple on Shuttle

Astronauts Mark Lee and Jan Davis, currently training for STS-47, have been married. They will become the first married couple in orbit when they blast-off in September 1992 on the Japanese Spacelab mission.

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SATELLITE DIGEST-241

Satellite Digest is produced in two sections. Orbital Data is in the form of a table which lists each satellite's name, international designation, launch time and date, launch site, launch vehicle, perigee, apogee, period and inclination. Launch times are approximate, except when marked with an asterisk, when the time given is that issued by the launching agency. All times are GMT, unless otherwise stated. Soviet launch vehicles have been named by the US DoD system of classification and, when known, by the Soviet name. Orbital data has been provided by the Royal Aerospace Establishment. The first section, Satellite Data, contains notes on each satellite's mission.

ASTRA 1B (1991-15A): Second in a series of TV direct broadcasting satellites owned by the Societe Europeene des Satellites (SES), a private company incorporated in Luxembourg. The three firings of the apogee kick motor took place on March 3, 6 and 8. The solar panels and the communications antenna were deployed on March 9.
METEOSAT 5 (1991-15B): Known as MOP-2 prior to launch. The apogee kick motor was ignited on March 4. The satellite is stationed at 0 degrees latitude. The first image from Meteosat 5 was received on April 3.
KOSMOS 2136 (1991-16A): Photo reconnaissance satellite based on the Vostok capsule. Recovered March 17.
USA 69 (1991-17A): Classified DoD payload. Orbital data based on visual observations.
INMARSAT 2 F-2 (1991-18A): Second of the new generation mobile communications satellite for the international INMARSAT organisation.
NADEZHDA 3 (1991-19A): A civilian navigation satellite. Also known as COSPAS 6.
PROGRESS M-7 (1991-20A): Carried two tonnes of supplies and equipment to the Mir space station. Two docking attempts on March 21 and 23 were unsuccessful. The cargo craft finally docked on March 28. Undocked on May 7 and reentered the following day.
KOSMOS 2137 (1991-21A): Unknown military mission.
MOLNIYA 3-40 (1991-22A): Domestic communications satellite.

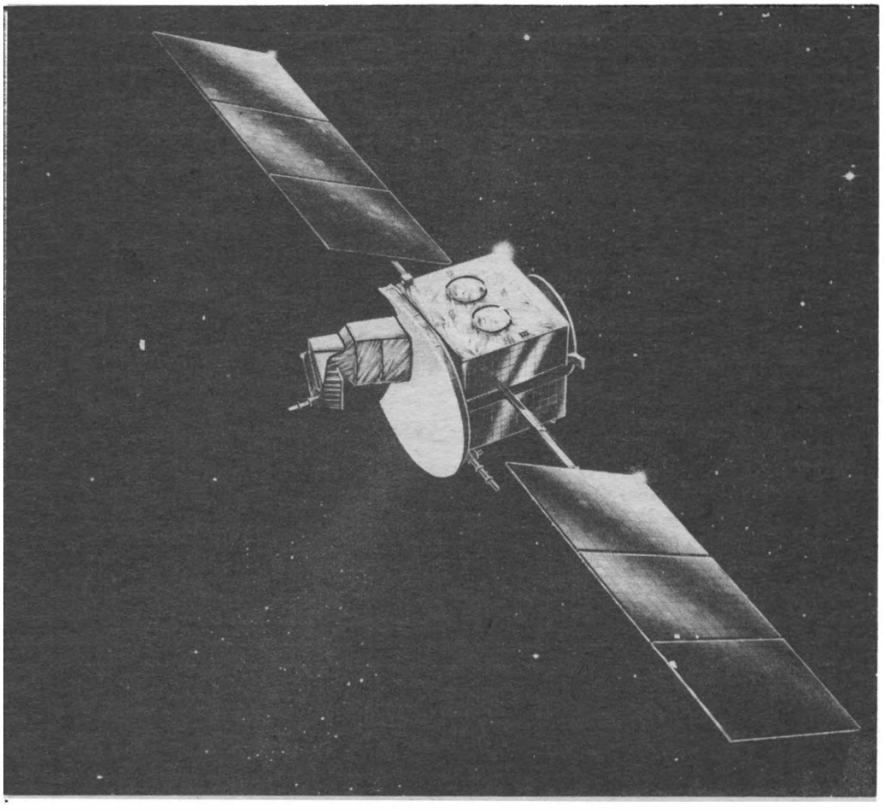
SATELLITE DATA

KOSMOS 2138 (1991-23A): Military photo reconnaissance satellite. Recovered May 24.
ALMAZ 1 (1991-24A): A large radar imaging satellite based on the Salyut space station design. Almaz means 'diamond'.
KOSMOS 2139-2141 (1991-25A to 25C): Three GLONASS satellites with laser reflectors.
ANIK E2 (1991-26A): Canadian telecommunications satellite. On April 12 the satellite's Ku-band and C-band antennas failed to deploy. Ground controllers were able to release the Ku-band antenna on April 15. Controllers finally managed to deploy the C-band antenna on July 3. Project officials believe thermal blankets jammed the antenna in place.
STS-37 (1991-27A): The Space Shuttle Atlantis, on its eighth flight, carried the Gamma Ray Observatory (GRO) into orbit. Two astronauts made a spacewalk to deploy the spacecraft's high gain antenna after it failed to swing out as planned. Onboard Atlantis were astronauts Steven Nagel, Kenneth Cameron, Linda Godwin, Jerry Ross and Jay Apt. Landed at Edwards Air Force Base on April 11. (See ***Spaceflight,*** June 1991, p.194-205.)
GAMMA RAY OBSERVATORY (1991-27B): The second of NASA's 'Great Observatories' carries four instruments for exploring the Universe in the gamma ray portion of the spectrum. The spacecraft was deployed from Atlantis on April 7.
ASC-2 (1991-28A): Owned by GTE Spacenet, ASC-2 provides satellite communications for domestic and foreign businesses. It is equipped with 24 transponders covering the entire United States and Puerto Rico.
KOSMOS 2142 (1991-29A): Navigation satellite.
METEOR 3-04 (1991-30A): Weather satellite.
STS-39 (1991-31A): On its 12th flight Discovery carried a collection of experiments for the Strategic Defense Initiative Organisation (SDIO). Onboard were astronauts Mike Coats, Blaine Hammond, Greg Harbaugh, Don McMonagle, Guy Bluford, Lacy Veach and Rick Hieb. Discovery landed at the Kennedy Space Center on May 6. (See ***Spaceflight,*** July 1991, p.232-240.)
IBSS/SPAS 2-01 (1991-31B): The Infrared Background Signature Survey (IBSS) instrument was mounted a SPAS free-flying platform. The satellite was deployed by the Shuttle's robot arm on May 1 and recovered on May 2. During its free-flying operations, IBSS observed numerous Shuttle thruster firings, the Earth's horizon and chemical releases.
MPEC/USA 70 (1991-31C): Multi-Purpose Experiment Canister (MPEC) a classified payload belonging to the US Air Force Systems Space Division. Ejected from Discovery on May 6.

ORBITAL DATA

Name & International Designation	Launch Time and Date	Launch Site	Launch Vehicle	Perigee (km)	Apogee (km)	Period (min.)	Inclin. (deg.)
ASTRA 1B, 1991-15A	2331* March 2	Kourou, French Guiana	Ariane 4	35,470	35,638	1,424.12	0.20
METEOSAT 5, 1991-15B				35,412	35,987	1,431.54	1.19
KOSMOS 2136, 1991-16A	1522 March 6	Baikonur, USSR	SL-4 Soyuz	206	255	89.11	62.85
USA 69, 1991-17A	1200 March 8	VAFB, USA	Titan 4	672	679	98.28	68.00
INMARSAT 2 F-2, 1991-18A	2302 March 8	CCAFS, USA	Delta II	35,767	35,815	1,436.21	2.71
NADEZHDA 3, 1991-19A	1926 March 12	Plesetsk, USSR	SL-8 Kosmos	958	1,018	104.92	82.93
PROGRESS M-7, 1991-20A	1438 March 19	Baikonur, USSR	SL-4 Soyuz	366	389	92.04	51.61
KOSMOS 2137, 1991-21A	1438 March 19	Plesetsk, USSR	SL-8	449	495	94.05	62.85
MOLNIYA 3-40, 1991-22A	1214 March 22	Plesetsk, USSR	SL-6 Molniya	429	39,090	700.90	62.87
KOSMOS 2138, 1991-23A	1355 March 26	Baikonur, USSR?	SL-4 Soyuz	192	364	90.09	67.16
ALMAZ 1, 1991-24A	1507 March 31	Baikonur, USSR	SL-12 Proton	268	281	90.04	72.70
KOSMOS 2139, 1991-25A	1048 April 4	Baikonur, USSR	SL-12 Proton	19,111	19,149	675.74	64.81
KOSMOS 2140, 1991-25B				19,105	19,154	675.74	64.81
KOSMOS 2141, 1991-25C				19,108	19,151	675.73	64.80
ANIK E2, 1991-26A	2331* April 4	Kourou, French Guiana	Ariane 4	35,692	35,754	1,432.76	0.06
STS-37, 1991-27A	1423* April 5	LC-39B, KSC, USA	Atlantis	446	462	93.48	28.45
GRO, 1991-27B				445	458	93.43	28.46
ASC-2, 1991-28A	0014* April 13	CCAFS, USA	Delta II 7925	5,559	35,712	1,428.00	0.26
3							

CRO C (1991-31D): Chemical Release Observation (CRO) satellite loaded with 6.8 kg of nitrogen tetroxide. Ejected from Discovery May 1.
CRO B (1991-31E): Loaded with 23.6 kg of unsymmetrical dimethyl hydrazine. Ejected from Discovery May 1.
CRO A (1991-31F): Loaded with 27.2 kg of monomethyl hydrazine. Ejected from Discovery May 3.
NOAA 12 (1991-32A): National Oceanic and Atmospheric Administration (NOAA) weather satellite. Replaces the aging NOAA-10.
KOSMOS 2143-2148 (1991-33A to F): Six military store-and-forward communications satellites weighing 230kg each.
SOYUZ TM-12 (1991-34A): Soyuz capsule carrying Soviet cosmonauts Anatoli Artsebarski and Sergei Krikalev and British astronaut Helen Sharman. Docked with Mir's forward port on May 20. Moved to rear docking port on May 28.
RESURS-F 10 (1991-35A): A manoeuvrable Earth resources photography satellite based on the Vostok design. Also carries small microgravity experiments.
KOSMOS 2149 (1991-36A): Photo reconnaissance satellite based on the Vostok capsule.
AURORA 2 (1991-37A): Telecommunications satellite for GE Americom and Alascom. Provides voice and data service to the state of Alaska and radio and data services to GE Americom's customers.
PROGRESS M-8 (1991-38A): Cargo craft carrying two tonnes of supplies and equipment to the Mir Space Station. Docked with Mir's forward port on June 1.



Artists' impression of the Aurora 2 telecommunications satellite launched on May 29 by a McDonnell Douglas Delta II. *GE Astro Space*

UPDATES

MOLNIYA 1-33 (1976-21A): Communications satellite launched on March 11, 1976. Decayed October 10, 1990.
MOLNIYA 2-16 (1976-116A): Communications satellite launch on December 2nd 1976. Decayed February 21.
NAVSTAR 6 (1980-32A): Deactivated March 6.
MOLNIYA 1-47 (1980-53A): Communications satellite launch on June 21, 1980. Decayed April 1.
KOSMOS 2134 (1991-11A): Reconnaissance satellite. Recovered April 1.
KOSMOS 2103 (1990-96A): Elint Ocean Reconnaissance Satellite (EORSAT). Decayed April 3.
KOSMOS 2124 (1991-08A): Reconnaissance satellite. Recovered April 7.
KOSMOS 2046 (1989-79A): Elint Ocean Reconnaissance Satellite (EORSAT). Decayed April 16.
KOSMOS 151 (1967-27A): Decayed May 6.
KOSMOS 1839 (1987-36B): Glonass satellite placed in unusable orbit after upper stage failure. Decayed May 8.
KOSMOS 1838 (1987-36A): See Kosmos 1839. Decayed May 15.
SOYUZ TM-11 (1990-107A): Landed May 26, 68km south-east of Dzhezkazgan. Aboard were Soviet cosmonauts Viktor Afanaseyev and Musa Manarov and British astronaut Helen Sharman.
TRIAD 2 (1975-99A): Communications/navigation satellite launch by Scout on October 12, 1975. Decayed May 26.
KOSMOS 673 (1974-66A): Electronic intelligence satellite. Decayed June 1.

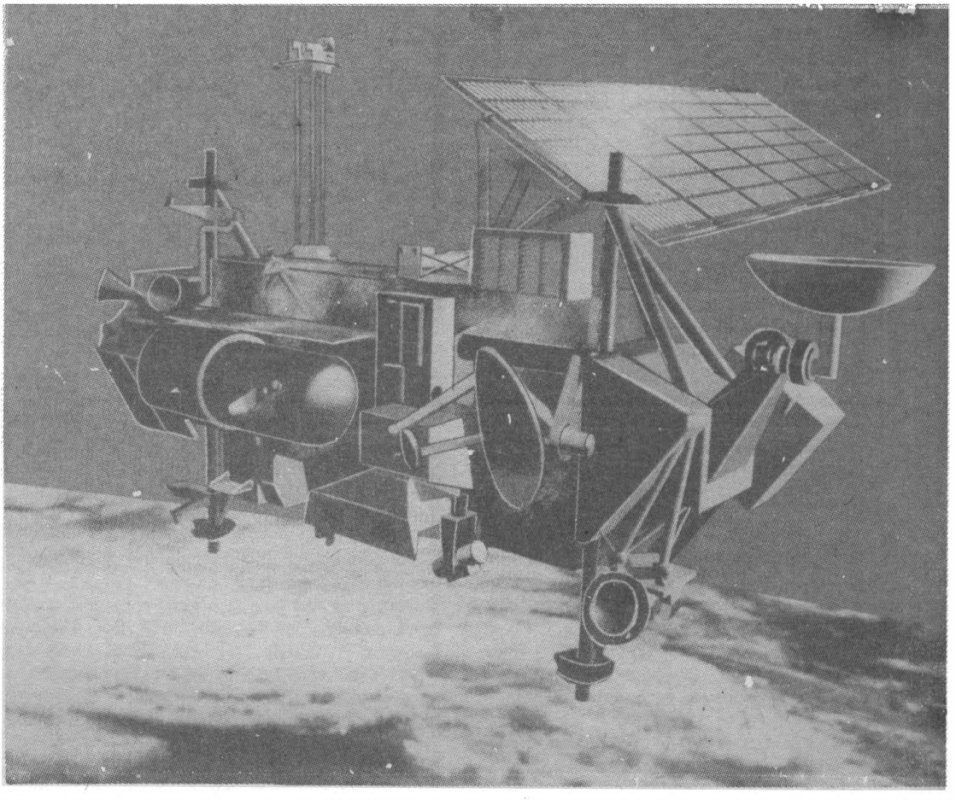
ORBITAL DATA

Name & International Designation	Launch Time and Date	Launch Site	Launch Vehicle	Perigee (km)	Apogee (km)	Period (min.)	Inclin. (deg.)
KOSMOS 2142, 1991-29A	0726 April 16	Plesetsk, USSR	SL-8 Kosmos	962	1,021	104.99	82.96
METEOR 3-04, 1991-30A	0141 April 24	Plesetsk, USSR	SL-14 Tsyklon	1,187	1,213	109.48	82.54
STS-39, 1991-31A	1133* April 28	LC-39A, KSC, USA	Discovery	253	268	89.68	56.99
IBSS/SPAS 2-01, 1991-31B				242	257	89.47	56.99
MPEC/USA 70, 1991-31C				ORBIT	SIMILAR	TO 1991-31A	
CRO-C, 1991-31D				243	261	89.52	56.99
CRO-B, 1991-31E				244	256	89.47	56.99
CRO-A, 1991-31F				250	270	89.67	56.99
NOAA 12, 1991-32A	1552* May 14	VAFB, USA	Atlas E	812	829	101.37	98.73
KOSMOS 2143, 1991-33A	2136 May 16	Plesetsk, USSR	SL-14 Tsyklon	1,400	1,416	114.02	82.57
KOSMOS 2144, 1991-33B				1,413	1,416	114.16	82.58
KOSMOS 2145, 1991-33C				1,406	1,416	114.09	82.57
KOSMOS 2146, 1991-33D				1,395	1,416	113.96	82.58
KOSMOS 2147, 1991-33E				1,390	1,416	113.91	82.57
KOSMOS 2148, 1991-33F				1,384	1,416	113.83	82.57
SOYUZ TM-12, 1991-34A	1250 May 18	Baikonur, USSR	SL-4 Soyuz	259	318	90.22	51.61
RESURS-F 10, 1991-35A	0907 May 21	Plesetsk, USSR	SL-4 Soyuz	230	235	89.21	82.32
KOSMOS 2149, 1991-36A	1536 May 24	Plesetsk, USSR	SL-4 Soyuz	189	379	90.21	67.14
AURORA 2, 1991-37A	2255* May 29	CCAFS, USA	Delta II	34,658	35,508	1,400.20	0.19
PROGRESS M-8, 1991-38A	0810 May 30	Baikonur, USSR	SL-4 Soyuz	279	290	90.14	51.60

Shuttle Discovery to Deploy Ozone-Watching Satellite

The Space Shuttle Discovery is scheduled to blast off in mid-September, with a crew of five and the Upper Atmosphere Research Satellite (UARS). After its deployment, the spacecraft will spend up to 36 months studying the three highest layers of the atmosphere. UARS also carries sensitive instruments that will monitor the depletion of the Earth's protective ozone layer. The special needs of the satellite make the deployment a challenging mission for the Shuttle. The flight is scheduled to end at the Kennedy Space Center in the early hours — the first nighttime Shuttle landing in Florida. STS-48 Lead Flight Director Al Pennington briefed *Spaceflight* on the upcoming mission.

STS-48 will be the 43rd Shuttle mission and the fifth flight this year. Discovery will be making its 13th mission. The flight is scheduled to last just over five days.



The Upper Atmosphere Research Satellite (UARS) orbits high above the planet in this computer graphic image. *NASA*

The Crew

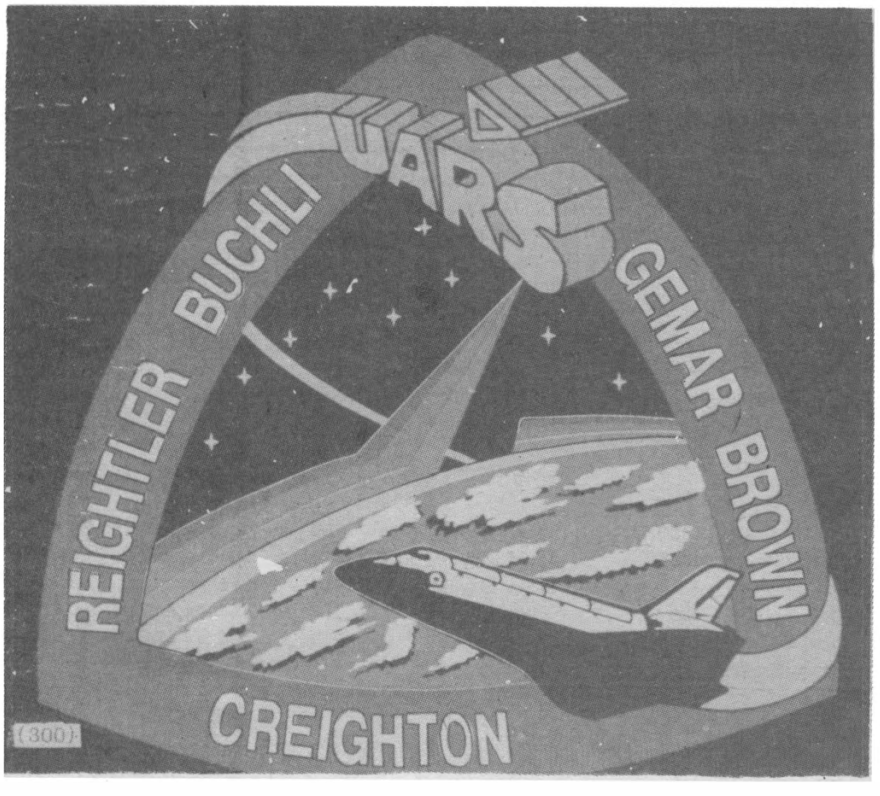
STS-48 has a highly experienced crew. Discovery's commander is John Creighton and the pilot is Kenneth Reightler. Mark Brown, James Buchli and Charles 'Sam' Gemar will serve as missions specialists.

Creighton, a Captain in the US Navy, will be making his third space flight. Previously, he was pilot on STS 51-G in June 1985 and commander of STS-36 in February 1990.

Reightler, a captain in the US Navy, is the only rookie astronaut on this flight. He was selected as a Shuttle pilot in 1987.

Buchli, a Colonel in the US Marine Corps, will be making his fourth space flight. He previously flew on STS 51-C in January 1985, STS 61-A in October 1985 and STS-29 in March 1989.

Brown, a Colonel in the US Air Force, made his first space flight in August 1989 on the classified STS-28 DoD mission.



Designed by the crew members, the STS-48 patch represents the Space Shuttle Discovery in orbit about the Earth after deploying UARS, depicted in block letter style. The stars are those in the Northern hemisphere as seen in autumn and winter when UARS will begin its study of the Earth's atmosphere. The colour bans on the Earth's horizon, extending up to the UARS spacecraft, depict the study of Earth's atmosphere. The triangular shape represents the relationship among the three atmospheric processes that determine upper atmospheric structure and behaviour: chemistry, dynamics and energy. In the words of the crew, "This continuous process brings life to our planet and makes our planet unique in the solar system." *NASA*

Gemar, a Major in the US Army, first flew on DoD mission STS-38 in November 1990.

Launch — 291 nm or Bust

Discovery is scheduled to blast off from launch pad 39A at the Kennedy Space Center at 11:57pm BST on September 12. The launch window will last three hours and is dictated by the needs of the UARS spacecraft. However, the actual launch window will be limited to two and a half hours by NASA's 'crew-on-back' rule, which restricts the time astronauts are strapped into their uncomfortable launch seats.

Discovery will follow a direct insertion launch profile to reach an initial orbit with an apogee of 292 nautical miles (nm) with an inclination of 57 degrees. About 42 minutes after launch, the Shuttle's two Orbital Maneuvering System (OMS) engines will be fired to circularise the orbit at 292 nm.

A forward Reaction Control System (RCS) burn, followed by an aft RCS jet firing, will be made to raise the orbiter's altitude to 305 nm or more — one of the highest orbits in Shuttle history.

"We are still discussing whether we are going to raise the orbit at the end of the first day or the beginning of the next day," Al Pennington told ***Spaceflight.*** "That's just to give us as much time as possible to figure out how many pounds of propellant we've got and how we are going to use them.

"We are using everything we can to get the best altitude with a pretty heavy payload," he added.

UARS has particularly strict requirements for its orbit. To maximise the satellite's life, programme managers have requested an altitude of at least 291 nm.

"We have a pretty good line in the sand," Pennington said. "Because of their particular job it doesn't do them any good if they can only go up there and stay six months — they just can't get the data they need."

If the orbiter is unable to reach 291 nm the deployment would probably be abandoned and UARS returned to Earth in the payload bay.

"If we could not make it after we pulled all our tricks — and we have quite a few — we wouldn't want to keep that valuable payload up there very long," Pennington explained. "Since we are not going to be deploying we can get all of the secondary payloads done in the first three days and come home on a minimum duration flight."

Crew Trained For Emergency Spacewalk

If all goes well, at a Mission Elapsed Time (MET) of 2hr 20min, UARS will undergo an initial power up in the payload bay. One hour 45 minutes later, the spacecraft will undergo a checkout by controllers at the Payload Operations Control Center (POCC) at the Goddard Space Flight Center to see how it survived ascent.

On flight day two, the astronauts will start preparations for a quick response EVA or spacewalk. UARS has one solar array and a High Gain Antenna (HGA) that must be deployed before the satellite can be released. If problems are encountered, a spacewalk may have to be performed to deploy the appendages manually.

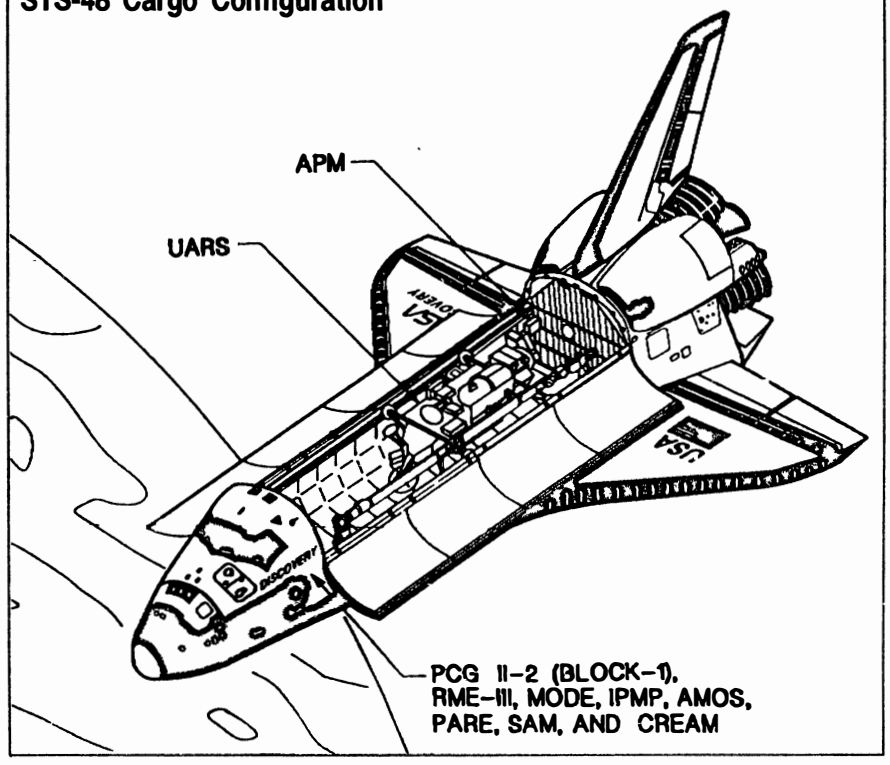
Astronauts Jim Buchli and Sam Gemar are trained for the spacewalk, should it become necessary.

Shortly after the crew is woken on the second day, the two men will breathe pure oxygen for an hour before reducing the cabin pressure from 14.7 psi to 10.2 psi. This will prepare the astronauts for the 4.3 psi atmosphere of their spacesuits by purging nitrogen from their bodies to prevent an attack of the bends.

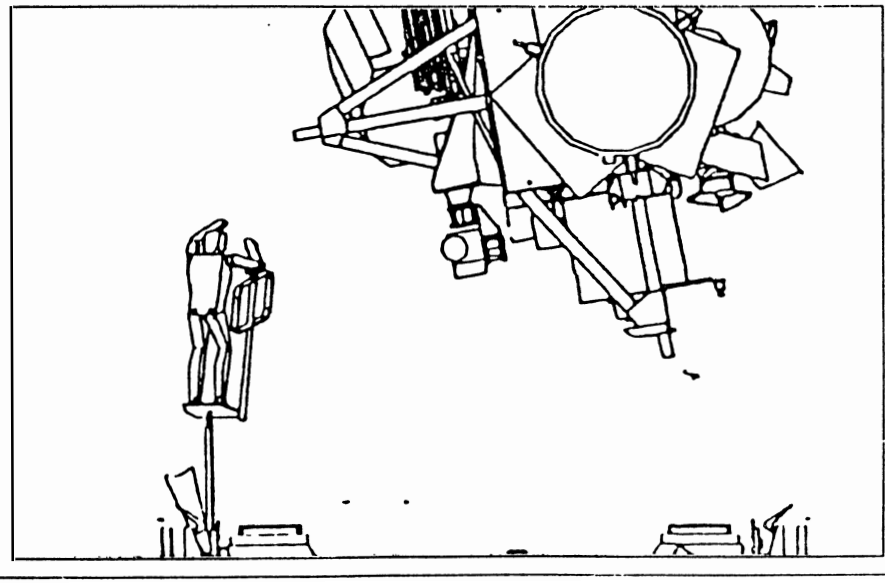
The crew will also check the space suits to make sure they are in working order.

If an EVA becomes necessary, it will be unlike the previous contingency spacewalks developed for the Hubble Space Telescope and the Gamma Ray Observatory.

STS-48 Cargo Configuration



In the event of an emergency EVA, an astronaut will stand on a stanchion, while the satellite is moved in front of him. *NASA*



"It's a lot more difficult from our standpoint since we can't climb on the payload," said Pennington. "The satellite is very contamination sensitive so we do not have EVA handrails on it as we normally would."

If a spacewalk becomes necessary the robot arm will move UARS down to the payload bay. A spacewalking astronaut will work in a foot restraint mounted on a pole, known as the stanchion, attached to the side of the payload bay. Then the arm operator will manipulate the satellite so the EVA astronaut can reach the necessary work areas.

"It's had us go through a lot more detailed work to make sure we put it in the right position and keep it from knocking into the stanchion, or anything else," Pennington explained.

UARS Deployment

The deployment of UARS will occupy the whole of flight day three. The operation will begin at MET 1day 22hr 15min when the orbiter Remote Manipulator System (RMS) arm is powered up. Working at a station on the aft flight deck, Mark Brown will 'grapple' the spacecraft with the robot arm.

UARS will be transferred from orbiter power to its internal batteries and the umbilical connector between it and the orbiter will be released. If necessary, the umbilical can be reconnected later. The latches holding the satellite in the payload bay will then be released.

The robot arm then gently lifts the 7.7 tonne satellite out of the payload bay and moves it to the deploy position, 35 feet above the orbiter. Once it is in place, Creighton and Reightler will manoeuvre the orbiter to the correct deployment attitude.

Deployment of the spacecraft's appendages will then begin, starting with the single solar array.

During launch the solar array is folded concertina fashion against the side of the satellite. It is held in place by four bolts that pass through all six of the array's five by six foot solar panels. Each bolt has a pyrotechnic separation nut.

The deployment of the array begins with the release of the two lower bolts, followed by the two upper bolts. Two of the hinges between the arrays panels are spring loaded to expand the array initially 16 to 18 feet, before it comes to a rest at the equilibrium point, approximately 12 to 16 feet from the stowed position. The deployment is completed by a powered hinge which extends the array to its full 30-foot length.

Solar array deployment should take about 35 minutes.

The extension of the array is the most critical part of the deployment. Without a fully deployed solar array, the UARS batteries will suffer irreversible damage due to loss of power within approximately 4.5 hours of switching to internal power.

"Once we have released the remote umbilical we start a clock," said Pennington. "If 100 minutes have passed and we still have not got the solar array out, we will go ahead and begin preparing to go outside."

At this point Buchli and Gemar will don their space suits. They will already be wearing their space suit cooling garments. After a final pre-breathe the astronauts will be able to depressurise the air lock and attempt to deploy the array manually.

The astronauts have been trained to release the array if one or more the retention bolts fail to separate. They are also prepared to crank out the array manually if the motorised system fails.

The first task on an emergency EVA would be to connect a 30-ft power cable to UARS to provide orbiter power until the solar array is deployed.

If the retention bolts fail the astronauts will begin by tying back the array with a rope to prevent it from springing open when they release the bolts using a wrench. Once all the bolts are undone they will manually deploy the array to the equilibrium point by carefully releasing the restraining rope.

The astronauts will then standby while the POCC commands the array to deploy fully. If problems are encountered at this point, the astronauts can manually deploy the array by driving the solar array deployment motor with a mini power tool.

If all attempts fail, the array can be jettisoned pyrotechnically by ground command and the satellite returned to Earth in payload bay.

If all goes well, a few moments will be spent checking out the array before the deployment of the high gain antenna.

The antenna is unlike those on the Hubble Space Telescope and Gamma Ray Observatory, which are mounted on booms. The UARS antenna swivels on gimbals which are mounted directly to the spacecraft so the deploy, in this instance, is just a case of unlatching the antenna. After this is accomplished the gimbals will be tested to ensure the antenna tracks back and forth.

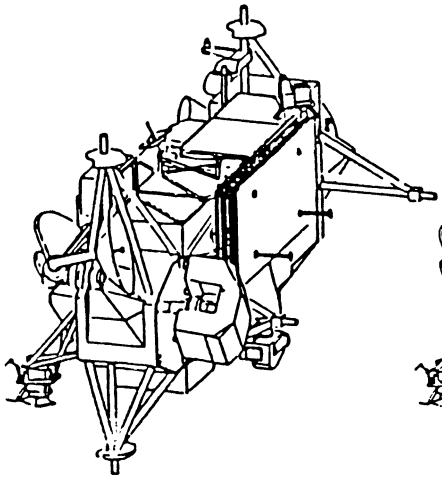
Once again, if there are any problems, the antenna can be manually unlatched by spacewalking astronauts.

The crew will be given a 'go' to deploy UARS after a final checkout on the end of the arm.

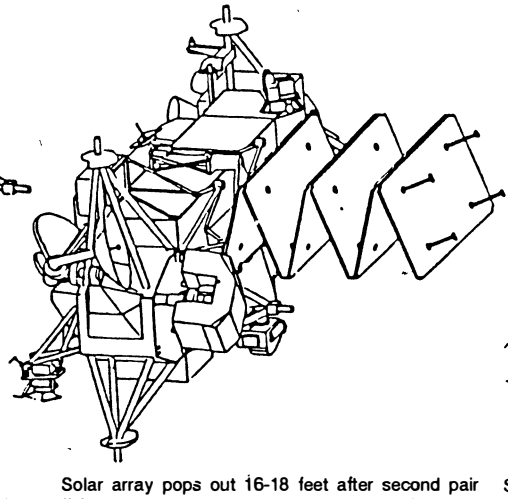
UARS Release

At MET 2days 4hrs 40min, on orbit 34, the first UARS launch window opens. There are further windows on

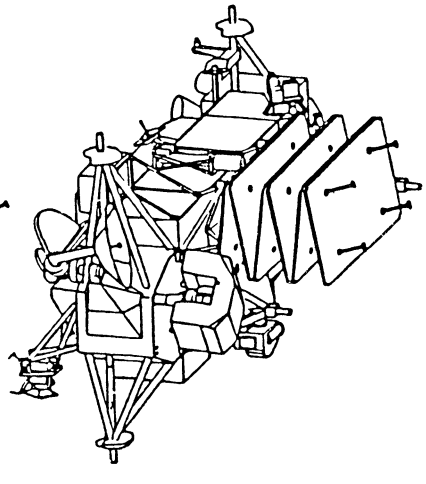
UARS Solar Array Initial Deployment



The lower solar array retention bolts are fired.

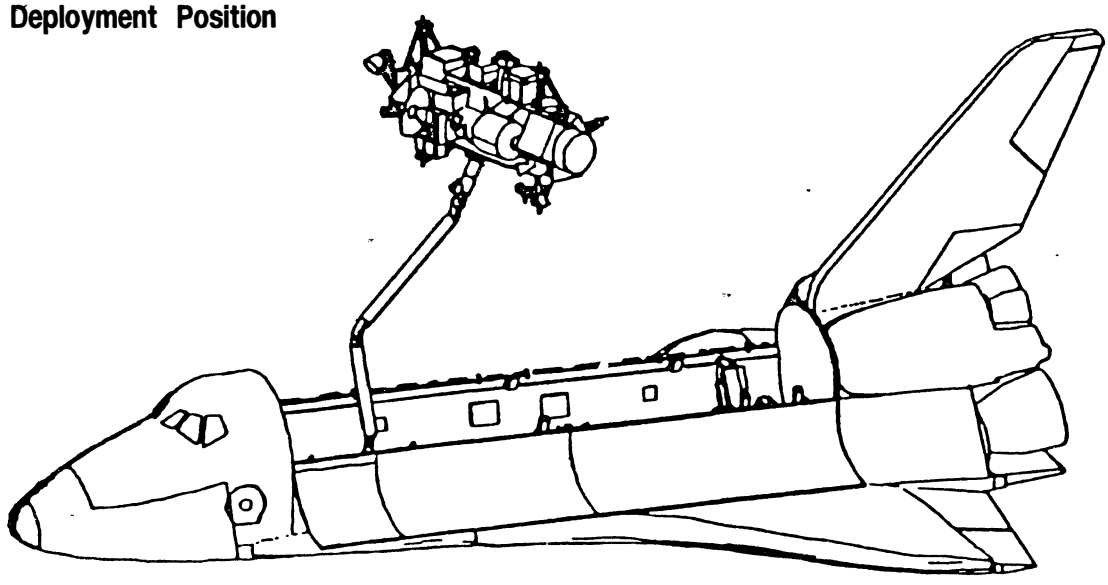


Solar array pops out 16-18 feet after second pair firing.



Solar arrary comes to rest 12-16 feet out. Later, a motorised hinge completes the deployment.

UARS Deployment Position



flight day three during orbits 35 and 36. Typically, the windows last 15-20 minutes.

As the robot arm releases UARS, the POCC will activate the satellite's reaction wheel and magnetic torquers for attitude control. Ninety minutes after release, the satellite's 0.2lb thrusters will be activated.

Almost immediately, the orbiter crew will perform two RCS burns to separate from UARS. Since considerable propellant will be used to reach the 305 nm altitude, the Shuttle will not move into a higher orbit as with most deployment missions. Instead, Discovery will do a retrograde manoeuvre and move down in front of UARS. The two will separate at a rate of about 10 nm per orbit.

Twenty four hours after the deploy Discovery will be about 160 nm in front of UARS. At that point the satellite will fire its four 5lb thrusters to boost it into a 375 nm circular orbit.

"There's no push to get UARS out on the first window," said Pennington. "We want to make sure the UARS team are very comfortable and have had plenty of time to command."

If necessary, the satellite can remain on the arm overnight and be deployed the following day.

Sun Could Block Transmissions

Because STS-48 is scheduled around the time of the autumn equinox, the Sun could block communications *via* the Tracking and Data Relay Satellites (TDRSs). During the equinox the Sun is directly above the equator where the TDRS satellites orbit. At certain times during the day the orbiter, TDRS and the Sun will line up.

"It's like the TDRS is trying to eclipse the Sun," explained Pennington. At the same the orbiter will have its antennas pointing at the satellite. "Communications do not work that well when you are trying to look at the Sun and when we do that we will probably lose comm' for extended periods of time."

During those periods, when the angle between the satellite and the Sun is less than five degrees, communications could be lost for the entire pass of up to 40 minutes. These incidents are expected to occur on one to two satellite passes a day.

"Out of 16 orbits, two of those might be affected on one of the two satellites," said Pennington.

Along with UARS, Discovery is carrying a variety of smaller secondary payloads.

Eight rats will be carried on board for the Physiological and Anatomical Rodent Experiment (PARE) designed to study muscle atrophy in microgravity. The rodents will be housed in a single animal enclosure occupying a locker on the orbiter middeck.

The astronauts will continue work with the Protein Crystal Growth experiment which has now flown on many Shuttle missions. The objective of the experiment is to produce large high quality crystals so the exact structure of certain proteins can be determined. With this information it may be possible to manufacture many new medicines.

The purpose of the Polymer Membrane Processing (IPMP) experiment is to investigate the formation of polymer membranes in microgravity. The Cosmic Ray Effects and Activation Monitor (CREAM) is a US Air Force payload designed to measure cosmic ray fluxes at various points in the orbiter middeck. The Shuttle Activation Monitor (SAM) will collect Gamma Ray data and the Radiation Monitoring Equipment (RME) will measure ionizing radiation. The Middeck 0-Gravity Dynamics Experiment (MODE) will study the behaviour of space structures and contained liquids which are gravity dependent.

The only secondary experiment in the payload bay is APM — the Ascent Particle Monitor. This fully automatic device will capture any debris dislodged from the payload bay during launch for analysis.

Nighttime Landing at Kennedy

STS-48 is scheduled to end with the first nighttime landing at the Kennedy Space Center on runway 33. Touchdown on September 18 is scheduled for 6:55am BST — 1:55am local time.

"From a weather standpoint the best time to land at KSC is at night," said Pennington. "You get very low winds and not a lot of cloud activity at that time frame."

Launch Preparations on Track

Discovery was rolled to launch pad 39A on August 12 and UARS was installed in the payload bay two days later.

The satellite had arrived at the Kennedy Space Center by barge on May 13. Originally it was due to fly to KSC in a Galaxy transport aircraft but the Air Force was uncertain if it could meet this commitment due to the Gulf War. Instead, NASA managers opted to ship the satellite in the barge normally used to deliver the Shuttle's huge external fuel tanks.

UARS underwent three months testing in the Payload Hazardous Servicing Facility and the Vertical Processing Facility at KSC before being moved to the launch pad.

As this issue of ***Spaceflight*** goes to press, launch preparations remain on track for a September 12 lift-off. An official launch date will be set at the Flight Readiness Review, scheduled for August 28/29.

According to Al Pennington, the deployment of UARS is a challenge the Shuttle team is looking forward to:

"It's an interesting satellite, it's got some good work and we're ready to get this up."

Exploring the Sun: Solar Science since Galileo

K. Hufbauer, The Johns Hopkins University Press, 701 West 40th Street, Suite 275, Baltimore, Maryland 21211, USA, 1991, 370pp, £28.50.

Galileo used the movement of Sunspots in 1612 to prove that the Sun rotated and that their waxing and waning demonstrated, contrary to the doctrine of Aristotle, that the Sun was changeable. But what exactly were Sunspots and why did they appear only in the Sun's equatorial zone?

Today, nearly four centuries later, solar physicists may be close to answering the questions posed both by Galileo and succeeding generations of astronomers.

This book traces the development of solar science from the 17th Century to the age of space research. The author propounds that new thoughts about the Sun have passed through three epochs and may be nearing the end of yet a fourth.

Throughout the first stage, from 1610-1810, natural philosophers thought of the Sun as a star, with an attendant planetary system, and had determined its rate of rotation, distance, size and mass to within ten per cent of today's values. The second epoch, from 1810-1910, witnessed the introduction of instruments, techniques and theories which brought more new discoveries and helped establish solar physics as a separate discipline. The third stage, from 1910-1940, was noteworthy for the fact that, while solar physicists followed up previous discoveries, outsiders had revolutionised views on the Sun's physical constitution, chemical composition and energy generation.

The most recent stage began during WW2 with military recognition of the value of solar monitoring. Satellite launchings from 1957 onwards introduced and accelerated the growth of spaceborne solar observation while improved ground-based solar telescopes and more sophisticated instrumentation added yet more data.

In retrospect, our knowledge of the Sun over the Centuries has not merely changed since Galileo first recognised it as little more than an immense rotating sphere, but has developed into an increasingly rich field of knowledge about solar properties and internal workings.

Lunar Sourcebook: A User's Guide to the Moon

Eds. G.H. Heiken *et al*, Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU, 1991, 736pp, £50.00.

This is a concise collection of the data obtained during the US and Soviet Lunar missions presented in an accessible and complete one-volume reference format.

It has been written and edited by a group of 24 scientists active in lunar research, all of whom are veterans of the Apollo Program.

Besides giving a comprehensive introduction to lunar studies, the book summarises current information about the nature of the lunar environment and explores the formation and evolution of the Moon's surface, the chemical and mineralogical nature of lunar rocks and soils and the current state of knowledge about the nature, origin and history of the Moon.

The volume concludes with a chapter on the potential advantages which may stem from returning to the Moon, using current knowledge as a base for future planning. Some goals for future lunar exploration are outlined and a list of unanswered questions about the Moon tabulated. Closing sections develop the assumption that a permanent presence on the Moon will take place which will lead, eventually, to a programme of lunar utilisation and the exploitation of lunar resources.

Astronomer by Chance

B. Lovell, MacMillan (London) Ltd., Cavaye Place, London, SW10 9PG, 1991, 380pp, £18.99.

It was a chance event in 1939 which led the author, eventually, to become an important pioneer in the new science of radio astronomy. It all began with an idea developed by army radar for detecting enemy aircraft and which led the author to develop telescopic instruments capable of investigating the depths of the universe. These famous radio telescopes, at Jodrell Bank, subsequently played a critical role in the discovery of many hitherto unknown stellar objects and raised questions now seen to be at the heart of our understanding of the structure of the universe.

The trailers towed into the muddy fields at Jodrell Bank late in 1945 contained radar equipment used to detect enemy aircraft so, from the beginning, the targets were more those of a physicist than those of an astronomer. In fact, the first Soviet Sputnik, in October 1957, saved Jodrell Bank from extinction. The telescope, then in the final stages of preparation for astronomical use but heavily burdened with debt became transformed almost overnight into the world's most powerful and most widely publicised radar system.

The story recounted in this book is really one of countering the many technical and bureaucratic difficulties which sought to impede progress. It is rich in personality and fascinating in its indications.

Book of the Universe

I. Ridpath, Dragon's World Ltd., 26 Warwick Way, London, SW1V 1RX, 1991, 191pp, £18.95.

The night sky is a window on endless vistas of time and space, hence this enthralling guide to some of the wonders of the sky. It is profusely illustrated and in words and pictures, traces the life story of a star from its birth in a gas cloud to its eventual fate either as a cool star or an intensely powerful supernova.

An introductory chapter provides a history of stargazing, beginning with the Greeks 2,000 years ago. From thence it ranges through the appearance and physical properties of their planets to a broader view of the universe with its myriad galaxies.

Most useful items are the inclusion of a Star Atlas with 12 monthly star charts and also a Lunar map for the easy identification of the main features on the side facing the Earth.

Space Mission Analysis and Design

J.R. Wertz and W.J. Larson, Kluwer Academic Publishers Group, PO Box 989, 3300 AZ Dordrecht, The Netherlands, 1991, 811pp, £67.00.

This book addresses problems of preliminary space mission design, beginning with the basic objective of creating a space mission to meet a set of broad, but often poorly defined, objectives. it provides a comprehensive presentation of the theory and practice necessary for such a project, drawing on the contributions of 40 experts from the space community.

Although its emphasis is on low-cost Earth orbit unmanned spacecraft, the principles described are probably broad enough to be applicable to other missions also. It is intended as a practical guide rather than a theoretical treatise and assumes that the reader has a general knowledge of physics, mathematics and basic engineering but is not necessarily familiar with space technology.

The aim is to assess the information needed to make a preliminary appraisal of overall performance, size, cost and risk. Topics included, which are not normally dealt with in such books, include matters such as orbit and constellation design techniques, a detailed prescription for the mission analysis and design processes, some legal and policy implications in mission design and an evaluation of "silent" matters i.e. those not normally apparent but which frequently dominate design decisions. There is also a collection of numerical recipes for creating preliminary estimates of mission parameters, where the data and methods needed to define systems to meet diverse mission requirements are dealt with.

Molecular Clouds

R.A. James and T.J. Millar, Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge, CB2 2RU, 1991, 336pp, £35.00.

Our understanding of molecular clouds has developed rapidly over the last few years, with the result that they are now seen to be as important a constituent in our own galaxy as they are in external galaxies.

The many expert contributions to this volume summarise the results of observations made in the radio, infrared, optical and gamma-ray regions of the spectrum. Discussions range over the structure of the clouds, their energy balance and chemical nature, the role of magnetic fields and interstellar dust and even the interactions between molecular clouds and comets.

The result is a coherent but very diffuse picture of the current status of a major subject, embracing not only the many new observations but the variety of theoretical topics which inevitably follow.

Satellite Remote Sensing of Polar Regions

R. Mason, Belhaven Press, 25 Floral Street, Covent Garden, London WC2E 9DS, 1991, 307pp, £39.50

Snow and sea ice are among the most dynamic and ephemeral geophysical features on the Earth's surface. Together with land ice, they exert a profound influence on local and global climatic and oceanic characteristics. Long-term global data sets are required for the detection of any climatic changes. The recent discovery on satellite imagery (Nimbus 7) of ozone holes over both polar regions caused public concern and led to the thought that the destruction of the protective layers of the atmosphere may expose polar organisms to increased intensities of UV radiation.

The threat of possible irreversible climatic changes is thus forcing Governments to re-evaluate their positions on the polar issues yet, in spite of this, the polar regions, with Antarctica in particular, remain the least explored and most poorly understood regions of the Earth.

This book outlines the evolution of satellite-borne remote sensing of polar regions, evaluates those satellites currently in operation and considers future developments.

Part one covers satellite sensor parameters and the physical basis and general principles of remote sensing of snow and ice. It comes as a review which places the current sate of the art in an historical perspective.

Part two is a practical reference manual covering satellites and sensors of polar interest, from the early TIROS series (1960 onwards) to future systems planned for launch in the late 1990s. Primary data archives, availability and format are described for each individual sensor.

Philip's Stargazer

P. Moore, George Philip, 59 Grosvenor Street, London W1X 9DA, 1991, £9.99.

This is a Starter Pack of three items intended for the complete beginner to astronomy. The pack comprises:

a. *Philip's Guide to the Night Sky.* This booklet is a beginner's guide to stargazing by Patrick Moore which shows how to recognise the principle stars and constellations and describes the major features of the planets and their satellite.

b. *Star Charts.* Stars and Constellations are depicted in three maps, i.e. the North and Southern hemispheres and the Equatorial region. All stars visible to the naked eye are shown, together with some of the fainter star clusters and nebulae to guide those having binoculars or small telescopes. Constellations, double stars and variable stars are listed.

c. *Planisphere.* This is a ten inch star finder useful for locating the positions of stars and constellations at any hour of any day in the year. When the top panel is turned to the required date and time, the stars overhead are shown in the circle beneath.

Society Honours Helen Sharman, Britain's First Astronaut

Britain's first astronaut, Helen Sharman, received the British Interplanetary Society's Special Achievement Medal at a ceremony in London on August 7. Miss Sharman then gave a presentation to the Society about her mission, illustrated with slides and video clips. About 400 members of the Society attended the event.

Society President Mr Tony Lawton gave the following opening address before the presentation:

"The Society has, throughout its history been a staunch supporter of manned space flight, and meets this evening to confirm its commitment to this work and to honour one of its members for her personal contribution and achievements.

"Many years have now passed since the start of the space era and, with the passage of time, the launch of a Briton into space has been long overdue. Indeed, it has seemed to be the one event that was destined never to happen.

"The Society's view is that Britain should be actively participating in all leading areas of Space research and exploration, inclusive of manned space flight. Only then can this country reap the benefits of international cooperation by having the ability to contribute, in a worthwhile and meaningful way, to the joint effort.

"In 1989 the Juno Project was set up as a joint British-Soviet programme with high hopes and worthy scientific aims. For financial reasons, the Project's initial objectives had to be drastically curtailed, but on the positive side there are two points that stand out in my mind.

Helen Sharman receives the BIS Special Achievement Medal from Society President Mr Tony Lawton.

Mrs Lawton presents Helen Sharman with a bouquet of flowers at the end of the Society's meeting.

"Firstly it resulted in an enormous level of interest and response from the general public, with 13,000 people putting their names forward for a possible mission to the Mir space station; and secondly, the launch took place in spite of the very short time schedule, within the planned range of launch dates with Project Juno revitalised to enable Britain's first space traveller to be put into space.

"From the initial large list of applicants for the Juno mission, four were selected to go to the USSR for medical tests to determine who would be the prime pair to train for the mission. These were RN Cmdr Gordon Brooks, Major Timothy Mace, Helen Sharman and Clive Smith.

"Many here tonight will no doubt remember seeing the TV programme where the announcement of the selected pair of Timothy Mace and Helen Sharman was made.

"As with all manned space launches, duplicate crews are trained for the mission and, at some stage, the decision is made on which one is to be the prime crew and which the backup.

Inevitably, the process is not without personal disappointments. However, backup crews traditionally move up to prime crew status next time round and I am sure that we would all like to see future opportunities for Timothy Mace and others.

"I feel that at this point it would be very remiss of me not to dwell briefly on one particular feature of Britain's first astronaut. The role of women in space has now become almost the accepted norm with their involvement in the US space shuttle program. But it was not always so and it is well documented in the history of the US space program that the first aspiring women astronauts had a tough time in breaking into what hitherto had been a man's world. Finally, the barriers came down to their enrolment as candidate astronauts for training and then to the gaining of new ground with their acceptance as flight crew.

"Now, Helen Sharman has added one more first for herself and Britain when, for the first time, a nation's first space traveller has been a woman. Also to be added to the record of firsts is that she is the first non-American and non-Soviet woman in space and holds the place of being the 15th woman in space.

"Helen's eight days in space were the culmination of a rigorous training programme that had to be completed in a minimum amount of time. The mission itself was not without its dangers and, thankfully, was successfully completed.

"It was a busy eight days and Helen carried out her tasks at the Mir space station, and also before at the docking, with a natural aptitude and competence. Her dedication and courage set an inspiring example of international collaboration about which we can all feel truly proud and which will be a great help in stimulating interest in space among younger people and for many years hence.

"The Society, from time to time, has been pleased to recognise outstanding personal achievement in the field of space exploration with the award of its medal.

Helen Sharman works with a scientific experiment aboard the Mir Space Station during her historic eight day mission. *Juno*

The Society's Special Achievement Medal.

"Past recipients include Yuri Gagarin, the first man in space and Valentina Tereshkova the first woman in space.

"The Society is pleased to confer this recognition on Helen Sharman and I am sure that you will feel, as I do, that it is very well deserved."

Helen then received the Society's Special Achievement Medal, engraved with the words 'Presented to Helen P. Sharman for Outstanding Contributions to Astronautics.'

She thanked the Society for the honour, adding:

"The British Interplanetary Society has been supportive throughout the Juno Mission and is one of the few organisations which thought that the idea of putting a Briton into space with the Soviets was a viable one.

"My 18 months in the Soviet Union at times seemed long and hard but when the chips were down and it appeared the British mission would be cancelled I was encouraged by the arrival of ***Spaceflight*** magazine - although it was still strange to see my own picture in print - and my days were lightened by the occasional phone call from ***Spaceflight*** Assistant Editor, Steven Young.

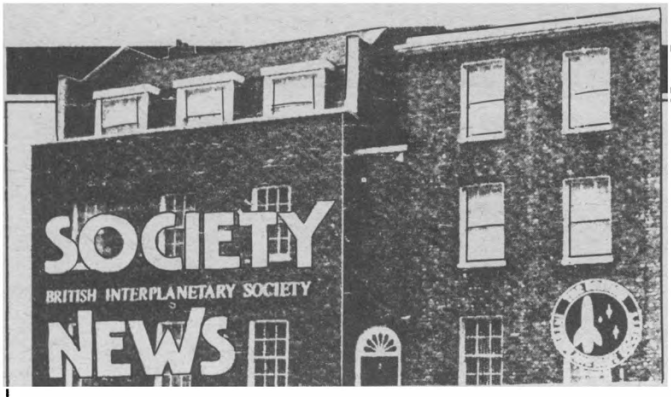
"So it is a great honour to receive the Society's medal and it gives me great pleasure to speak to you this evening."

Helen went on to describe how she first heard of the Juno Mission on her car radio as she drove home one evening. Several months later she was training in Star City with fellow British astronaut Tim Mace.

Helen described her training and the rigorous medical checkups that were necessary before she blasted-off from Baikonur Cosmodrome on May 18 this year.

As she spoke about the mission itself, Helen showed some of her own video footage, most of which had not been shown before.

At the end of her presentation Helen spent about twenty minutes answering questions.



1992-1993 Membership Cards

A new-style membership Card will be introduced for both 1992 and 1993, thus covering the period of the Society's 60th Anniversary.

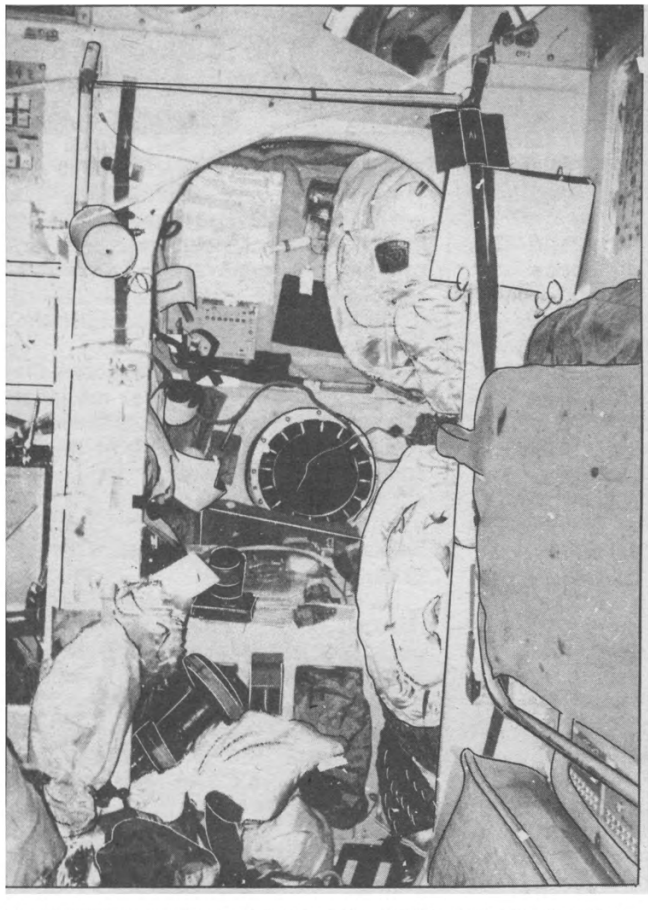
The new version will be similar in size to the existing cards, but will be fully laminated, as is done for credit cards, so the result will be much superior to those currently in use.

Both cards will feature the Society's Comet Logo.

'Spaceflight' in Orbit

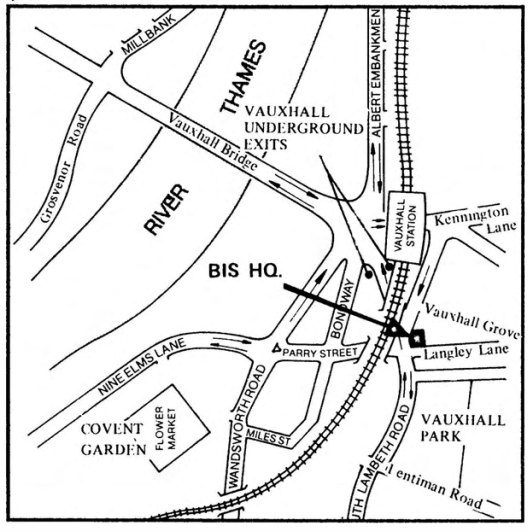
When Soyuz TM-12 blasted off from the Baikonur Cosmodrome on May 18, it carried the first issue of ***Spaceflight*** to go into orbit. Cosmonauts Anatoli Artsebarksi and Sergei Krikalev had a copy tucked away in their personal luggage. British astronaut Helen Sharman had been reading the May issue of the magazine at Baikonur as she waited for launch. The two cosmonauts took the copy, featuring Helen on the front cover, to remind them of her for the remainder of their long mission.

Living quarters on the Mir Space Station with a copy of the May issue of ***Spaceflight*** disappearing off the top of the picture.



Visitors to HQ

We extend a warm welcome to all our members, particularly those from overseas, who wish to include a visit to the Society as part of their itineraries. However, it is essential, if our work is not to suffer, that arrangements for a visit are made well beforehand. Our small staff have many commitments to carry out, a number of which are subject to severe time limits, so a visit "out of the blue" could cause problems we would rather avoid.



Library Re-Opens

Even though not fully complete in every detail, we are pleased to announce that the Society's Library will re-open on Wednesday, 4th September and will thereafter resume its regular pattern of opening on the first Wednesday of every month, except August.

Members will note substantial differences. The new Library layout is now open-plan and much more spacious. Tables have been laid out singly, rather than in a solid block and the whole of the shelves opened up for easy access. Members will also appreciate the new decor which is both pleasing to the eye and conducive to reading and study.

Considerable changes have taken place in the Library stocks, too. Many of the older books, all the duplicates and most of those in foreign languages, which were seldom in demand, have all been withdrawn, along with earlier editions since supplanted by improved versions. All have been replaced with a wide selection of more specialised, up-to-date books so that the overall impression is of a modern forward-looking Library.

The card index system will continue in operation until early next year, by which time it should then be in the process of being replaced by an electronic database which will enable holdings to be identified both more readily and quickly. Completion of the database is likely to take up most of next year.

At the same time, collection of Archival material relating to the Society and many of its leading Fellows is being undertaken and a new range of bookstacks are in course of acquisition to hold these items. When completed, these will provide a Library which, for the first time, will have been prepared as a composite whole, completely modernised and highly effectual.

All this will provide a firm base for future acquisitions and is to be followed, over the next few years, with a programme of requisition and display items to fill any emergent gaps.

As before, members of the Library Committee will man the Library on its open days.

CORRESPONDENCE

Helen Sharman Presentation

Sir, I attended as a guest the presentation of the Society's Special Achievement Medal to Miss Helen Sharman and would like to congratulate the Society's members that helped to organise the meeting. It was a memorable occasion with very much a 'club' atmosphere - thankfully without the hype and razzle so often encountered these days.

I am enclosing my membership application and 18 month subscription. I look forward to future meetings.

R.CAMERON
Buckinghamshire, UK

Sir, May I offer my congratulations to all involved in bringing about this occasion and an opportunity for members to see our first British astronaut in person.

R.W. BIRCH
East Sussex, UK

Sir, I was very pleased to hear that Helen Sharman was going to be presented with the Society's award.

M.A COWELL
Surrey, UK

Sir, My friend and I thoroughly enjoyed Helen Sharman's presentation and felt very privileged to be there.

R. BIZLEY
Surrey, UK

Lack of Government Support

Sir, I was one of those who attended the Medal Presentation for Miss Sharman but, however much we may admire her, there must be regrets that the best this country can do is to hitch a lift into space through the goodwill of some other nation.

I have been a Fellow of the Society for some 45 years. I joined because I believed in space exploration and because I felt that Britain should and could be in the forefront of such endeavours. But I despaired when, for the lack of Government support, the use of Blue Streak/Black Knight for placing a satellite in orbit was cancelled. It was, I suppose, inevitable that HOTOL should suffer the same fate. It is the nature of British Governments in matters of science and technology, especially space, that they stride into the future with their feet embedded in concrete and their heads firmly fixed in the sand.

It was unfortunate that discussion time at the meeting was so short. I would have liked to ask Miss Sharman if any member of the Government or Opposition had shown any interest in her achievements and if not, does she have any plans for approaching them.

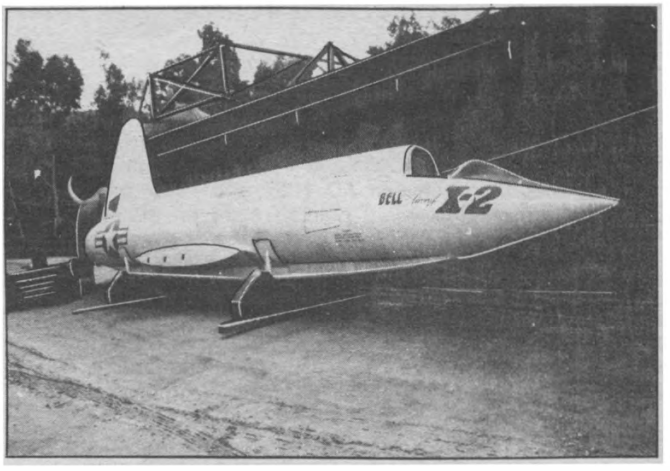
T. MILLER
London, UK

ED. Miss Sharman has been to 10 Downing Street twice and has been received at the House of Commons.

Physician Cosmonauts

Sir, According to German Arzamazov (Atkov's back-up in Soyuz T-10) published in *Rabochaya Tribuna* newspaper on April 12, 1990, there are two more physicians in the Soviet Cosmonaut team, namely, Alexander Borodin and Boris Morukov.

S. KRUKS
Radio Riga, Riga., USSR



Bill Rose

A Third Bell X-2 Rocketplane?

Sir, More than forty years ago, two pioneer X-2 rocketplanes were constructed by the Bell Aircraft Corporation of Buffalo, New York and subsequently received US Air Force serial numbers 46-674 and 46-675.

After its conception in the late 1940s, the X-2 test programme began with glide tests in 1952, although numerous development problems with the Curtiss-Wright XLR25 two chamber rocket engine held up the start of powered flights until the following year.

On May 12 1953, while undertaking a captive flight test below a modified bomber, the prototype X-2 No. 46-675 was destroyed in an explosion inside the bay of the EB-50A.

Bell's test pilot, Jean Ziegler, was killed in the accident, along with an observer on board the EB-50A. The wreckage of the aircraft fell into Lake Ontario.

Some years later, while investigating the loss of four rocket powered X planes with similar propulsive systems, the cause of this accident was traced to a leather gasket. It was found that the organic nature of this minor component reacted with the liquid oxygen stored within the rocketplane's fuselage, thus resulting in a violent explosion.

The second Bell X-2, which carried the earlier serial number 46-674, went on to undertake a series of flights beginning in 1954, the programme finally finishing in 1956 when the rocketplane was destroyed in a crash caused by inertia Coupling.

Tragically, the pilot, Captain Milburn Apt, was killed, having just reached the unofficial world speed record of 2094 mpg. (Mach 3+).

However, during this period, the Bell X-2 achieved considerable success, capturing a new unofficial altitude record of 125,907 ft and proving a number of new technologies and materials, leading to the development of the North American X-15.

What is special about the Bell X-2 rocketplane shown in the photograph. The serial number on the tail identifies it as 46-674, the second X-2 which was destroyed in the 1956 crash.

The fact is that the photograph was taken in early 1991 and is a full scale mock up of the X-2 rocketplane currently located in a back lot of Universal Studios in Hollywood, California.

The replica, now minus a few parts and beginning to show signs of weathering, was originally built for the movie *Right Stuff* and has also appeared in at least one TV series since then.

BILL ROSE
Reepham, Norfolk

Supernova Coins

Sir, The Society has put out two enquiries and statements on coins [1 & 2] which bear not only the name and figure of a ruling person (Emperor, magistrate etc) but also depict stars on either the face or the obverse side.

Using a coin issued by Constantine IX, which can almost certainly be dated to between AD 1057 and 1055, a link is established between the eight pointed stars on either side of the Emperor's image and the appearance of a magnitude -5 or -6 new star i.e. a supernova at a position now occupied by the Crab Nebula, the first optically identified pulsar.

At one time it was thought that Chinese and the Japanese records were the only indications of this event. Later research [3] has shown that Arab astronomers recorded the event as an "Athari Kawkab" which may be translated as "brilliantly spectacular star". Ali Ibn Butlan (a Christian physician of Baghdad) went on to record a disaster "14000 people alone were buried in the Church of St. Luke after all other cemeteries had been filled" and blamed this disaster epidemic on the appearance of the supernova.

Primitive records on Indian pottery and rock drawings (both dated) indicate that the event was also noted by the contemporary inhabitants of the New World [4].

In spite of this worldwide sighting there are no presently discovered European records of this event, apart from the single coin. This seeming absence of Roman/European star event records may be a sad result of the destruction of the famous Alexandrian Library in 389 AD. Fired by Christian zealots, the loss of material was complete. Perhaps in some monastery records (Nuremburg, St. Gallen etc,), we may find evidence.

Turning to the other coin, which depicts the Roman magistrate Consul Fannius (office term 49 - 48 BC), the obverse side carries two stars in similar fashion to the much later coin of Constantine IX. The question is then posed: "Is there, somewhere, a Greek or Roman account which refers to a Supernova in 48 BC in unmistakeable terms?"

At present the straight answer to this question must be "No". But that can be qualified by adding "But there are several interesting candidates in the few records known at present".

The first point is that the ancient astronomers and observers did not - and could not , differentiate between novae and supernovae. However, they did distinguish between comets and new stars. Comets were "stars of disaster and ill omen" and many Roman writers (e.g. Diodorus, 60 - 21 BC and Seneca, 4 BC - 65 AD) so commented, as does the note in ***Spaceflight*** which quotes Lucanus and de Maille.

A new star *(nova siderum)*, on the other hand, was almost universally accepted as good news, heralding the birth or appointment of a person of importance e.g. "Where is he born King of the Jews for we have seen his star rising in the East?" [5]

At present we have no known records of European origin which quote the sighting of a new star in 48 BC but there is an entry in the records of the Chien-Han (or Qian-Han) Dynasty of 206 BC - 9 AD which quotes:-

"During the fourth month of the first year of the Chhu-Yuan reign period (in our terms 3rd May to 31st May) a guest star (k'o-hsing) of the size of a melon and with a bluish white colour was seen about 4 chhih (ft) away east of the second star in the Nan Tou (eighth lunar mansion)."

Biot [6], Williams [7], Lundmark [8] Xi and Bo [9] all regard this star as a nova rather than a supernova.

This viewpoint is supported by additional evidence from Clark and Stephenson in their book *Historical Supernovae* [10] in which table 3.1 *viz* gives no duration (days) which often means the real duration was less than 7 - 10 days.

The position given in Ref 10 (RA 18h. 40 min. Dec + 25° epoch 1950) places it outside the plane of the Galaxy and is incorrect.

The correct location is given in Reference 9 and is RA 18h 20 min, Dec -25° i.e. in the Western constellation of Sagittarius.

This places the sighting, correctly, in the Chinese lunar mansion of Nan-tou and incidentally only a few degrees from the Galactic Equator wherein lie most of the nova and supernova sightings.

A "new" star which really stood out would need to shine at about magnitude +1 and thus be comparable with Vega, Deneb, or Altair.

The altitude of such a star with a southerly declination of - 25° would be approximately 15 degrees above the horizon of either Rome or Tralles (Asia Minor) and there would be no atmospheric extinction or diffraction problems.

The "new" star seen by the Chinese would therefore also have been seen throughout the Roman Empire and would have been comparable with Nova Persei No 2 (1901) Nova Aquilae No 3 (1918) Nova Pictoris RR (1935) and Nova Puppis (1942).

The area itself lies close to the boundaries of Hercules and Lyra and is devoid of any bright stars above magnitude +4, most of the occupants being of magnitude +6 or less.

If such a "new" star really stood out to be noted it would need to shine at about magnitude +1 and thus be comparable with Vega, Deneb, or Altair.

Nova Persei and Nova Aquilae are particularly good examples of what may have been seen in 48 BC. They brightened with remarkable rapidity, showed the bluish light of Deneb and Vega (with additional bright bands in detailed spectra) and then (to the naked eye) vanished rapidly in a few days.

However, at peak magnitude, they were obvious even to the untrained eye.

Supernovae generally remain visible to the unaided eye for the order of a year and usually leave detectable remnants (radio sources, filaments of glowing gas, a pulsar, or all three) as a legacy for hundreds or even thousands of years afterwards. These are now well documented.

Novae also leave a legacy of remnants but since the event is on a much smaller scale (several thousand times reduced) these remains are rapidly dissipated. Modern equipment and techniques have identified the types of star that give rise to novae and in some cases have identified the gaseous shells still travelling out from the initial explosion.

Theoretically, it should be possible to trace the parent star(s) - invariably binary - and see the remaining shell remnants of the nova of 48 BC.

However, the position quoted is not sufficiently adequate or accurate and the scanty data available does not allow us to identify precisely the distance to, and the type of parent star system involved.

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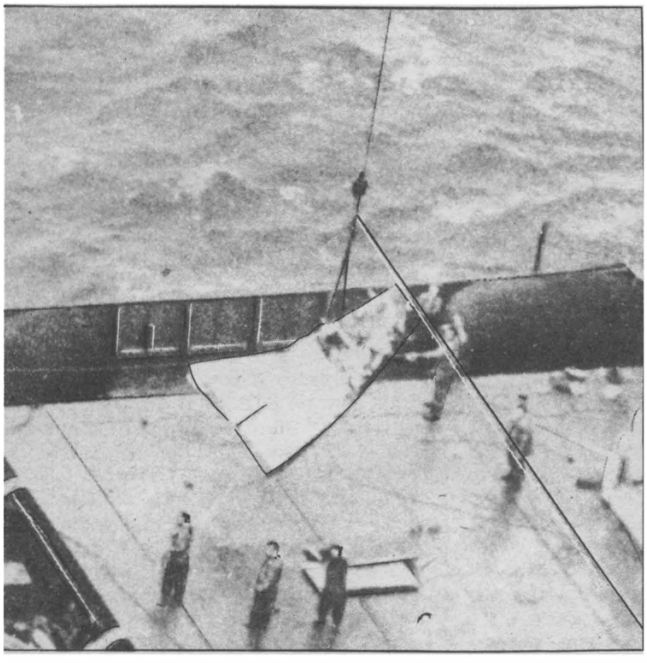
Payne-Gaposchkin quoted an absolute peak magnitude of -7 for "fast" novae [11] and if we suggest a peak magnitude of +1 for the 48 BC event, this gives an approximate distance of 400 parsecs (1300 l. yrs) for the parent star system. Due to lack of precise data no such searches for this event have been undertaken to date.

However, because of the binary nature of the parent systems, such events are usually repeated - on time scales ranging from tens to thousands of years. So ,at some future date, we may again see a "bluish-white guest star east of the second star in Nan-tou".

Our Society possesses two possibly unique European commemorative coins of past heavenly events. It would be interesting to discover if there are any other known examples of supernova coins.

A.T.LAWTON
Worthing, Sussex, UK

Cosmos 1374, 1445 Photographs Compared



Cosmos 1374 being lowered on the deck of the Soviet recovery ship Yamal following its launching from Kapustin Yar on June 3, 1982. Recovery locator aids and devices have been removed. Distinctive "camouflage" pattern noticed on nose of spacecraft. *Royal Australian Air Force via Tim Linder*

Cosmos 1445 being retrieved from the Indian Ocean on March 15, 1983. Differences from Cosmos 1374 include a "cockpit", tile thermal protection system and national markings. *Ken Llewelyn*

Sir, During the early 1980s there were several Soviet spacecraft tests lasting less than two orbits that were for testing reentry materials for the Buran space shuttle. Four tests, flown under the guise of Cosmos 1374, 1445 and 1614, have been identified as using the reentry test vehicle type called BOR-4 [1].

For testing heat ablating or absorbing materials, one would logically want to fly the same craft more than once [2,3]. However, recently released photographs of the Cosmos 1374 retrieval show that the same spacecraft was apparently not used on the subsequent BOR-4 mission of Cosmos 1445.

Comparison photographs of the two retrievals, show that Cosmos 1374 does not:

a. Have a tile thermal protection system, as did Cosmos 1445, Buran and the US space shuttle fleet. it appears that it used an ablative coating on its forward section, resulting in the "camouflage" pattern seen in the photographs.

b. Have a "cockpit" section, as did Cosmos 1445, perhaps indicating more of an interest in basic hypersonic aerodynamic features rather than in a complete "manned" shuttle mock-up shape. Indeed, the recovery devices for Cosmos 1374 appear to have taken up much more space than in the subsequent 1445 space plane, as nearly the whole forward end of 1374 is empty.

c. Exhibit thruster burns on either of its wings, as does Cosmos 1445. This may indicate either a lack of cross-range manoeuvrability for 1374, or that its reactive control thrusters (RCT) were of a different size or angling from the follow-on BOR-4. The rear views of Cosmos 1445 released by the Royal Australian Air Force, indicate much evidence that the RCTs fired, giving the tail end of the spacecraft a "sooty" appearance. The tail end of 1374 is pristine.

There are two more interesting notes. Firstly, Cosmos 1374, unlike 1445, did not have any identifying national markings, indicating that the RAAF was an unexpected visitor to the retrieval area. Secondly t the recovery ship (the *Yamal*) and apparently many members of the Soviet recovery team, were the same for both spacecraft retrievals. There is one man with an identical head of Afro-styled hair who appears in both photographic series of the retrieval sequences, despite the two missions happening 285 days apart!

PETER PESAVENTO

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Atlantis Makes 'Picture Perfect' Flight

TDRS Deploy & Kennedy Landing Highlight Mission

The 42nd Space Shuttle mission was described by NASA as 'picture perfect' after Atlantis concluded the mission with a landing at the Kennedy Space Center in Florida. Nine days before, the Shuttle had blasted off from launch pad 39A, just five miles east of the runway. During their first day in orbit the five member crew successfully accomplished the main goal of their mission, the deployment of a Tracking and Data Relay Satellite (TDRS). The astronauts spent the remainder of their mission performing a variety of scientific and medical experiments.

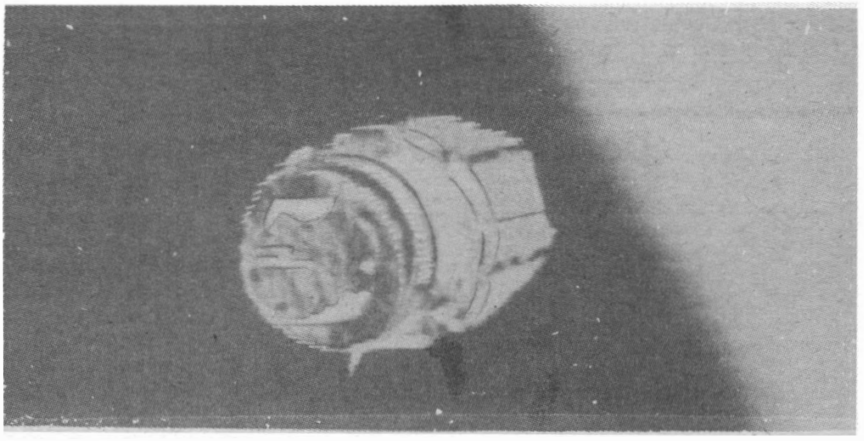
On August 2 Atlantis roared into orbit with a four man, one woman crew consisting of commander John Blaha, pilot Mike Baker and mission specialists Shannon Lucid, David Low and James Adamson.

Technical problems and bad weather delayed the launch ten days, but on August 2nd Atlantis blasted off into clear blue skies just 0.0038 seconds past the planned 4:02pm BST launch time. The eight and half minute ascent was near-perfect.

"It was the best ride in the world," Blaha told mission control after reaching orbit.

Six hours and 13 minutes into the flight Shannon Lucid deployed the TRW-built TDRS-E satellite on an Air Force IUS upper stage.

The two IUS stages burned normally placing the satellite into geostationary orbit where it was renamed TDRS-5. The boost to geostationary orbit went so well that deployment of the satellite's appendages began early. The two solar panels were unfolded, extending 57 feet from tip to tip. The space/ground link and C-band antennas were then deployed, followed by the satellite's large umbrella-like single access antennas.



TDRS-E on its IUS upper stage is captured by a video camcorder drifting away from Atlantis' payload bay soon after deployment on August 2. *NASA*

On August 4, the satellite began to drift towards its checkout location at 178 degrees west longitude, west of Hawaii.

The TDRS satellites provide near-continuous communications with NASA and Department of Defense spacecraft in low earth orbit. The satellites can handle vast quantities of data. At its highest capacity the TDRS system can transfer in a single second the equivalent of a 20-volume encyclopedia containing 34 million words.

With this latest launch NASA has four TDRS satellites in orbit, two of which will become in-orbit spares.

With the TDRS satellite deployed the crew of Atlantis settled down to an eight day programme of experiments.

In the payload bay, the 50-ft long Space Station Heat Pipe Advanced Radiator Element (SHARE-II) experiment was tested. SHARE is a prototype heat radiator for Space Station Freedom. It previously flew on STS-29 in March 1989 but was less than successful because bubbles blocked the flow of ammonia through the heat pipe. The system was redesigned prior to STS-43 and this time worked extremely well, according to early reports.

Also in the payload bay was SSBUV, the Space Shuttle Backscatter Ultraviolet instrument, a device for calibrating ozone sensors on spacecraft already in orbit.

In the crew cabin the astronauts used the Lower Body Negative Pressure (LBNP) apparatus to try to improve their re-adaption to gravity on return to Earth. Also, they conducted experiments to grow pure protein crystals, process biological materials and study the spread of fire in zero-g.

Atlantis performed perfectly throughout the mission. Things went so well that lack of problems became a joke at one of the regular mission press briefings.

"At the risk of sounding like a tape recording, all I can tell you is the mission is just going extremely well," flight director Phil Engelauf told reporters.

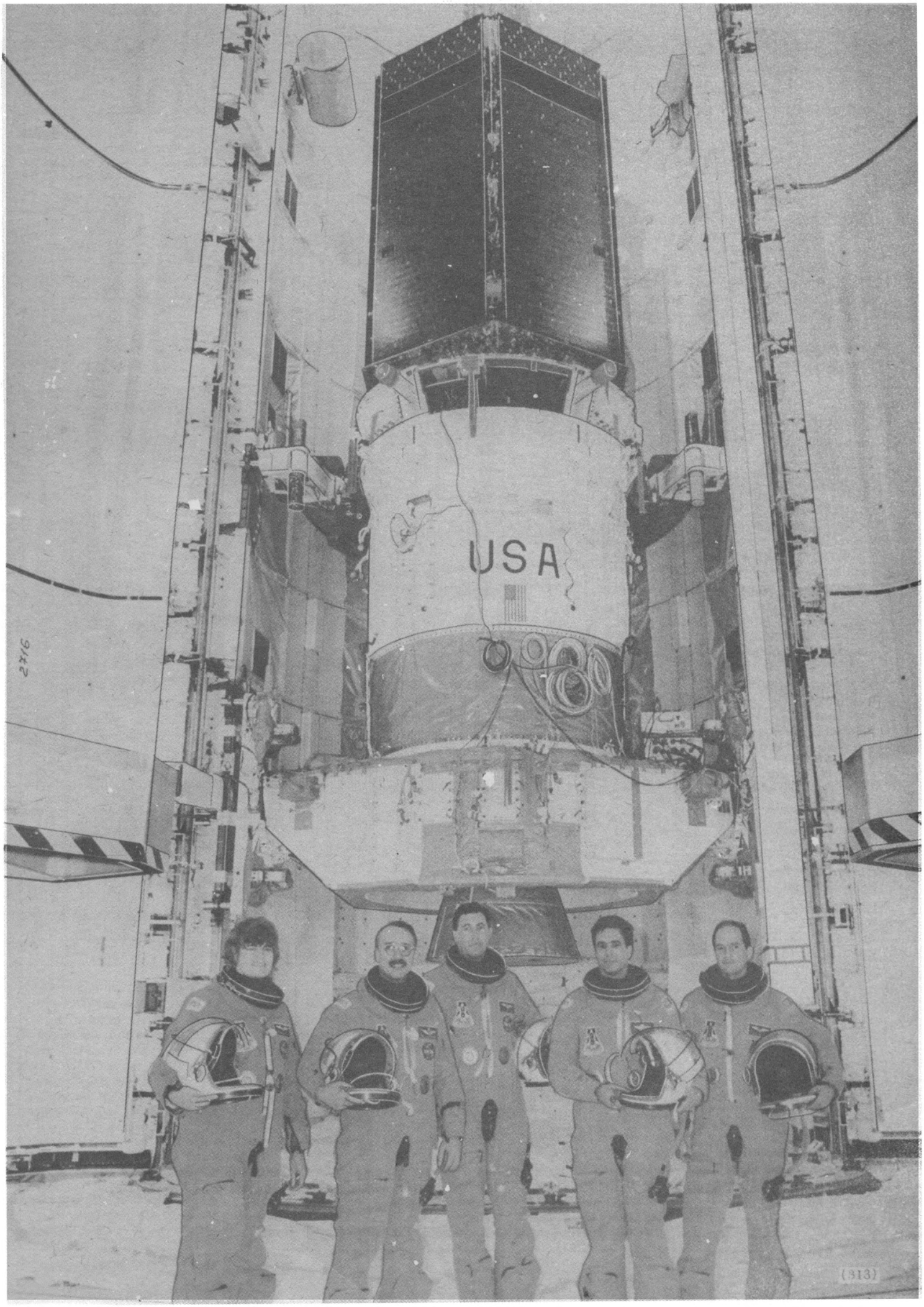
STS-43 ended on August 11, with the first planned landing at the Kennedy Space Center since April 1985.

The orbiter's main gears touched down on the grooved runway surface at 1:23:25pm BST, followed by the nose gear eleven seconds later. Atlantis came to a complete stop within a minute.

"Welcome home Atlantis. Congratulations on a picture perfect mission," CAPCOM Bob Cabana radioed the crew.

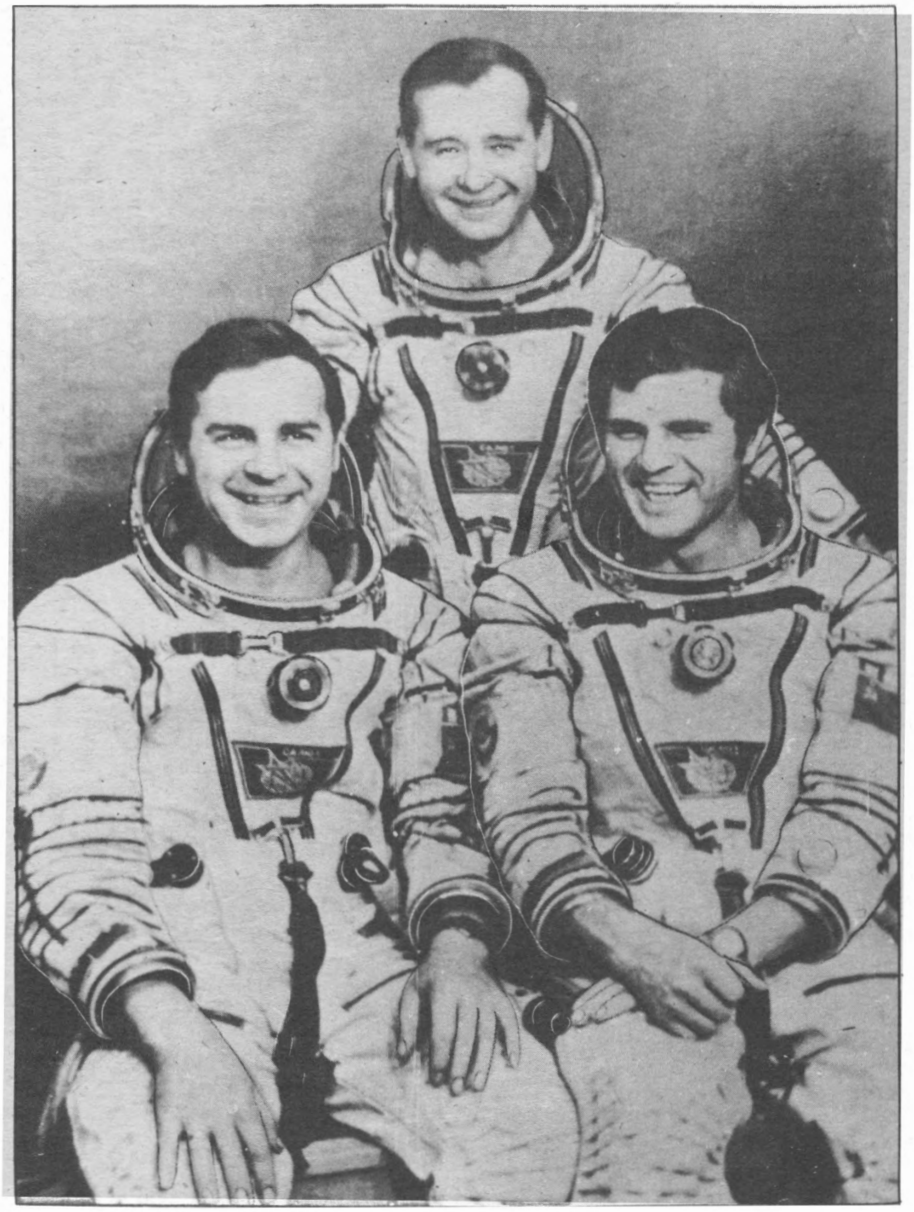
David Low (left) and Mike Baker set up the Lower Body Negative Pressure (LBNP) apparatus on Atlantis' middeck. This TV view was recorded on August 4. *NASA*

The STS-43 astronauts pose before the TDRS satellite on its IUS upper stage mounted in the payload bay. The photo was taken in the payload changeout room at the launch pad. (Left to right) Shannon Lucid, James Adamson, Mike Baker, John Blaha and David Low. NASA


USA

Yevgeni Salei: A Rare Interview with a Rookie Cosmonaut

During a recent visit to Moscow, Gordon R. Hooper had the chance to talk with Lieutenant-Colonel Yevgeni Vladimirovich Salei, a former cosmonaut, a unique opportunity as "rookie" cosmonauts rarely speak to the press. In an exclusive interview for *Spaceflight*, he spoke about his cosmonaut training, why he left the cosmonaut team, and what his new responsibilities are.



The Soyuz T-14 Back-up Crew: (left to right)Viktorenko, Strekalov and Salei. *Vadim Molchanov*

How were you selected to become a cosmonaut?

In 1976, I enrolled at the Gagarin Air Force Academy, but before I could begin studying there, I received orders from the Commander-in-Chief of my military district, Alexei Mikoyan, telling me to report for medical tests to see if I was suitable to join the cosmonaut team.

I was very certain that I would not pass the tests and that instead I would commence my studies at the Gagarin Air Force Academy as planned. However, much to my surprise, I passed and was selected to join the cosmonaut team in August 1976.

This was together with Leonid Ivanov, Leonid Kadenyuk, Nikolai Moskalenko, Sergei Protchenko, Anatoli Solovyov, Vladimir Titov, Vladimir Vasyutin and Alexander Volkov?

Yes, that is correct, there were nine of us.

Did you continue with your work as a test-pilot?

No, but after being chosen as a cosmonaut-candidate, I enrolled at a test-pilot's school and graduated in 1977. Later, in 1981, I was awarded the title of Test-Pilot, 2nd Class and I have flown more than 32 different types of aircraft and helicopters.

The job of a pilot is a dangerous one - did you ever have any "near-misses"?

But of course! For example, in 1975, I was nearly killed when the canopy of the MiG-21 fighter I was flying suddenly shattered after being struck by a bird. Slivers of glass struck my helmet and my oxygen mask and smashed my helmet visor.

I was flying at a height of only 500 metres,at a speed of 800 km/hr and was stunned by the airflow. it took some time for me to work out what had happened, but I realised that my aircraft had flipped over and was flying upside down. I quickly righted it, but was blinded by the air flow and tried to shelter under the windscreen but was prevented from doing so by the seatbelts.

I tried to radio the flight control centre but my neck-microphones had been torn from my neck, so they could not hear me. I therefore had no choice but to land without instructions and only narrowly missed colliding with another MiG-21, the pilot of which had no idea I was landing.

Fortunately, I made it safely and when my oxygen mask was removed, it was found to be full of blood, prompting the ground crew to ask "how did you breathe?" The broken helmet was later put on display in the Air Force Museum at Monino.

Do you think that the flying skills you demonstrated in that incident were instrumental in bringing you to the attention of the cosmonaut selectors?

I don't know. Maybe - I'm not sure.

Following your selection as a cosmonaut, you said that you underwent test-pilot training. So when

did you first begin spending more time on space flight training?

I began work as a test-pilot, but at the same time I took part in preparations for various space programmes.

What was your first mission assignment - the original Soyuz T-13?

Yes. Originally, Soyuz T-13 was to have been flown by Vladimir Vasyutin, Viktor Savinykh and Alexander Volkov, and I served as the back-up to Volkov, the research-cosmonaut. The other members of my crew were the commander, Alexander Viktorenko and the flight-engineer, Alexander Alexandrov.

However the mission was cancelled when Salyut 7 suffered an onboard power failure. Instead, Vladimir Dzhanibekov and Viktor Savinykh were launched on a special mission, and successfully repaired the space-station.

(Left to right) Yevgeni Salei, author Gordon Hooper and Vadim Molchanov, a Soviet reader of ***Spaceflight*** and regular contributor to the 'Correspondence' section. *Gordon Hooper*

You were re-assigned to the next mission - Soyuz T-14?

Yes, I served as Volkov's back-up.

It is believed that you should then have flown on the next mission, Soyuz T-15, in an exchange of crews. Why did this not happen? Was your mission simply cancelled because Vladimir Vasyutin became ill and had to be returned to Earth early?

I can't say that I am 100% certain that we would have flown on Soyuz T-15 and exchanged crews, but that would have been logical.

As regards the cancellation of the mission, nobody asked us!

You left the cosmonaut team shortly afterwards?

Yes. Following Vasyutin's illness, doctors carried out stringent medical tests on all the cosmonauts and as a result, I was dismissed in July 1987 for medical reasons. it was a minor problem - my right kidney was found to be lower than my left. Officially, I actually left the cosmonaut team in November 1987.

What did you do then?

Well, in June 1989, I was appointed Deputy Commander for flight-training at the Chkalov Central Air Club in Moscow, and this is my job today.

Do you continue to fly?

Yes, of course!

You have a great many aircraft here - are there any special favourites of yours?

Yes, we have a Douglas DC-3 - it is a unique plane - a long-liver! This plane, also known in the US as the C-47, was constructed under licence in many countries and many of the aircraft are still flying all over the World.

In fact, I believe a club of DC-3 lovers has been established in the West.

During World War 2, the Soviet Union began producing the DC-3 under licence as the Li-2. Unfortunately, our Li-2 is no longer flightworthy due to the unavailability of spare parts for the plane in the Soviet Union.

However, the Chkalov Central Airclub is seeking Western sponsors to help with supplying the necessary spares as we are very keen to have our Li-2 in the air again!

We are therefore offering Western sponsors the opportunity to advertise on the wings and fuselage of the aircraft during its planned tour of the Soviet Union and Western countries.*

I wish you every success. You obviously feel passionately about this plane.

Yes I do. it should be preserved.

Finally, could you tell me a little about your family. Are you married?

Yes, I am. My wife Natalya Pavlovna works in the Progress Insurance Society and we have a son, Pavel, and a daughter, Yelena.

Thank you very much for your time.

It was a pleasure. Please send my very best wishes to all the readers of ***Spaceflight***.

SOVIET NEWS IN BRIEF

❑ Cosmonauts Viktor Afanasyev and Musa Manarov have received an insurance policy payout of 5,000 Roubles in respect of the risk they undertook during their recent 175 day space mission. The cosmonauts had to make an emergency spacewalk to repair loose thermal insulation blankets on their Soyuz TM-9 spacecraft.

❑ An offer to fly an Italian cosmonaut to Mir to operate a special platform being built by that nation has been made by General Vladimir Shatalov, head of cosmonaut training at Star City. He made the offer during a recent Soviet/Italian space cooperation seminar. The platform will hold an astronomical telescope.

❑ The Salyut design bureau's planned Polyus orbital factory, weighing about 100 tonnes, could produce products worth three to eight billion Roubles for an outlay of one to two billion Roubles, according to a recent radio report. The space factory would be visited every six months by cosmonauts who would charge the furnaces and make repairs if required. The facility is expected to manufacture one tonne of materials each year.

❑ The ambitious plan to fly a 20-metre radio telescope for VLBI studies, using a Soviet communications satellite bus and a European payload has been rejected by ESA's Space Science Advisory Committee. The committee says that although the project was impressive, not enough is known about the antenna design. The proof of the space-based VLBI concept and technique would emerge from the ongoing VSOP and USSR RadioAstron projects.

Neville Kidger

Bright Eyes on the Earth

Matra Marconi Space

Norman Longdon concludes his article (see *Spaceflight*, May 1991, p.168) on the European Remote Sensing satellite ERS-1 with an eyewitness report on the satellite's launch:

First-time visitors to French Guiana, stepping off the plane into the sticky humid night will find ample proof that, technically at least, they are still in Europe, for a large notice proclaims that the airport was built with European Community regional funds.

The atmosphere during the journey, on a special charter flight to witness the launch of the ERS-1, reflected the knowledge of all on board that this launch was most important to Europe.

Coming ahead of a meeting of European Ministers responsible for space matters scheduled for the winter and carrying with it the hopes that its instruments would play a significant role in the global and continuous monitoring of the Earth's environment, its success would be not only scientific and technical but also political.

By Norman Longdon
ESTEC, The Netherlands

Launch Day

After only four hours sleep we were ushered into a fast moving, well organised prelaunch programme. On the journey to the Guiana Space Centre (CSG), we noiiced the signs of many of the garages, shops and restaurants were in Chinese. Our guide explained that the Chinese had a dominant role in retail business while the Vietnamese had made a success of the difficult agricultural conditions in this tropical climate.

It became clear very quickly that CSG had been responsible for the prosperity in the region. Its clean-cut buildings and launch sites set against shrub country give it a unique style. Whereas the Kennedy Space Center has a bustling air about it, at CSG there was a sharp, neat presence.

Speakers placed emphasis on the amount of data which ERS-1 will hopefully provide, due to its ability to cover so much of the Earth's surface in 72 hours normally not monitored but crucial to an understanding of weather patterns.

An appetizer was the visit to the first construction to herald the beginning of the Ariane 5 launch area (ELA 3). When finished, it will stretch across the countryside approximately the width of Paris.

The next site, ELA 2, allowed us to take a close-up view of the next Ariane,

44L, being readied for launch .

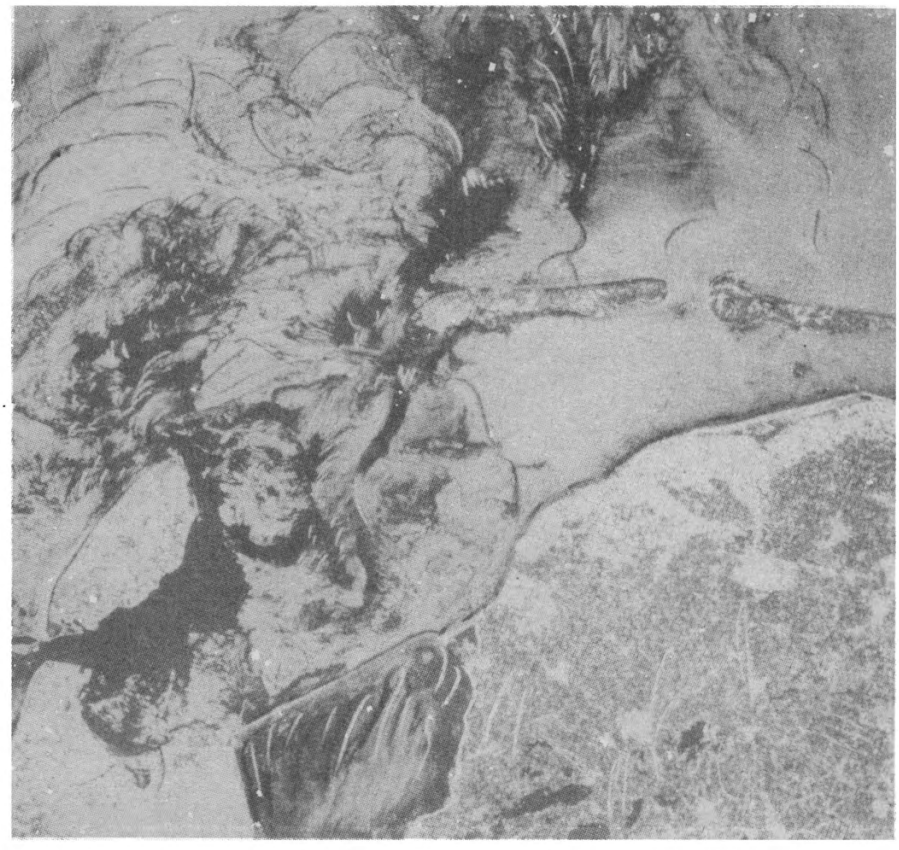
Night found us on a hill some kilometres from the launch, with Ariane standing in a pool of light. We were kept in touch with the countdown by television screens.

Launch produced a muted roar and the swift transition from a fiery start to four blue jets of flame.

For many of those present, the real worries were how near the nominal trajectory was she riding? Was each stage of the launcher performing as planned?

As the plotter curve matched the theoretical path and as each stage fulfilled its task, faces told of considerable burdens being lifted. Those responsible for the launch relaxed but those responsible for the spacecraft were easily identified - they were still concentrating, waiting for news from the ground stations.

A heart-stopping few minutes occurred when Alaska failed to acquire the satellite until Perth reported all's well.



This first ERS-1 image, acquired at Fucino, Italy, during the night of 27/28 July 1991 at 23:40 (Paris time). The scene, located in the North-West of the Netherlands, has an extent of about 95 km x 95 km. This is the region of the Western Frisian islands. The agricultural regions of Friesland (bottom right part) and Wieringermeer polder (bottom left part) exhibit a regular pattern of agricultural fields. The cities appear as very bright tones The most extraordinary feature in this image is the water pattern in the North Sea (top part) and the Ijselmeer separated from the Waddensee by the 'Afsluitdijk' (bottom centre part). Numerous ships are identifiable (bright points) and some of them produce turbulence wakes that we can recognize over more than 20 km. The features in the North Sea are mostly due to density variations of the water creating various kinds of surface roughness. When the water surface is flat, it appears in the image in very dark tone. This is the case near Texel island, but also in the little lakes in the bottom part of the image. Other details should also be noted like the 'wave breakers' perpendicular to the West coast of North Holland (near the bottom left corner), or the land reclamation area on the North coast of Friesland. *ESA/ESTEC*

A Busy Day's Work

The May issue of ***Spaceflight*** described the five instruments on board ERS-1: the Active Microwave Instrument (AMI), the Radar Altimeter (RA), the Along-Track Scanning Radiometer and Microwave Sounder (ATSR/M), the Laser Retro-Reflector (LRR) and the Precise Range and Range-Rate Equipment (PRARE).

Before these could be put to work with the accuracy expected, a complex and unusual calibration and validation period had to be completed.

Basic measurements to be made by ERS-1 instruments are sensor measurements of the following:

a) radar backscattering from the Earth's surface (AMI, RA)
b) time delay between transmission and echo reception (RA)
c) infrared emission from the Earth's surface and the atmosphere (ATSR)
d) microwave emission from the Earth's surface and the atmosphere (ATSR/M)
e) satellite range and range-rate (PRARE).

It is from these engineering quantities that geophysical data will be derived such as surface wind fields over the ocean, significant wave heights and directional ocean-wave spectra.

As a result, the calibration and validation of the ERS-1 payload will take place in two distinct stages.

The engineering calibration is under way and is due to continue until October. This is the process of converting spacecraft payload telemetry into engineering units within known limits of accuracy and precision, e.g. radar backscattering coefficient (m^2/m^2), antenna brightness temperature (K) and time delay (s). Engineering calibration is achieved *via* inherent instrument stability, the use of internal references to compensate for system variations caused mainly by temperature variations and ageing and the use of external references such as specially designed radar transponders or carefully selected targets of opportunity.

The second step, to take place later, will be geophysical calibration, the process of converting engineering quantities such as radar backscattering into geophysical units (winds and waves) within known limits of accuracy and precision. To do this successfully, it is necessary to have good wave heights and strong winds, which is why the Norwegian sea in the winter months of November and December have been chosen.

This conversion takes place in the ERS-1 ground processors and uses models to relate the engineering quantities to the geophysical quantities of interest.

The calibration and validation measurements take place against a background of numerous airborne scatterometer campaigns which enabled a model to be constructed which was used in the design and performance assessment of the ERS-1 scatterometer.

Engineering Calibration of the Active Microwave Instrumentation

To achieve engineering calibration AMI ground processors use pre-launch information about the instrument, such as its electronic gain and antenna patterns, ERS-1 orbit information and in-flight measurements of, for example, instrument noise.

These ESA transponders, located in Flevoland, The Netherlands, will be used for calibration of the AMI image and Wave Modes. Three transponders in the south of Spain will be used for the AMI Wind Mode.

Flevoland is located at about 52° N and is re-visited several times during the 35 day repeat orbit, thus providing good temporal resolution for calibra-

tion and performance monitoring. This area, which will also be covered by ERS-1 during the commissioning phase, consists of some 97,000 hectares of land reclaimed from the former Zuiderzee. Because of its characteristic geometry, with relatively large-scale agriculture, the lack of relief and the availability of many well-surveyed control points, the area has often been used in the past for radar remote-sensing experiments and calibrations.

In Spain, one of the transponders is located near a rocket-launching site, in Arenosillo, operated by INTA. The second is placed on the roof of the computer centre of the University of Malaga and the third is on the roof of a school in Adra.

The current prediction of residual errors after radiometric calibration have been analysed in detail is that ERS-1's overall absolute radiometric accuracy for the Image Mode will be 0.7 dB (or ±9%), for the Wave Mode 0.5 dB, (or ± 6%) and for the Wind Mode 0.5 dB (or ± 6%).

Engineering Calibration of the Radar Altimeter

Height measurements from the Radar Altimeter will have a long-term stability of the order of 5 cm. An absolute system calibration to this level was not possible prior to launch for a number of reasons, including difficulties in calibrating the test equipment to the required accuracy.

It is thus necessary to establish a calibration of the system bias in-orbit. Historically, this task has been performed twice before, for GEOS-3 and Seasat. Bias values of the order of 0.5 m were found.

Of the many potential calibration techniques available, the best-known is the classical "Bermuda method", in which the satellite overflies a laser-ranging system located on a small island. This was done for Seasat in 1978 but it is not without its difficulties, particularly when a calibration at the 5 cm level or better is required.

It was thought that some of the potential problems could be overcome by moving the reference laser from an island to an offshore platform, but finding a platform large enough to support a laser system in European waters implies the North Sea, which was not favoured because of the likelihood of bad weather and high waves.

A different approach was adopted which makes maximum use of existing European facilities and capitalises on the density of existing satellite laser-ranging (SLR) stations.

The satellite will make a northward pass over a small research platform about 14 km offshore from Venice, owned by CNR (the Italian National Research Centre) and used for oceanographic measurements. It is fixed to the sea-bed in about 16 m of water in a part of the Adriatic free from significant dynamic sea-surface changes. The area has negligible currents, small and well-modelled tides and only rarely, under storm conditions, is there appreciable wind set-up of the water surface. All this is important because the satellite cannot be guaranteed to fly directly over the tower.

The CNR Oceanographic Research Platform off the Italian coast, near Venice. The upper decks of the tower have since been modified to accommodate a PRARE station and microwave radiometer. *ESA*

Due to air-drag effects on its orbit, the satellite's ground track can vary by up to 1 km from the nominal track. The actual surface slope must be known in order to refer back to the reference platform's position. A further contribution to this surface slope stems from the detailed geoid in the area. An extensive series of local measurements have been made and the construction of a very detailed local geoid was possible.

This has confirmed a further advantage of the site as the local geoid is extremely smooth with a small slope.

The satellite will be tracked simultaneously from several satellite laser-ranging sites. A number of fixed sites provide a network of lasers surrounding the Venice platform. The Venice platform, as the main reference point for the sea-level determination, will be equipped with a number of measurement facilities. Some of these are permanent, such as a tide gauge, wave measurement sensors, etc.; others will be specially installed for the purpose, including a microwave radiometer to measure atmospheric water vapour.

Engineering Calibration of the Along-Track Scanning Radiometer

The ATSR instrument was tested and calibrated in a specially-designed space simulator and test facility at the Department of Atmospheric, Oceanic and Planetary Physics of Oxford University (UK).

To meet its scientific objective of measuring sea-surface temperature to better than 0.3 K, the ATSR has to measure brightness temperature in the infrared to better than 0.1 K. The radiometric tests showed that this was achieved over the entire sea-surface temperature range, with no scan-dependent strays or biases.

Primary calibration of the infrared radiometer will be achieved with two on-board black bodies which will stabilise at temperatures of around 263 K and 303 K, respectively. The black-body temperature is measured accurately by platinum-resistance thermometers and each black body is seen once per scan of the optical system.

The 1.6 micron (near-infrared) channel will be calibrated by observing ground features that have known albedos. One such site is the White Sands Missile Range in New Mexico, which will need to be observed in sunlight when cloud is absent. Drift and noise in the near-infrared channel can be assessed from data taken at night.

Calibration of the thermal channels involves close observation of the on-board black-body performance and the thermal environment within the instrument. A comparison can then be made with the performance of the detectors during the ground calibration and any necessary corrections made. The way in which each channel responds to sharp changes in ground temperature will be found from data collected over cloud/sea and sea/land boundaries.

Instrument tests on the Microwave Sounder (ATSR/M) include:

1) a survey of the instrument stability with time (gain, internal temperatures, horns)
2) checking of the sky-horn measurements during one special orbit
3) examination of antenna-pointing and sidelobe-contamination effects.

Validations of brightness temperature will be performed twice during the commissioning phase and several times during the satellite's lifetime.

The validation of geophysical data will be based, essentially, on the comparison of calculated water-vapour content with observations from radio-sounding provided by the French Meteorological Office. This will be done twice during the commissioning phase and occasionally during the satellite's lifetime, in order to sample all possible meteorological

conditions.

Other validations will be performed using available data such as the Special Sensor Microwave Imager products (from SSMI instruments flown on NOAA operational satellites) and ground-based microwave radiometer data (the campaign planned for August 1991 with CNES' "Portos" radiometer).

Engineering Calibration of the Precise Range and Range-rate Equipment (PRARE)

Although the PRARE space segment and ground tracking units contain facilities for the determination of hardware-related calibration parameters for each measurement interval, there is also a strong requirement for a calibration procedure to monitor the overall performance of the tracking measurements against the most precise laser systems, and to tie the PRARE observations into the internationally accepted standard of laser tracking measurements.

The calibration procedure selected is based on comparative measurements to the ERS-1 satellite from the two tracking systems, laser and PRARE, installed adjacent to each other on the Wettzell tracking station site, in Bavaria. This station has extensive experience of co-location campaigns for stationary and mobile laser systems.

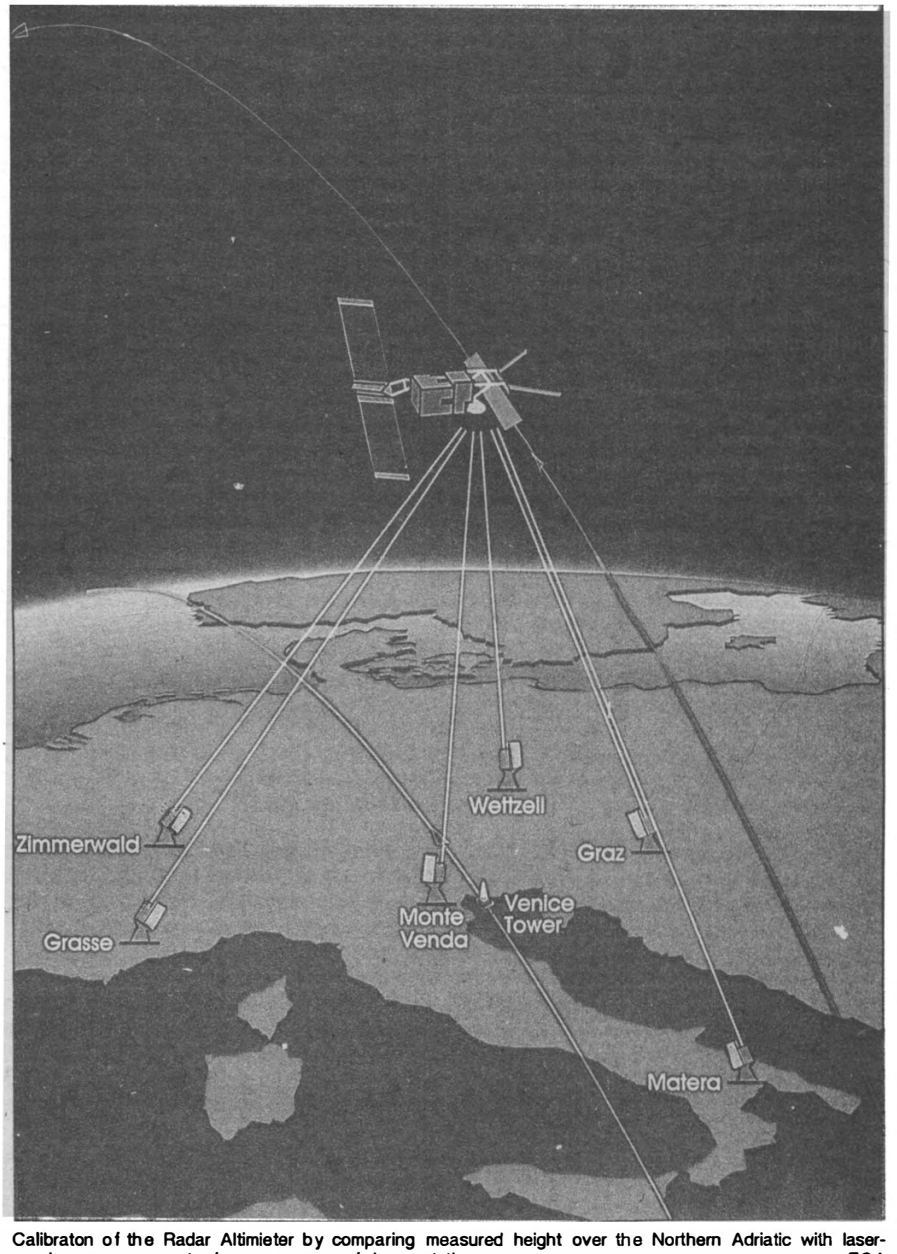
An intensive calibration campaign is being carried out to derive the most reliable calibration parameters and to use the co-location setup during the subsequent exploitation phase to monitor the system's behaviour.

Geophysical Calibration of ERS-1

The geophysical data products produced routinely by ERS-1 instruments will include the speed and direction of the surface winds over the ocean, the directional spectrum of the ocean waves derived from radar backscattering measurements from the AMI and the significant wave height and surface wind speed derived from the radar echo signals measured by the Radar Altimeter.

The models used to convert radar signals into the wind and wave parameters will be checked and, where necessary, modified by comparing the satellite-derived estimates with the analysis fields derived from meteorological and oceanographic models on both a regional and a global scale.

This activity is being carried out in cooperation with the European Centre for Medium-Range Weather Forecasting (ECMWF) and the major Meteorological Offices in Europe. A large database will be built up from routine *in-situ* observations by ships and buoys and co-located satellite observations. This data set will be available for making a quality assessment of the ERS-1 wind and wave products and for detailed analysis of the ERS-1 interpretation models on a global scale.



Calibraton of the Radar Altimieter by comparing measured height over the Northern Adriatic with laser-ranging measurements from an array of laser stations. *ESA*

In addition, a dedicated field campaign will be conducted at an ocean site off the Norwegian Coast, near Trondheim, where an array of meteorological buoys will be deployed for measuring wind speed, wind direction and significant wave height during the ERS-1 overpasses. Low-flying aircraft will also be used to make complementary wind-vector measurements. These aircraft will also carry airborne radars to verify both the wind-retrieval and the ocean-wave imaging models used for ERS-1 data.

Research vessels will be used for *in situ* wind and wave measurements and the shipborne radars will image the ocean surface during ERS-1 overpasses to determine the ocean wave field. Similar surface measurements and airborne observations are planned in collaboration with non-European organisations in Canada, the USA and Australia.

Simulations indicate that, after a three-month geophysical calibration period, sufficient data will be available to determine and verify the geophysical performance of the operational ERS-1 wind and wave retrieval models.

Bright Eyes - Bright Future

The early SAR images give every expectation that ERS-1 will provide data of extreme importance in unravelling the intricacies of the global environmental parameters.

It will lead the way where others will follow, including second and future generations based on the lessons learnt from ERS-1. It is clear to scientists that "unravelling" will not be possible through data from one satellite's lifetime. Remote sensing from satellites will need to continue until governments and international agencies have the fullest possible understanding of what is needed to predict and preserve our environment.

Officers of the Society

President:: G.W. Childs
Vice Presidents:
A.T. Lawton
Prof. I.E. Smith

Council Members:
R.A. Buckland
Dr. R.D. Gould
Prof. G.V. Groves
Dr. R.C. Parkinson
Dr. L.R. Shepherd
G.V.E. Thompson
Dr. P. Thompson
C.R. Turner
G.M.Webb

Executive Secretary:
L.J. Carter

Deputy Executive Secretary:
Ms. S.A. Jones

Promoting Space and Astronautics

Report on the British Interplanetary Society for 1990

Officers of the Society

I can hardly believe that a year has passed since I wrote my last report. My third and final year as President seems to have gone in a flash. Looking back over the year much has been accomplished, however, thanks to the work of the Council, its various committees and the Society's staff. Re-elected as Vice Presidents in 1990 were Mr A.T. Lawton and Professor I.E. Smith. It has been a great pleasure to continue working with them and with Mr L.J. Carter, the Society's Executive Secretary.

In September I was pleased to welcome Dr Paul Thompson to the Society's Council following his election at the Annual General Meeting. He is already active in the special committee dealing with the Society's 60th anniversary preparations and will bring to the Council his substantial experience in the field of satellite communications.

Committees and Working Groups

The work of the Council has been supported during the year by its various committees and specialist groups. All are continuously reviewed by the Council to ensure that they are meeting the Society's needs in the most effective way.

The Executive Committee, with myself as *ex officio* Chairman, has continued to exercise its delegated responsibilities for the running of the Society and overseeing its financial affairs. During 1990 the Executive Committee's work included international liaison, the project to renew our HQ building and monitoring various Society events of the year such as Space '90.

A major area of Society activity relates to our two regular monthly magazines, ***Spaceflight*** and ***JBIS*** and the production of these in 1990 was under the control of the Publications Committee chaired by Mr A.T. Lawton.

The contribution of BIS Working Groups to the Society's activities has also been notable in 1990.

The Library Working Group held a number of meetings in 1990, under the Chairmanship of Mr L.J. Carter, to continue planning the library's long-term role as a depository of space and astronautics material. The library is now bursting at the seams and the long awaited library extension cannot come soon enough to relieve the pressure.

The Library Working Group is looking forward to the extra space to enable it to rearrange and to update the contents of the library for the benefit of members.

A new Working Group has also been set up under the Chairmanship of Martin Fry to decide on the arrangements to mark the Society's 60th Anniversary (Diamond Jubilee) in 1992/3. We are awaiting its recommendations with interest.

Particular mention must also be given to the effective work undertaken by Dr R.C. Parkinson and Mr C.M. Hempsell in Space Technology.

I would also like to thank many others whose work is of the greatest assistance to the Society. These include Eric Waine, our projectionist, Max Wholey, our Archivist, and the Members of the Library Working Group (Yvonne Cooper, Pat Girton, Derek Geoff and Doug Liddle) who man our Library at every evening meeting.

International Relations

The Society was represented at many leading international astronautical events during 1990 by designated Fellows of the Society and its staff.

The Society had a strong presence at the 41st Congress of the International Astronautical Federation held in October in Dresden, just days after German reunification. The BIS is the UK voting member and was officially represented by Dr L.R. Shepherd, council member and past president. The theme of the Congress was "Space for Peace and Progress".

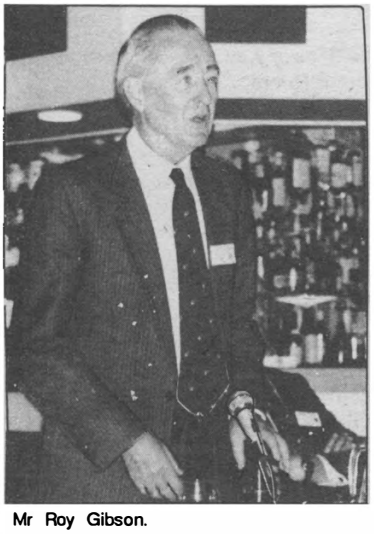
Also held in October was the International Symposium entitled "Towards Columbus and the Space Station" in Friedrichshafen, organised by the DGLR, where the Society was represented by Mr P.C. James.

The Society was one of six organisations that joined forces to sponsor the International Space Summit Conference held in June 1990 in Huntsville, Alabama. It was attended by many senior fellows of the Society including Roy Gibson, Peter Conchie, Bob Parkinson and our Executive Secretary. At the conference Peter Conchie, former BIS Council member, called for a World Space Exploration Programme based on the model of Intelsat.

The 25th Anniversary of Intelsat, the worldwide satellite communications organisation, occurred earlier in the year and the Society was pleased to send its congratulations to the Director General, Mr Dean Burch. In July Mr S. Young, ***Spaceflight's*** Assistant Editor, represented the Society at the Association of Space Explorers annual gathering at Groningen in the Netherlands. Steven Young also represented the Society at the biennial Space Commerce 90 exhibition and conference at Montreux.

In addition, the Society is actively supporting arrangements for the International Space Year in 1992 as part of an extensive international initiative.

UK and International Space Policy



Mr Roy Gibson.

The Society has continued actively to monitor the development of events, to put the case for greater awareness and commitment to space and to make more widely known and understood the unsatisfactory UK position and its long term consequences. January's edition of ***Spaceflight*** printed an abridged version of the opening address of the 40th Congress of the IAF in Torremolinos, Spain. The address given by Dr Tom O. Paine, a former administrator of NASA and Fellow of BIS for nearly 20 years, was entitled "The Next 40 Years in Space". In it he painted a picture of exploration and settlement of the Moon and Mars supported by the development of a transportation infrastructure and a scientific exploration programme.

Late in 1990 President Bush's Space Exploration Initiative came under increasing financial pressure and was dealt a devastating blow when the House Appropriations Subcommittee made $1.2 billion budget cuts. 1990 also saw the launch of the Hubble Space Telescope in April after many years of delay, an event that was closely reported in ***Spaceflight***. The triumph of the launch turned to near-disaster when it was discovered that the primary mirror was faulty.

Spaceflight also closely followed the changing fortunes of the Anglo-Soviet Juno mission. The project reached a low point in May but, by September, a rescue package was being put together and prospects were looking better for a launch in 1991.

The theme paper of the BIS Space '90 meeting in Hastings was published in the December issue of ***Spaceflight***. This paper, presented by Roy Gibson, BIS Fellow and former ESA Director General, gave a sober but realistic view of the next few years in Space and the likely UK position. In these difficult times the BIS must continue to make the case for UK participation in the reshaping and eventual carrying out of a practical programme of Space development.

Society Events

A major event of the year was the Society's Space '90 meeting, once again held in Hastings. Some 140 members enjoyed both the excellent lecture programme and the social events which included a civic reception and banquet. Space '90 admirably continued the Society's biennial series of meetings and I would like to take this opportunity of thanking all who participated and to the Society's staff for the excellent arrangements.

The 4th Symposium organised by the Society's History Committee was on the subject of British Solid Propellant Rocketry and, once again, was held at BIS HQ, as was our Annual Symposium of Soviet Astronautics which, once again, attracted a capacity enthusiastic audience. I thank both teams who made these events so successful.

Although not a Society event, as an ex-Chief Designer of Blue Streak, I was pleased to see the Society well represented at the reunion of ex-employees of the Blue Streak project held at RAF Spadeadam in June.

Publications

The Society's main technical journal, ***JBIS***, continued to develop with the publication of over 100 authoritative papers in 1990. As in previous years most issues were devoted to special topics. Those for 1990 featured: Origin of Life in the Universe (Pt II), The History of the Black Knight Rocket, Logica in Space (Pt II), INTELSAT 25th Anniversary, Norway in Space, Soviet Astronautics, Space Science at the Rutherford Appleton Laboratory, Space Engineering, Space Astronomy, Human Exploration of Mars, Interstellar Studies.

The Society is grateful for the editorial and administrative assistance of the following in bringing to fruition another successful year of ***JBIS*** technical publishing and in retaining its position as a leading technical space journal: Mr L.J. Carter, Mr M.J. Fogg, Dr R.T. Gallagher, Mr P.A. Hansson, Mr C. Nicholson, Dr S. Santoli, Prof I.E. Smith and Mr C.R. Turner.

Spaceflight has continued to provide an up to date source of space news and features and to command world wide respect. Standards have continued to improve during the year, thanks to the outstanding efforts of the editorial team of G.V. Groves and S. Young supported by other staff members. One only needs to compare the ***Spaceflight*** of today to one of a few years ago to realise what has been achieved.

Among the special features highlighted in 1990 were Soviet Scene, Mir Mission Report be Neville Kidger, STS mission reports, America in space and the ever-popular Space at JPL articles by Bill McLaughlin. We extended our publication capacity in 1990 still further by adding a range of new equipment. This has enabled us to work on a number of Journal issues simultaneously and free our existing equipment for use wholly with ***Spaceflight***.

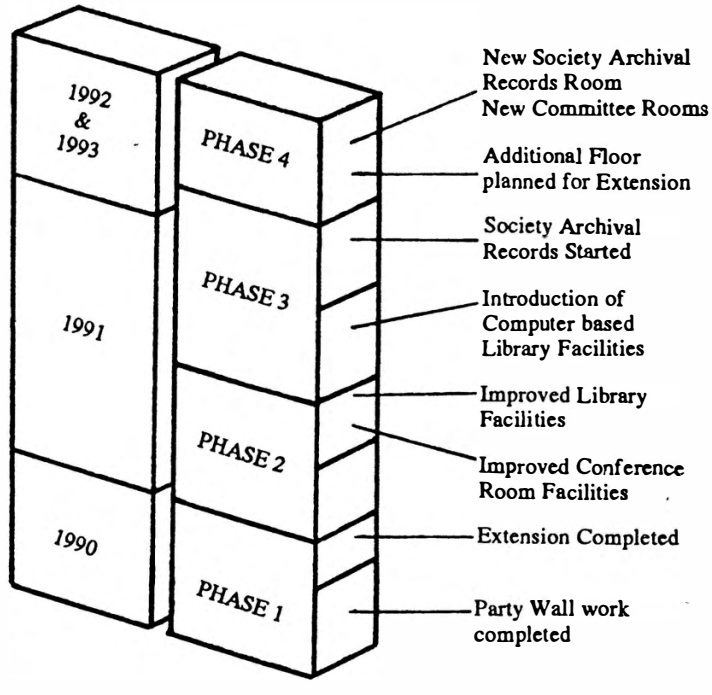
A new departure in 1990 was the start of the BIS Video Collection. This has already proved to be an exceedingly popular development and we plan to extend it progressively to include new subjects.

Renovation and Extension of the Society's HO

Much of the Council's work in 1990 has continued to be on the extension to the Society's headquarters and it is very gratifying to see the fruits of these efforts now beginning to appear as the work is progressively completed.

With the Extension Fund passing the £80,000 mark in April 90 the Council decided to go ahead with further work to that already completed on the foundations. The walls and roof were soon in place but leaving extensive internal working still to be done. It was necessary to carry out the work in stages in view of the difference between the funds in hand and the expected final cost. We have both conserved our funds and maximised the return from them, in every possible way.

The first steps to install air conditioning in the Society's new Conference Room.



During the year our Executive Secretary Len Carter has been a tower of strength revealing hidden talents as a "Master of Works" and driving hard bargains where necessary to get the best value for money for our members.

I would like to pay tribute to members for their outstanding generosity during the year in support of the extension programme. It is now possible to get an impression of what the building will be like when all is completed and it is clear that the final product will be one of which members can be proud. My thanks also go to the staff for their continuing fortitude as the work goes on around them. Although it has been necessary to restrict access at times, their unflagging efforts have ensured that disruption of day to day business has been kept to a minimum as the work proceeds on the internal fitting out.

Acquisitions

In February the Society was honoured to announce that it had recently purchased, through the generosity of one of its members, the portrait in oils of Sir William Congreve, which for a number of years has hung in our reception room but was available only on extended loan. Sir William, among a host of attainments, made a significant contribution to the advancement of rocketry in the 19th century and it is very gratifying that his portrait is now part of the Society's Archival Collection.

Membership

The membership of the Society at 31st December 1990 compared with 31st December 1989 was as follows:

	31.12.90	21.12.89
Fellows	1,921	2,062
Members	1747	1,542
Totals	3668	3,604

Finance

A major accounting entry in our 1990 accounts is the retransfer of accumulated Building Fund of Donations of £39,575 (Note 4) to use towards the cost of completing the Extension. This is simply a book entry but is of significance in showing that (Note 5) the funds accumulated were still inadequate to cover the cost of all the building work involved. However, it is our hope that continuing support from members over the next few years will enable this deficit to be fully met. In the meantime, part of this shortage has been funded by using the surplus of £17,502 gained for the year, though a warning has to be expressed in view of the significant reduction from the 1989 surplus of £32,707 and with continuing inflation in 1991 expected to average 8%.

The most apparent conclusion from these figures is that, although we have managed to keep a firm grip on our day-to-day costs, we must continue to rely on the generosity of members if we are to embark on a host of other desirable projects which would not only enhance the Society but prove of great value and pride to all members.

Conclusion

I would like to express the Society's gratitude to all members of staff for their dedicated efforts in the successful administration of the Society's affairs in 1990. The year saw the Society continuing to fulfil an active role in the promotion of Space and Astronautics both nationally and internationally. It also saw major progress in the development of the Society's Headquarters Building.

Throughout the year my work as President has been made all the easier and more enjoyable through the support I received from all the Society's staff and from Society members generally.

My three years in office as President have been most enjoyable and rewarding and I look forward with great confidence to continuing progress by the Society as it moves towards its 60th Anniversary.

G. W. CHILDS
President

1990 ACCOUNTS

Report of the Auditors

We have audited the financial statements on pages 2 to 7 in accordance with approved auditing standards, having regard to the matters referred to in the following paragraphs.

The financial statements do not specify the manner in which the operations of the Society have been financed or in which its financial resources have been used during the year as required by statement of Standard Accounting Practice No. 10.

Subject to the foregoing, in our opinion the financial statements give a true and fair view of the Society's affairs as at 31st December 1990 and of its results for the year ended on that date and comply with the Companies Act 1985.

Ledger, Mead and Sparks
Certified Accountants

Income and Expenditure for Year Ended 31st December 1989

	Notes	1990 £	1989 £
TURNOVER	1	217,146	217,999
COST OF SALES		108,678	(107,439)
GROSS PROFIT		108,468	110,560
Administrative Expenses	2	101,899	(96,049)
OPERATING PROFIT		6,569	(14,511)
Bank Deposit Interest Receivable		10,933	18,196
SURPLUS FOR YEAR	3	17,502	32,707
Balance at 1.1.90		113,178	72,107
Prior Year Adjustment	4	(39,575)	(31,212)
		73,603	40,895
BALANCE at 31.12.90		91,105	73,602

Balance Sheet as at 31st December 1990

	Notes		1990		1989
TANGIBLE ASSETS at cost	5		403,209		289,122
Less Contributions received			(363,966)		(284,561)
			39,243		4,561
Investments:					
R. Fleming Bank a/c	6		57,007		40,670
			96,250		45,231
CURRENT ASSETS					
Debtors	7	7,426		7,269	
Extension Bank a/c		51,702		75,555	
Cash at Bank		3,469		2,334	
		62,597		85,158	
LESS LIABILITIES DUE WITHIN ONE YEAR					
Creditors	8	67,742		17,210	
NET CURRENT LIABILITIES/ASSETS			5,145		67,948
			91,105		113,179

Represented by:

ACCUMULATED FUND		
Balance at 1.1.90	113,178	72,052
Less Premises Development Donations retfrd (5)	(39,575)	8,419
	73,603	80,471
Add Surplus for Year	17,502	32,707
Balance at 31.12.90	91,105	113,179

Certified to be a true copy.

A. T. Lawton, G. V. Groves } Members of the Council — L.J. Carter, Executive Secretary

1. TURNOVER

Turnover represents subscriptions receivable and income from th sales of publications.

2. STAFF COSTS

	1990	1989
Salaries, Pensions and National Insurance Contributions	75,870	65,625

The average number of employees during the year was 7 administrative staff.

3. OPERATING PROFIT is after charging:

	1990	1989
Auditors' Remuneration	1100	1000

4. PRIOR YEAR ADJUSTMENT

This relates to earlier donations etc. towards the cost of the Extension, previously credited to the Accumulated Fund and now utilised against the cost of the work carried out.

5. TANGIBLE ASSETS

	Freehold Land & Buildings £	Library & Equipment £	Total £
COST			
Balance at 1.1.90	198,391	90,731	289,122
Additions during Year less disposals	105,687	8,400	114,087
Cost at 31.12.90	304,078	99,131	403,209
Less Contributions Received			
Balance at 1.1.90	198,391	86,170	284,561
R/cvd during year	66,444	12,961	79,405
	264,835	99,131	363,966
Net Book Value	39,243	*NIL*	39,243

(a) Depreciation has not been charged against assets as the Society finances purchases of these through donations from members and contributions from other sources.

(b) The accounts have been prepared under the historical cost convention, with a modified income and expenditure account.

6. INVESTMENTS

	1990	1989
Robert Fleming Bank Account	57,007	40,670

7. DEBTORS

	1990	1989
Prepayments and Accruals	6,453	6,145
VAT Recoverable	973	1,124
	7,426	7,269

8. CREDITORS - amounts falling due within one year

	1990	1989
Trade Creditors	67,292	14,978
Others	450	2,232
	67,742	17,210

46th ANNUAL GENERAL MEETING

NOTICE IS HEREBY GIVEN that the 46th ANNUAL GENERAL MEETING of The BRITISH INTERPLANETARY SOCIETY Limited will be held in the Society's Conference Room at 27/29 South Lambeth Road, London, SW8 1SZ on 21 September 1991 at 12 noon precisely.

Attendance is restricted to Fellows of the Society. Admission is by ticket. Those wishing to attend must apply for tickets not later than 10 days before the date of the meeting.

AGENDA

1. To received the Report of the Council on the Society's Affairs for the year to 31 December 1990.
2. To receive the Society's Balance sheet and Accounts for the year ended 31 December 1990 and the Auditors' Report thereon.
3. To appoint Auditors and to determine the method of fixing their remuneration. The present Auditors have expressed interest in continuing in Office.
4. to elect four Members of the Council of the Society. As required by the Society's constitution, the following Members of the Council will retire at the meeting:

   G W Childs
   L R Shepherd
   R D Gould
   G W Webb

   Should the number of nominations exceed the number of vacancies, election will be by postal ballot. The final date for the receipt of ballot papers will then be 31 January 1992.
5. Closing Remarks by President.

By Order of the Council
S.A. JONES
Executive Secretary

A Fellow who cannot be personally present at the meeting may appoint by proxy some other person, who must be a Fellow of the Society, to attend and vote on his behalf, subject, however, to the proviso that a proxy cannot vote except on a poll.

SOCIETY MEETINGS DIARY

LECTURES

9 October 1991 7 pm - 8.30 pm

KENNEDY, APOLLO AND THE COLUMBUS FACTOR

L. Suid

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ.

Why did President John Kennedy commit the United States to landing a man on the Moon? Most historians cite a space race with the Soviets to prove that America had not lost its technological superiority. In fact, while the President expected technological gains from the manned space programme and recognised the need to "beat" the Russians to the Moon, he was motivated by other factors. The President saw himself to Apollo in much the same way as Isabella of Spain saw herself to Columbus. Simply put, Kennedy did truly see space as the New Frontier and that the success of Apollo would ensure his place in history. This paper will look at the decision to go to the Moon as a turning point in history for man to celebrate 500 years from now as he prepares to celebrate Columbus in 1991.

Admission is by ticket only. Members should apply in good time enclosing a sae. Subject to space being available members may also apply for a ticket for one guest.

6 November 1991 7 pm - 8.30 pm

A HISTORY OF MANKIND, 2000 TO 5000 AD

P. Birch

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ.

A talk on the potential of Mankind in space. An overview of the continued growth of his technology, industry and population, transportation and habitats; from the early days of space colonies and terraforming, through the building of supramundane planets and interstellar settlements, to the construction of galactic-mass artifacts and the taming of the entire visible universe.

Admission is by ticket only. Members should apply in good time enclosing a sae. Subject to space being available members may also apply for a ticket for one guest.

4 December 1991 7 pm - 8.30 pm

STRING IN SPACE: THE SPACE APPLICATIONS OF TETHERS

C Welch

Venue: The Conference Room, British Interplanetary Society, 27/29 South Lambeth Road, London SW8 1SZ.

The history and background of tethers. The basic physics that govern their behaviour and their applications in the space field. Upcoming tether missions, in particular the US/Italian TSS (Tethered Satellite System) shuttle flight.

Admission is by ticket only. Members should apply in good time enclosing a sae. Subject to space being available members may also apply for a ticket for one guest.

INTERNATIONAL CONFERENCES

27-30 August 1991

POWER FROM SPACE '91

Vanue: Ecole Supérieure d'Electricité, Paris/Gif-Sur-Yvette, France.

The path to making power from space available to mankind is long and difficult but for that very reason it is necessary to begin now. This meeting, organised by the Societe des Electriciens et des Electroniciens and the IAF, and co-sponsored by the Society, will address the major issues of power from space.

Registration: Forms are available from the Executive Secretary. Please enclose a sae.

5-12 October 1991

42nd IAF CONGRESS

To be held in Montreal, Canada, hosted by the Canadian Aeronautics and Space Institute.

The theme will be "The Next Century - Prospects for Space".

Members of the Society wishing to present papers may obtain procedural details for the submission of Abstracts from the IAF, 3-5 Rue Mario-Nikis, 75015 Paris, France.

The 43rd IAF Congress will be held in Washington, DC over the period 28 August to 9 September 1992 and will be combined with the 29th Plenary Meeting of COSPAR.

The meeting will be hosted by the AIAA and held under the auspices of the NAS and NASA.

2 - 4 October 1992

SPACE '92: INTERNATIONAL SPACE PROJECTS

The Society's biennial two day meeting will be held at the White Rock Theatre, Hastings 2-4 October 1992. With the theme of "International Space Projects".

Offers of papers are invited. Please contact the Executive Secretary.