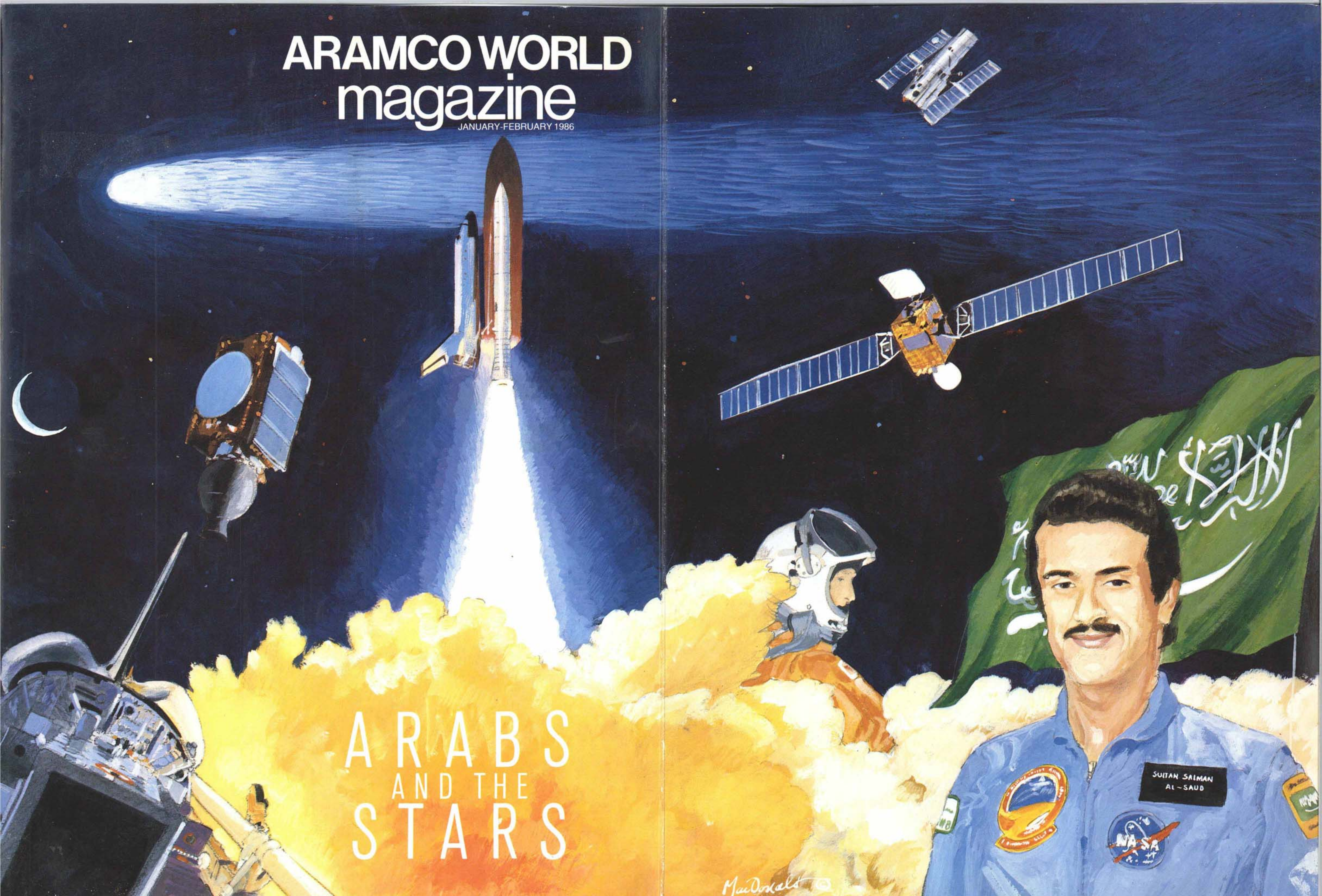
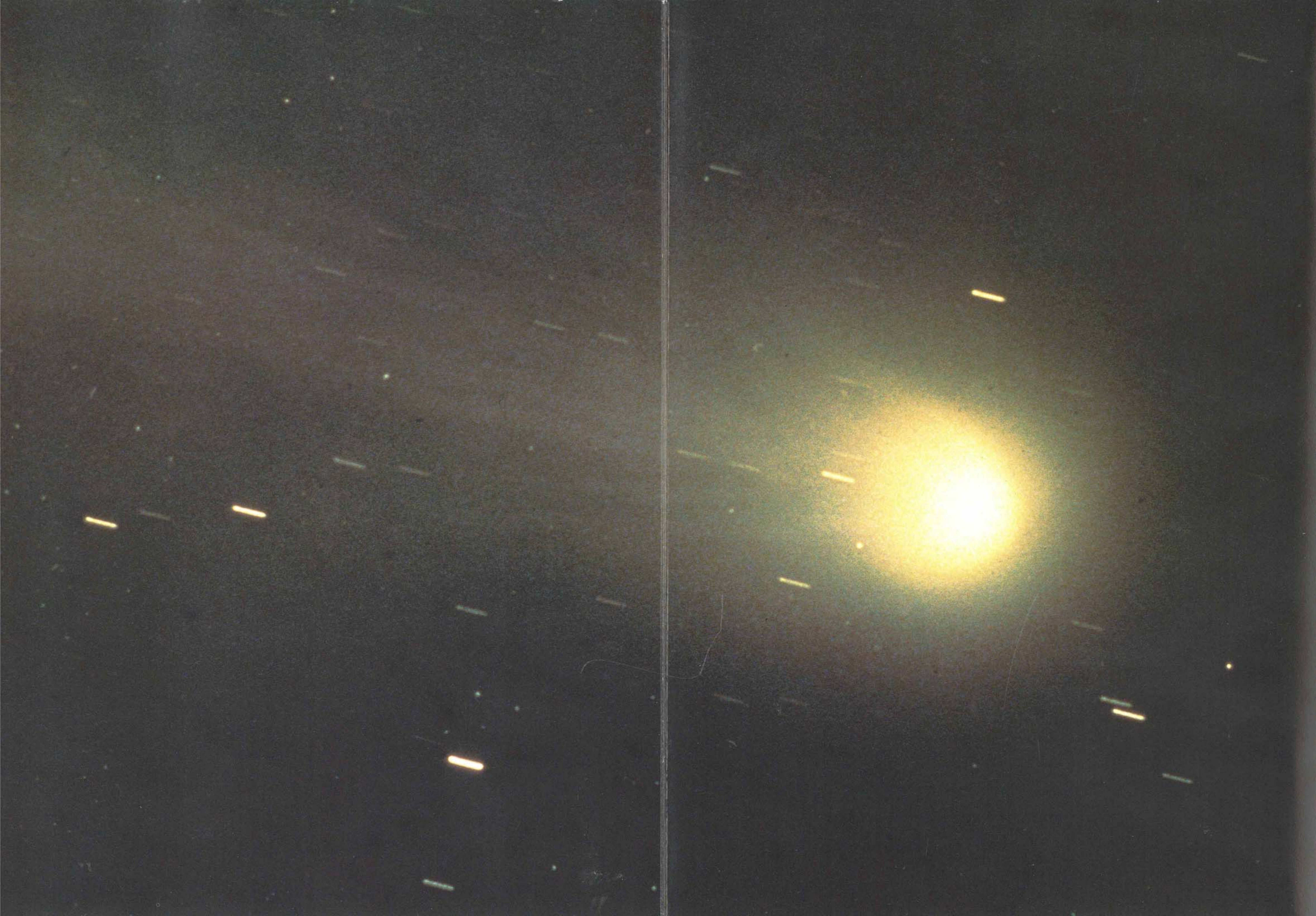
ARAMCO WORLD magazine

JANUARY-FEBRUARY 1986

ARABS AND THE STARS





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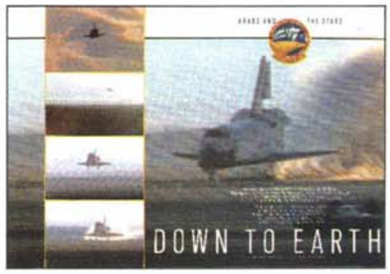
ARABS AND THE STARS

A SPECIAL ISSUE

An Introduction The Editors 2

A Prince in Space John Lawton with Patricia Moody 20

Arabs and Astronomy Paul Lunde with Zayn Bilkadi 4



Down to Earth Kenneth Storey with Joe Fitchett 30

The Long Haired Star Paul Lunde with Russell McGuirk and Jaber Jum'ah 8

Question Time Kenneth Storey 34


LUNDE


LAWTON


STOREY


MACDONALD


MOODY


FITCHETT


BILKADI

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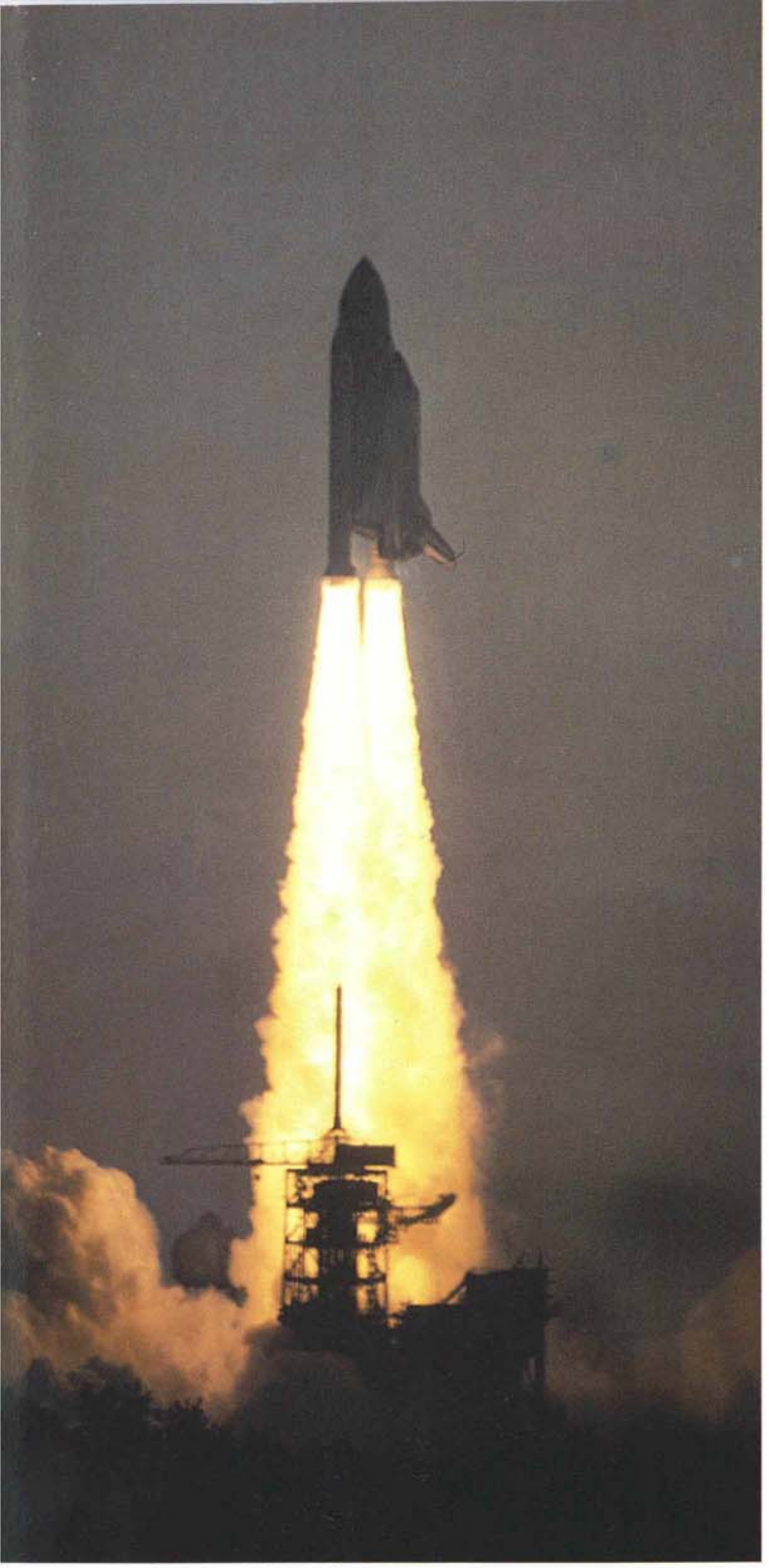
Cover: To suggest the contributions by Muslim scientists to astronomy over the centuries, illustrator Norman MacDonald focused on this year's astronomical highlight – Halley's Comet – and the Arab world's most recent contribution: the trip into space by Prince Sultan of Saudi Arabia. MacDonald also included a space shuttle launch, the first Arab satellite, and the proposed space telescope to study the stars. Back cover: Sitting on its launch pad, the space shuttle *Discovery* is illuminated by a blaze of lights, shortly before a perfect lift-off. Photo by Burnett H. Moody.

◀ A photograph taken by astronomers at the Helwan Observatory in Egypt during the last appearance of Halley's Comet, in 1910.



ARABS AND THE STARS

The stars, gleaming with special brightness above the dunes and salt flats of the deserts of the Middle East and their environs, have always beckoned to the Arabs. They provided a celestial map for the ancient nomads, and later challenged the greatest minds of the Muslim world.

To all ancient civilizations, the night sky provided a fascinating and often frightening array of mysterious astronomical phenomena that even the greatest scholars could not explain: brilliant Venus and the North Star, meteors streaking suddenly across the blackness, curved shadows moving ominously across the moon and the sun, and comets blazing unexpectedly into view, their fiery tails warning of death, plague and defeat in the months ahead. But of all the scholars who sought to unravel those mysteries, few compared with those in the Islamic countries: the mathematicians, philosophers, astronomers and linguists who flocked to the *Bait al-Hikmah*, (The House of Wisdom) during the Abbasids' Golden Age in Baghdad or later expanded and extended their studies in Islamic Spain and transmitted their discoveries, concepts and theories to Europe.

In Golden-Age Baghdad, Muslim scholars often tended to be polymaths, i.e. scholars whose interests encompassed such disciplines as mathematics, philosophy, medicine and literature. As a result, most of the great scholars of the Golden Age not only pondered the problems of astronomy, but also built instruments to make observations and measurements or developed the mathematics needed to calculate and test their data. Thabit ibn Qurrah, for example, was primarily a mathematician, as was the great Muhammad ibn Musa al-Khwarazmi, but Ibn Qurrah also produced original work in astronomy and al-Khwarazmi developed important astronomical tables. The famous trio of scientists called the *Banu Musa* (the sons of Musa) were mathematicians and also contributed a book on celestial mechanics.

King Fahd speaks by phone to nephew Prince Sultan in space

The same was true in Islamic Spain. Men like Ibn Abi 'Ubaidah in the ninth century, Mashlah al-Majriti in the 10th century and al-Zarqali in the 11th century developed theories, corrected al-Khwarazmi's tables and built instruments, while al-Bitruj came up with a new theory of stellar movement. Al-Zarqali – Arzachel in the West – also contributed to the highly accurate compilation of astronomical data called the "Toledan Tables," and before the age drew to a close the Arabs had put their names on most of the important stars and planets and left a legacy of astronomical speculation still seen in such important astronomical and mathematical terms as "zenith," "nadir" and "azimuth," all clearly Arabic in origin.

For all those reasons, it was particularly appropriate for 22 Arab League countries to launch the first Arab satellite and for the first Arab astronaut to ride a space ship into orbit in 1985, the year when Halley's Comet, one of the wonders of astronomy, returned after 75 years. Altogether, these developments suggest not only the historical contributions of the Arab world to the study of astronomy, but also the extraordinary renaissance of scientific and technological learning in and throughout the Arab world in the past decade.

To cover this story, *Aramco World*, early in 1985, lined up an international team of reporters, scholars, researchers, illustrators, photographers and photographic agencies to report, write on and illustrate the February 8 launch of Arabsat-A from the jungles of French Guiana and to analyze the expected impact of the space age on communications in the Arab world. This team included Yasar Durra, an executive of Worldwide Television News , Arthur Clark, an *Aramco World* correspondent in Saudi Arabia, John Christie, a former British diplomat and now publisher of *Middle East Newsletters*, Patricia Moody, a former Aramco employee now free-lancing in the United States with her husband Burnett H. Moody, former Aramco chief photographer, Douglas A. Boyd, University of Maryland communications expert,and the result was a 14-page special section – "The Arabs in Space" – in the March-April issue.

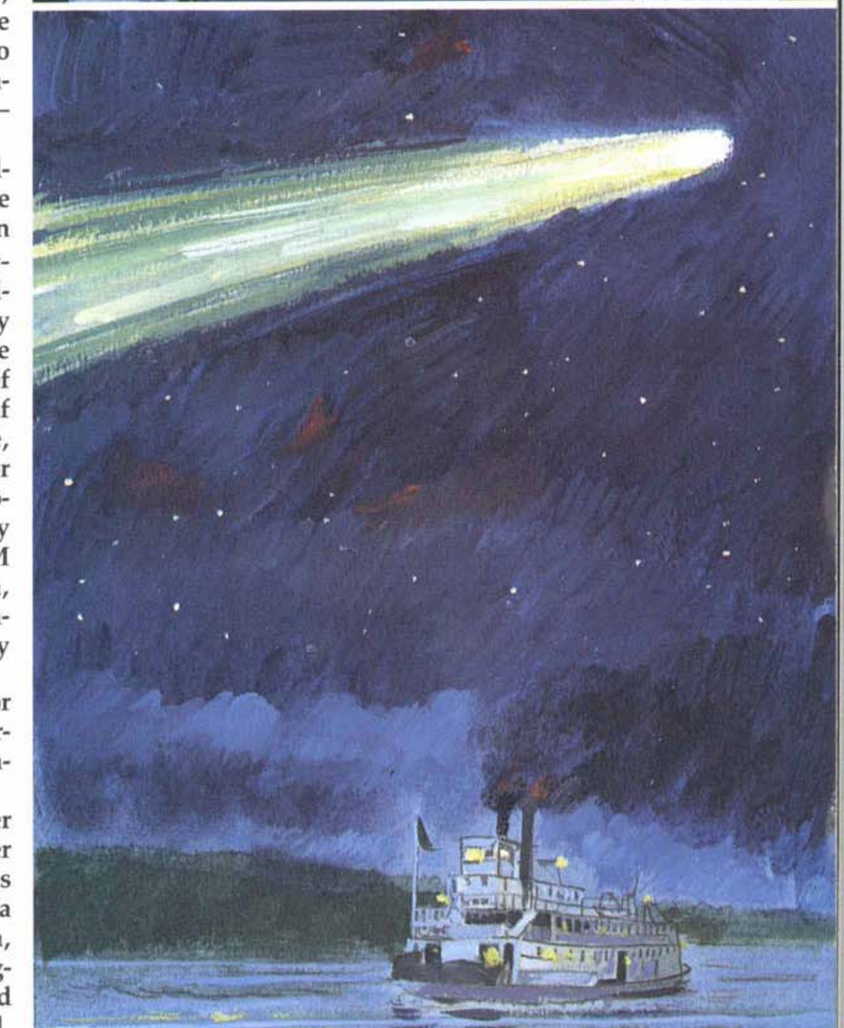
But that was just the beginning. By the time Arabsat-A was actually launched, the Arab League had accepted the invitation of the National Aeronautics and Space Administration (NASA) to place an Arab payload specialist on the space shuttle *Discovery*, and had chosen Prince Sultan ibn Salman Al Sa'ud of Saudi Arabia to fill that slot. By then too, astronomers all over the world were beginning to crank up their telescopes for one of the great moments in astronomy: the return of Halley's Comet. So, the story still incomplete, *Aramco World* assigned Contributing Editor Paul Lunde to provide a history of Arab astronomy, and to weave in research submitted by Dr. Zayn Bilkadi, a research scientist at the 3M Corporate Research Laboratories in Minnesota, but also, as he puts it, "a Tunisian Arab ... interested in the history of science and technology in the Middle East."

As lift-off time approached, *Aramco World* Contributing Editor John Lawton, assigned to help Saudi Television provide daily coverage of the event, found himself in Houston – and thus able to add on-the-spot coverage.

Still more contributors went into action when Prince Sultan later flew to France and the United States. Joe Fitchett, a veteran reporter with the *International Herald Tribune*, covered the prince as he was inducted into the French Legion of Honor; Kenneth Storey, media advisor to the Royal Embassy of Saudi Arabia in Washington, traveled with the prince as he flew – himself – to Boston, Washington, Dallas and Los Angeles, met President Reagan and answered pointed questions from sharp students in a Dallas high school. Meanwhile, still another contributor, Daniel Pawley, working on a story on the travels of American authors in the Middle East, came up with a short item about Mark Twain and Halley's Comet and Arthur Clark in Saudi Arabia came up with background material on what, basically, is one of the more important aspects of the space flight: scientific experiments developed by Arabs to be carried out by an Arab in regions of the universe that Arab science has studied since at least the ninth century. ⊕

– *The Editors*

AN INTRODUCTION



Arabs and Astronomy

WRITTEN BY PAUL LUNDE – WITH ZAYN BILKADI
ILLUSTRATED BY ERRÓ – AND MICHAEL GRIMSDALE

The launch of Arabsat-B was Prince Sultan's primary assignment in space, but he also had to carry out, or participate in, four experiments and two of them – observation of the new moon and photography of the Arabian Peninsula – would not have been totally incomprehensible to medieval scientists in Islamic lands. They too were interested in such areas as optics, mapping and ephemerides – tables showing the positions of celestial bodies on given dates.

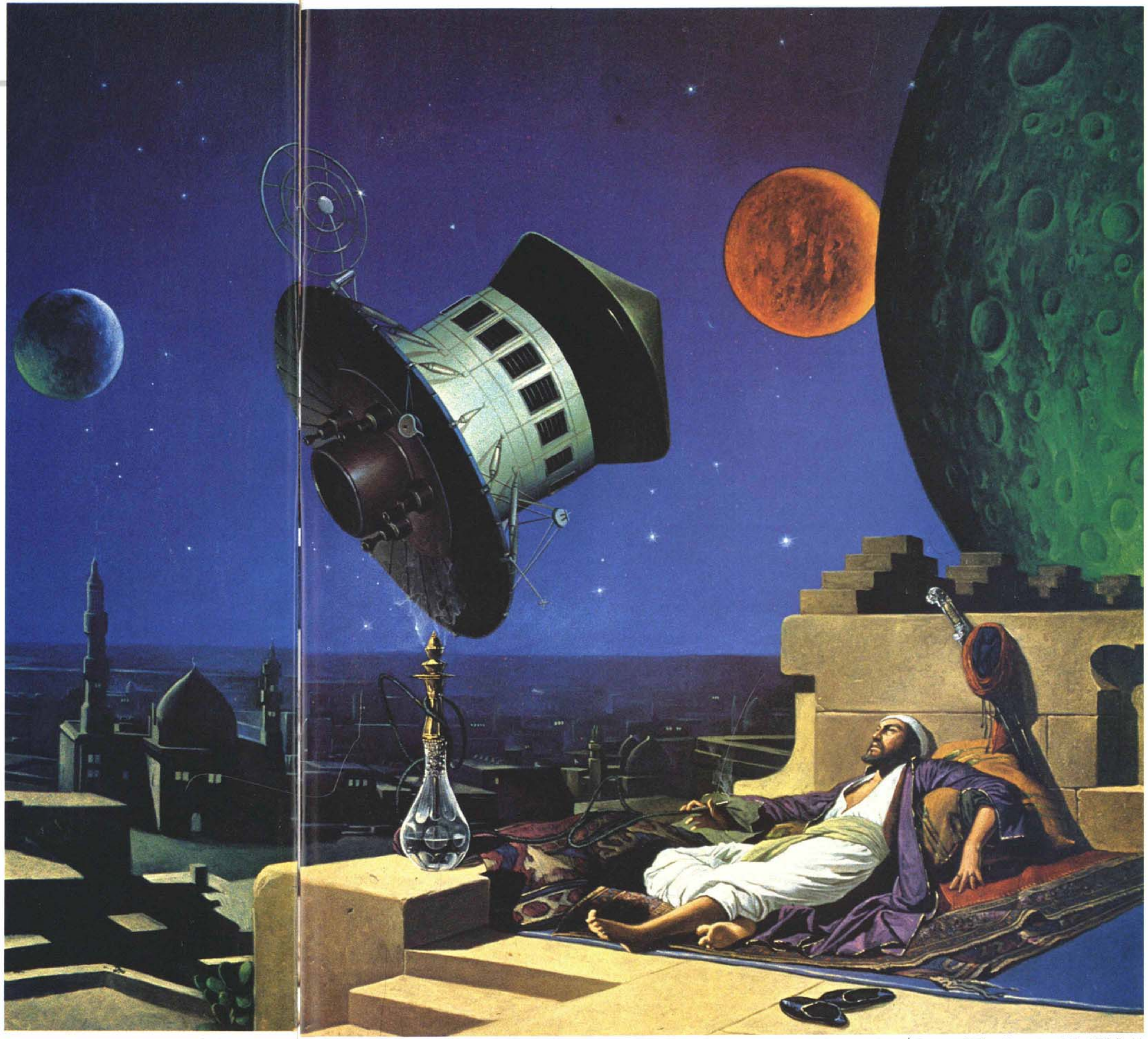
The observation of the new moon, for example, was, and is, important to Muslims; for religious purposes they follow a lunar calendar and the new moon marks the beginning and end of the fast of Ramadan and determines the date of the pilgrimage to Makkah (Mecca) – the Hajj – two of the five religious duties incumbent upon all Muslims.

Mapping too sprang from a religious concern: the need to establish correct coordinates of cities so that Muslims could determine the direction of Makkah – the *qibla* – towards which all Muslims prostrate themselves in prayer five times a day. And though observation of the new moon and determination of the *qibla* may seem prosaic subjects today, it was by pondering just such everyday phenomena that advances in science were made.

The mathematical determination of the *qibla*, for example, was no easy matter; in fact it was one of the most advanced problems in spherical astronomy faced by medieval astronomers and mathematicians. The trigonometric solution eventually found was of great sophistication, and trigonometry itself, largely an Arab development, is fundamental to the computation of planetary orbits as well as to terrestrial mapping. Nevertheless, medieval *qibla* tables often attained great accuracy. That of al-Khalili, who wrote in Syria in the 14th century, gives the coordinates of a large number of towns in degrees and minutes and is generally accurate to within one or two *minutes*. In Europe, this sort of accuracy in establishing geographical coordinates was not attained until much later.

It could be argued, in fact, that precise observation and an ability to find new mathematical solutions to old problems were the two main strengths of Muslim scientists in the Middle Ages. And though they, like their European counterparts, never fully escaped the tyranny of Aristotle and Ptolemy – whose models of terrestrial geography and of the heavens dominated men's minds until the Renaissance and were not finally demolished until the publication of Newton's *Principia* in 1687 – Muslim scientists were the first to express doubts about many of the details of the Ptolemaic system. Indeed, it was the growing awareness of the divide between Ptolemy's theoretical model of the universe and observed reality that culminated in the discoveries of Nicolaus Copernicus, Tycho Brahe and Johannes Kepler during the 15th to 17th centuries, and some of those doubts had been transmitted to European scientists from Spain in 12th- and 13th-century translations of Arabic scientific works.

Al-Battani, called by his European translators Albategni, is a case in point. He wrote in the ninth century on a wide number of scientific topics and some of his observations struck at cherished Ptolemaic dogmas. He showed, for example that, contrary to Ptolemy, annular eclipses – in which a ring of light encircles the eclipsed portion – were possible, and that the angular diameter of the sun was subject to variation. He showed – again contrary to Ptolemy – that the solar apogee was subject to the precession of the equinoxes; he corrected a number of planetary orbits; he determined the true and mean orbit of the sun. Interestingly, in the light of Prince Sultan's observation of the new moon, al-Battani also developed a theory of the conditions of visibility of the new moon.



On the terrace – by Erró: Courtesy of Gilbert Brownstone & Co. (CIE, Paris)

Other Muslim astronomers also came up with data that conflicted with Ptolemy, one of them perhaps the greatest Muslim physicist of them all: Ibn al-Haytham, called Alhazen in the medieval West. Al-Haytham argued that the Milky Way was quite far from the earth no matter what Aristotle said, and estimated the height of the earth's atmosphere at 52,000 paces – a pace being roughly one meter, or three feet. Al-Haytham worked that out from his observation that the astronomic twilight begins when the negative height of the sun reaches 19 degrees. Since the atmosphere is about 50 kilometers up (31 miles) and 52,000 paces is roughly 31 kilometers (32 miles), Ibn al-Haytham was not far wrong.

In the pre-telescope age, observational astronomy was, of course, carried out with the naked eye. Muslim scientists, however, perfected observatories in a number of places; those at Maragha and Samarkand are the most famous. At these observatories, astronomers gathered to refine Ptolemy's coordinates for the stars and, eventually, to revise Ptolemy's catalog of stars. This catalog which gave the positions of 1,022 stars, classified, as they are today, by magnitude, or brightness, was heavily revised, notably by the 10th-century astronomer Abd al-Rahman al-Sufi, whose *Book of the Fixed Stars* is the earliest illustrated astronomical manuscript known; the copy in the Bodleian Library, the work of the author's son, is dated 1009 and the author expressly states that he traced the drawings from a celestial globe.

There is an even earlier representation of the heavens in an Umayyad hunting lodge built about A.D. 715 in Jordan. It is called Qasr al-'Amra (See *Aramco World*, September-October 1968; July-August 1980) and in the dome of the bath

house in the lodge are fragments of a fresco showing some 400 stars and parts of 37 constellations, drawn on a stereographic projection – which implies a familiarity, even at that early date, with Ptolemy's *Planispherium*.

Arabs also excelled at making astronomical instruments – particularly astrolabes which were used for navigational purposes, for determining the positions of stars and for solving problems in spherical astronomy. There were three sorts of astrolabes: planispheric, linear and spherical. These were used at the observatories of Maragha and Samarkand, and were substantially the same as the instruments used by European astronomers until the invention of the telescope.

The observatory at Maragha was founded by the famous mathematician Nasir al-Din al-Tusi in 1259, one year after the fall of Baghdad to the Mongols. Because the Mongol invasions into the lands of Islam had opened a land route to China, Muslim astronomers were eventually able to work together with their Chinese counterparts.

The main theoretical work done at the observatory had to do with simplifying the Ptolemaic model and bringing it into line with the Aristotelian model, which postulated uniform circular orbits for the planets. Although they were often misguided, they made very important contributions; Ibn al-Shatir, for example, came up with models of the movement of the moon and of Mercury that are strikingly similar to those of Copernicus.

The observatory of Ulugh Beg at Samarkand, built between 1420 and 1437, (See *Aramco World*, January-February 1976; July-August 1984) was used to re-compute the positions of the stars in Ptolemy's catalog, and there is little doubt that the organization of this observatory and the instruments employed there influenced Tycho Brahe's observatories at Uraniborg and Stjerneborg.

Another observatory thought to have influenced Tycho Brahe was that proposed and built in Istanbul in the 16th century. In 1571 in Istanbul, Taqi al-Din Mohammed ibn Ma'ruf, a former judge from Egypt and author of several books on astronomy, was appointed head-astronomer of the Ottoman Empire and immediately proposed construction of an

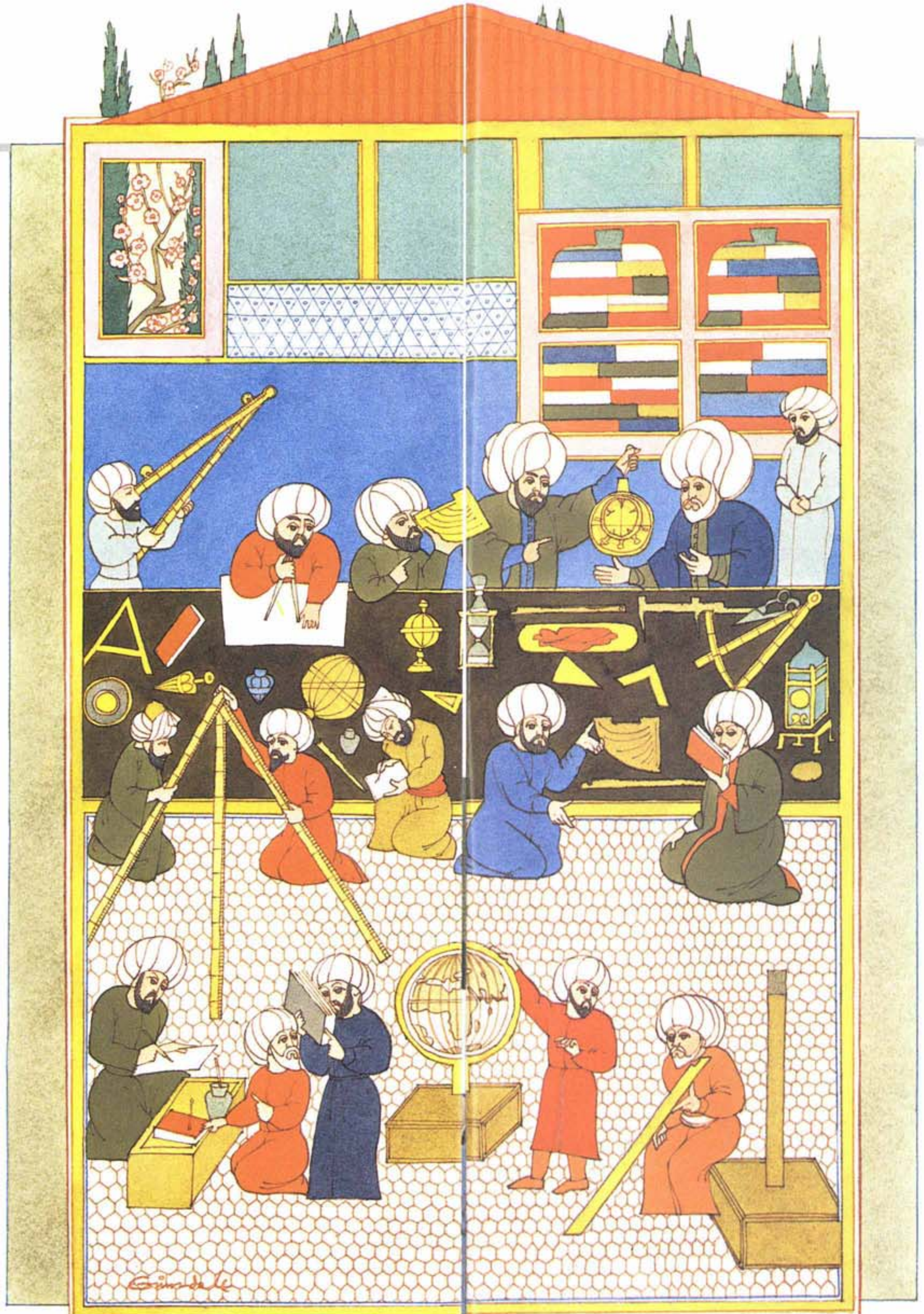


Illustration by Michael Grimsdale – After the Ālāta-i Rasaïya li Zij-i Shahinshâhîya manuscript /Topkapi Museum Library.

observatory. He wanted to begin the urgent task of updating the old astronomical tables describing the motion of the planets, the sun and the moon. His request was well received by the Grand Vizier and patron of sciences, Sokullu Muhammad, but between 1571 and 1574 the Ottomans had to fight no less than three costly wars against the three major powers of Europe, Venice, Spain and Portugal, so it was not until mid-1577 that the project was completed. Taqi al-Din's observatory consisted of two magnificent buildings, perched high on a hill overlooking the European section of Istanbul and offering an unobstructed view of the night sky. Much like a modern institution, the main building was reserved for the library and the living quarters of the technical staff, while the smaller building housed an impressive collection of instruments built by Taqi al-Din himself – including a giant armillary sphere and a mechanical clock for measuring the position and speed of the planets; aware that Europe was beginning to move ahead in astronomy he was determined to restore the Islamic world's once uncontested supremacy.

A few months later, unfortunately, on a cold November night – the first night of the holy month of Ramadan – a comet with an enormous tail unexpectedly edged into sight and set off a controversy that would put an end to his dream – and the observatory. Twisting and twirling, the comet grew brighter and steadier by the day for 40 days, and soon became a fireball soaring in the heavens like the sun and terrifying observers on earth.

One such observer was the Sultan, Murad III, whose own father, Sultan Selim, had died shortly after another comet had appeared. About to open a campaign in the Caucasus against Persia and its allies, Murad demanded a prognostication on the comet and Taqi al-Din, working day and night without food and rest, did so. He noted first that both the tail and head of the comet seemed to point east towards Persia – as if, he thought, to discharge their ominous fire there. He also noted that the comet appeared first in the house of Sagittarius, symbolizing, he decided, the Ottoman archer, and that it would disappear in Aquarius, a sign of peace and plenty awaiting the archer. Thus persuaded that such phenomena were undeniable signs of good fortune for the Ottomans, and confident in the accuracy of his observations in regard to the path of the comet, Taqi al-Din requested an audience with the Sultan and announced that:

There are joyful tidings for you
concerning the conquest of Persia, for the
foe is lying, with failing breath, upon the
ground.

The appearance of such a sublime flame
Is for this realm an indication of well-
being and splendor,

But for Persia it is a bolt of misfortune.

Unfortunately for Taqi al-Din, his predictions didn't quite turn out right. Though two Persian armies were defeated in the war, the Ottomans experienced certain reverses, a devastating plague broke out in some parts of the empire and several important persons died, and within a short period of time the Ottoman court began to quarrel about the observatory. One faction, headed by the Grand Vizier Sokullu, favored continued support of the institution, and the other, led by Sokullu's political rival, said that prying into the secrets of the future was not only beyond man's power but was also a waste of funds.

For a short period Sokullu prevailed and Taqi al-Din plunged into astronomy at a feverish pace for two years. But then Sokullu was killed and in 1580 a wrecking squad from the Marine Ordnance Division appeared on the premises, and its commander, citing the misfortunes that had befallen the Ottomans since the apparition of the comet, gave orders to level the buildings.

Another subject allied to astronomy that deeply interested Muslim scientists – and to which they made important contributions – was optics. Thus Newton's *Optics*, published in 1704, had a long history of experimentation behind it. Classical theories of vision held that sight was the result of rays emanated from the eyes, rather than the reflection of light from the object viewed. It was Ibn al-Haytham who broke with this classical theory and developed a theory, with mathematical proof, in accord with the facts. His work with the *camera obscura* and discovery of the mathematical principles behind the phenomenon of the rainbow were important steps in the development of optical instruments – though an explanation of the colors of the rainbow had to wait for Newton.

Other Muslim scientists also made important contributions to this subject, including the famous al-Biruni. One of the scientists connected with the Maragha observatory, Kamal al-Din al-Farisi, wrote an important commentary on Ibn al-Haytham's work on optics, in which he gives the results of a fascinating series of experiments with the *camera obscura*.

Men like these would have been fascinated at the idea of photographing the earth from outer space, and with the theories that make such achievements possible – theories that are in some cases based on observations they themselves originated. It is thus peculiarly fitting that an Arab Muslim should take part in a mission in the heavens that so interested and perplexed the scientists of the Middle Ages to whom we all owe so much. ⊕

Battle of Hastings, 1066

THE LONG HAIRED STAR

WRITTEN BY PAUL LUNDE – WITH REPORTS FROM RUSSELL H. McGUIRK AND JABER JUM'AH.
ILLUSTRATED BY NORMAN MacDONALD

In 1066, two widely separated men recorded a stunning celestial phenomenon, one a Muslim chronicler named Ibn al-Athir, the other an anonymous scribe in an English monastery. Ibn al-Athir's note read like this:

In the year A.H. 458 [A.D. 1066], during the middle of the month of Jumada II, a comet appeared just before dawn. It was white, and to the eye appeared to be 10 cubits long and one cubit wide [roughly 19 feet by two feet]. It remained visible until the middle of the month of Rajab [that is, for one month], then faded away.

The other chronicler, whose entries would be included in what was later called the *Anglo-Saxon Chronicles*, reported that King Edward had died, that Harold had succeeded him and that the Normans under William the Conqueror had invaded England – and won the Battle of Hastings. He also noted that a comet – called by some "the long-haired star" – had appeared in the skies six months before the Normans landed:

At that time, throughout all England, a portent such as men had never seen before was seen in the heavens. Some declared that the star was a comet, which some call "the long-haired star": it first appeared on the eve of the festival of Letania Major, *that is, on 24 April, and shone every night for a week.*

A century or so later, Ibn al-Jawzi, a Muslim historian, found a description of the same phenomenon – as seen from Baghdad:

On 10th Jumada I, a large comet appeared in the sky. It had a tail towards the east approximately three degrees in width and its tail was very long – reaching right to the zenith. It stayed until Sunday night of the last six days of the month. Then it came back on Tuesday evening at sunset with its light folded around it like the moon. People were terrified. As night darkened, it threw its tail towards the south, staying for 10 days before it faded. Later, merchants' books said that 26 ships headed for Oman sank near the coast on the last day the comet appeared. About 80,000 people perished along with all their belongings.

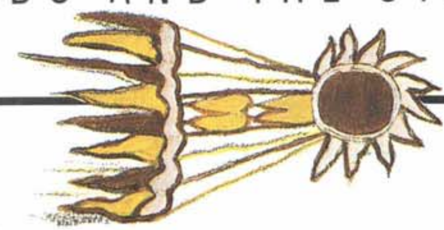
Galileo

That comet, though no one knew it then, was Halley's Comet, which, last July, edged into telescopic range again for the first time since May, 1910.

Halley's Comet (commonly pronounced "Hail'ee's but also "Hally's" as in "valleys" and, according to the *Times* of London, "Haul'ee's") is named after Edmund Halley, the 17th-18th century astronomer who first observed it, calculated its orbit and predicted almost precisely when it would appear again. It is also the most famous comet in history; big and brilliant, it is one of the few comets whose orbit periodically brings it into the range of the naked eye.

According to one British scientist, Halley's Comet was sighted as early as 164 B.C., and 87 B.C. in Babylon; both those sightings were recorded on recently deciphered Babylonian clay tablets. By the time it vanishes – again – in May, 1986, it will be the only comet in history to be thoroughly examined, measured and photographed – thanks to the exceptional advances made in astronomy since Galileo first trained his 4.4-centimeter lens (1¾ inches) on the moon in 1609.

As late as 1910, when the comet last appeared, 102-centimeter optical telescopes (40 inches) were the biggest available. But by the 1970's, the U.S.S.R. was building a 600-centimeter optical telescope (236 inches), radar was tracking the ionized-air trails of meteors, and radio telescopes with dish antennae were tracking the stars. Even more important, the United States, Europe and Soviet Russia have explored space, put men on the moon,



scattered satellites throughout space and instituted regular space shuttle flights, all of which have enabled astronomers to expand their studies of space – and comets.

On its current visit, consequently, Halley's Comet is being studied more closely than nearly any other celestial body in history. The United States, for example, will devote two space shuttle flights to observation of the comet and has four of the largest telescopes in the world trained on the comet from Hawaii. In addition, the Soviet Union has telescopes from 10 major observatories focused on it, Great Britain has set up a telescope in the Canary Islands and Europe has set up an observatory in Spain. And in 1986, the National Aeronautics and Space Administration (NASA) will send up a shuttle with a telescope mounted on it.

Europe, Russia and Japan, furthermore, have each sent up satellites, to probe the mysteries of space: the *Giotto* named after the painter who depicted the comet in a 1301 fresco on the walls of a church in Assisi, Italy, Vega 1 and 2 from Russia and Japan's Suisei and Sakigake.

The comet is also attracting excited attention throughout the world. In September, for example, the U.S. Naval Observatory in Washington installed a special telephone line to provide information on the comet – the "Halley Hotline" – and recorded more than 1,600 calls the first week. And thousands of people have booked cruises to the southern hemisphere where the comet will be visible in January and then again in March and April. In the United States, lines are scheduling comet cruises and the famous Cunard Line had booked some 2,500 passengers on three ships as early as November. Most of the ships plan to offer lectures by astronomers, ex-astronauts or science teachers.

In the north, British Airways is offering one hour comet flights over the North Atlantic and its first flight was fully booked in mid-November. Flying at an altitude of 11,000 meters (35,000 feet) – well above atmospheric haze and city lights – passengers were afforded the opportunity to enjoy a clear, unrivaled view of the comet's spectacular progress.

On the ground, amateur astronomers and others who purchased telescopes and binoculars for the occasion have been trying to spot the comet too, though, with the comet low on the horizon and dim, good sightings have been rare.

It's a far cry, obviously, from 1066, when even learned men, reflecting millennia-old fears, linked the appearance of the comet with the disasters that overwhelmed England that fateful year; then, and for a long time afterwards, comets were thought to presage the death of kings. As Shakespeare wrote:

When poor men die there are no comets seen;
The very heavens blaze forth the death of princes.

Those beliefs, in fact, endured for a long time: until the discoveries of Isaac Newton and Halley disclosed the true nature of comets and gave the *coup de grace* to the ideas of Aristotle that had blocked a rational approach to astronomy.

Aristotle believed that the earth was the center of the universe and that the planets – including the sun – revolved around the earth attached to very thin, transparent spheres. The last of these spheres, beyond Saturn, was the sphere of the fixed stars, those whose positions do not change with the passage of time. Everything that happens above the sphere of the moon is eternal and unchanging. Change – and transitory phenomena – all take place in the sublunar world, the area between the earth and moon.

Since comets appear and disappear, Aristotle said, they obviously could not exist in the unchanging translunar spheres; they must be phenomena like clouds, mists, lightning and other "corruptible" events of the sublunar world.

There are two other features of the Aristotelian system that influenced the ancient idea of comets. The first is that Aristotle's sublunar world was made up of four elements in varying proportion – earth, air, fire and water – but the translunar world was made up of a fifth, which he called "ether" – an unchanging substance. The heavens and celestial bodies were formed of it – hence their incorruptibility.

The second feature is that motion in the translunar world was circular and uniform, without beginning and without end, while in the sublunar world it was linear, had a beginning and end and was not perfect, that is to say, not uniform. Thus Aristotle's model elegantly explains everything: a stone falls in a straight line here in the sublunar world, while the planets circle the earth on fixed and immutable orbits.

Later thinkers, like Ptolemy, refined this system and adjusted it by increasingly complex mathematical explanations of observed phenomena – like the eccentricity of planetary orbits. But the basic model was not questioned until the time of Copernicus – in the late 15th and early 16th centuries – and was not *proved* to be wrong until the time of Newton and Halley.

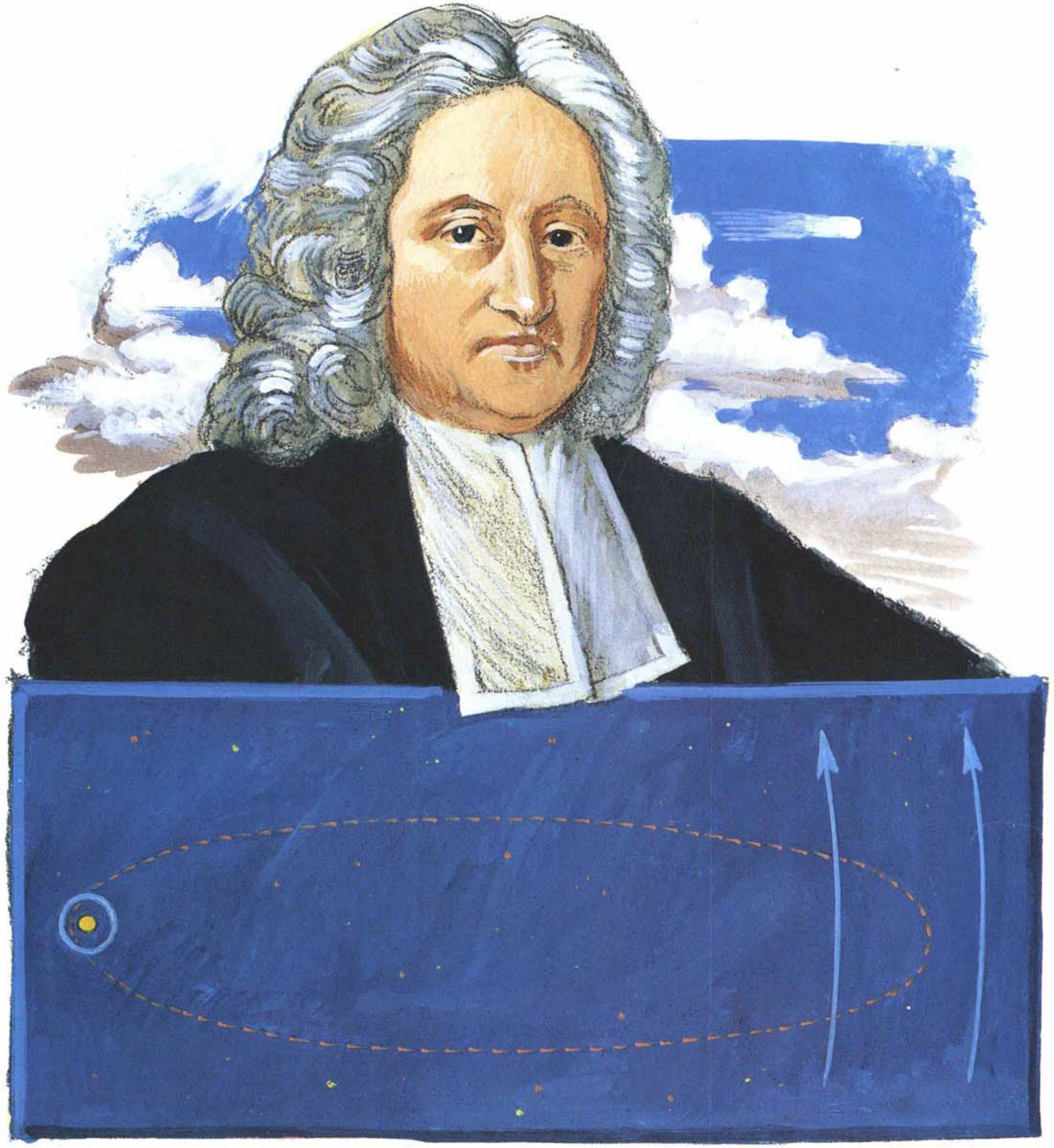
Comets, for Aristotle, were not astronomical objects at all, but meteorological, and were very close to the earth: in his sublunar world. They were formed under certain conditions, he thought, by accretions of hot air, which rise, and sometimes catch fire. Furthermore, he said, the frequent appearance of comets heralded dry, windy years – thus establishing an association between comets, weather and other natural events that increasingly came to grip men's imagination.

Because those ideas were accepted almost without question for 2,000 years, few scientific observations of comets were ever undertaken; if comets were transitory meteorological events, like clouds, the only point of observation was to predict good and bad harvests, epidemics – and other disasters.

Genghis Khan, for instance, is said to have taken the appearance of Halley's Comet in 1222 very seriously. Interpreting the first sighting as an ominous sign from his pagan gods, he halted his invasions of Eastern Asia and turned instead on the Muslim world to the west – bringing devastation and destruction.

Even the Muslim world, however, accepted Aristotle's belief that comets and disasters were somehow linked. In the early ninth century, for example, astrologers in the Abbasid Court in Baghdad warned Caliph al-Mu'tasim (795-842) *not* to go to war with the Byzantines in Asia Minor because of a bad portent: in 837

Cruise ship in southern hemisphere



Halley and the orbit of his comet

Halley's Comet had appeared again.

As it turned out, the caliph went to war anyway and won, in spite of his astrologers' warnings, and a Damascus-born poet, Abu Tammam, greatly moved by his leader's courage, wrote a famous poem about the battle and al-Mu'tasim's defiance of his astrologers.

The sword which can decide the outcome
of events is more reliable than books (of
astrology).

Truly the white sheets (swords), not the
black sheets (papers) are apt to clear all
doubts and uncertainties.

The true news is better told by the
glimmer of lances, not the seven planets.

They frightened the people (with omens
of) a horrible catastrophe that would
strike when the comet appeared from the
west.

They arranged the heterogeneous
constellations in accordance with their
whims.

They speak on behalf of the stars while the
stars move in their orbits or axes
unaware of their talks.

Hence their prophecy and the fabricated
tales could not stand the test of time.

In the Muslim world, as elsewhere, Aristotle's view was accepted widely even though Muslim astronomers made some important adjustments of detail. The popular 10th-century encyclopedia, *The Epistles of the Brethren of Purity*, for example, classifies comets along with atmospheric phenomena such as winds, thunder, lightning, snow, frost and rainbows. The encyclopedia also says that comets are composed of vapors that are condensed by the action of Saturn and Mercury and then become as transparent as crystals – which is why the sun's light can be seen through them. Furthermore, says the Epistles, comets turn with the heavens until they dissolve – and herald both good news and bad.

There *were* dissenters. Seneca, the Roman philosopher, for example, had given an amazingly modern account of comets in his *Natural Questions* as early as the first century:

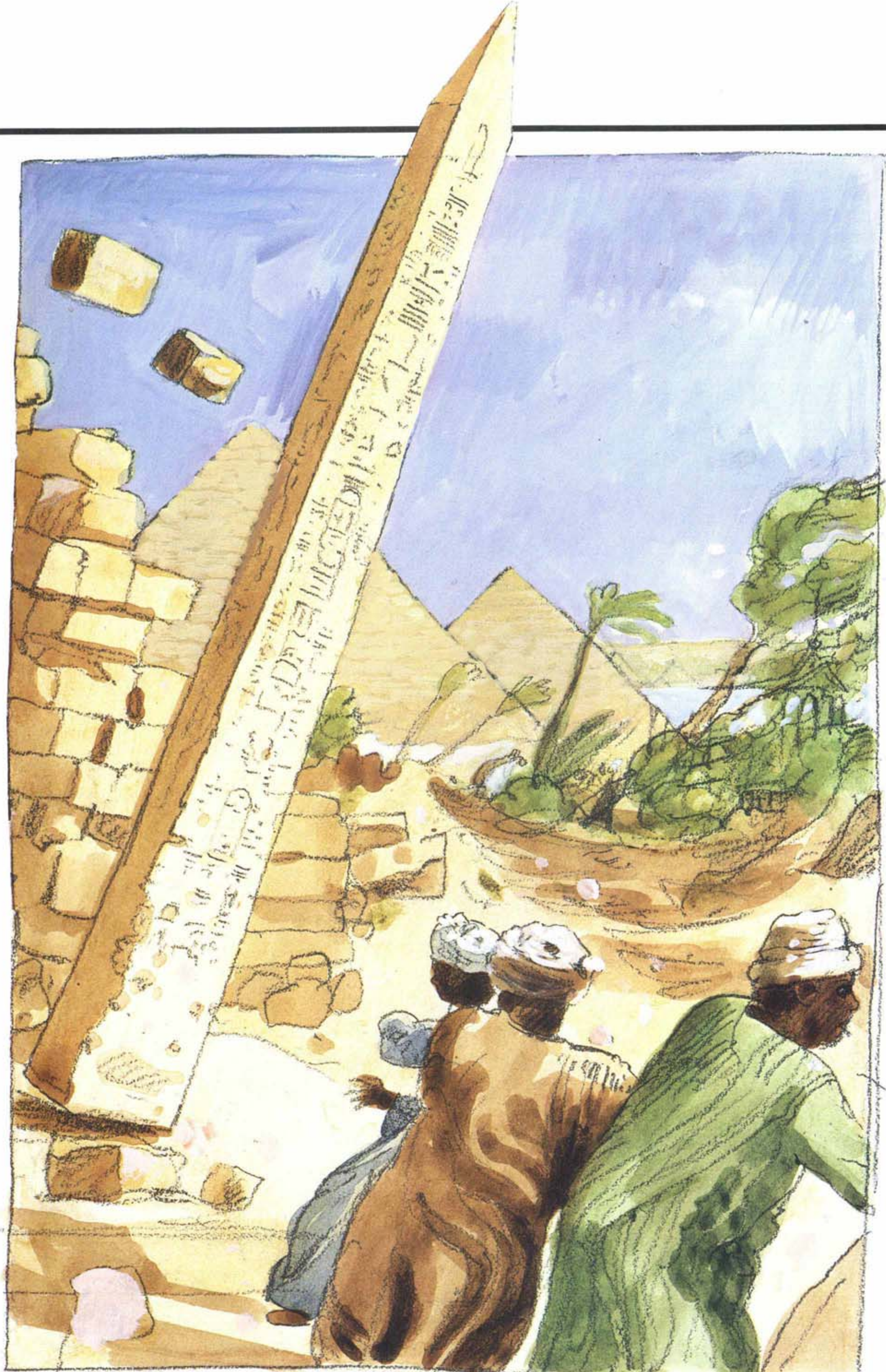
TWAIN'S COMET

For an amazing number of American writers, the Middle East was a source of delight and instruction. One was Edgar Allan Poe, another John Gardner (See Aramco World March- April, 1983; July-August, 1983) and, a surprising third, Mark Twain.

In 1867, Twain, set out to tour Europe and the Middle East, a trip that took him to Istanbul, Cairo, Beirut, Damascus and Palestine, which provided a rich source of inspiration. According to one writer, in fact, he was "carried away, infatuated and entranced" with the Alhambra, in what had been Islamic Spain, and with the "supernatural beauty of the Alcazar."

Such facts began to come to light in 1985, the 100th anniversary of his masterpiece – Huckleberry Finn *– and on the 150th anniversary of his birth and the 75th anniversary of his death, both of which have an eerie connection with the reappearance of Halley's Comet: Mark Twain, then Samuel Langhorn Clemens, was born November 30, 1835 just 13 days after Halley's Comet reached its 1835 perihelion, and died April 21, 1910 just two days after the comet returned.*

Twain, moreover, frequently predicted just that. "I came in with the comet and I shall go out with the comet," he said. And though many biographers thought this another example of his vivid imagination, an unpublished manuscript suggests that he took it somewhat more seriously. "How do you know when a comet has swum into system? Merely by your eye or your telescope – but I, I hear a brilliant stream of sound come winding through the firmament of majestic sounds and I know the splendid stranger is there without looking." – **Daniel Pawley**



Earthquake in Egypt

Do you really believe that in this immense and splendid universe, among the innumerable stars which adorn the night in diverse ways, without leaving the slightest part of the heavens empty or inactive, only five stars have the right to move freely and that the rest must all stay fixed, an immovable crowd? He who believes that those things which are most common are the only ones possible is ignorant of the power of nature. Comets are rarely seen because Nature has assigned them another place, other times, movements different from those of the other stars . . . Why, then, should you be so surprised that comets, a spectacle so rare, should be subject to fixed laws and that we should not know the beginning or the end of a journey whose return occurs only after long intervals of time?

This extraordinary passage – which clearly indicates that Seneca thought comets were astronomical rather than meteorological phenomena, and even more amazingly appears to indicate that he thought they followed periodic orbits – anticipated Edmund Halley by 1,640 years. Furthermore, it was immediately followed by an equally astonishing prediction: "There will come a time when a careful and centuries-long study will throw light on these natural phenomena."

But Seneca and other dissenting voices were ignored and Aristotle, rigorously logical if totally mistaken, reigned supreme in most of the West and East. One exception was China – and thus Chinese celestial observations helped uncover the truth about comets.

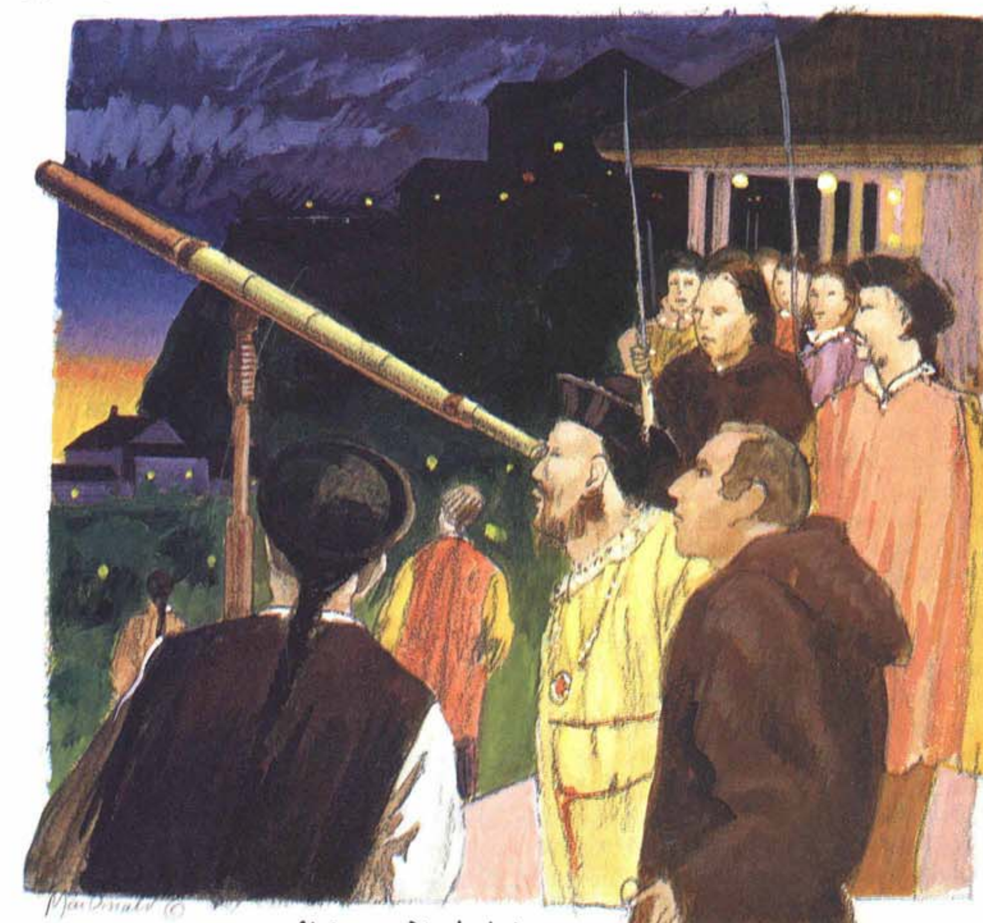
Since the Islamic world – geographical intermediary between the Latin west and China – had access during the early Middle Ages to the scientific heritage of Sassanid Persia and India, as well as Greece, at least one Muslim astronomer also questioned the Aristotelian dogma concerning comets. In 1602, for instance, a curious passage in *Astronomia Instauratae Progymnasmata* by Tycho Brahe, a famous Danish astronomer, credited an Arab with having been the *first* scientist to disprove Aristotle. Brahe said Abu al-Ma'shar observed comets in the translunar spheres; he was referring to the 10th-century Arab astronomers' personal observations of comets "beyond the sphere of Venus."

One of the difficulties in assessing the Muslim world's contribution to "cometology" is the fact that many key texts remain unpublished, and that many others have not survived. There is no doubt that Islamic astronomers *saw* Halley's Comet, but they knew little or nothing about its nature. Ibn al-Athir's sighting in 1066 is one example, and Ibn al-Nadim's 10th-century bibliography, the *Fihrist*, includes two monographs by the ninth-century astronomer and scientist al-Kindi on the appearance of what is surely Halley's Comet. The titles are: *The Star Which Appeared and Was Observed for Some Days, until it Disappeared* and *What Was Observed about the Great Sign during the year A.H. 222.* That year, Anno Hegira 222, is equivalent to A.D. 837, the year in which Halley's Comet appeared and Caliph al-Mu'tasim defied his astrologers and went to war against the Byzantines.

Muslim historians and annalists, however, recorded sightings of comets and, like their European counterparts, typically linked them to disasters. Al-Mas'udi, a 10th-century historian with more than a passing interest in science also spotted a comet in A.H. 299 (A.D. 912)

A great hailstorm, with stones weighing as much as a Baghdadi ritl, *afflicted Kufa at the same time as a heavy wind, in the month of Ramadan; many houses and buildings were knocked down. This sinister event was followed by an earthquake which cost the lives of a large number of inhabitants. These disasters took place in Kufa in 299 A.H. The same year saw an earthquake in Egypt and the appearance of a comet.*

This passage from the *Meadows of Gold* is typical of most notices in Arab histories, and is very similar to that in the *Anglo-Saxon Chronicles*. Although the comet he referred to was not Halley's, al-Mas'udi associated it with meteorological phenomena and with the earthquakes in Kufa and Egypt, just as Aristotle would have done.



China's first telescope

The value of such notes as those in *Meadows* – and the sighting by Ibn al-Athir – should not be underrated; modern astronomers have been able to derive important information by collecting and studying them. Even Halley, who was able to prove Newton's theory of universal gravitation by collecting information about the appearance of comets in the past, inferred the "negative acceleration" of the moon from a historical study of eclipses.

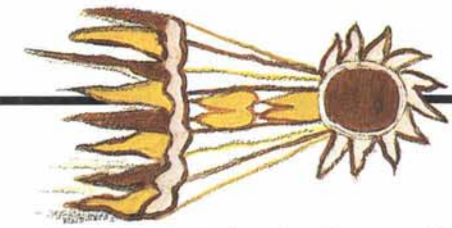
Modern scientists, furthermore, using the same method, but with access to Chinese, Babylonian and even Mayan records of eclipses, have been able to not only confirm his inference (that the moon is slowing down), but that the earth too is rotating about its axis more slowly than in the past. [Three hundred million years ago, the lunar month had 31 days. It now has 29.5. The moon, since classical times, has been decelerating, in relation to the earth, at the rate of six centimeters per year.]

The fact that the length of the day has not remained constant can be graphically seen if we consider that the total solar eclipse visible in Mesopotamia in 136 B.C. would have been seen in Europe if the rate of the earth's rotation had remained fixed.

Islamic records of eclipses, recording the exact times they occurred and where they were visible, have – when taken in conjunction with Chinese, Mayan and European observation – given scientists a very precise knowledge of when, where and at what time eclipses have occurred during the past millennium and a half.

Such observations have not only allowed scientists to draw the startling conclusions they have, but have proved of great use to historians. Since almost all ancient and medieval chronicles mention total – and sometimes even partial – solar and lunar eclipses, as well as the appearance of comets, they provide a sort of clock against which to check dates. Sometimes this is complicated by the fact that there was an understandable tendency in the past to link eclipses too with great events, such as the death of kings, wars, famines and epidemics. By using the precise tables compiled by scientists, historians can often sort out the chronological confusions of the past.

Since the shadow cast by the moon upon the earth during a total solar eclipse only covers an area of the earth 270 kilometers across (167 miles) and is only visible outside the region for a few hundred miles



on either side of the band – the record of such an eclipse can often help locate where a chronicle must have been composed, or at least where the chronicler was at the time.

Efforts are constantly being made to push further back into time – the earliest recorded eclipse seems to be 2095 B.C. Serious efforts are now being made to correlate eclipses, comets and ancient records of meteorological phenomena in hopes of discovering if there is a periodicity in the long run of cycles of plenty and famine, wet and dry periods. Islamic chronicles have much to contribute to these efforts, and as yet have been scarcely used.

Despite Aristotelian theories – they endured for centuries – European astronomers did make progress. In the 15th century, Toscanelli, a Florentine scientist, became the first European to make precise observations of comets; he observed five, between 1433 and 1472, marked their positions accurately and correctly drew them with their tails facing *away* from the sun. A German contemporary, Regiomontanus, observing the comet of 1472, suggested, but could not prove, that comets were celestial rather than sublunar phenomena. And in the 16th century, scientists noted again that the tails of comets *always* faced away from the sun – an observation that planted a seed of doubt; it implied a relationship between comets and the sun which Aristotle had ruled out.

But it was Tycho Brahe, in 1588, who was the first to prove that comets were not sublunar. In his book *De Mundi aetherei recentioribus phaenomenis Liber secundus, qui est de illustri stella caudata ab elapso fere triente Novembris anno MDLXXVII usque ad finem Januarii sequentis conspecta*, he showed that a luminous comet which appeared in 1577 – not Halley's – was at least six times farther away than the moon. Tycho Brahe, interestingly, had built an observatory in 1577, the year he saw the comet, and it was reportedly similar to that just opened by Taqi al-Din Muhammad ibn Ma'ruf in Istanbul: a main building with a library and quarters for the astronomers and a smaller building for the instruments. This was no coincidence; the Muslim influence in the study of astronomy was so strong in 16th-century Europe that Brahe placed a portrait of al-Battani next to that of Copernicus in his office at the observatory.

Even earlier, however, in 1543, the Polish astronomer Nicolaus Copernicus had published his revolutionary *De Revolutionibus Orbium Coelestium*, which placed the *sun* in the middle of the universe, with earth and the other planets orbiting around it. Next came Johannes Kepler, a disciple of Tycho Brahe, who showed that the orbits of the planets were ellipses and set down his famous three laws of planetary motion, which explained the form of planetary orbits, how they move along them and how the motion of the planets is related to their distance from the sun. But even Kepler could not explain why those laws should obtain. This was left to Sir Isaac Newton, one of the greatest scientists in history, and, indirectly, Newton's friend Edmund Halley who not only pushed Newton to publish his findings – he paid publishing costs himself – but predicted the great comet whose reappearance would prove Newton's theories.

It is a disturbing thought that without Halley, Newton might not have published a work which explains basic principles of the universe. Born in 1656, Halley had been interested in astronomy, since he was 16, at which age he went up to Oxford, "well versed in Latin, Greek, and Hebrew," according to John Aubrey. A geographer as well as an astronomer, Halley explored the Atlantic and penetrated the Antarctic before he was appointed Royal Astronomer in 1720. Halley went on to describe the system of trade winds and monsoons, and discover the Law of Inverse Squares.

Halley's contributions to science, however, must also include his financing the publication of Newton's epoch-making *Philosophiae Naturalis Principia Mathematica* in 1687, in which Newton explained Kepler's three laws and stated the principal force at work in the universe: gravity.

As early as 1666, Newton, reflecting on Kepler's Third Law – that the farther planets are from the sun the more slowly they move in their orbits – deduced "that the forces which maintain the planets in their orbits must vary as the inverse of the squares of the distance from the centers around which they move." At the same time, he found that the force necessary to hold the moon in its orbit was the same as the force of gravity on the surface of the earth – ideas elaborated in the *Principia*, as the Law of Universal Gravitation: "two bodies, with mass respectively m_1 and m_2 attract one another with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance r that separates them."

Even Newton, however, could not apply this outside the solar system. Did the same law operate outside it, throughout the universe? The answer, of course, was yes, and the proof was Halley's Comet.

In the *Principia*, Newton stated that comets were *beyond* the moon, and showed how three precise observations of a comet in different positions could be used to describe its orbit, which could be parabolic, hyperbolic or elliptic. In the first two cases, the curve followed by the comet is open, and the comet passes through our solar system never to return. In the latter case, when the orbit is elliptical – that is, closed – the comet will return. Newton also made a number of deductions about the physical properties of comets which still hold good: that the heads were solid and durable and surrounded by their own atmosphere, that the tails were made up of gases, were always opposed to the sun and shone because they reflected sunlight.

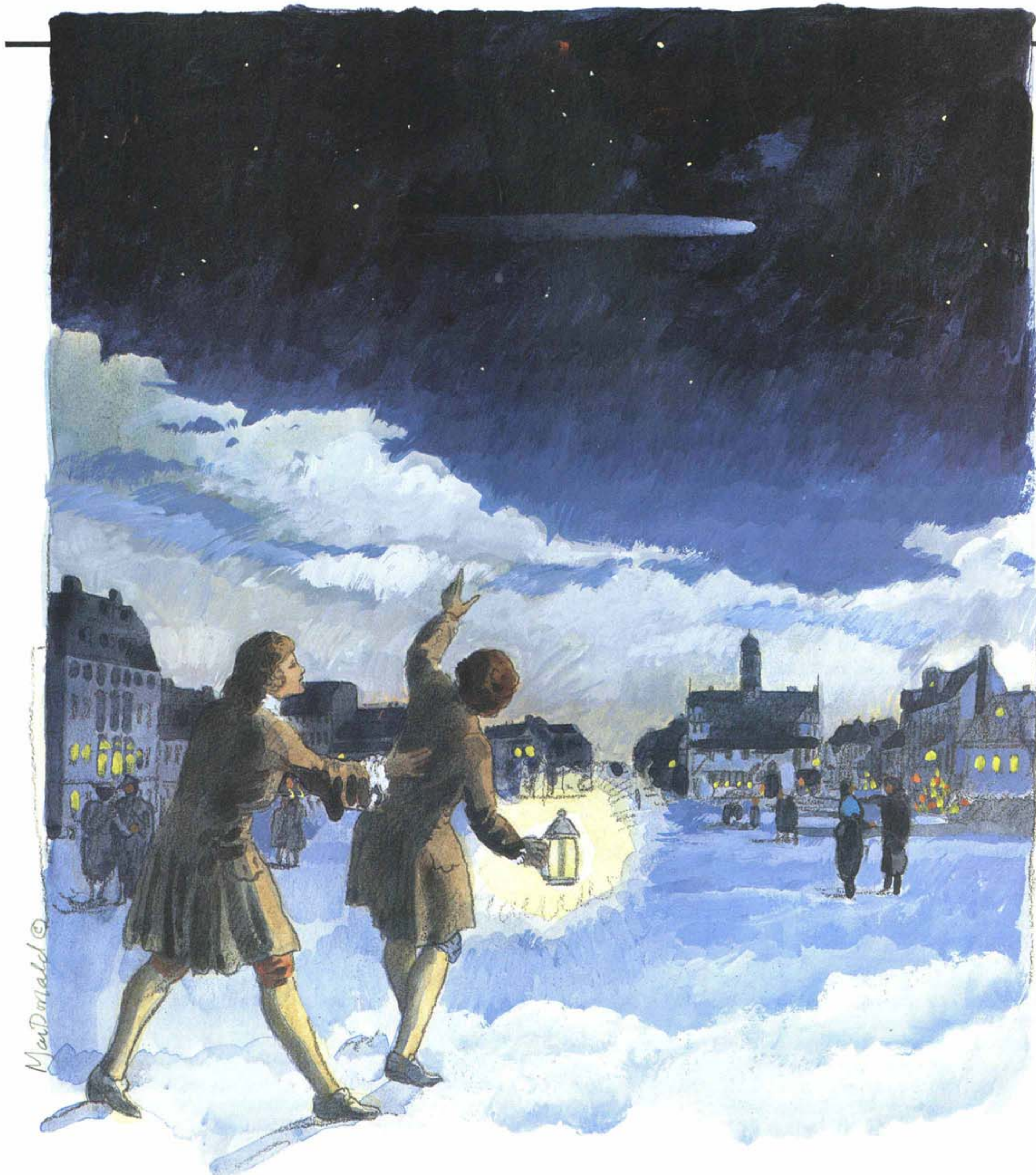
Modern observations have added considerable detail to Newton's deductions. In the 1950's, for example, F.L. Whipple proposed the "dirty iceberg" theory: that when comets were far from the sun they were composed of solid blocks of frozen gases, plus such meteoric material as metals, silicons, oxides and carbon particles. As the comet nears the sun, and the "iceberg" defrosts, the gases and meteoric materials form the "coma" – which are then diffused by the "solar wind," and form the tail of the comet. On September 11, 1985 this theory was apparently reconfirmed when a spacecraft flew through the tail of another comet: the Giacobini-Zinner comet 71.2 million kilometers from earth (44 million miles.)

These gases, which, with dust, glow in sunlight, make up the great fiery tails of the comets that once terrified ancient peoples. In 1910, for example, the tail of Halley's Comet was 100 million kilometers long (60 million miles).

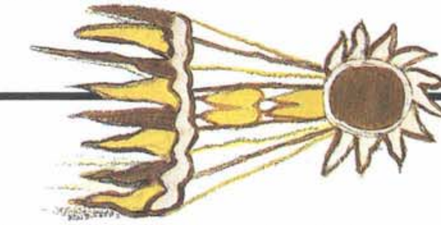
It would have been impossible to prove Newton's theory, however, if he had not also provided the means to calculate com-

Newton

etary orbits. Realizing that the physical appearance of comets – their size, brilliance, length of tail – was not adequate to identify them, Newton showed that each comet, like each planet, has its particular orbit, and that its orbit, not its physical appearance, identifies it, and that the orbit can be determined if six things are known: (1) the inclination of the comet's orbit with respect to that of the earth; (2) the orientation of the "nodes" – the two places where the comet's orbit intersects that of the earth; (3) the longitude of the "perihelion," the point at which the comet is closest to the sun; (4) its eccentricity; (5) the major semi-axis of the orbit; and (6) the time at which the comet passes the perihelion. In addition to these, the velocity of the planet or comet must be known. Thus notes like that in *Anglo-Saxon Chronicles* or in al-Mas'udi's work are not enough to identify a comet; astonomers must have precise information and in the pre-Newtonian era, the only people in the world who could provide this sort of detailed information about comets were the Chinese.



Dresden sighting, 1758



Because the Chinese believed that celestial and meteorological events were warnings to the emperor, China had official astronomers attached to the court for 2,000 years: from 200 B.C. to 1912. Since their task was to record the smallest changes in the heavens, the imperial observatory was supplied with instruments to measure the positions of the planets and the stars, and nightly observations were recorded each morning in a log book. Furthermore, five mathematicians spent every night looking at the heavens – one at the zenith, the others at the four quadrants – noting changes in the direction of the winds, rain, eclipses, meteors, conjunctions of planets, and, of course, comets. Thus, unhampered by Aristotle, China recorded *all* celestial events – data that would prove invaluable to later researchers.

In 1623, two Jesuits, one a former student of Galileo named G. Schreck, arrived in Peking with the first telescope seen in China, as well as news of the recent discoveries in Europe by Kepler and Copernicus. Their success in predicting an eclipse in 1629 – discomfiting the Arab and Chinese astronomers at the Ming court – led to a close relationship between European and Chinese scientists and in 1759, another Jesuit sent a translation of Chinese sightings of comets to the Royal Observatory in Paris, observations which eventually helped Europeans trace former appearances of Halley's Comet back to 240 B.C.

That same year – 1759 – was the year in which Halley had predicted the comet sighted in 1682 would return, if Newton's theory on orbits and his own calculations were correct. This comet, he had also said, was the same comet sighted by Apiano in 1537 and by Kepler in 1607.

Since Halley's prediction, scholars all over Europe had busied themselves trying to predict the *exact* date that the comet would appear in 1759 – and trying to establish the dates of previous sightings so that the periodicity of the comet could be established. With the help of the dates from China, they decided that it would not be exactly 76-year periods between visits – and that proved to be correct. The period between that comet's appearance in 1531 and 1607 was 76 years and 2 months, while that between 1607 and 1682 was 74 years and 11 months.

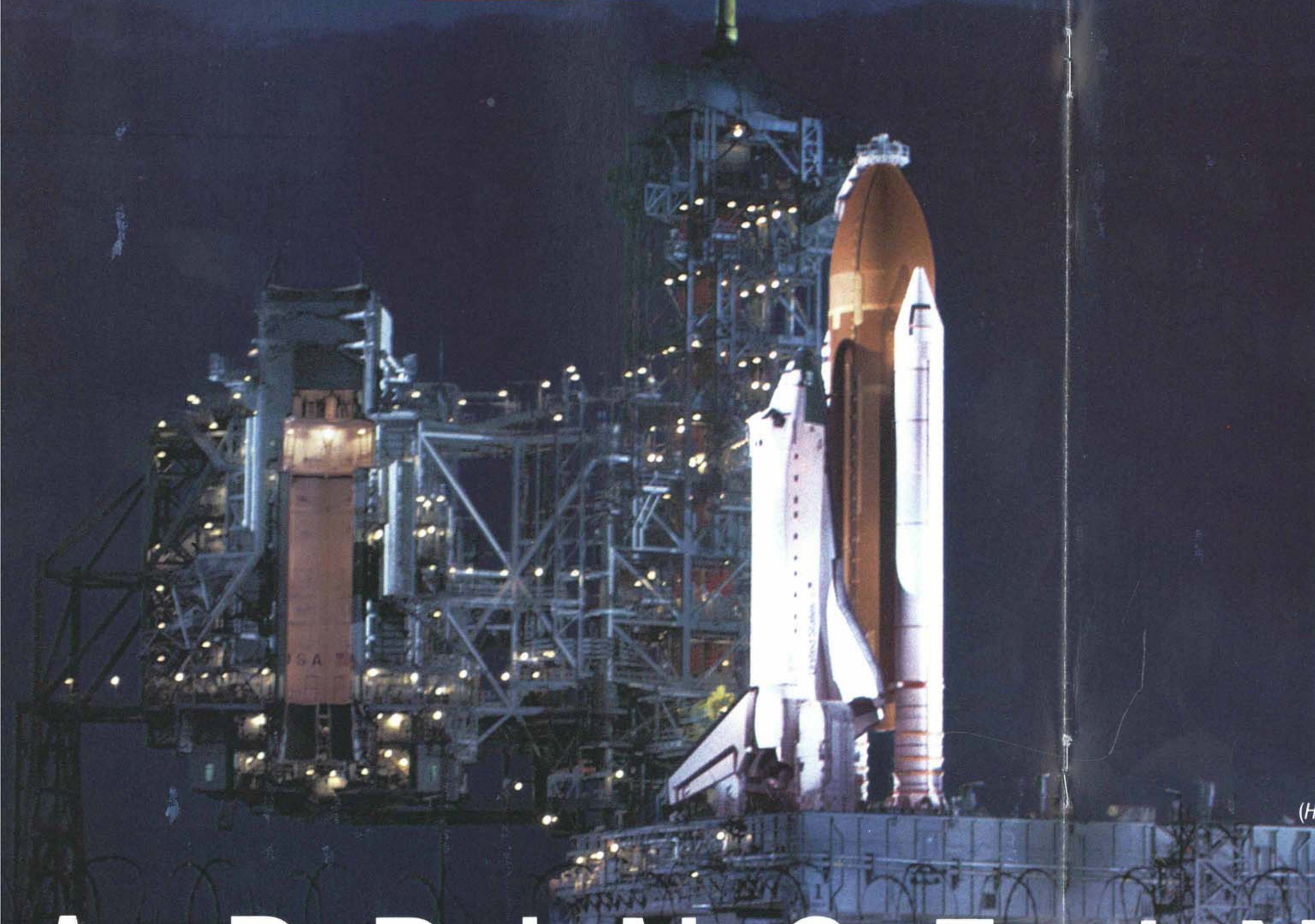
It even came earlier than Halley predicted: on Christmas night, 1758, a farmer and amateur astronomer named Palitzsch, who lived near Dresden, sighted the long-awaited comet. But the sighting nevertheless fulfilled Halley's prediction and conclusively proved Newton's law of Universal Gravitation.

Since then, the comet has been seen in 1835, 1910 and is visible right now as 1986 gets underway, having reached its aphelion in 1948 – the point when it was farthest from the sun after the 1910 visit – and having begun to return at an initial speed of 910 meters (2,985 feet) per second.

In its 1910 appearance, interestingly enough, the ideas of Aristotle seemed to emerge again: in the American South, pills were sold against its evil effects, in Russia special masses were celebrated to protect the people and in Italy bottled air was sold to protect people against the evil miasma the comet was thought to bring in its wake. Some people, terrified by the comet's approach, spent 1910 in caves, mines and underground tunnels, and even some scientists were concerned. One French astronomer, Camille Flammarion, warned that the comet's tail of "poisonous gas" could wipe out life on earth.

This year there is another link with Aristotle. As part of the world's massive welcome, Fred Hoyle and Chandra Wickramasinghe, two of Britain's leading astronomers, hope to test their theory on the origins of life: both believe that life originated in outer space and came to earth as microorganisms that bombarded the earth in the wake of comets – causing, over millions of years, evolutionary changes not explained by Darwin's theory. It is interesting – and probably would have amused Aristotle – that Wickramasinghe arrived at that theory by studying influenza epidemics; he thinks they are caused by microorganisms from outer space. Maybe Aristotle and the learned men of the Middle Ages were not so wrong after all.

Sightings in 1986



B. MOODY

A PRINCE IN SPACE

From the time that the roar of rocket engines rumbled across the lagoons of Florida's Atlantic coast to the almost flawless touchdown at Edwards Air Base in California, Mission 51-G was what one American space agency official called "one of the most successful missions" in the space program. "It was a fantastic flight," said Shuttle Director Jesse W. Moore, "One hundred per cent of the objectives were accomplished. I take my hat off to the crew." The crew in fact *was* special – it included astronauts of *three* nations, including Prince Sultan ibn Salman ibn 'Abd al-'Aziz Al Sa'ud of Saudi Arabia, the first Arab, the first Muslim and the first member of royalty in space.

NASA

Written by John Lawton (*Washington, D.C.; Houston, Texas*) with Patricia Moody (*Houston; Cape Canaveral, Florida*).
Photographed by: The National Aeronautics and Space Aministration, NASA, (*Houston; Cape Canaveral; Edwards Air Force Base, California, and in Space*), Burnett H. Moody (*Houston; Cape Canaveral*), Aerospatiale, and Worldwide Television News (*Houston; Cape Canaveral; Edwards AFB*).

ARABS AND THE STARS

Prince Sultan, French scientist Patrick Baudry, and Americans Daniel Brandenstein, commander; John Creighton, pilot; John Fabian, mission specialist, Steven Nagel, the 100th American in space, and Shannon Lucid, the sixth woman in space, worked hard for Moore's praise. They launched three communications satellites – including one for the Arab Satellite Communications organization (Arabsat) – deployed and retrieved a scientific platform to probe the Milky Way, and their space ship served as the target for a laser in the first "Star Wars" space shuttle test.

In addition, Prince Sultan carried out a series of in-cabin experiments designed by Saudi scientists, talked to his uncle, King Fahd, by telephone from space, gave a guided tour of the space shuttle's interior in Arabic, which was beamed back to Arab television viewers on earth, and also found time to pray and to read the Koran.

There were *some* bad moments: when lightning hit the launch pad the night before blast-off, and when instruments indicated that one of the Arab satellite's long solar wings had extended before launch. The Cape Canaveral storm caused no damage, however, and after a perfect lift-off on June 17, the winged spacecraft roared into orbit through a near-cloudless Florida sky, cheered and applauded by about 230 Arab guests of the National Aeronautics and Space Administration (NASA), including 29 Saudi princes – four of them brothers of Prince Sultan; Dr. 'Ali al-Mashat, director general of Arabsat, and Muhammad al-Onsur, Morocco's minister of communications. Also present at the launch was Gene Roddenberry, creator of the science-fiction series *Star Trek*.

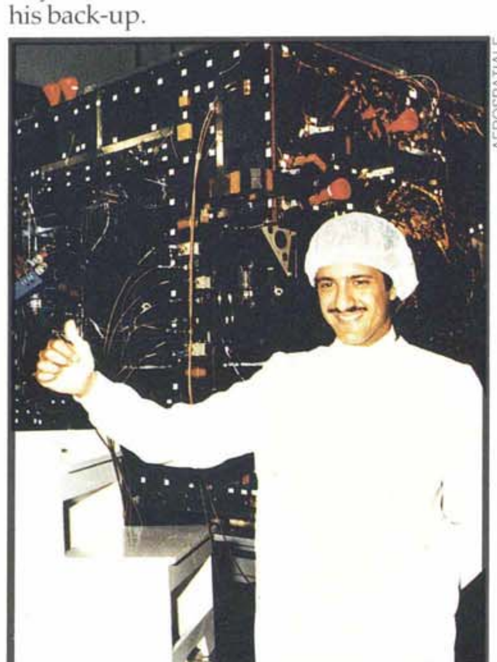
One day later – after a probe by a TV camera mounted on a movable arm showed its solar wing in place – the Arab satellite, Arabsat-B, *was* deployed in space: 35,900 kilometers (22,300 miles) above the equator. "A very, very good job," said Prince Sultan as Arabsat-B – an in-orbit backup for the first Arab communication satellite, Arabsat-A, launched by a French Ariane rocket in February (see *Aramco World*, March-April 1985) – spun out of *Discovery*'s cargo bay.

"My job now," the prince, an official at the Saudi Ministry of Information, told *Aramco World* later, "is utilizing the satellite to its maximum." This includes intra-Arab telecasts, telephone and telex calls, news and date exchange and community TV.

Prince Sultan, a 28-year old graduate of the University of Denver – with a degree in mass communications – and a trained pilot, was picked to be the first Arab in space after a search of several months. Because the Arabsat organization was to have its second satellite launched by NASA during the June flight, its 22 member countries were permitted to select a payload specialist to travel aboard *Discovery*, and Saudi Arabia won the slot.

Lacking the usual 12-month time frame for training, it was necessary to limit the search to candidates who were qualified pilots, who spoke fluent English and who were in exceptionally good health. Eventually, therefore, the list of candidates was narrowed to 20 men, then four and finally three.

NASA, however, could accept only two – the primary payload specialist and a back-up who would be trained to take over should the primary astronaut have to drop out of the mission. Prince Sultan was named the primary payload specialist and Major 'Abd al-Mohsin Hammad al-Bassam, a 36-year old instructor in the Royal Saudi Air Force, was selected to be his back-up.



AEROSPATIALE

Above: Prince Sultan at Aerospatiale plant in France. At right: the space shuttle Discovery *heads for space.*

Payload specialists are not involved in the launch or operation of the space shuttle; they begin to function only when the spacecraft commences its orbit around the earth. Nonetheless, their training schedule is intense.

Arriving in the United States on April 1, Prince Sultan and Major al-Bassam began the 114 hours of what NASA calls "habitability" training, or – in layman's language – learning to adapt to the routines of daily life in a space shuttle.

Initial tasks at the Johnson Space Center in Houston covered such ordinary, down-to-earth chores as choosing what clothing – selected from NASA's list of possibilities – and what food – again from NASA's proposed menu – they would desire while aloft. For the launch and landing procedures, light blue jumpsuits, decorated with various mission-related patches, were required, but once the shuttle reached orbit, the astronauts were free to wear whatever suited their individual taste. Obviously the Saudi national dress – the flowing *thawb* and *ghutra* – is not appropriate in zero gravity, but one traditional food of Saudi Arabia was stowed in the fresh food locker aboard the orbiter and consumed by the Arab astronaut: dates from Medina.

Generally speaking, Prince Sultan and the other astronauts on the mission ate foods that they themselves selected, before departure, from NASA's space shuttle menu; these foods were then color-coded with each astronaut's assigned color and packed for each day's meal. But in another first, Mission 51-G included gourmet foods for five of the 20 meals eaten in space by Prince Sultan. Patrick Baudry picked jugged hare, lobster, crab mousse and French chocolate pudding.

The astronauts also had to learn to handle general housekeeping chores in the confines of the crew's compartment – prompting Prince Sultan to describe the voyage as "a high-tech camping trip."

Prince Sultan also mastered three scientific experiments and two remote observation tasks that he later undertook during the mission; these experiments and the training of the specialists in the procedures were the responsibility of the Arabsat Scientific Experiments Team led by Dr. Abdallah Dabbagh, director of the Research Institute of the University of Petroleum and Minerals (UPM) in Dhahran, Saudi Arabia.

B. MOODY

Of the three scientific experiments performed by Prince Sultan, the most complex was an Ionized Gas Experiment designed by another member of the Saudi Royal Family, Prince Turki ibn Sa'ud ibn Muhammad Al Sa'ud, as part of his Ph.D. dissertation at Stanford University.

The purpose of this experiment was to obtain measurements which might help explain the extent of the chemical combination of the atoms of gas discharged from rocket engines with the atoms composing the earth's ionosphere – 50 to 1,000 kilometers up (30 to 620 miles). Though most scientists believe rocket-exhaust gases do *not* combine with ionospheric gases, some have noticed recently that there are ions and electrons in proximity to space vehicles as a result of the ignition of rocket engines.

To record the experiment, Prince Sultan used the shuttle's television cameras, which register changes in the gases discharged by the engines, such as temperature change, structure of chemical makeup, the mechanism of gas diffusion and the time required for dissipation; this was done by augmenting the strength of the television signals which will be interpreted with the help of computers.

The experiment was divided into five parts. In four of them, six television cameras were mounted on the shuttle's exterior, and in the fifth, a 70-mm still camera installed on the shuttle cabin's front window was used; thus it was possible to observe the *three* positions and the combination of gases in areas close to and distant from the shuttle. Now, at UPM, Saudi scientists are developing a new mathematical model from the experimental data – with the help of computers – and hope to emerge with new information on the phenomenon of gas diffusion in space.

In the earth-observation task, Prince Sultan – using a modified Hasselblad 500 EL/M camera and 70-mm Ektachrome film – took photographs of the southwestern section of the Arabian Peninsula during 49 passes over the kingdom. In spite of a small dust storm that originated in Somalia, most of the photographs were of good quality and, when compared with earlier remote sensing data, are expected to define known mineralized areas for future exploration. The photographs can also be used to help develop a groundwater exploration program and ongoing research into sand movement in Saudi Arabia.

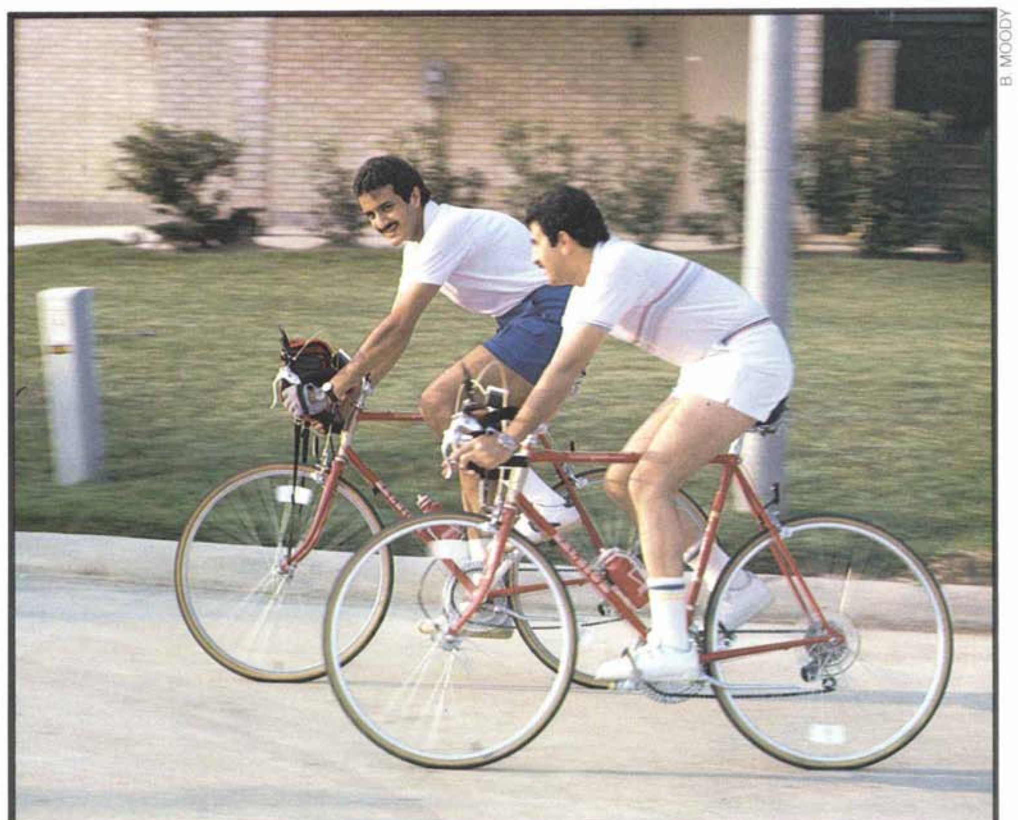
In another experiment, Prince Sultan had to follow a detailed list of 23 specific steps to record the behavior of oil and water when mixed in the zero gravity of space – this time using a 35-mm camera with a zoom lens. At Prince Sultan's request, Kuwaiti oil and Algerian oil were used as well as Saudi oil in this experiment. When the results are compared with similar experiments on earth, valuable information may be added to on going research into combatting oil spill pollution and into possible improvements in oil recovery techniques.

In another first, Prince Sultan sighted – and photographed – the new moon from *above* the earth rather than on it; this is important in Muslim life because the sighting of the new moon at the end of the Muslim month of Ramadan signals the end of the Ramadan dawn-to-dusk fast and the start of the joyous Id al-Fitr holiday.

The final experiment in which Prince Sultan was involved was actually initiated by the French. Originally performed by a French cosmonaut aboard the Soviet's Salyut-7 flight, this experiment was repeated by Patrick Baudry on Mission 51-G, when daily checks were carried out to measure the effects of weightlessness on the human body and its ability to adapt to the conditions of space.

Using biochemical electronic sensors, data, tape recorders, and a camera, Prince Sultan and Baudry tested each other's muscle tone, posture, vision, reflexes and spatial memory. One potential benefit from the experiment is a better understanding of the space adaptation syndrome – commonly known as motion sickness. In the past, this has affected nearly half of the astronauts sent into space, and victims usually display nausea, dizziness, and headaches.

"We are going to see some very good science come out of this," said NASA's Payload Integration Manager, Charles Chassay. "We look forward to them (the Saudi scientists) coming back in the future... many of the things they're doing, NASA is very interested in... and we are quite willing to work with them again."


B. MOODY

During training in Houston, Prince Sultan and Major al-Bassam combine exercise and pleasure by going bicycling.

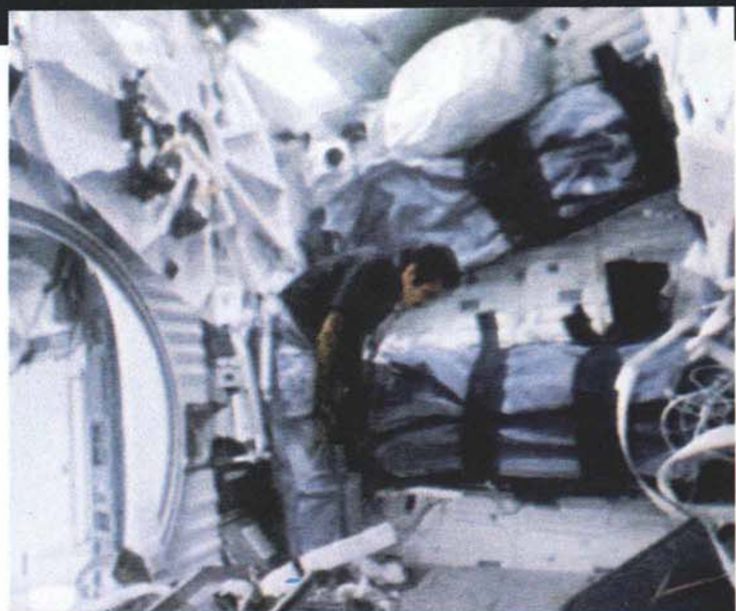

NASA
NASA

Above: Arab back-up astronaut Major al-Bassam, left, and right, Prince Sultan in training. Below (l to r): Commander Brandenstein, Sultan and Baudry at Johnson Space Center.

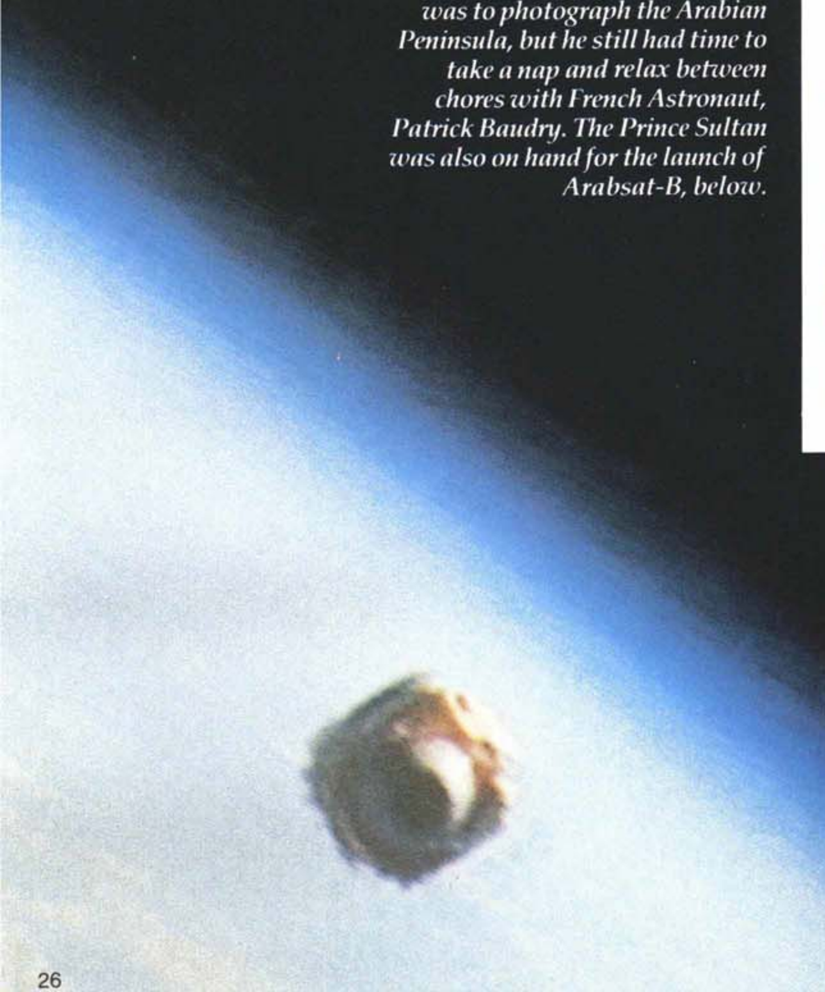
NASA

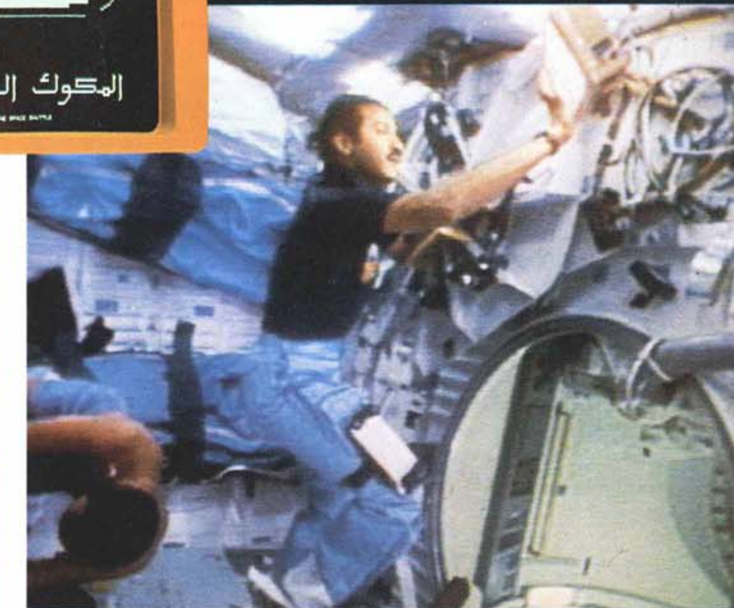
“You miss space most in space”

– *Prince Sultan*



In space (clockwise) Prince Sultan still observed the religious practices of Islam: he prayed regularly and also read the Koran. One of the Prince's scientific tasks was to photograph the Arabian Peninsula, but he still had time to take a nap and relax between chores with French Astronaut, Patrick Baudry. The Prince Sultan was also on hand for the launch of Arabsat-B, below.

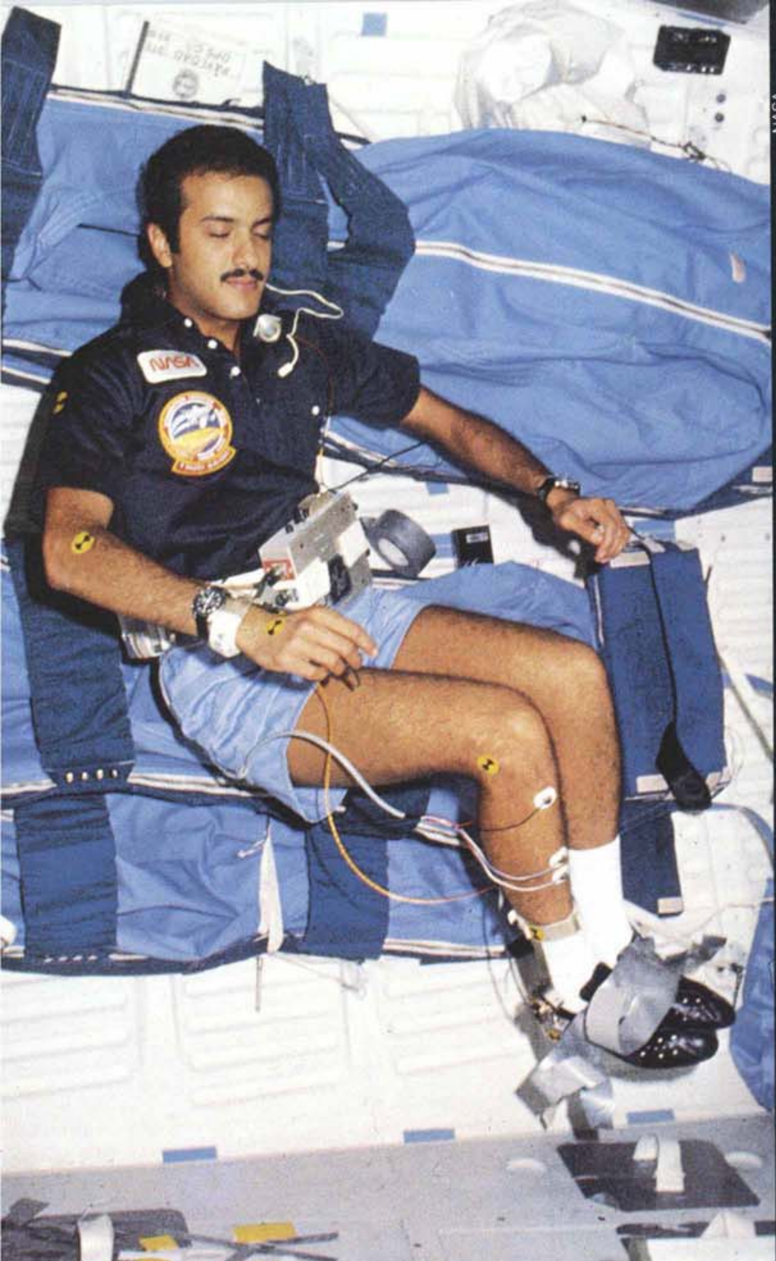


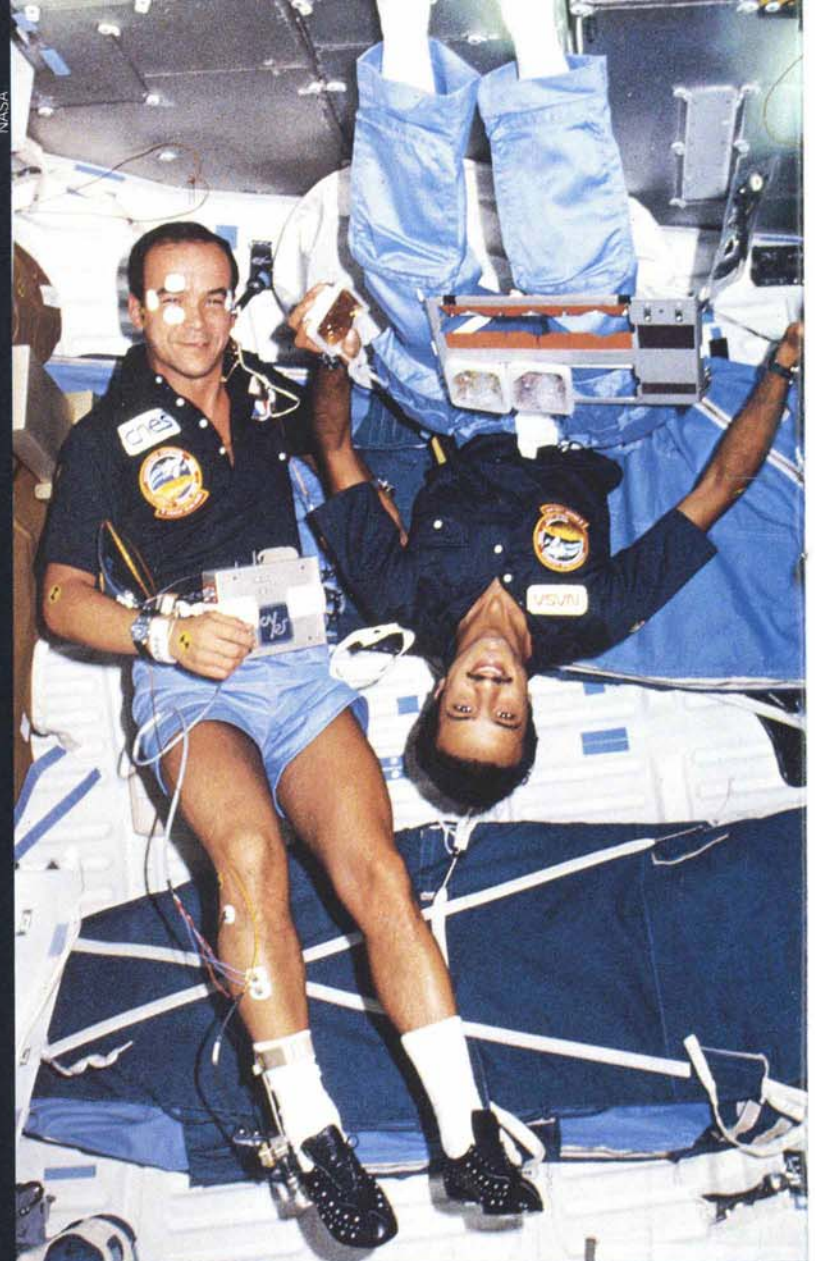


“It was a fantastic flight. One hundred percent of the objectives were accomplished. I take my hat off to the crew.”

– *Jesse W. Moore, (Shuttle Director, NASA)*

PHOTOGRAPHS FROM NASA IN FLIGHT FILM/REPRODUCED BY VIDEO GRAPHICS





NASA
NASA

Above left: Prince Sultan participated in a French experiment. Below: the Prince floats above the Discovery's flight deck. Above right: Prince Sultan eats during postural experiment.

NASA

ARABS AND THE STARS

Essentially the Saudi experiments were organized by Dr. Dabbagh's team: Dr. Mansour Nazer, Dr. Muhammad al-Suwayel and Dr. Hashim Yamani, assistant leaders; Dr. Zeni Saati and Dr. George Bucher, technical assistance/documentation; Dr. Nasser al-Homaid, Dr. Muhammad Tawfiq and Professor Abdulkadir al-Sari, investigators/earth observation; Dr. Adan Niazi, originator, investigator lunar crescent observation; Dr. Muhammad Z. al-Fi'r and Dr. Hamza Asar, investigator, phase separation experiment; Prince Turki ibn Sa'ud ibn Muhammad Al Sa'ud, originator, principal investigator, ionized gas experiment; Dr. Mohammad Budair, co-investigator, ionized gas experiment; Dr. Saad M. Al Rajih, Dr. Ali Abu Saleh, co-investigators/French posture experiment (FPE).

Working together, these men outlined the experiments, trained Prince Sultan and Major al-Bassam in the proper procedures and have subsequently been analyzing the findings in the kingdom's state-of-the-art laboratories.

These laboratories – particularly those at the Research Institute of UPM – have the sophisticated research equipment needed to analyze the data returned from Mission 51-G. One example is the Image Processing Center (IPC) of the Research Institute. In operation for three years, and the most sophisticated facility in the Arab world, it can process and analyze remote sensing data from aircraft, the space shuttle, and other satellites in orbit. The IPC has proven to be invaluable in such Research Institute projects as tracking oil spills, mineral and water exploration, agricultural monitoring, control.

The scientific experiments and observations carried out on Mission 51-G have a direct relation to ongoing research at the UPM and other universities in the Arab world. UPM Research Institute, for example is studying the movement of oil slicks, pollution, turbidity and fish communities in the Arabian Gulf and the Red Sea. Institute specialists are also studying the movement of sand and how to control that movement. Chemistry, physics and petroleum and engineering departments have also been involved in similar serious research.

For Arab scientists, with their proud memories of the Golden Age and the House of Wisdom (See *Aramco World*, May-June 1982), the opportunity of working at the leading edge of science is an exciting challenge.

"The Arab world," says Prince Sultan, "is at a turning point. We have gone through the phases of oil, money and early technological development. The new generation is looking forward to joining the rest of the world by obtaining the most important things in that turnaround: opportunity and education. Together they are the keys that open the door for our future. My space flight is just a crack in that door."

When the astronauts disembarked, after circling the earth 111 times on their 2.9-million-mile journey, Prince Sultan got a particularly warm welcome from his brothers, his backup astronaut Major al-Bassam and Dr. al-Mashat.

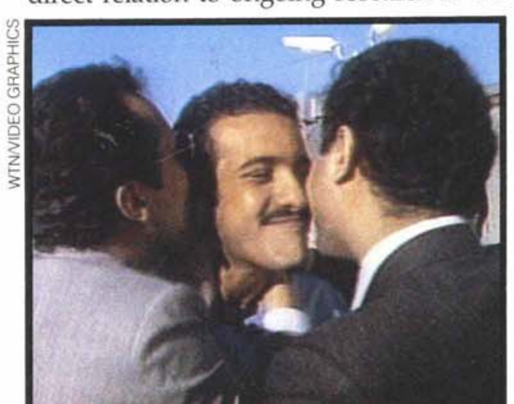
After a medical, Prince Sultan flew back to the Johnson Space Center, Texas, headquarters of Mission Control, where he told reporters that the highlights of his space flight were the blast-off from Cape Canaveral and the moment when, by passing out of the earth's atmosphere into space, he officially became an "astronaut."

Later, Prince Sultan told a television interviewer that another big moment was when he had first glimpsed Saudi Arabia from space. "Once," he said, "I was woken up by some crew members who said: 'Come and see your country.' I was looking from the upper deck window. The earth was above us, and I saw the Eastern Province with its lights. It was a very moving sight." But the "happiest moment," Sultan said "was coming back – reentering the earth's atmosphere. Whatever distance we travel away from earth, man always feels that this is his home, not space or anywhere else."

At the same interview, Prince Sultan praised the team of Saudi scientists, who had been monitoring his experiments from earth. "We don't lack talent in the Arab world. We have plenty of it," the prince said. "All we need to do is give people the chance to prove themselves." Prince Sultan also displayed the small Koran he had carried into space; inside was a prayer dictated by his mother asking God to take care of travelers – and the prince's Saudi pilot's licence. "I was saying the prayer during take off," said Sultan. "And the pilot's license?" he was asked. "I took that with me in case we had to land somewhere and I needed to hire an areoplane."

As it turned out, of course, this was not necessary; mission 51-G turned out to be one of the most trouble-free space flights to date. It also proved, said Shuttle Director Moore, a particularly important point: "30-35 countries participated in the mission – 22 of them Arab as part of Arabsat – demonstrating we can all work together for peaceful exploration of space."

WTN/VIDEO GRAPHICS



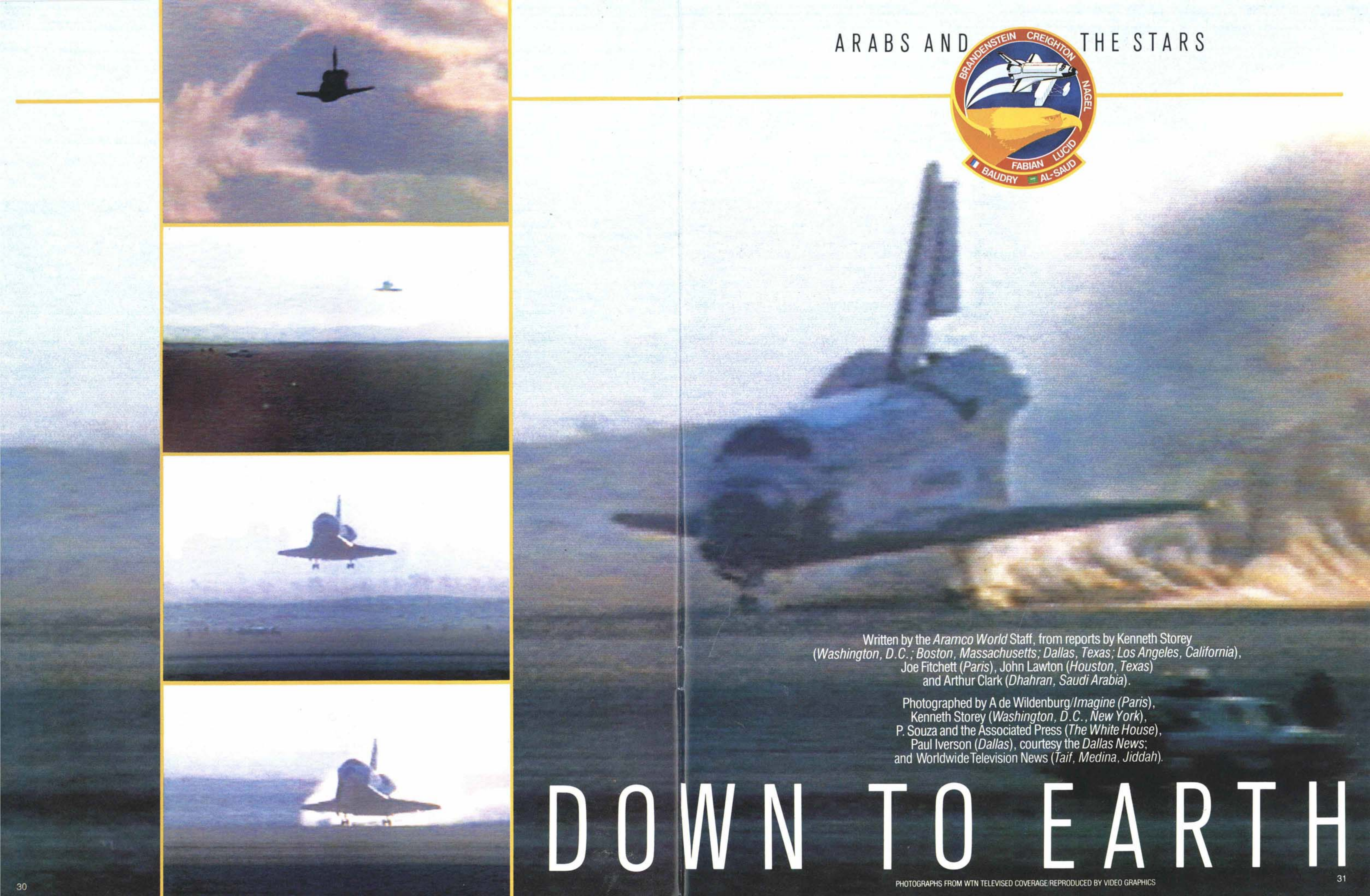
Saudi relatives give the prince warm welcome on return.

WTN/VIDEO GRAPHICS

Medical checkup shows space did no harm to Prince Sultan.

WTN/VIDEO GRAPHICS

In space, Prince Sultan read this beautiful Koran.



Written by the *Aramco World* Staff, from reports by Kenneth Storey (*Washington, D.C.; Boston, Massachusetts; Dallas, Texas; Los Angeles, California*), Joe Fitchett (*Paris*), John Lawton (*Houston, Texas*) and Arthur Clark (*Dhahran, Saudi Arabia*).

Photographed by A de Wildenburg/*Imagine (Paris)*, Kenneth Storey (*Washington, D.C., New York*), P. Souza and the Associated Press (*The White House*), Paul Iverson (*Dallas*), courtesy the *Dallas News*; and Worldwide Television News (*Taif, Medina, Jiddah*).

DOWN TO EARTH

PHOTOGRAPHS FROM WTN TELEVISED COVERAGE/REPRODUCED BY VIDEO GRAPHICS

ARABS AND THE STARS

Since Prince Sultan ibn Salman ibn'Abd al-'Aziz Al Sa'ud, the first Arab astronaut, returned to earth, swooping out of the darkness to a smooth dawn landing at Edwards Air Force Base in June, he has been lauded and applauded as few astronauts have been since the early days of exploration.

According to one reporter Prince Sultan won the instant regard of the media when he returned to Houston by heading straight for the press box immediately upon leaving the jet from California. "That was a good move," the reporter smiled. "He knew why we were there."

With his background in communications – he has a degree in that subject – His Royal Highness probably did realize that he was the star of Mission 51-G. If not, however, he soon found out as, in the next three months, he toured Europe and the United States, accepted medals and awards, met President Reagan and appeared on such nationwide television shows as CBS's *Morning News*.

When the Prince first returned to earth the National Aeronautics and Space Administration (NASA) immediately awarded him a Space Pioneering Medal and a Certificate of Merit. But it was in Saudi Arabia that the prince, a nephew of King Fahd and a grandson of King 'Abd al-'Aziz ibn Sa'ud, founder of the modern kingdom of Saudi Arabia, received what the Associated Press described as a "hero's welcome across the kingdom." This welcome, a seemingly endless series of "processions and motorcades, flying flags and festive decorations, singing and dancing, poetry reading, gifts, awards and commendations," as an embassy newsletter in Washington, D.C. described it, was not unlike the ticker-tape receptions accorded Lindbergh on his return to the U.S. after he flew the Atlantic nearly 60 years before.

At the airport in Taif, Prince Sultan was met by his uncle, the king, who awarded him the Order of King 'Abd al-'Aziz and announced his promotion to major in the Royal Air Force. From there he went on to Medina, to pray at the Prophet's Mosque; to the King Khalid Air Force Base near Abha in 'Asir Province; and to Riyadh – where his motorcade was welcomed by throngs of cheering people.

In addition to those honors, the Saudi government also issued two new stamps. One, a 20-*halala* stamp, shows the space shuttle, a satellite, a minaret and the official emblem of the Saudi government. The other, a 115-*halala* stamp, shows the shuttle on one side and a NASA emblem on the other, with the names of all the astronauts that went up in the *Discovery*.

The excitement began to build as soon as it was announced that a member of Saudi Arabia's royal family had been picked to be the first Arab in space – and reached staggering proportions between June 17 and June 24 when hours of live telecasting from the Cape Canaveral launch pad and Houston's Mission Control – plus daily Washington updates – kept millions of Arabs in the kingdom glued to their television sets. According to Worldwide Television News (WTN) an estimated 10 million people in the Gulf and Saudi Arabia were tuned in.

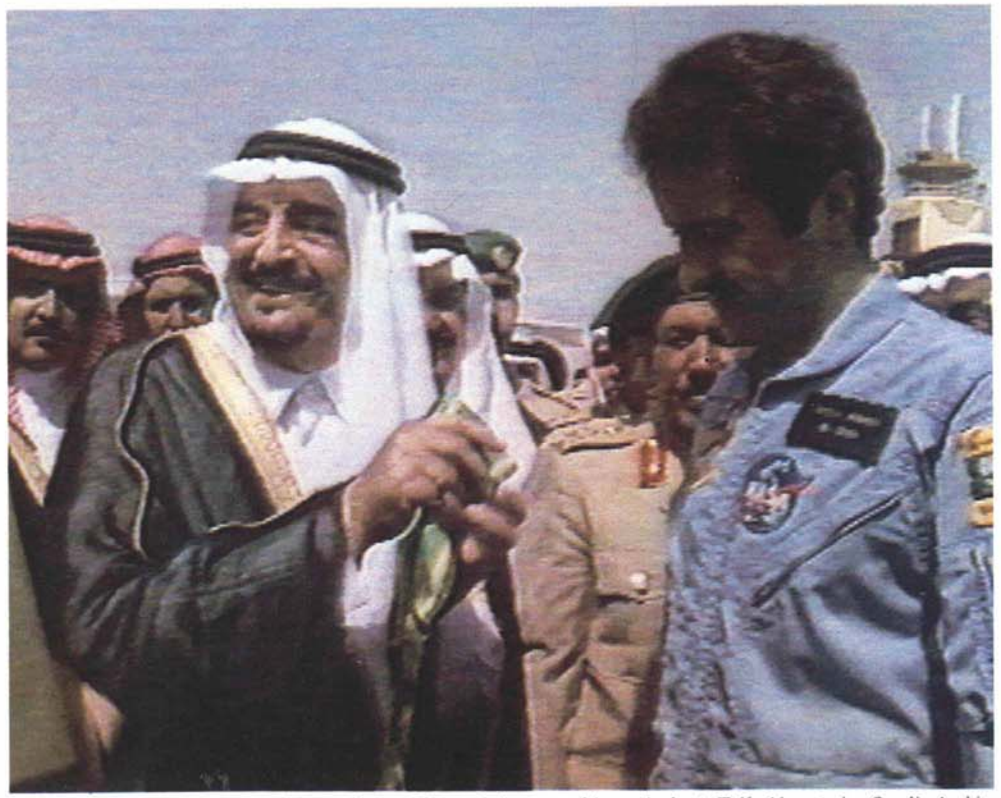
Interest was by no means limited to Saudi Arabia and the Gulf. Lured by the fact that a tall, darkly handsome jet pilot was to be the first Muslim in space, millions in Europe, Asia, Africa and Latin America eagerly followed the progress of Mission 51-G on television and in print. Even in the United States, where space flights have become almost routine, the presence of Prince Sultan on board the *Discovery* created fresh interest. ABC-Television, calling the prince the "real celebrity" of the flight, showed a film of him talking from space to his uncle King Fahd in Ryadh. And Sandy Gilmore of CBS, *USA Today*, America's nationwide daily newspaper, and the prestigious *New York Times* all responded with enthusiasm when he said, "Looking at it [the earth] from up here, the troubles all over the world and not just in the Middle East look very strange as you see the boundaries and the border lines disappearing."

Important international personalities echoed the TV commentators and newspaper columnists. In London, Jonathan Aitken, a British member of parliament, said the prince's involvement in the space program was a "historical step" forward for Saudi Arabia. In New York, Clovis Maksoud, Arab League ambassador to the United Nations, said: "The flight is a symbol of the resilience of our people . . . and the determination of the Arab people to cope with the latest scientific challenges." And in Cambridge, Massachusetts, Dr. Farouk El-Baz, the first Arab to participate in the American Space Program, (See *Aramco World* November, 1976), predicted that it would "cause a revolution in the thinking of the Arab youth." In the 1960's and 1970's, Dr. El-Baz, an Egyptian and now a vice-president with Itek Optical Systems, participated in site selection for the Apollo missions to the moon, and was in charge of astronaut training for orbital science and photography.

In Europe, in September, Prince Sultan, setting off on an international good will tour, attended a reception at the residence of U.S. Ambassador to France, Joe M. Roger – whose construction company had once done work in Saudi Arabia. The highlight of the visit to Paris, however, took place on a drizzly gray morning when he and five other astronauts – including France's astronaut on Mission 51-G, Patrick Baudry – were inducted into the prestigious Legion of Honor. Established by Napoleon, the legion's famous medal is the highest honor that France can bestow – and in a special gesture for the occasion, it was awarded to Prince Sultan and the other astronauts by Prime Minister Laurent Fabius personally.

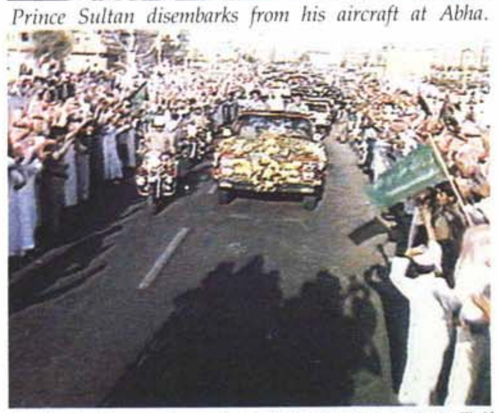
It was a colorful ceremony. With television lights glinting off the swords of an elegant French Honor Guard and picking out gold threads in tapestries at the Hotel Matignon, home of France's prime minister, an international cross section of diplomats, ministers, scientists and industrialists crowded into the 18th-century palace to see the astronauts – Prince Sultan, Baudry and the four Americans, Commander Dan Brandenstein, John Creighton, Job Fabian and Shannon Lucid, the sixth woman in space – and to hear Prime Minister Fabius appeal for peace in space. "If there is one domain where international cooperation should exist," he said, "it's space, because space is the future and we want it to be a peaceful one for mankind."

For the astronauts, the gathering in Paris was also a reunion and though they were



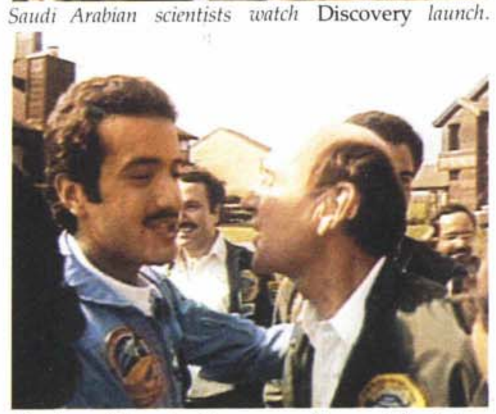
King Fahd warmly welcomes his nephew, Prince Sultan, on his arrival at Taif Airport in Saudi Arabia.

Prince Sultan disembarks from his aircraft at Abha.



Enthusiastic crowds applaud Prince's motorcade in Taif.

Saudi Arabian scientists watch Discovery *launch.*



Members of the scientific community greet the Prince.

Colorful postage stamps, top of page and above, issued by the Kingdom of Saudi Arabia to commemorate Mission 51-G of the space shuttle, Discovery, *and the presence on the mission of Prince Sultan.*

The Prince meets the press on return to Houston.

TV anchorman Issa Sabbagh, chats to the Prince in space.

PHOTOGRAPHS BY WTN/REPRODUCED BY VIDEO GRAPHICS

QUESTION TIME

WRITTEN BY KENNETH STOREY. PHOTOGRAPHED BY PAUL IVERSON

ARABS AND  THE STARS

One of the highlights of Prince Sultan's tour of the United States was a stop at the Science/ Engineering Magnet School in Dallas, Texas – "S/EMS" – a special school reserved for bright students in the Dallas Independent School District. At S/E a total of 136 students, from grades 9-12 in 17 high schools, spend a half day with eight top teachers at Magnet taking vigorous advanced courses in engineering, science and computerization.

After greetings from School Principal Helen Shafer and a tour of the school, Prince Sultan gave the students some personal background and showed a film of Mission 51-G – with the sound track turned off so that he could provide his own personal narration.

To the pupils at Magnet, this was particularly interesting since it permitted the prince to add information not in the film script. He told them, for example, that he had a small personal recorder with him, but when he tried to use it to record his emotions during the liftoff, the "G-force" was so strong he couldn't talk. Though he had experienced strong G-force before while flying jets – G-force is the pull of gravity – it was only for a few seconds: in the space shuttle it lasts up to three minutes during launch.

Prince Sultan went on to say that when they were in space launching the three payload satellites – one of them Arabsat-B, the second Arab space satellite – the whole shuttle jolts when the satellite is spring-ejected. "It's not a scary jolt," he said, "but you can feel it."

After the film, Prince Sultan agreed to accept some questions – and was immediately swamped with queries. Indeed, the question-and-answer session went on for an hour and could have gone on longer. The Prince's schedule, however, required that he go. First though, he told the kids to form a line and he patiently signed pictures of himself from press kits passed out to the students at the start of the program. It was, said one observer, "the sort of warm gesture that many people forget when they become famous. Prince Sultan did not forget and the kids of Dallas won't forget either."

What follows are excerpts:

Student: What are the different types of astronauts and what type are you?
Prince Sultan: O.K. You have four positions on the shuttle. The first one is the commander. Then the pilot, mission specialists and payload specialists. You also have observers, like Senator Garn. [U.S. Senator Jake Garn of Utah, who in April 1985 became the first senator to fly into space]. I was a payload specialist as was the French astronaut Patrick Baudry. I was a payload specialist because I accompanied our own satellite and NASA [permits] each payload to be accompanied by a payload specialist...

Usually a payload specialist is named about a year ahead of time... comes to NASA about six months ahead to work on crew training. And before they come to NASA they usually train in their country, with their experiments, satellite or whatever. But in our case, the selection program had to be done in three months. I was among many others, about 30 other people, and had to go through the committee selection program, the medicals and all of that. When I came to NASA I only had two and a half months to train, so we actually had to do double shifts... We had a lot of scientists with us, so I was working almost 16 hours a day for two and a half months. Usually a payload specialist trains about six months, a mission specialist, a commander or a pilot, a position like that, is usually longer: two years minimum of training and then even longer to wait for a mission. But of course the shuttle missions are becoming more frequent so perhaps they will get to go up sooner.

Student: What was it like during the take off?
Prince Sultan: It was almost more than I bargained for. I had trained very hard, but when you are going Mach 13 or 14 [13-14 times the speed of sound, approximately 10,000 miles an hour] you are accelerating about three times your weight. A pilot would know what that is like, but when you're doing it upside down, that is almost equivalent to four and a half, to six and a half... When I fly a jet, I... pull, sometimes, maybe nine G's, but this acceleration goes on for about two minutes. And... you can't change your mind about it.

Student: Do you hope to go up again?
Prince Sultan: I hope so.

Student: How long does it take to get used to the earth's gravity once you come back down?
Prince Sultan: That's a very good question. About a day and a half. The medical report on us when we came back was one of the better medical reports for all of the crews. But it's hard to get used to, because you are used to things floating. When I was getting my medical exam and had all those wires hooked up to me, I had a cup of water in my hand that I was holding out. A paper cup, thank heavens. I was talking to my father on the phone and I just let go of the cup and it fell right to the floor.

Student: Was it fun up in space being weightless?
Prince Sultan: It is a lot of fun, and I've always maintained they should send high school kids up in space so they could come up with some new tricks. But... it's not all fun and games. When you go up, you spend the first two, three days in misery. All the fluids in your body move up into your chest and head. Your back hurts, your head hurts. And I don't like to take pills so I just had to bear it.

Student: What's the worst part in space?
Prince Sultan: The worst part is sleeping. We slept well, we had eight hours of sleep every day, but no matter how you sleep in space, you don't relax. Expecially the first two days... Here, when you lie down on a bed you relax. But in zero-G [no gravity], no matter what position you take, it's the same, so your body doesn't feel any different from when you work and when you stop. So the best thing you can do, is find a corner and strap yourself down to something. But after three days or so you start to get used to it.

Student: How many sunrises and sunsets did you see?
Prince Sultan: You go around the earth once every 90 minutes, so you see 16 sunrises and sunsets every day. And that's one of the parts about space travel: the days seem longer. When you wake up in the morning, you can't wake up and order breakfast and sit around. You get out of your sack and you start work. You get your papers and you start work, so you immediately have to be in that mental frame. And when you wake up you have the sun shining. But then a half hour later it might be dark and you say, "I just got up. What happened?"

Student: What did you miss most when you were up in space?
Prince Sultan: You miss space most in space. There were seven people in the shuttle. Don't let those cameras fool you, they have fish-eye lenses which make it look bigger. NASA tells you it's three dimensional because you can float, but it doesn't make any difference – it's still crowded. When I came back, all I wanted to do was go out and sleep in the middle of a big empty parking lot.

Student: I noticed in the film you were wearing two watches, why?
Prince Sultan: That's very good, hardly anyone notices that. The reason I wore two, was because one was Florida time, which I used for my prayers and my personal things, and the other was for mission elapsed time, which starts at zero when you lift off. A good observation.

Student: Did you make a lot of friends here while you were training?
Prince Sultan: You know I went to school here [in the United States] and I have also traveled around a lot. I think I have been to 42 states and I know about your history, but don't quiz me on it.

One thing in space you notice... the first day and the second day you notice countries: you [and the other astronauts] say, oh there is *my* country, and there is *my* country. But then the third day as you go around, you start noticing continents, not countries. You miss the countries completely. The fifth day you miss the whole thing completely; at least mentally, you see only the earth. It becomes... one place, one ball. That's why, when I was over L.A. or wherever, I would call that my home, not just when I was over Saudi Arabia.

You know, I hear a lot of people talk about wanting to go find other places to live. To Mars and this and that. It's nonsense. I think we have the best one right here, we really do. And God has given us the best place to live. We don't have to waste time looking for somewhere else and adapt ourselves to it. I think maybe we should use our time to try and maintain it. It really *is* beautiful. It really is.

IVERSON

One of the highlights of Prince Sultan's four-city tour of the United States was a stop at "S/EMS" in Dallas where gifted science students quizzed him on the joys of space travel.

kept busy posing for photographers and mingling with such guests as Research Minister Henri Curien, former head of France's Ariane space program, Ambassador Jamil Al-Hejailal of Saudi Arabia and other officials, they also managed to reminisce a bit, compare their famous medals and crimson rosettes and chat with the press. Prince Sultan, for example, reminded *Aramco World's* Paris correspondent that he had interviewed the prince in Riyadh three years before. Back then, the prince recalled, "I was passionately interested in airplanes long before Saudi Arabia had any thought of having any astronaut, let alone me."

The impact of his becoming an astronaut, and the flight into space, Prince Sultan went on, was tremendous, especially on young people in Saudi Arabia. "I think it showed them that space, like the rest of high technology, is not the exclusive hunting ground of the West and that – literally – not even the sky is the limit any more." In addition, he said, the flight had an important effect on Saudi-American friendship. "This flight," he told Charles Wick of the USIS, "had more effect than a million hours of *Voice of America* broadcasting because it *showed* our friendship."

During a soccer game in Riyadh, Prince Sultan continued, he switched to English when he addressed nearly 50,000 people and spotted the U.S. Ambassador in the crowd. "Afterwards I noticed groups of enthusiastic Saudis clustering around the ambassador to offer congratulations to the United States too."

From Paris, Prince Sultan went on to visit Cannes, Tours, Bordeaux and Toulouse – heart of the French aerospace industry – before flying off to the United States for another round of appearances and interviews during a four-city, five-day good will tour, much of it arranged by the National Association of Arab Americans (NAAA).

In the States, Saudia, the kingdom's national airline, put a Grumman Gulfstream jet at Prince Sultan's disposal and the prince, who loves to fly, decided to pilot the aircraft himself starting with a flight from Washington to Boston.

In Boston, his first meeting was with reporters and editors from the *Boston Globe*, New England's biggest newspaper, and his second at the Massachusetts State House where House Speaker George Keverian welcomed Prince Sultan in his


WILDENBERG

Prince Sultan at the Saudi Arabian embassy in Paris.


SOUZA

President Reagan meets Prince Sultan at White House.


WILDENBERG

French Prime Minister receives a gift from Prince Sultan.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Prince Sultan and astronaut John Creighton in Paris.


WILDENBERG


ASSOCIATED PRESS

President Reagan, above, receiving T-shirts from Prince Sultan commemorating space mission 51-G, and, below, Prince Sultan tries stetson at National Association of Arab Americans.

private chambers and presented him with a "Revere Bowl," a sterling silver bowl originally designed by Paul Revere, a silversmith and patriot who, in alerting colonists in Lexington that British soldiers were coming, helped fire the famous "shot heard round the world," the first shot fired in the American Revolution."

Prince Sultan also received a citation from Massachusetts and delivered a moving address focused on the links between the United States and the Islamic world. "When I went up, I . . . represented 800 (million) to a billion Muslims, and I . . . took all of them with me to space in an American space ship," he said. "I hope one day you will see the significance of what happened. You have generations of young people in Saudi Arabia who are really extremely very proud of what happened, and I am very proud to have been connected with America on this one . . . I think through cooperation, like what happened with NASA . . . our peoples will become closer."

Continuing to cheerfully cooperate with the media, Prince Sultan also taped an interview for a 200-station radio network at the *Christian Science Monitor*, participated in a live phone interview with WEEI radio, an all-news station in Boston, and taped an interview with *Middle East Insight* show.

In Boston, Prince Sultan and his party also attended a reception at the Boston Museum of Science – including a quick look at the museum's Middle East science section – and an interview with the *Arabic Hour*, a television program shown regularly in Boston and San Francisco.

From Boston, Prince Sultan flew to National Airport in Washington, D.C. where, the next day, with Prince Bandar, the Saudi Ambassador to the United States, Prince Khalid al-Sudairi and Commander Daniel Brandenstein, he met President Reagan in the Roosevelt Room in the White House.

Echoing sentiments voiced in France and Massachusetts, President Reagan congratulated the Prince and Commander Brandenstein, "not only for your mission . . . but what it did in regard to our friendship and what it represents . . ."

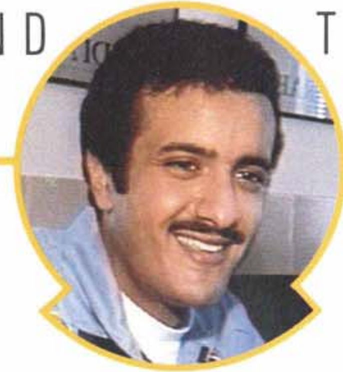
In response, Prince Sultan told the President about the enthusiasm shown in Saudi Arabia for Mission 51-G. "All of the people are very appreciative of the opportunity the U.S. has given us. I was telling Dan (Commander Brandenstein) as a matter of

Amid celebrations and rejoicing Prince Sultan returned to Saudi Arabia after his successful flight. He visited the cities of Taif and Medina where enthusiastic crowds greeted the first Arab astronaut and gave thanks for his safe return. These photographs are montaged against a background of earth taken from the space shuttle.

"I think it's a religious obligation to go out and discover the wonders that God has made"

– Prince Sultan

PHOTOGRAPHS FROM WTN TELEVISED COVERAGE/ REPRODUCED BY VIDEO GRAPHICS



fact, that the reception we got was well beyond the dreams we had. So everyone has a lot of good will for this country and its people."

Prince Sultan also gave President Reagan an astrolabe, an ancient navigational instrument, some T-shirts commemorating Mission 51-G and a flight jacket with the Saudi Arabian flag sewn on it. The garments should be worn, he suggested, when the President was at his Santa Barbara ranch. "Well, thank you very much," said President Reagan, "I assure you I'll use these, but I won't go higher than the back of a horse."

From the White House, the Prince drove to the CBS studios on M street to tape an interview with Charlie Rose, host of the late night CBS news show, *Nightwatch*. Next, the Prince and his party went to the Dirksen Building to meet Senator Jake Garn, who had gone up on the *Discovery* two months before. Senator Garn escorted Prince Sultan to the Senate dining room where they met two other congressional spacemen: Congressman Bill Nelson of Florida – who has since gone into space himself – and Senator John Glenn, the first astronaut to orbit the earth, in February 1962, and a Democratic presidential nominee in 1984.

That night, Prince Sultan was guest of honor at a 7:30 p.m. reception at the Royal Embassy of Saudi Arabia on New Hampshire Avenue, where NASA Chief James Beggs said there was nothing unusual in Saudi Arabia's enthusiasm for space since it was the Arabs who pioneered space research, "long before there was a NASA."

As elsewhere, the Prince gave interviews almost constantly. At one point, he talked to reporters – including those from the *Washington Post* and *Platt's Oilgram* – for three straight hours. But finally at 3:00 p.m. he took the controls of the Grumman again and flew to the next stop: Dallas.

The highlight of the Dallas stopover was undoubtedly the Prince's visit with the kids at the Science/Engineering Magnet School (See page 34), but he didn't neglect the grown-ups either. After an eight-mile run in the afternoon, he smiled his way though another massive banquet: a 150-guest affair sponsored by NAAA. Then, at 11:00 p.m., barely pausing for breath, he took off to Los Angeles, the last stop.

By then, even the apparently tireless prince, as one observer described him, was beginning to feel the strain, so aides kept the *Los Angeles Times* and *Middle East Magazine* at bay until 6:00 p.m. the next day. Then, after another banquet – attended by 300 elegant guests – and another gubernatorial greeting, he took off for Hawaii, this time for a vacation under the stars.

For Prince Sultan, clearly, his international travels were a resounding personal success. Over and over, reporters and writers covering him came up with glowing descriptions like that in the *Los Angeles Times*: "boyish enthusiasm, princely responsibility and a unique mix of confidence . . . and good manners . . ."

But his tour was also a triumph for Saudi Arabia and the Arab world as a whole. One writer, on seeing Prince Sultan talking to King Fahd from space, said that the people of Saudi Arabia suddenly realized what has been happening during the last 30 years as the kingdom developed "at 2,000 miles an hour," as Prince Sultan put it.

Prince Sultan himself tended to downplay the quite natural hyperbole that cropped up here and there in the press; he said he didn't really think of himself as "the personification of the Islamic renaissance," as one paper described him. But he was certainly aware of the symbolic importance of being the first Arab in space. In an interview with Maria Shriver of *CBS Morning News*, for example, the Prince said, thoughtfully, that as a result of space voyage, Arabs generally were "reliving what the Islamic civilization had, and enjoyed . . . in the past . . . the sciences . . . which form the basis for what we see now in the space program."

In Istanbul, a month later, the prince picked up the theme of Arabs and science again. This time, though, he was actively promoting it. It's time he suggested, that Muslim states develop their own technology – as they did so successfully in the glorious eras of the past.

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TV screen view of Prince Sultan with US President Reagan at White House presentation

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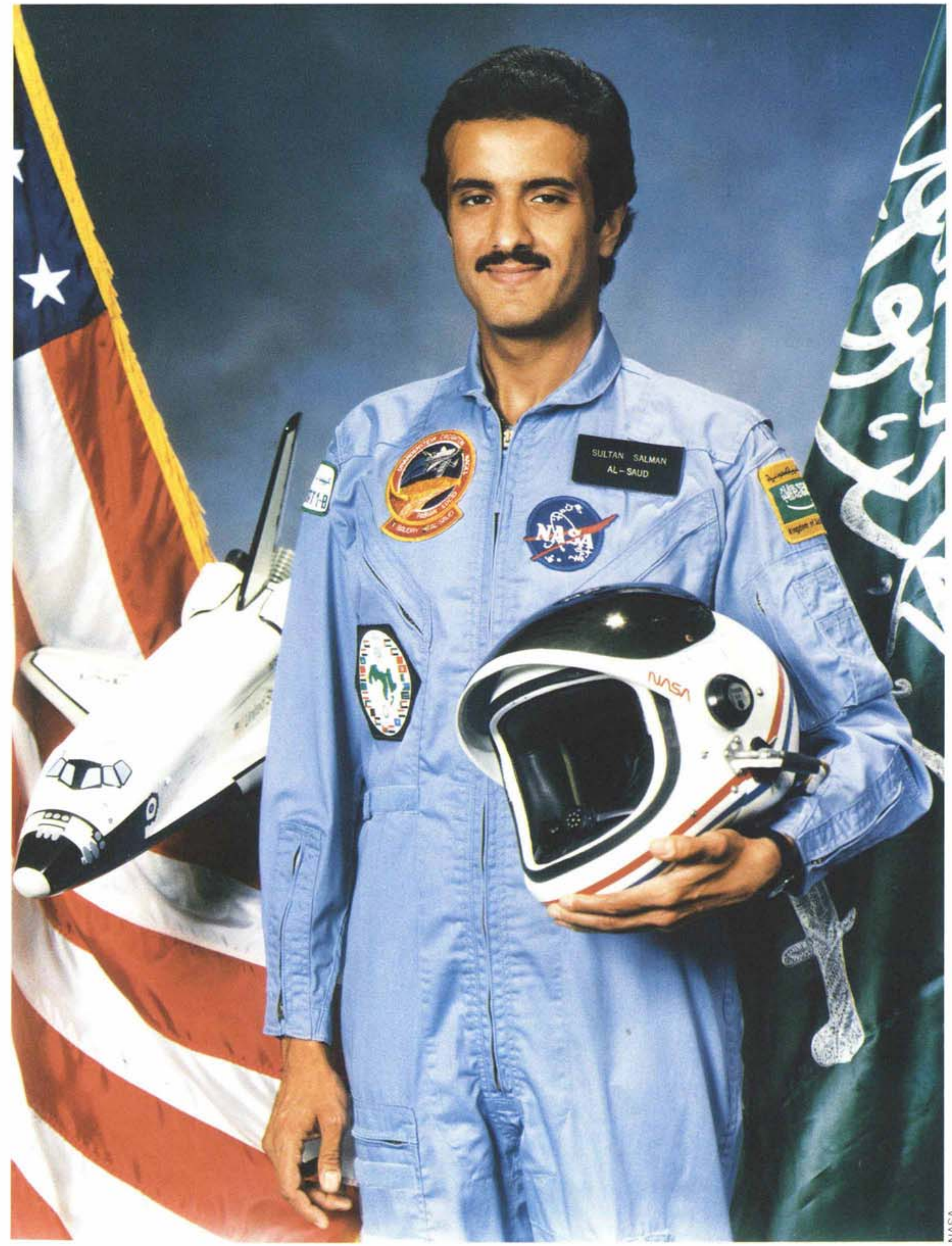
Maria Shriver in New York interviews Prince Sultan in Washington DC for CBS News.



NASA

"It was one of the most breathtaking experiences of my life"

– Prince Sultan

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