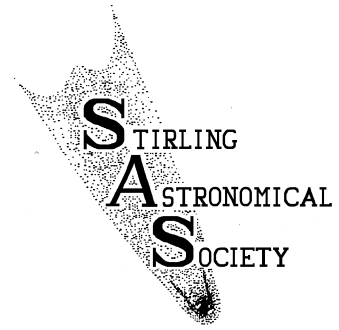


Newsletter



Vol. 15 No. 2 April 2001

GHOSTS OF THE PAST

We continue Harry Stout's discussion of famous names in Physics and Astronomy from the early part of the last century.

JAMES CHADWICK (1891-1974) became famous for his discovery of the neutron in 1932. This fundamental particle had been predicted to exist by Rutherford in the 1920s, but some years elapsed before real progress was made in verifying its existence. In 1930/31 Bothe and Becker in Germany showed that when beryllium is bombarded with alpha particles (helium ions) a new type of radiation is produced. It seemed at first that it might be gamma-rays until it was found that this radiation expelled protons from paraffin wax, which gamma-rays do not do. The neutron was waiting to be discovered, and Chadwick realised this. By studying a large number of photographs of the impact of the new radiation on atomic nuclei, taken with the Wilson cloud chamber, he was able to infer that it consists of uncharged particles of similar mass to the proton. Being neutral, these particles do not ionise molecules of air, and so their tracks are invisible. After collision, the track of the atomic nucleus is visible as usual.

Chadwick himself studied physics at Manchester University under Rutherford. He obtained first class honours in 1911 and an MSc in 1913. He then went to work at a German university was interned when the 1914 World War started, and during his detention became interested in radioactivity. He returned to Manchester after the war but almost immediately moved with Rutherford to Cambridge, where he began work on the structure of the atomic nucleus. This led to his discovery of the neutron in 1932, for which he received the Nobel Prize for Physics in 1935.

In the same year, Chadwick and Rutherford fell into dispute over the need to build a cyclotron, which Chadwick felt was essential for high energy work. He finally left Cambridge to take the vacant Chair of Physics at Liverpool University, where he began to build his own cyclotron which was completed in 1939.

Chadwick's predecessor at Liverpool was Lionel Wilberforce, a former research colleague of J. J. Thomson. In addition to a wide knowledge of walks and climbs in the Lake District, Wilberforce was an expert with the diabolo. This Victorian toy, which comprises two cones joined at the tips, can be spun, tossed and caught on a string attached to two sticks, one in each hand. An eyewitness once reported him standing on the lecture bench, using his diabolo to demonstrate principles of dynamics, much as Professor Taylor-Jones used to do at Glasgow University, seated on a rotating stool!

P.A.M. DIRAC (1902-1984) is famous for his work on theoretical quantum mechanics, (especially with regard to its compatibility with special relativity). He had developed considerable mathematical skill at school in Bristol, and in 1918 enrolled for a degree course in Electrical Engineering at

Bristol University. He graduated B.Sc. with first class honours in 1921, and for the next two years studied mathematics at Bristol, achieving first class honours in 1923. In that same year he obtained a research grant, and started life as a research student in mathematics at Cambridge.

A few years later Dirac had established himself as a leader in understanding and formalising quantum mechanics. In 1927 he formulated the famous Dirac equation, not spelled out here, but will be found on a plaque in the floor of Westminster Abbey, next to Newton's grave.

The equation produced many predictions, one of which was the existence of a positively charged anti-electron. This turned out to be the positron, discovered by Anderson (USA) in 1932, and for which he received a Nobel Prize. Dirac share a Nobel Prize with Schrödinger in 1933 .

Dirac carried his leaning very lightly, and never sought stardom. He worked best. alone, and whilst not a great conversationalist, he had a mild sense of humour, as shown in his invention of the Bra and Ket vectors. He refused all offers of honorary degrees, on the grounds that if he accepted one, he must accept the lot, and, it was said, he didn't wish to emulate J. J. Thomson!

Dirac had the status of a "Great Man", and was often spoken of as a "Great Physicist". But on the latter, let him speak for himself. The occasion was a talk by Max Born to a group of mathematics students, at a time when there was argument about whether momentum was conserved in atomic collisions. The talk was about to begin when in came Dirac, who took a seat at the back. At a question time he asked if he might write on the blackboard, and this he did, and had a quiet chat with the speaker. He was then asked what his equations said about conservation of momentum. Dirac replied "Nothing. This is a matter of experimental fact, which physicists must find out. If they say momentum is conserved, I will put. that in my equations when appropriate. If it is not to be, I will put that in instead." Verdict ?

Harry Stout

MAGNIFICENT SEEING WITH THE STIRLING TELESCOPE

(Or "What's in a Name"!)

At the end of last year, a group of SAS members headed for the Highland Hotel to use the Old High School Telescope. The staff there welcomed us warmly, as two of their guests had just asked if it would be possible for them to see the telescope. As we escorted them up the stairs, they told us that this would be the first time for them to view the sky through a telescope. They were very impressed by the 110 year old, 12.5 inch instrument which Ken unveiled to them.

When the telescope had been focused on Jupiter, one of the guests was invited to climb the ladder to view the planet and its four Galilean moons. "That's marvellous", he said, "I can see the moons and the rings as well!"

Stunned silence from the SAS members.

We gently explained that Saturn was the planet with the rings. However, he was correct in saying that Jupiter had rings as well - but they had only been discovered after prolonged examination of the data sent back by Voyager! Even after the recent re-alignment of the telescope mirror, there was surely no chance that he could actually see rings around Jupiter. Then it clicked. Ken's voice came from the floor, "Ah, you mean the bands - the cloud bands around the planet!"

Albert Mackenzie

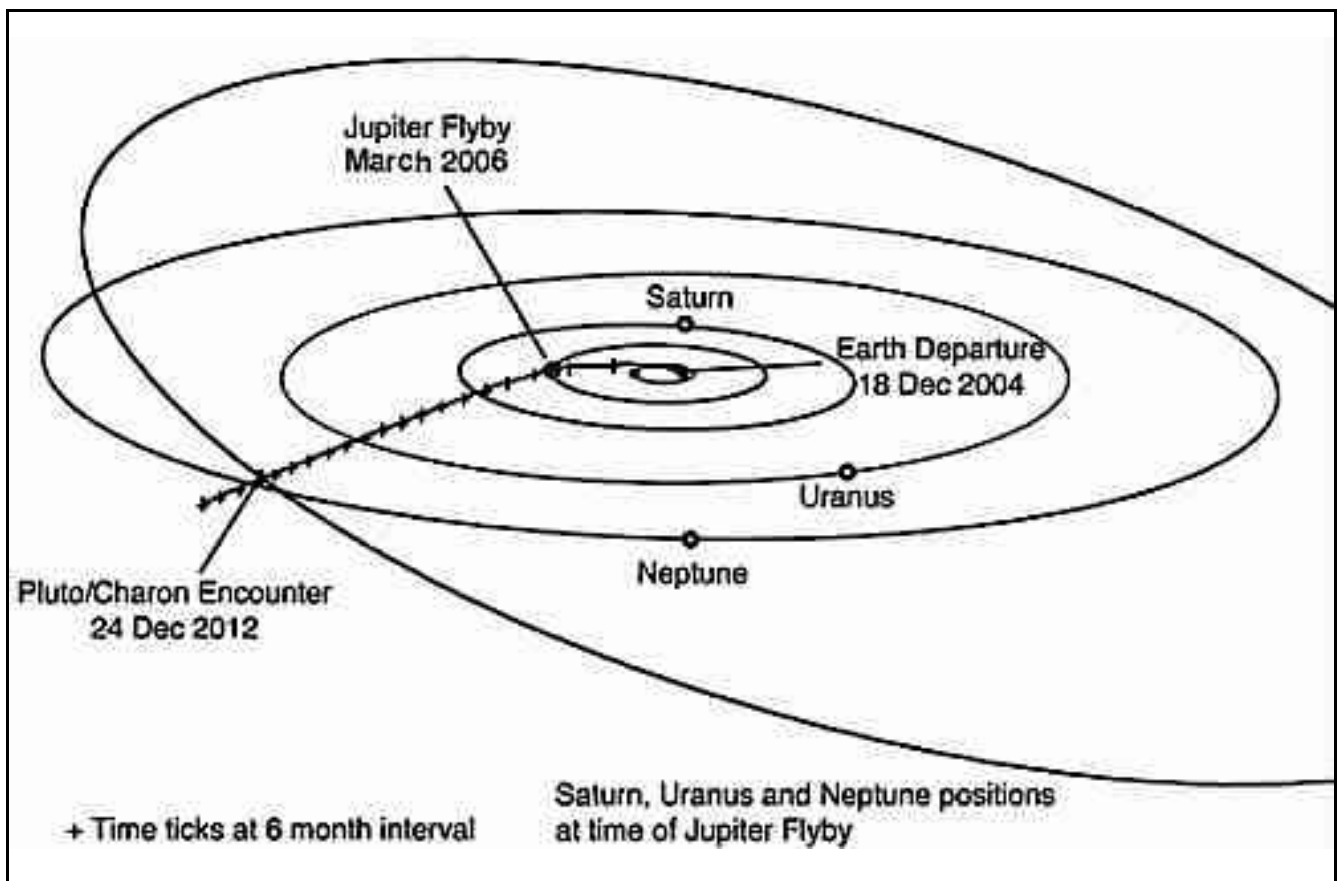
VISTING PLUTO?

The only planet not yet visited by a spacecraft, and so the one we know least about, is Pluto. It's only been known about at all for a fraction of a Pluto year. Since it was discovered in 1930, Pluto has not yet traversed a third of its orbit around the Sun, which takes 248 years altogether. Pluto is only two-thirds of the size of our Moon and never comes closer to the Sun than 2700 million miles. But it also has its own moon Charon, discovered in 1978 - or are they a binary planet? At half the size of Pluto, Charon is very large in comparison for a satellite moon. Its diameter is 790 miles compared with Pluto's 1440 and they take six days to orbit around their common centre of gravity.

There is a plan for a space probe to fly past Pluto on its way to the Kuiper Belt (see the last *Mercury*). It has been named the Pluto-Kuiper Express, or PKE. The plan has been to launch it in 2004 so that an encounter with Jupiter can give it a gravity slingshot to throw it into a high speed trajectory to reach Pluto in 2012. However, when it reaches Pluto it will be whizzing past at twelve miles per second, so there won't be much time for detailed examination. It is not feasible for it to carry the extra rocket booster and fuel load needed to slow it down.

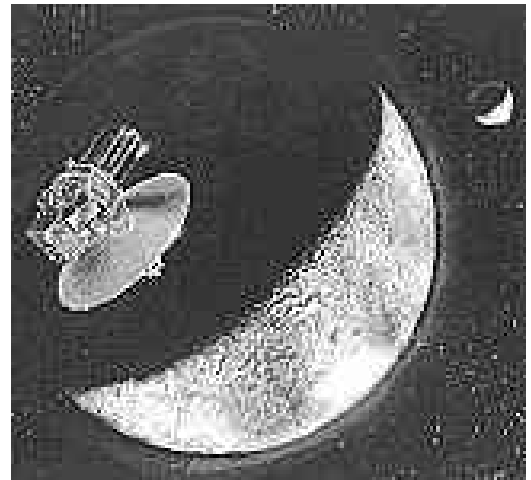
Jupiter of course has to be correctly positioned to give PKE the right gravity slingshot. If the 2004 launch window is missed for any reason (and delays and cancellations are common in space programmes!), the next opportunity is a launch in 2015 to reach Pluto in 2022 - a long time to wait! An alternative would be to develop a novel propulsion method for PKE so it would not be dependent on assistance from Jupiter. But that would cost serious money, whereas Jupiter is free.

A 2004 PKE launch has been costed at \$600 million, and NASA has already lowered its priority, provoking a storm of protest - the Planetary Society collected 10,000 letters in its support within two weeks of NASA's announcement. NASA's top priority now is a mission to the Jupiter moon Europa, with its suspected frozen ocean with liquid water (and maybe life?) underneath.



Would it matter very much if a visit to Pluto were to be delayed for a decade or so? Pluto came up with a surprise in 1980 when it was found to have a tenuous atmosphere composed largely of methane. At that time it was at its closest to the Sun (nearer than Neptune) in its eccentric orbit, and therefore at its warmest. As it goes further away from the Sun and cools, this atmosphere is expected to freeze out. This phenomenon provides an explanation for the brightness of Pluto in relation to its small size. It could be coated with methane snow, which is highly reflective, and is replenished anew every orbit around the Sun.

This adds another important factor to the timing of PKE. Soon the methane atmosphere will have frozen again, but PKE is designed specifically for atmospheric investigation - not much else is possible during its rapid fly-past. If PKE is delayed, there will be little for it to investigate and it will be more than two hundred years before Pluto's atmosphere can be investigated again in this position on its next orbit. So, if there is no PKE in 2004 it looks as if there will be none at all. In two hundred-odd years our descendants will make the decision, which hopefully should be easier with the much more advanced space technology. which should be available by then.



NASA impression of Pluto, Charon and PKE

Stop Press : New President George W Bush has just announced that one of his tax-saving measures on taking office is the cancellation of PKE - Aah well!

THE EARTH - A HEAT ENGINE

It is easier to follow an engine from a standing start, than by peering at its bewildering orchestra of running parts. Therefore imagine a planet hanging motionless in a nice 20 degree centigrade warm universe (this is not of course how the Earth actually started but it will serve for illustration). The oceans would be still, the air would be still, and everything would be in pleasant equilibrium.

To start things moving, turn on a vast hydrogen fusion reactor in nearby space: a sun. The side of the planet facing its sun starts to heat up. Next bring down the temperature of the universe to its real, very cold state near absolute zero. The dark side of the planet begins to cool, radiating its heat away into cold space. The air on the sun side warms and rises, sucking in a ring of cold air from the dark side of the planet, and so the the atmosphere starts to circulate; up at the equator and over the top of the atmosphere to the shadows where it cools and falls again.

To make the heating less one-sided, imagine the planet starts to spin, like cooking meat on a vertical spit. This gives nice even heating all round the equator, but the surface of the planet curves further away from direct sunlight the nearer the poles it lies. The cold side of the planet is warmed by the spinning, but two cold poles remain and the air circulation continues, still rising at the equator but making its way just North and South to the poles where it cools, falls and returns towards the equator.

Superimposed on this convection is another force. On Earth it is called the Coriolis effect: because the roughly 24,000 mile circumference Earth is turning every 24 hours, the equator and the air above it

are travelling at about 1000 miles an hour. Therefore when air is convected towards the poles it tries to continue travelling at that speed, while the ground below is actually travelling slower the nearer the pole it is. You could walk round the little ring of ground at a pole in less than a minute but the polar ground takes all day to go round turned by the Earth.

Conversely, the near-stationary cold polar air convecting down towards the equator tends to get left behind by the Earth's surface which is travelling increasingly faster towards the equator. With the Earth's surface rotating eastwards the result should be cold easterly winds at ground level and warm westerlies in the upper atmosphere, except that the two opposing winds at the two levels shear and mix where they try to pass over one another and generate huge swirling spirals which are the cyclones and anticyclones characteristic of Earth weather.

While these wind phenomena may be the most obvious signs of heat transport between equator and poles, the oceans are far more significant heat transporters due to their immensely greater mass and heat capacity. On average the oceans are several kilometres deep, but just the top metre layer of ocean has the same heat capacity as the World's entire atmosphere, despite the fact the atmosphere reaches up over a hundred kilometres to the edge of space.

However, convection is the basic heat transporter in the oceans just as it is in the atmosphere. The main difference is that while the Coriolis force acts in a virtually unobstructed layer of atmosphere it acts in a very obstructed layer of water. The primary obstructions being North and South America, Africa and the Eurasian continents. These give rise to a complex of currents within and between the oceans worldwide.

The swirling atmosphere and oceans interact and exchange heat and water vapour. The oceans, being the more massive, virtually drive the activities of the lighter atmosphere. A warm patch of ocean can inject huge quantities of water vapour into the overlying air. This water vapour carries gigawatts of latent heat which is released when the vapour condenses to cloud and rain, not to mention yet more gigawatts of potential energy stored in the millions of tons of water raised thousands of feet above the ground. Hydroelectric schemes intercept a little of this energy as the water falls back towards sea level.

Some of the energy released in tropical cyclones accelerates their rotation, in other words increases their wind speed. This in turn induces faster evaporation from any underlying warm sea surface, feeding the storm yet more latent and potential energy. The result is a build-up of ferocious winds and torrential rains to produce a hurricane. A likely result of global warming is that these storms will find more ocean heat to feed on, making them more intense and probably more frequent.

To summarise the spinning Earth's heat engine, we could say the Equator gets more energy than the Poles and "weather" is the sea and the air trying to resolve the difference.

Chris Davis

FACTS and FIGURES : The LARGEST CONSTELLATION

The largest of the 88 constellations is Hydra, the Water Snake. The area of sky designated as Hydra is 1302.84 square degrees, which is 3.16% of the whole sky. The next largest constellation is Virgo, at 1294.43 square degrees. Given its name, it is not surprising that the Water Snake is a long thin constellation, winding a quarter of the way around the sky, with most of it is just south of the celestial equator. One legend associated with Hydra says it is the many-headed monster killed by Hercules. Despite its size, Hydra is not a distinct pattern. It is largely made up of rather faint stars and is not easy to find. Its brightest star is Alphard, a second magnitude orange giant, 130 light years away.

GETTING OUT OF A SPACE SHUTTLE - DOUBLE QUICK!

After the success of the first four shuttle flights, astronauts exchanged hot bulky pressure suits for just blue overalls and an oxygen mask when in their pressurised crew cabins. In an emergency it was expected that they would be able to land at the nearest acceptable runway, and they were provided with no other means of escape. For shuttle flights 5 to 24 this was adequate, but then came the disastrous explosion of Challenger after lift-off in 1986, and all was changed. NASA developed a comprehensive escape plan for future shuttle flights and revived the use of pressure suits, this time using the latest technology.

These bright orange escape suits are now always worn on lift-off and re-entry, and protect the wearer from fire, immersion in cold water and also sudden cabin decompression, as the suit automatically takes in or lets out air depending on outside pressure. Other survival equipment includes parachute, life raft, flare gun, strobe light, signal mirror, green sea dye, drinking water and motion sickness pills. The escape suit material includes a layer which holds pressurised air inside the suit while allowing water vapour to escape. A second outer layer provides flame and abrasion protection. During return to gravity, astronauts also wear an anti-gravity suit which squeezes the legs to keep blood from pooling in them.

A parachute pack forms the back of the astronaut's seat in the shuttle, but it is strapped to the astronaut in case of an emergency bail-out. The pack and harness work even if the wearer is incapacitated: the parachute, life jacket and life raft all operate automatically.

A shuttle bail-out is the last resort to be used only if landing becomes impossible. Ideally, the astronauts equalise the cabin pressure with that outside and remove their lap belts at 40,000 feet. A designated crew member blows the escape hatch at 30,000 feet and each astronaut hooks a D-ring on his or her suit to an 8.5 feet telescoping escape pole. As each astronaut slides clear of the shuttle, the force on the D-ring initiates the parachute sequence. A SARSAT locating beacon is activated when the main parachute canopy leaves its pack. At splashdown, the life jacket and yellow life raft inflate and sea dye is released.

An emergency shuttle bail-out for real has fortunately not taken place yet, but the US Navy routinely jump tests the system every two years.

Derek Allen

WHY IS EASTER DAY ON THE 15 APRIL THIS YEAR?

Easter day can be on any date between 22 March and 25 April. The date changes every year because it has to be a Sunday and because Good Friday took place during the Jewish passover, which is celebrated for eight days following the first full moon of spring. The date of Easter is thus linked to several astronomical cycles. The lunar month is currently about 29.53 days while the solar year is about 365.24 days. This leads to an inconvenient relationship because it is not in whole numbers. It so happens that 235 lunar months are very close to 19 solar years and the method of fixing Easter makes use of this.

In A.D.325 the Council of Nicaea decided that Easter should fall on the first Sunday after the first full Moon occurring on or after the Spring Equinox, when the day and night are of equal length. At that time the year was based on the Julian calendar, with one leap year every four years. The dates of full Moons were assumed to repeat every 19 Julian years, and a bit of juggling with the calendar made this period equal to 235 lunar months. The 19-year period was called the lunar cycle and each year's

position within this cycle was indicated by its Golden Number, which went from 1 to 19. The entire cycle of the Julian calendar would repeat every 76 years, as after four lunar cycles of 19 years each the pattern of leap years would repeat. Easter dates repeated in a 532-year cycle, which is the multiple of the Julian cycle (76 years) and the weekly cycle (7 days).

It was a nice arithmetical method, but unfortunately it did not accurately reflect the true lengths of the lunar month and solar year. Over the centuries it became ever more evident that the calendar was slipping in relation to the seasons. Finally in 1582 Pope Gregory XIII reformed the calendar by omitting the leap year in all years that are multiples of 100, except for years that are multiples of 400 - that is why 2000 was a leap year, whereas 1900 was not. To correct for the slippage which had occurred, when the new Gregorian calendar started in 1582 it jumped from 4 October straight to 15 October, and there were many complaints that ten of God's days had been stolen!

A new method of calculating Easter was now introduced. This assigned to each year a number between 0 and 29 called the Epact, which indicates the phase of the Moon on 1 January. Epact (0) indicates a new Moon, and (15) a full Moon. Every so often the Epact cycle has to be adjusted to account for the fact that 235 lunar months do not exactly equal 19 solar years. The last such adjustment was in 1900 and the next one will be in 2200.

The date of the first full Moon after the Spring Equinox can be calculated using the year's Golden Number and Epact. Easter is the first Sunday after this full Moon and each year is also assigned a dominical letter, from A to G, which indicates the date of that year's first Sunday: A for 1 January, B for 2 January, and so on. A leap year has two dominical letters, one used to calculate the Sundays in January and February, and the other to calculate the Sundays for the rest of the year.

This still is not perfect. The church, which of course fixes Easter, considers 21 March to be the permanent date of the Spring Equinox, whereas the real astronomical date can be as early as 19 March, as it will be in 2096. Also, the Moon does not exactly follow the church's conventions. In 1845 and 1923 the first full Moon of Spring actually occurred after Easter Sunday in the World's easterly latitudes. Except for occasional hiccups, the date of Easter slips back by about eight days each year until it then has to jump right forward again. Under the rules of the Gregorian calendar the cycle of Easter dates repeats exactly after 5,700,00 years! Long before this, however, the rules will have become out of step with astronomical reality, as the lengths of the month and day are slowly changing, mainly due to tidal friction.

In 1965 Thomas O'Beirne of Glasgow University published a method of calculation of Easter which puts the various cycles and adjustments into an arithmetic algorithm suitable for routine computation. It is reproduced on the next page.

Derek Allen

SO YOU WANT TO BE A SPACE SHUTTLE PILOT?

Some requirements: Vision - at least 20/70, correctable to 20/20
Height - 5'4" to 6'4"
Education - BSc in Engineering, Mathematics or Science
Jet flight experience - 1000 hours minimum
Blood pressure while sitting - 140/90 maximum
Duration of basic training - 1 year

The odds that you would vomit the first time in the "Vomit Comet", a zero-gravity simulating aircraft, are one in three.

CALCULATING EASTER

Choose any year of the Gregorian calendar and call it X. To determine the date of Easter, carry out the following ten calculations.

1. Divide X by 19 to get a quotient (which we ignore) and a remainder A. A is the year's position in the 19-year lunar cycle. $(A + 1)$ is the year's Golden Number.
2. Divide X by 100 to get a quotient B and a remainder C.
3. Divide B by 4 to get a quotient D and a remainder E.
4. Divide $(8B + 13)$ by 25 to get a quotient G and a remainder (which is ignored).
5. Divide $(19A + B - D - G + 15)$ by 30 to get a quotient (which is ignored) and a remainder H. The year's Epact is $(23 - H)$ when H is less than 24 and $(53 - H)$ otherwise.
6. Divide $(A + 11H)$ by 319 to get a quotient M and a remainder (which is ignored).
7. Divide C by 4 to get a quotient J and a remainder K.
8. Divide $(2E + 2J - K - H + M + 32)$ by 7 to get a quotient (which is ignored) and a remainder L.
9. Divide $(H - M + L + 90)$ by 25 to get a quotient N and a remainder (which is ignored).
10. Divide $(H - M + L + N + 19)$ by 32 to get a quotient (which is ignored) and a remainder P.

Easter Sunday is the Pth day of the Nth month (N can be either 3 for March or 4 for April). The year's dominical letter can be found by dividing $(2E + 2J - K)$ by 7 and taking the remainder. A remainder of 0 is equivalent to the letter A, 1 is equivalent to B, and so on.

Example: Easter Day in 2001 ($X=2001$)

1. $A=6$
2. $B=20$; $C=1$
3. $D=5$; $E=0$
4. $G=6$
5. $H=18$
6. $M=0$

FLOATING MOONDUST At the time of the Moon landings, a tenuous, barely visible layer of dust was seen floating a metre or so above the moon's surface. A full explanation of this has now been published. The Sun's ultra-violet light knocks electrons off particles of moon dust lying on the surface and off the moon rock itself, so giving them both a positive charge. Because positive charges repel each other, the dust is pushed away upwards from the rock to the point where this repulsive force just balances the Moon's feeble gravity. The phenomenon has been simulated by experiments with mineral grains in a vacuum chamber bathed in ultraviolet light.

ION BEAM PROPULSION

Readers of *Mercury* will recall an article by John Moffat in vol. 14 No.1 “Deep Space 1: The First Millennium Mission”. The spacecraft for this mission carried equipment designed around several new (for NASA) technologies, and its propulsion is by ion beam thruster.

The first thruster of this type was built by NASA in 1959, and has been under continuous development since then by NASA, and also in Germany and Russia. It is a type of jet propulsion, and its main features were clearly explained by JM. However, it is so different from the usual chemical propellants that it is interesting to look at some of the more technical data about it given by NASA.

The fuel used must be gaseous, because it has to be bombarded with electrons of sufficient energy to ionize the atoms with which they collide. In early designs caesium, which is solid, and mercury, which is liquid, were tried, although each had to be heated to be vaporised first. But it was found that after being ejected from the thruster, caesium and mercury atoms cooled sufficiently to condense on the exterior of the spacecraft, which is very undesirable. Currently rare gases such as argon, krypton or xenon are being tried, as being cleaner and simpler fuels to handle.

All the rare gases are very resistant to chemical reaction, and they have rather high ionization energies. Of the above three, xenon has the lowest ionization energy, about 12 electron volts (compared with caesium's 4 eV), and is now the preferred fuel. Its average atomic weight is 131.3, but it consists of nine stable isotopes differing in the number of neutrons they contain, and ranging in atomic weights from 124 to 136. However, all xenon atoms have a full outer shell of eight electrons, which is a very stable arrangement and is the reason for its high ionization energy. The bombarding electrons are given an energy of 40 eV.

NASA states that 1.5 kg of fuel will keep a spacecraft going for 20 months. This means an average usage of about 1.5 milligrams of fuel per second. This amount is carefully metered; it is ionized by the applied 40 eV electron beam, accelerated to high velocity by an applied DC voltage of up to 1280 volts, and then ejected from the thruster. A neutralising stream of electrons is also ejected into the ion beam to prevent the spacecraft becoming electrically charged. As with all cases of jet propulsion, the thrust achieved is the product of mass per second ejected and the jet velocity. In the NASA 30 cm thruster, the ion beam is ejected through a metal grid and provides a thrust of 90 milliNewtons at full throttle. This corresponds to an ejection velocity of about 60 km per second.

Ionizing 1.5 mg of xenon per second requires an energy rate input of about 1.7 kW. The maximum energy rate the thruster could utilize at full throttle is about 2.5 kW. However, if power is supplied only by solar panels, the thruster would have to be throttled back as the distance of the spacecraft from the Sun increases and the energy received by the solar panels decreases.

The acceleration developed by this thruster is quite small, and the ratio of velocity to acceleration, a measure used by NASA of specific impulse, is around 3000 seconds. Chemical propellants commonly are in the region of 300 seconds, and use up the fuel much more rapidly. The ion beam is only one of several “electrical” methods of jet propulsion, but it seems to be a preferred method for current development.

Harry Stout

THE NIGHT SKY for April, May and June 2001

SUN

	April				/	May		/	June	
	8	22	6	20	3					
(approx) Rises	6.12	5.37	5.05	4.38	4.20	4.13				
(approx) Sets	19.53	20.21	20.49	21.16	21.37	21.49				

MOON

	April					/	May				/	June			
Phase	FQ	FM	LQ	NM	FQ	FQ	FM	LQ	NM	FQ	FM	LQ	NM	FQ	
Date	1	8	15	23	30	7	15	23	29	6	14	21	28		
Rises	10.34	20.20	3.27	4.55	-	20.42	3.01	5.09	11.21	22.12	1.57	4.12	13.25		
Sets	3.26	6.54	10.31	18.47	-	5.32	11.33	21.50	2.16	4.44	12.52	22.01	1.18		

PLANETS

Magnitude

MERCURY	April	Unsuitable for observation.	
	May	Visible from 5th to 26th low WNW at end of twilight. (A guide to finding - on the 16th it is 2.7° above right of Jupiter.)	-1.1 to 1.0
	June	Unsuitable for observation.	
VENUS	April	Brilliant morning object low ENE sky shortly before sunrise.	-4.5
	May	Brilliant morning object low eastern sky shortly before sunrise. Apparent diameter shrinks 41 to 26 arcseconds and phase increases from 23° to 45°.	-4.5
	June	Eastern sky in morning from approx. 2hrs before sunrise.	- 4.2
MARS	April	Morning object low SE. By end of month, visible from midnight.	1.0
	May	In Sagittarius low SE. First stationary point 11th then slow retrograde	-1.0 to -2.0
	June	Very low SE sky all night .	-2.4
JUPITER	April	Evening object SW sky. (5° North of Aldebaran on 16th and 2° North of crescent moon on 26th)	-2.0
	May	Western sky in early evening first three weeks then lost in the lengthening twilight.	
	June	Unsuitable for observation.	
SATURN	April	Low western sky for most of month then disappears into lengthening twilight.	+0.2
	May	Unsuitable for observation.	
	June	Unsuitable for observation.	

CONSTELLATIONS (near meridian at 22.00)

1st April Cepheus and Cassiopeia (below pole), Ursa Major, Leo Minor, Leo, Hydra.

1st May Cepheus and Cassiopeia (below pole), Ursa Minor, Ursa Major, Leo Minor; Leo; Crater; Hydra.

CONJUNCTIONS (with the Moon unless stated otherwise)

April

Date	Time	
8	16.00	Venus 9 ⁰ N
13	03.00	Mars 1 ⁰ S
20	06.00	Venus at stationary point
21	04.00	Venus 9 ⁰ N
23	10.00	Mercury in superior conjunction
23	17.00	Mercury 4 ⁰ N
25	17.00	Saturn 1 ⁰ N
26	14.00	Jupiter 2 ⁰ N

May

Date	Time	
4	19.00	Venus at greatest brilliancy
7	01.00	Saturn 4 ⁰ S
10	20.00	Mars 2 ⁰ S
11	02.00	Neptune at stationary point
11	17.00	Mars at stationary point
16	12.00	Jupiter 3 ⁰ S
19	14.00	Venus 4 ⁰ N
23	07.00	Saturn 1 ⁰ N
24	08.00	Jupiter 1 ⁰ N
24	21.00	Mercury 3 ⁰ N
25	14.00	Saturn in conjunction with the Sun
29	16.00	Uranus at stationary point

June

Date	Time	
4	06.00	Mercury at stationary point
4	13.00	Pluto at opposition
6	21.00	Mars 4 ⁰ S
8	07.00	Venus at greatest elongation
13	19.00	Mars at opposition
14	14.00	Jupiter in conjunction with the Sun
16	14.00	Mercury in inferior conjunction
18	01.00	Venus 2 ⁰ N
18	11.00	Jupiter 4 ⁰ N
19	23.00	Saturn 0.9 ⁰ N
21	01.00	Mercury 3 ⁰ S
21	04.00	Jupiter 0.7 ⁰ N
28	07.00	Mercury at stationary point

TWILIGHT In June the twilight lasts all night for a short time around solstice as the Sun is less than 18° below the horizon.

Hamish MacPhee

FACTS and FIGURES - JUPITER and SATURN

Jupiter is both the largest planet in the solar system and the most massive. Its equatorial diameter is 143,884 km, which is 11.209 times the diameter of Earth, and 0.103 times the diameter of the Sun. Jupiter is not spherical because it spins rapidly and is made of gas and liquid. Its polar diameter is 133,708 km. The volume of Jupiter is equivalent to 1,319 Earths. Jupiter's mass is 318 times Earth's mass, which is 2.5 times greater than total mass of all the other planets. It would take 1,047 Jupiters to make up the mass of the Sun. The equatorial diameter of the next largest planet, Saturn, is 0.84 that of Jupiter and its mass is 0.30 Jupiter's. Both Jupiter and Saturn grew into relatively large planets because they formed at a place and time in the early development of the solar system that enabled them to collect vast quantities of gas from the solar nebula.

Stirling Astronomical Society

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REMAINING PROGRAMME, 2000-2001

13 April	The waltzing Universe - Dr Mark Casali
23 April	Members' evening
18 May	A tour of the Universe through X-rays - Dr Omar Almaini
25 May	Members' evening

Lectures are held at the Smith Museum, Dumbarton Road, and Members' Evenings at the Mayfield Centre, St Ninians. Both start at 7.30 p.m.

WANTED!!

Contributions to *Mercury* from members, for members, and about what members are doing!

Such as -

- New articles
- Discussion of previous *Mercury* items
- Reports of Members' Evenings and other meetings
- Reports of Lectures
- Observations (astronomical and verbal!)
- Telescope and viewing activities
- Members' photography
- Comments
- Interesting information

Please send your contributions to (or first discuss them with)

either:-

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