MIRA

2011.1
Number 90
Price 50p

The Journal of the
Coventry and Warwickshire Astronomical Society

http://www.covastro.org.uk/

Chris Longthorn's M66 image from the New Mexico Skies visit

Image Details are,

Date April 13th 2010, I took 3 off 15 minute exposures, the last one finished at 22:58. The telescope was a 16" Meade LX200 Schmidt Cassegrain on an equatorial mount controlled by *The Sky 6 Professional* software. The images were all captured with an SBIG ST-2000XCM one shot colour CCD camera operated using SBIG CCDOP's capture software. The telescope was also guided using the same capture software. All images were automatically calibrated on download, also by the capture software.

The 3 images were stacked on the following day using CCDOP's again, using New Mexico Skies' facilities. Some post processing was also done there using Photoshop CS4. I finished the processing at home once we'd returned to the UK using Photoshop CS3.

CONTENTS

Meteorites

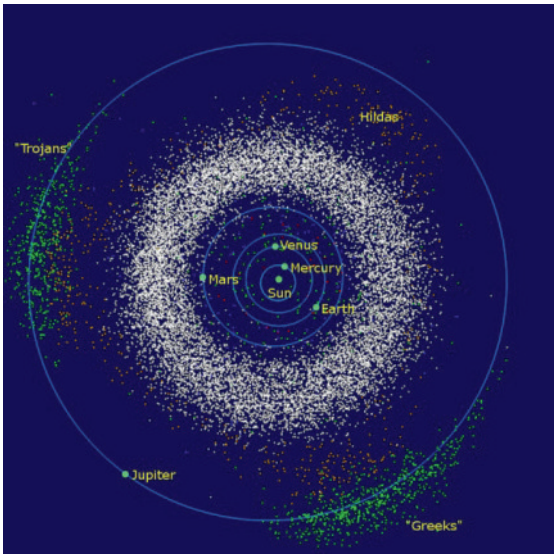
By Paritosh Maulik

Debris leftover from the formation of Solar System is still orbiting in the Solar System. Dust from the roving comets enters the atmosphere of the Earth in regular intervals as meteor shower or shooting stars. These are very small and only a very little evidence of dust from meteor shower surviving the journey. In addition to the comets, there are asteroids. These are denser than the comets and orbit as a group. From time to time, asteroids get moved out of the parent orbit and travel to other planets and satellites. During the travel, some get broken up, but some can survive the journey and land as a solid body. Some of these also land on the Earth. These are meteorites. Most of the meteorites have remained unchanged since their formation with the Solar System and therefore observations of the meteorites gives us an opportunity to understand the formation of early Solar System.

About 4.5 billion years ago the Solar System formed. As the dust grains began to gather together, planetesimals formed, objects greater than 1 km diameter can have enough gravity to attract others to form protoplanetes, of about the size of the Moon. Protoplanetes eventually grew into planets. Some of the protoplanets will, over time, veer into zones of instability or collide with each other and break into smaller pieces. Others grew in size, forming around the Sun, these are now called asteroids. But once Jupiter reached its current mass, it ejected the majority of asteroids from their orbits into a new location, the asteroid belt. Larger objects over about 120 km size that had formed earlier than the intervention by Jupiter and small ones formed by the repeated collisions, these small objects now reside in a roughly ciruclar orbit between Mars and Jupiter.

Objects in the asteroid belt vary in size; for example the 950 km diameter dwarf planet Ceres, and over 500 km diameter is asteroid 4 Vesta; its day – night temperature varies between –60° to 130°C. Some are a few tens of metres in diameter and consist of a loosely held collection of rocks, but the majority are very small irregular objects, planetesimals or objects resulting from repeated collisions.

In addition to the main asteroid belt, some asteroids share the orbit of Jupiter. Such asteroids are called Trojans. Before we look at asteroids, we shall take a quick look at the comets.



Comets

During the formation of the Solar System, comets formed around the areas when the temperature was low enough for water to form ice. These icy particles accumulated dust particles; so comets are in fact a loose collection of ice, dust, rock and some atmosphere. Comets preserve the early history of the formation of Solar System and can be a few hundreds of metres to a few kilometres in size, most are smaller than the asteroids.

Comets orbit in a highly non-circular orbits. When a comet comes close the Sun, heat melts icy particles and the solar wind causes materials to be ejected from the comet. Often this appears as a tail pointing away from the Sun. Some comets originate in the Kuiper belt, beyond the orbit of Neptune. Longer period comets may reside in the Oort cloud, at the outer boundary of Solar System, comets can enter the inner Solar System swing round the Sun and then leave for interstellar space. The period of a comet depends on their origin, the further from the sun, the longer is its period from a few years to tens of thousands of years. Sometimes the entire orbit of the comet forms a dust lane and when the Earth's orbit meets such a dust lane, we get meteor showers. Probes have been sent to crash into comets. These suggest the particles in the comet are about 1 mm in size; as these particles enter the atmosphere, they burn up by the friction with air and this we see this as a meteor shower. Very fine particles eventually land on the Earth and because of such fine size, are difficult to positively identify.

Asteroids

Asteroids often collide and fragment, the fragments are called meteoroids. Some of these are attracted by the gravity of Earth, the meteoroids travel in the range of about 11 km/sec (7 mile/s) to 72 km/sec (45 mile/sec). Nearing Earth the friction with air molecules causes the meteoroids to heat up and the surface of the meteoroids begins to glow and vaporise, this is called ablation and occurs in the range of 100 – 115 km above the Earth. How hot the meteoroid gets depends on the surface area of the meteor. However a meteor of less than 1 gm cannot survive the travel and it is estimated that about 20,000 tonne of extra-terrestrial dust falls on the Earth every year. The meteoroids are generally less than of kilograms in weight. The heating of the meteoroids produce light and sound and we see these as fireballs. The friction due to the air near the Earth slows the meteoroids down; the outer surface may melt, but the bulk of the meteorite survives the travel and remains unaltered; some may get broken down. Smaller meteors do not survive the travel, these get vaporised. A centimetre size meteoroid when entering the atmosphere, frictional heating will produce a streak of light. Once the meteoroids have landed these are called meteorite.

Meteorites often have a conical edge; this points to the direction of entry. During the travel the meteorites can

tumble and may get somewhat rounded. By the time a meteorite has landed on the Earth, it is cold or at the most warm to the touch. Sometimes people can see a meteorite to fall to Earth and recover it. But majority of the meteorites are either found accidentally or only after an exhaustive search. These are find meteorites. Dry desert conditions reduce weathering of meteorites and deserts are good places to look for meteorites. Antarctica is also a good place for meteorite finds. This is a very dry continent and this dryness reduces weathering. The deep snow cover buries the naturally occurring rocks: however ice flows often tends to concentrate fallen meteorites to one area.

Despite the fact that there were eye witness accounts of meteorite falls, meteorites were once thought to be of terrestrial origin. One possible reason may be the learned gentry thought the eye witness accounts of "the common people" are not reliable. It was a German physicist who first suggested that the meteorites are from extraterrestrial source.

It is more likely that meteorites land near the equator, because the meteorites and the Earth are travelling in the same plane. It is also true that more meteorites fall during the early hours of the morning than the early evening. During the early morning, the Earth is turning towards the Sun and therefore faces the direction of the meteoroids along its orbit, so we see more meteors; whereas in the early evening, we are facing away from the Sun back down the Earths path and we see fewer meteors.

Glowing meteorites are easy to spot in the night and therefore, we can see meteorite falls, but it not easy to locate the spot where the meteorite has landed. Seeing a meteorite falling to Earth during the day and early evening makes the chance of locating the meteorite high. Some camera networks have been set up to record meteorites. These also help to identify the possible site of meteorite fall. In November 2008, a meteorite fall in Saskatchewan, Canada, was recorded by many security cameras and it helped to locate the fall.

What are the meteorites are made of?

We have seen earlier that the meteorites falling on the Earth are in fact parts of asteroids. It is not easy to examine the asteroids directly, but meteorites are. So we can attempt to examine both to get a better understanding. Majority of the asteroids are orbiting around the Sun are in an orbit between the inner rocky planets (Mercury, Venus, Earth and Mars) and the gas giant Jupiter. Some of these get attracted by the planets. When a large meteorite hits the surface of a planet or a satellite, craters form, examples are found on Earth, but the Moon, Mars and Mercury are covered in them. Weathering and geological activities on the Earth have removed many craters.

Asteroids themselves are not immune from such impacts. Images from the space missions show that the surface of asteroids are heavily catered by impacts from other asteroids; some of these asteroids are nothing but a loose collection of minerals and ice. Asteroids also collide with each other and the debris from such collisions can fall to Earth. We have some knowledge of the constituents of the asteroids from spectroscopic observations both from terrestrial observations and space missions. Japan Aerospace Exploration Agency (JAXA) sent a probe in 2003 to impact on the surface of the asteroid Hayabusha in 2005. The dust from this impact was to be collected and due back on the Earth in 2007. After problems, it finally returned on 13 June, 2010 in Australia. There is some doubt, if the dust from the impact has indeed been collected or not, but despite the mixed success, the mission is a great technical achievement.

Lutetia at closest approuch

Launched in 2004, ESA Rosetta mission is on it way to meet comet 67/P Churyumov-Gerasimenko in 2014. On its way, Rosetta has imaged asteroid Stein from a distance of about 800 km, also imaged the asteroid Lutetia in the main asteroid belt, on 10 July 2010 from a distance of about 3200 km. From ground based observations we have mixed information on the nature of Lutetia, in some respect it appeared to be a very early object leftover from the formation of the Solar System and in some cases it appeared to reddish in colour and has a metal core, a typical reminiscent fragment of an larger asteroid.

Some of the meteorites show very similar chemical and geological make up. These are most likely parts from one asteroid or a group of asteroids. Their compositions also match that of a asteroid. On the other hand, some of the meteorites do not match any known asteroid and are probably from another part of the asteroid belt.

Types of meteoroids

There mainly three types of meteoroids

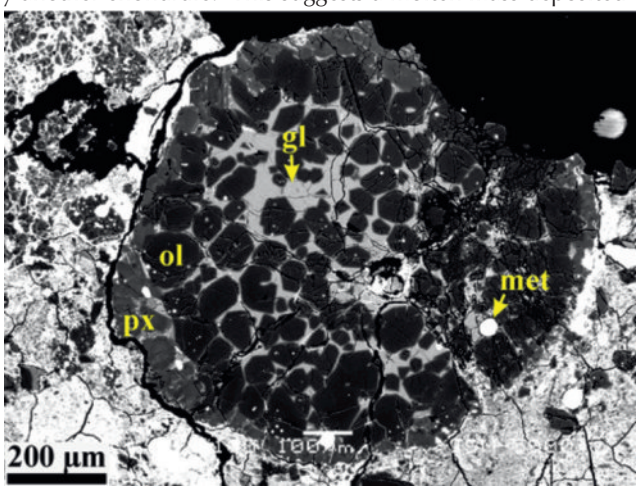
Stones, Iron and Stony–irons. We shall discuss these briefly.

Stony Meteorites

These can be either not melted chondrites, (Greek seeds) or melted achondrites

Some of the chondrite meteorites contain a reasonable amount of carbonaceous volatile compounds. The composition is somewhat similar to that of the Sun and is believed that such meteorites might have formed from the similar building blocks as that of the inner Solar planets.

Chondrules are nearly spherical and are about millimetre in size. The original material might have gown through a process of melting at a temperature above 1400°C to form these chondrules. Sometimes one chondrule can be covered by another chondrule. This suggests a molten mass deposited



This Scanning electron image shows a typical normal chondrule in a CR carbonaceous chondrite. Most of the grains are olivine crystals (black, labeled ol). They are surrounded by a glass (grey, labeled gl). Pyroxene (px) and droplets of metallic iron (white, labeled met) are also visible.

over an already solidified chondrule. There are two theories on how the melting of the material took place. When the solar system was in the nebulous state in its early life, shock waves could have melted the dust particles, or these entered in the early Sun and were then ejected by the magnetic field of the Sun.

One of the distinguishing features of the chondrites of extra-terrestrial origin, from the terrestrial rocks is that, the majority of the chondrites contain iron and nickel and hence these are magnetic. Had such a meteorite been melted, we would have expected the heavier iron and nickel to be present at the core the rock. But this is not to be the case, and the conclusion is that it has not melted since its formation.

Some of the chondrites also contain millimetre to centimetre size minerals rich in calcium, and aluminium. These are some of the earliest compounds formed. Their structure suggests that these froze from molten droplets or condensed from vapour without melting.

Minerals like diamond, silicon carbide, corundum, silicon nitride, graphite can also occur in chondritic meteors. This material forms in supernova explosions and the dusts from explosions floating in the interstellar space, got embedded in the forming Solar System. In one lump of meteorite there may be minerals from supernova explosions and material from different stars.

Some of the chondritic material can melt in the temperature range of 1000° – 1300°C. Once the process of melting has begun, the constituents begin to separate according to their densities. This process of separation is called differentiation. These meteorites raises questions, if such minerals were common in the early Solar system and their role in the formation of planets.

Iron Meteorites

Magnetic iron meteorites originate from differentiated asteroids. If the melting process is incomplete the iron meteorite is nonmagnetic. The main constituents of iron meteorite are iron, nickel, sulphur, carbon and phosphorus. In some iron meteorites, the nickel level is very low, in orders of parts per million, but in some other cases nickel content may be as high as 50%.

When polished and lightly reacted with acids iron meteorites show a characteristic crystal pattern called a Widmanstätten pattern. It forms during slow cooling in the temperature range of 700° to about 450°C. This pattern forms by diffusion of metal atoms in a solid state. Similar patterns sometimes occurs inadvertently during metal processing, but are best avoided. The thickness of the platelets in the Widmanstätten pattern gives an idea of cooling rate. If sulphur is present, then it forms iron sulphide.

Stony–Iron Meteorite

As the name suggests, the stony–iron meteorites are mixture of minerals and iron alloy. In one group these meteorites; the formation does not involve a melting process. The consensus is that these are from at the core-mantle boundary of large asteroids. In the other group, there is nearly equal amount of iron alloy and minerals. Minerals in these meteorites seem to have undergone a melting process. It is likely that these are from asteroids which were molten and also possible collided.

Lunar Meteorites

Since the Moon is our closest neighbour, it is natural that people believed that all meteorites are from the Moon. But the camera network to find the trajectory of meteorites suggested only a small fraction of meteorites are from the Moon. One meteorite found in Antarctica in 1981, matched the rock sample brought back by an Apollo mission. The pale region of the Moon is from calcium rich minerals and the dark regions are from basaltic mineral. We know of the nature of the lunar surface not only from the Apollo missions but also from remote sensing. Human landings on the Moon have covered only a tiny area of the surface, but from the lunar meteorites we know about other areas not visited by the Apollo mission. Lunar meteorites contain more nitrogen and noble gases compared to a terrestrial mineral. Since the Moon has no atmosphere, the Solar wind bombards the surface and embeds these elements in the Lunar system.

Meteorites from Mars

There are some meteorites which are somewhat different from meteorites from asteroids. The main differences are

1) The minerals in these meteorites are from a parent body that has gone through a melting process. But we have seen that such melting can also occur in the asteroidal meteorites.

2) The chemical make up of these group of minerals, form a distinct pattern and is different from similar minerals of know sources.

3) If the minerals form from the molten rocks, we can state the age of the rock from the time it solidified. Meteorites from asteroids are about 4 billion (4,000 million) years old, but one group of meteorites are about 1.3 billion (1300 million) years old. This young mineral can form in a large body, which remained molten for a long time, such as a planet.

4) Some of this group of meteorite contained dark glassy material. Glasses often form during fast cooling. Analysis of gasses trapped in these glasses matched very well to those analysed by the Viking lander. It is likely that and an asteroid or a comet hit the Martian surface at a shallow angle, and the ejecta eventually landed on the Earth. We can rule out the possibility of other sources. The atmosphere around Venus is very thick. It is unlikely that any ejecta will leave Venus. Jupiter's moon Io shows volcanic activity, but it unlikely that anything could escape the gravity of Jupiter.

One of the well known Martian meteorite is ALH 84001, found in the Allan Hills region of the Antarctica in 1984. This mineral showed carbonates and organic compounds. Some of the features looked like fossilised bacteria. This meteorite has been looked by different laboratories around the world, but the jury is still out, if these features are really fossilised bacteria.

Why should we study meteorites

The asteroids and also the comets have changed very little since their formation at the beginning of the solar system. We have sent probes to asteroids and comets. Dust from comets has been collected, but on the Earth we collect meteorites, the broken fragments of asteroids. Obviously meteorites are easer to examine than asteroids and such information helps us to understand the formation of the Solar system. As we have seen, some of the meteorites are from the areas of the Moon, not visited by humans. Martian probes have given us some idea of Martian geology, ESA and NASA are planning of joint missions to collect Martian rocks, but on the Earth now we have samples of Martian minerals in the form of meteorites.

Further reading

Meteorites; C Smith, S Russell, G Benedix, Natural History Museum, London, 2009

WHAT DIFFERENCE DOES IT MAKE?

By

Dennis W. Spratley

"What *difference* does it make?" asked my companion, interrupting for what seemed the n-th time my vain attempt at an explanation. I was beginning to find it most irritating. Indeed, who wouldn't?

It was a bitterly cold late evening in the back-end of January and we stood in the almost empty pot-holed car park of the grim Victorian Church Hall. Only a handful of vehicles remained, including my companions sporty job and my very own old banger. The air was dry and crisp, a tad below zero, with just a whiff of the exhaust fumes from the almost frantic mass exodus of Society members that occurred at 21.00 hours after every monthly meeting. This rather indecent haste to vacate the building had always been a source of great puzzlement to me. After all, at every meeting the room was booked for at least another half-hour and the members had paid for it from their subscriptions.

Come to think of it, the room was always booked a half-hour before the meeting got started. What always held up proceedings at 19.00 hours was the persistent, unexplained late arrival of the Chairperson, whose imposing bulk finally cruised into the building and entered the meeting room with all the majesty of a Spanish galleon under full sail. A loaded briefcase hit the table at the front of the room and the well-known authorative voice called us to order, telling us to take our places, there being a lot to get through this evening, you know! Members scuttled to their seats. Guilt at having held up proceedings for a disgraceful twenty seconds or so was written over their concerned features. Amazing. Risking the gun-ports opening up and the galleons cannon being run out, I made a point of being always the last member to sit down.

But to return to the Society members and their mass exodus. This was a puzzle. Was it to rush home to grab their telescopes and, as proper astronomers, drive on to some distant dark-sky site? Or perhaps, as less hardy souls, to slump gratefully into a comfy armchair, mug of bedtime cocoa in their fists and slippers on their feet, to become engrossed in the latest astronomical book with its beautiful glossy photographs (courtesy of NASA) but with very little text. Or was it merely to view a video recording of *EastEnders* or *Corrie?* Undoubtedly, some of the more sociable souls had rushed off across the city for liquid refreshment at *The Moon & Stars,* their favourite water-hole. With the licensing laws being what they were in those days it was necessary not to waste valuable drinking-time. But why did no one ever want to stay behind to extend the animated conversation that took place at the coffee break?

Now, outside on the Church Hall car park, only the two of us remained and, had we been proper amateur astronomers, we should have been manning our telescopes under the splendour of the heavens. On that particular night, as was the case on most winter nights in that mean city, to speak of the splendour of the heavens was a travesty of the truth. Near the zenith gleamed a few pale stars either side of a ghostly, blue tinted vapour trail, now a ragged feather arcing across the vault. Of course, for all I knew it could have been a night of good "seeing" at some distant dark-sky site but here in the grim city the sickly yellow haze bathed the sky. In the distance was the incessant rumble of unseen traffic where motorists happily contributed to the smog, and all around were the silent inefficient streetlights whose output illuminated the smog, the cosmos, and with what power was left over, the streets. No doubt in urban gardens the plant life and the unfortunate non-migratory birds were being forced to stay up late under the glow of the now fashionable garden lamps. Will flora and fauna adapt or, like the astronomer, be driven out? Yet on that freezing cold night these issues were being driven from my mind. I had more pressing problems than the campaign for dark skies and insomniac birds. For one thing, my feet were getting frostbitten.

The discussion had started during the coffee break in the cosy warmth of the Hall. As seems to be common in most astronomical societies, this short interval preceded the main talk of the meeting and was always the time for ritual pseudo-scientific chitchat. Small groups of members gathered together to discuss topics of mutual interest. The very small group to which I belonged was without doubt something of an anachronism. For a start, we were all retirees and consequently, like the accountant in the *Monty Python* sketch, too boring to be of interest. The row of seats at the rear of the hall where we always sat had been dubbed the 'park bench' or 'codger's corner'. Then to confound matters, we were not regarded as being 'proper' amateur astronomers. Our status was as mere 'amateur theoreticians'; something of a contradiction in terms, I suppose. Well, that is what other members thought of us. It was not too bad a description. Of course, we didnt know of any others, which probably a good thing. To make matters even worse for other members, not only did we discuss, we argued, especially when the subject was one that always seems to arouse passions — *cosmology.*

Yet this evening had been different. Something quite remarkable had occurred. All concerned were of one mind that the Universe was in some state of expansion. Not one of us entertained the view that the red-shift of the light from

distant cosmological objects was due to anything but their recession, give or take, of course, a little bit due to so-called 'peculiar' motions (I have always thought it peculiar that these motions are called peculiar). For example, there were none amongst us who gave support to the so-called 'hypothesis' of *tired light*. This is the idea – there is no physical basis for it at all – that light, in travelling across the vast reaches of inter-galactic space over billions of years, becomes somewhat knackered due to loss of energy (well, who wouldn't be?) and thereby having its wavelength lengthened. Over the years the tired light idea has remained popular. Well, its so easy to understand. Perhaps there is a soft spot for something that clocks along at 186,000 miles per second for billions of years. That no one in our little group gave the *speculation* of tired light - its no theory - any credence was as amazing as it was gratifying. Unfortunately for enthusiasts, the idea of tired light simply does not work but I wont go down that path. So, given such a consensus of opinion, one might have expected that nothing contentious could possibly arise. Oh dear, No! This had proved quite impossible. The sticking point had been and still was between my present companion and myself.

So strong were our opposite views that both of us had renewed our 'discussion' after the evenings proceedings had ended. The others of our little group had wisely withdrawn at the Society's witching hour of 21.00 hours and were part of the undignified mass exodus. Owing to their advanced years, they were of the category heading for their cocoa, comfy armchair and slippers. I should have had the good sense to do likewise but in those days I was prone to get the proverbial bit between my teeth. So now I was out in the cold with the old gnashers beginning to chatter. And at the same time I was continuing in the vain hope of convincing my companion, who, I must hasten to explain, was not a resident of the 'park bench'.

Oh dear, No! He was in the full flush of relative youth, enjoying bachelordom, brain still honed by and for the cut and thrust of the aggressive workplace. This was in stark contrast to the 'park-benchers', including myself. Having been forced by ill health to retire some time ago, it was inevitable that I had lost what few sharp debating skills I ever had. Now, I preferred the calm, sedate and genteel environment of the 'park-bench'. The other bus-pass holders felt the same. We agreed that it must be a bit like moving from the Commons to the Lords. There was another parallel here. This was reflected in the inevitable nodding off during boring lectures. But in fairness to the park-benchers, it was noticeable that it was the youth of the audience that was sent into a deep coma by the insidious modern type of lecture that has lost the relationship between lecturer and audience. This is the hi-tec version of a boring slide show. In these modern lectures the laptop computer has usurped the old-fashioned slide projector. In effect, it is merely like watching a film. Yet, because it is all hi-tec, it is fashionable.

But I digress! Far worse for me that night was not the youthful vigour of my present companion but the fact that he worked at the local University. Consequently, from the start of any discussion, anyone who challenged him was disadvantaged in the minds of other Society members. Well, anyone on the University staff had to be right, didn't they? Not quite; I suppose that had any member of the Society been a specialist in the university's Department of Outer Mongolian Pottery or engaged in painstaking research for a PhD on the mating habits of the Antarctic whelk, things just could have been different. Society members might have harboured a sneaking suspicion that in certain areas of astronomy such members knew no more than they did. Alas, on that fateful night, this was not the case. Oh, no such luck, Im afraid! My companion worked as a technician in the Department of Physics. This had always been sufficient for the majority of the Society members to regard him with a sort-of mild reverence. The Chairperson and entourage were delighted to have him as a member. Only a few were less enthusiastic. One park-bencher asked why it was that those in educational establishments took it for granted that all outsiders knew less than they did on any subject. So, in any public argument one might have had with my present companion, the playing field was anything but level. And in private, because of his supreme self-confidence he could move the goalposts as well! Was it because of his involvement with the University's scientists that he was so very self-assured in his personal views? I was never sure. The alternative, that the top men around him were the source of his 'knowledge', was too alarming to contemplate.

So, just what was the contentious issue? Well, our sticking point was that we were in total disagreement in our different explanations as to the very nature of the expansion of the Universe. He could not get his head around those *model* universes that explain the universal expansion as being the *expansion of space itself*. Or put another way; the galaxies observed at the present epoch are not receding *through* space but are moving *with the expanding space*. It made no difference to him that these 'universes' are based on the theory of general relativity. And the trouble is that *it does make a difference, a very big difference*. In fact, one could say: not so much a case of all the difference in the world but all the difference in the Universe!

Over in the direction of the Church Hall a heavy door crashed shut and there was the jangle of metal. Those on duty for the evening were shutting up shop. All the harsh blazing lights of the Hall were now extinguished which I suppose contributed a gnats whisker of reduction in the citys sky pollution. The car park was now considerably darker. Beyond the Hall the black silhouette of the crouching bulk of the Church of The Right Ascension could now be discerned. Two people engaged in muted conversation emerged slowly from the shadows and walked past, giving us odd looks. Suddenly it seemed rather late. Moreover, the cold of the night was taking its toll and I found myself almost dancing a jig. The effect of my somewhat heavy coffee consumption during the interval was beginning to be potentially disastrous. And idiot that I was, I had allowed my option of nipping back into the Hall to be curtailed.

We had fallen silent during this little interlude. Then once more my companion pulled me back to what had been his starting point. It was a 'discussion' akin to a game of snakes and ladders. We had just slithered down again. On the other hand, this breathing space had enabled me to marshal my thoughts. Just what did he accept? So I

inquired if during his reading he had met authors who expounded on *expanding space* being the cause of the universal expansion. Well, yes; he had a recollection of reading something about it. Clearly, he had emerged from the experience unimpressed. However, he was quite correct, and I had to agree with him, when he said that other authors do describe the cosmological red-shift as being nothing more than the common or garden Doppler effect. And that is what he insisted was correct.

Well, of course, it came as no surprise to be told that he was familiar with the Doppler effect. Lets face it; anyone who isn't *au fait* with Doppler has not exactly got very far in physics, have they? Or astronomy! So, very briefly, we chewed over that bit of GCSE level science. We were in agreement. There was no need for us to discuss train whistles, or the urban cacophony of passing motorcycles, or ice-cream van chimes, all to understand the Doppler effect on sound waves, which is the popular route to an understanding of the Doppler effect on light.

All this is part of what is dubbed classical physics. Well, not necessarily; it all depends how it is defined, of course. By classical, I mean pre-1900 or thereabouts but I am not going back to the Ancient Greeks. So, along with quantum theory I exclude relativity theory from classical physics. Strict definitions mattereth not so long as ones boundaries are made clear. Doubtless, this statement could result in a good dose of the proverbial coming my way!

As far as classical physics is concerned, history tells us that we have to thank Galileo Galliei for literally starting the ball rolling. Well, balls actually; he sent them down inclined planes in what was his lab. And, so we are told, for good measure he chucked them off the Tower of Pisa. Lucky for him there was no Health and Safety Executive around but apparently the good citizens of Pisa were not too happy about it. Galileo laid the experimental basis and later, of course, our very own homegrown Isaac Newton produced his whopping great book, *Principia,* the foundation of classical physics. Amazingly, Halley had to twist Newton's arm to get him to publish. Editors note!

Now, classical physics is supposedly based upon 'common sense'. But in Galileos time common sense was the dogma of the Aristotelians, enforced by the Church with its 'believe or burn' rule. For any progress to be made in what we now call physics, all this dogma had to be swept away. The task is still unfinished. What's more there is a long way to go. I recall standing in a queue at a supermarket checkout. It was way back just after July 20th 1969. In front were two young unnatural-blonde things. You know the type; all bust and bum, regulation tight mini-skirts and jaws working furiously on the cultural gum chewing. The precursors of ladettes, I suppose. Quite an eyeful! But it was my ears… and the brain behind them… that were reeling with shock. The girls were nattering away about the Apollo XI astronauts! Amazing! So, they were caught up in the universal excitement. What a surprise! How gratifying! I was tempted to speak to them but hesitated. As I did, one shifted her wad of gum and uttered: *"Well, I looked at the Moon last night and couldn't see owt of 'em"*. The other thought carefully. *"No, you can't see nuthin. But I don't understand why they don't fall off!"* I have often wondered if they joined an astronomical society.

But this duo… bless them!… simply had a worldview that was not even Galileo-Newton. And they were applying their 'common-sense' to an unfamiliar situation. They are extreme examples… well, aren't they? Yet a full grasp of classical physics still eludes many despite their education and having a better worldview than the two supermarket beauties. I can recall society members who knew the distance to and size of the Moon and why the intrepid astronauts couldn't be seen or fall off it. But they failed to understand why a spacecrafts rocket engines can be cut, leaving the craft to coast on its journey. Like Aristotle, they thought that the natural inclination of a moving body was to come to a state of rest. Well, everything on Earth does so, does it not? Nowadays, no such misunderstanding will be found amongst members in any astro-soc. Or will it? Perish the thought!

Not surprisingly, my companion on that dark, dismal night was well versed in classical physics. Well, lets face it; his job depended on it. Indeed, as had mine. And I was pretty sure that in his own personal educational steeplechase he had cleared the next great fence. This is the barrier where, over the years, many, many students have become cruelly unseated. Others have baulked at even attempting the leap. This is still happening and will continue so to do. This nasty fence is, of course, relativity theory… more precisely the *special* theory.

Now, in many texts… not just in the 'popular' variety but also in students' books… explanations of special relativity abound with observers rushing around empty space at constant relative speeds… presumably these days this activity can be envisaged to take place in one of these inter-galactic voids, far away from matter, radiation and gravitational fields… carrying meter rules, clutching clocks and flash-lights and sending light signal to each other over unlimited distances. Its traditional. This *particular method*… there are other roads to relativity… is also very good in enabling a quick start up the jolly new learning curve. But the student faces a first great obstacle. This is being obliged to take head-on the hard fact of *the constancy of the speed of light.*

This mental adjustment really can hurt! But there is more pain to follow. Relativity theory *and its experimental testing* has forced scientists (and we lesser crack-pots with an interest in the subject) to accept that space and time are not as laid down by ether 'common sense' or classical physics! So, after years of study at school spent slogging away under the tutelage of the physics teacher, the students at university are told there is some 'un-learning' to do. The message is that: "the two gentlemen whose work you have been studying for your A-levels were not quite right, you know. But don't be downhearted; Galileo-Newton theory is a rattling good approximation. That is why all engineers are quite happy with it. Now… pay attention! Listen to what Herr Einstein and others have to say. They've made drastic changes to physics. And you had better master all this or you won't be able to understand quantum theory and then you won't be able to work in lovely projects in electronics or go to wonderful places like CERN to make life hell for poor little unassuming sub-nuclear particles!"

Clearly, my companion *had* paid attention. During coffee break, an event that now seemed a lifetime ago, he had argued that if a bunch of photons from a distant galaxy

entered an astronomer's telescope they would pass down the 'tube' at the speed of light. All of us… the park-benchers… had agreed. This is the *constancy of the speed of light.* When measurements are made *locally,* the experimentalist will always obtain this value. Also, the light that passed through the telescope to the spectrometer we took to be red-shifted. Had we not agreed on this point there would have been no 'discussion'! From this measured red-shift my present companion was quite happy to conclude that the galaxy was receding from the Earth. Once again, all had agreed. Then we imagined an alien scientist… presumably long dead… on planet Zog in this distant galaxy who had measured the speed of light *over a 'short' distance.* That is, a length akin to that of the Earthly astronomers telescope. What value would be obtained? Well, there was a little tricky discussion about Zogian units but this can be overcome and we agreed the answer would be *the speed of light.* This is the principle that the speed of light is a *universal constant,* meaning that whatever ones time and place in the Universe, this is the value obtained. So, for the very last time, we all agreed. But controversy was looming.

One member of our fraternity of park-benchers had been thoughtfully sipping the hot water and adobe brick-dust that passed for coffee at the Church Hall and musing over the huge time-scale involved in photons travelling from Zog to Earth. He argued that the recessional velocity of the galaxy was not required for any calculation; all that was needed was Hubbles red-shift/distance law. We have the red-shift, so the law gives us our estimated distance to the galaxy *at the time* when the light set off towards the Earth. Correct? We all nodded sagely. Then it was stated that the photons traverse the galaxy-Earth distance in a time equal to this distance divided by the speed of light. Correct? There was a faint half-hearted murmur of approval from a couple of members who clearly werent too sure. Then an old acquaintance passed the buck to me. Wearing a huge grin he said that he felt sure that I would not agree. And he was quite right! So for the next few minutes there was heated debate, with myself trying to put forward the reason for this misconception. Someone pushed another cup of 'coffee' into my fist. He said that I looked in need of it.

I had been insisting that, depending on how far away the galaxy was, it could take light much longer to reach the Earth than given by this naive calculation. My point was that, *relative to the Earth,* the photons just leaving the distant galaxy had a speed equal to the speed of light *minus* the recessional speed of the galaxy. That produced a snort of disbelief from our technician colleague. Such a statement was to him a complete heresy! But to understand this seemingly rather shocking result that appears to cut across the basic tenet of relativity, it is necessary to see the universal expansion as being *the expansion of space itself.* Receding galaxies are moving *with* the expanding space and not *through* a static space. That brought about a lively exchange amongst us, useless of course because, like a bunch of politicians, everyone was trying to talk at once. It was then for the first time, I heard what was to become that ear-grating phrase:

"What difference does it make?"

Discussion came to an abrupt end with a loud authorative order to take our seats for the main talk of the evening. Conversation ceased and members hurriedly made for their seats. I strolled back to codgers corner and waited for the inevitable introduction of the speaker. The Chairperson informed us that our talk was by someone who was a long-serving member of the Society and needed no introduction, then promptly launched into a lengthy and detailed one.

Eventually, I lost interest in the talk. Once again a Society member and spouse had globe trotted to see the latest solar eclipse. This time it had been non other than the Society Treasurer. Innumerable slides had been made of which only about a half-dozen actually showed the eclipse. The rest were nothing more than cringingly boring holiday snaps: arriving outside the airport, our taxi-driver, the hotel, our room, the restaurant, sunset over the Pacific, some nice people we met, the Plaza, the drive through the desert they were all there in colourful monotony. After the eclipse slides were viewed many of the audience were in torpor. As for myself, I was thinking about the discussion during coffee break. Had there been an absorbing lecture, I might have forgotten all about it and gone home to my comfy armchair and mug of cocoa. Such is the fall of the Dice. Einstein said God doesn't throw them. Well, maybe its Old Nick!

So I found myself ruminating as to why there was… and still is for that matter… so much misunderstanding in the basics of cosmology. The answer is simple. It is because within relativity theory there is another great fence to clear. This is the so-called general theory, which, believe it or not, is a theory of gravitation. What is so acute here is that, for the student who wishes to continue studying relativity, there is yet more 'un-learning' to do! Once again, it means that the student, or indeed anyone who has tried to master some understanding of relativity theory, has to swallow the bitter pill that the special theory is *restricted.*

Oh, Yes! It applies only over restricted regions of space-time. Also, it is strictly valid only in the complete absence of a gravitational field. *And it cannot be applied over cosmological distances and time-scales.* Actually, this should come as no surprise. In the popular way of setting up the special theory, those imaginary intrepid observers, armed with their metre rules and clocks, are in a very artificial environment and although whizzing around in their space are restricted to be *not accelerating* relative to each other.

But the Universe is filled with chunks of matter; gravity is everywhere, so the situation of mutual accelerations between masses is the norm. Cosmologists take it for granted that the physical system we call the Universe is dominated by gravity. So to obtain nice mathematical models of the Universe, they use the general theory. And certain models demonstrate *the expansion of space.* As for the special theory of relativity, well after all the toil in mastering it, the hard fact is that it is an approximation. It works on the Earth's surface because by astrophysical standards the gravitational field of planet Earth is very, very weak, even if a free-fall parachutist with a 'chute malfunction and no reserve will not find this interesting fact at all comforting.

But to return to general relativity as explained in

popular texts. In my experience it remains a sad fact that, despite the best efforts by professional scientists and science writers, understanding amongst the lay public remains poor. In popular books and articles on cosmology, the recession of the galaxies is usually demonstrated by means of a picture of a child inflating a spotty balloon… or is it a spotty child inflating a balloon? Well, if the spots, which represent galaxies, are made on the balloon using a marker pen, then as the balloon inflates, they will grow apart but unfortunately they will also grow in size. This is incorrect; the galaxies do not expand. So instead of spots, the 'galaxies' must be tiny discs stuck on to balloon. The spots can stay on the child.

All this seems something straight out of the nursery. But mock ye not! This well known model… although not the mathematical kind… has some interesting and informative features. Space, as represented by the *surface* of the sphere, is curved. It is also *closed,* but I won't go into that. If you don't want curved/closed space, then choose flat space by replacing the balloon by an infinite rubber sheet… assuming, of course, that you can visualise it! Now, it is easy to see that the only motion of the stickers on the balloon is due to it being inflated and that the distance between any pair of stickers is increasing with time. But wait! What is the exact meaning of the distance between any pair of stickers? Note that in everyday Euclidean space, by the distance between two points we mean the *shortest* distance, or as our forbears said: as ye crow flies. On the balloon things are different. Well, we are dealing with a curved surface. But the answer is not difficult. For a non-expanding balloon, take a fine white thread and hold it *taut* over the balloons surface between any pair of stickers. Then take a black marker pen and using the taut thread as a guide draw a line between the stickers. Also, mark the thread at the two points where it crosses the stickers. A helping hand or two might be needed here unless you're an alien. We can now see the black line that shows *shortest possible* distance between the stickers *provided we stay on the balloons surface.* And the measured distance between the two stickers is that between the two marks on the thread now removed from the balloon and made taut again. The mathematician calls this curve of shortest distance a *geodesic.* Sounds complicated but it isn't. The word is merely a label, although an appropriate one. Examples are on a globe of the Earth; the equator and any line of longitude. If you haven't heard of those, well…!

But what about the Hubble Law? Well, starting with the balloon already inflated, let it be expanded a little more. Intuitively, the greater the distance between two stickers, the greater they have moved apart. This could be seen to be more precise if we had a nice well-shaped balloon, ideally spherical, which is not very likely in practice. But with a spherical balloon *before* and *after* it was further inflated, the *proportion* by which any distance increases is the same all over the balloons surface. If it were not so, the spherical balloon would go out of shape, which is not on, as they say. Why? Because cosmologists take for granted that the homogeneity of the expanding Universe always was, is now and forever will be, Amen. So the Hubble Law is due to these basic assumptions.

Regrettably, at this point in describing the cosmic balloon model many authors miss a trick. This is a cunning and extremely informative addition but is something we have to imagine rather than being able to perform the experiments. Firstly, consider again the case when the balloon is not being inflated. We introduce Randy (for Randolph), a little beetle who does one of two things in his exciting life. Either he sits quietly munching on a leaf or rushes off at his only speed, which is strictly constant (beetle-speed) in an attempt to find a mate. You know the sort. In addition to his natural abilities, Randy has received advanced training. He has been taught to stay still on one of the stickers (Sticker 1) then on command, head off at unerringly at beetle-speed towards another distant sticker (Sticker 2). Randy achieves this by following the black geodesic drawn between the stickers. It is rumoured that this can be satisfactorily achieved by coating the black geodesic line with female insect pheromone but I remain somewhat sceptical.

We now play a rotten, dirty trick on poor Randy by inflating the balloon as he carries out his task. (Incidentally, should anyone succeed in performing these experiments, I would be delighted to be invited to see a demonstration). Now, it is arranged that, as Randy's journey starts, the distance between the stickers is the same as in the above static case. Suppose we choose *any* point on Randy's geodesic path between the stickers. Then he would be clocked as passing over the surface *at this point* at beetle-speed. This is his *local* speed. However, note that due to the expansion of the balloon, *this* point is moving *away* from Sticker 2 at a speed that depends on how far this point is from Sticker 2 *at that instant.* This speed is obtained from the Hubble Law for the surface of the expanding balloon. Subtracting this speed from beetle-speed gives poor old Randy's *effective* headway speed towards Sticker 2 *at that instant.* As Randy makes his enthusiastic journey, more space is appearing ahead of him. Life's tough on an expanding balloon!

But one thing should be clear from this description of Randy's exploits. When the balloon is expanding it *will* take a longer travel-time for him to make his journey from Sticker 1 to Sticker 2. Likewise, a photon *will* have a longer travel-time from a distant galaxy to Earth than would be given by the calculation outlined during coffee break.

As for the cosmological red-shift of the light, well this is an accumulative effect on light as it propagates across cosmic space. In the same way as space is stretching, so is the wavelength of light. Lets make use once more of Randy and his balloon. Firstly, return to this model when the geodesic line was set up between the stickers. Repeat the process but now represent the geodesic by a series of *equally spaced dots.* As the balloon is inflated, these dots will slowly separate but they will remain *equally spaced.* This is the view we get looking down on the balloon; a sort of gods-eye view. On the other hand, at beetle-speed, Randy will be 'tearing along the dotted line'. As he makes progress, assuming that his mind is not solely concerned with his destination, he would see that the separation of the dots as they pass under him is mysteriously increasing. If the dots represent the interval between two successive crests of a wave, it can be seen that the wavelength is being steadily stretched.

When the meeting ended and as the Society members fled the scene, my technical colleague and I gravitated together. It was clear that both of us wished to continue

the discussion. It seemed that the talk had not been his cup of tea either. Had he drifted off into a deep reverie about the deep issues of cosmology? Not exactly; I was still facing someone for whom the expansion of space itself was a completely unnecessary and barmy construct. He was keen to do battle.

It was as we wandered out into the night that he changed tack. For good measure he added that even if the expansion of space were the reason for the recession of the galaxies, there was no way that astronomers could prove this to be true. They could not exactly measure it, could they? This was a fatuous argument. It is the *observed consequences* that are measured. Indeed, his criticism applied to all of observational astronomy. After all, I pointed out, the *observational* astronomer is like the man in the strip-joint. He can look, but not touch. Like grand old Queen Victoria with Mr. Disraeli, he was not amused, as most likely are my present readers. Assuming, of course, that anyone has read this far. But hope springs eternal!

It was then that I myself decided to change tack. Throwing aside all analogies, I turned technical. Well, I had to. One serious disadvantage of discussing expanding balloons with beetles legging it across their surfaces is that it only works when it is being used on a receptive audience. Otherwise whoever is expounding it is open to searing ridicule, like a third-rate entertainer in a Northern working-mans club. Yet to be fair, it is perfectly reasonable for an unbeliever to ask: How do cosmologists come by these zany ideas? Good question!

Well, since curved space has long been a buzz phrase, it should come as no surprise that the first step in the setting up of *general* relativity was the throwing overboard of good old-fashioned Euclidean geometry. That which we all grind through at school. Painful! But to enter the black art of general relativity, this means yet more 'unlearning' for the student. Even more painful! Now, in general relativity, Einstein asserts that the appropriate geometry to describe the Universe is what is known as Riemannian (named after Bernhard Riemann). So, was old Euclid spouting rubbish? No! It works out that Euclidian is a special case of Riemannian geometry and… lo and behold… Euclidian is the geometry of the space (but not *space-time!*) of special relativity, which is a special case of general relativity. What could be neater? So, no aspiring student need feel suicidal… well, not yet.

Now the general theory of relativity has been described as impenetrable. I am not about to quarrel with that. It's the maths, you know… all post grad stuff. Yet, quite remarkably, all this advanced stuff is not needed here. Although the mathematics of the expansion of space is not everyones cup of tea, it should be well within the grasp of anyone with a good A-level. The basic ideas of Riemannian geometry describe three-dimensional homogenous expanding *space*. But they are applicable also to the two-dimensional *surface* of the inflating spherical balloon! That is a fact. And for that reason, the inflating balloon model with the spotty child is not childish at all. It is a description based upon the maths but without the maths. Yet on that cold January night, without the aid of good old-fashioned blackboard and chalk it was this maths that I was trying to get across to my companion. Crazy, man!

And it was soon obvious I was getting nowhere. Well, I had been getting nowhere since coffee time but my fresh tack was also failing. Could it be that I had drifted into the mistake of waxing too technical? I am told that it is a fault I have. Yet I must ask the reader to consider how one can possibly keep ones concentration whilst giving what was in effect giving an impromptu tutorial on a one-one basis after dark in the middle of a freezing car park. Especially when being no tutor, having grown weary, and suffering from the serious effects of over indulgence in what passed for liquid refreshment at the Church Hall. Added to this was the suspicion — it was rather dark — that my companions was thoughtfully picking his nose. He was not even bloody listening!

I had run out of steam and stopped speaking. There was a sudden silence broken only by the night sounds of the city that had gone on unnoticed whilst we argued. I waited for my companion to utter something. He did.

"Yes, but I mean. What *difference* does it make?"

I quit. My departure was somewhat abrupt. I muttered something unintelligible to the effect that I really would have to go. It was very late and 'Er Indoors would have expected me home some time ago, was my rather lame explanation. I recall that he looked rather astonished. Then followed the usual pleasantries about seeing each other at next months meeting. In fact, I have never seen him since that night. It is quite on the cards that he went away with the view that I had capitulated. Once I might have felt quite annoyed by the prospect but at my age, no longer. In one real sense I was rather annoyed with myself for once more having been drawn into the verbal equivalent of a punch-up. With my adversary the whole point of this futile exercise was not the resolution of a difference of opinion or even an understanding of the opposite point of view but merely endless argument and futile point-scoring. He would have done extremely well at Westminster.

It was some time before I felt the welcome effect of my car heater. I was obliged to crouch over the wheel nursing my predicament. All thoughts of cosmology faded from my mind. My route out of the city was changed to avoid the build up of traffic at this time. There was no chance of finding what the Victorians termed a convenience.

Vandalism, and to a certain extent, unsavoury goings-on had resulted in their being boarded up. And the City Council, in its infinite wisdom, had made sure that they were always on double yellow lines. But the pubs were emptying. I thought of dropping into one. Just past the sprawling complex of the police station was *The Pig & Whistle,* a favourite haunt of the local arm of the law after a shift, as in *The Bill* when they all troop off to the Sun Hill boozer to celebrate nicking a few more villains. I drove past. Stopping there was not a good idea at this late hour. Call it a guilty conscience if you like. At the next roundabout I made a left turn to avoid the dockland, which was the direct route. It was not a good move. I was approaching the Army Barracks. Ahead I could see that there was a commotion, with a blaze of flashing electric blue lights clustered around The *Axe & Pikestaff*. Clearly, tonight there would be fewer propping up the bar in *The Pig & Whistle*. And it was not even Saturday. Then I had to stop behind a massive truck. A queue formed. Time passed. Motorists fumed, engines idled, and tail pipes

fumed. More obnoxious muck rose slowly heavenwards to contribute to the smog. I switched off my car engine. Before me the diesel powered engine throbbed, the truck half obscured in a haze a vapour loaded with particulates. It began to enter the car and, as a lifetime non-smoker, I felt really brassed-off! I was being gassed, the car heater was off and the temperature was plummeting. I felt that I was on Mars or whatever. The recollection of a lecture on terra-forming that planet came to mind. All serious stuff but all futile; the way things are going we will soon have to be terra-forming planet Earth. Time passed. I was nearly too numb to hear the bells of a couple of ambulances. What was more, I was paying the agonising full price for Church Hall coffee.

As chaos around *The Axe & Pikestaff* was abolished and relative sanity and relative law and order restored, for the first time I really became aware of the incandescent brightness of the city. It was also an occasion for a further wave of disillusionment. We could reach the Moon, we were reaching for the planets, and we wanted the stars but society was crumbling and we were buggering-up the planet. And yet, as astronomy nerds, we are all witnessing and thoroughly enjoying this so-called Golden Age of Astronomy. But this research owes its existence to the quite incredible technological advances made during and in the decades since WWII. And this research has been made possible only by the vast economic-industrial-military complex of the developed world. In turn this world has an insatiable hungry for energy that was going to cost us our biosphere. You can't have your cake and eat it.

Twenty minutes later, having crossed the river bridge, I was clear of the city and all its diverse cultural activity. The short suburbs slipped behind me. Now I was desperately looking for a dark site. The actual state of the sky over it was of no concern to me. As I climbed up the twisting road into the hills, I caught glimpses of the sprawling city below. I pondered as to what is the total wattage lost into the void of space. Well, have not we all? I do not imagine that working it out is difficult, only an exercise in mind-blowing tedium. The traffic had thinned. I had added to the light pollution with my main-beam headlights. Yes, we all contribute, do we not? A signpost slid by. It pointed down a country lane to the little sleepy village of Nether Hogsbottom wherein dwelt the Chairperson of the Society, presumably now safely tucked up in bed. Partly responsible for the existence of the park-bench, the Chairperson had a strongly enforced personal policy within the Society that unashamedly discriminated in favour of those in the flush of youth and, for whatever misguided reasons, those recently drawn to astronomy. Consequently, by default the older members suffered neglect. That is the trouble with positive discrimination. There is a lesson here from physics; an increase in positive energy has to be balanced by more of the negative variety. I drove on, muttering. It amazed me how very different are individual astronomical societies but then my thoughts returned to the more practical matters in life. My final chance of a pit stop at a pub came into view. However, this was denied me. In those distant days the licensing hours were very different. The ground floor was in total darkness and only a single upstairs light gleamed at *The Bishop & Actress*.

I found my dark-site just off the main road. It was a great relief so to do. As I tumbled out of my car, I had half expected to find fellow nerds of the observational variety… the 'proper' astronomers… happily using their equipment, but it was not a dark-sky site; for celestial observations just not good enough. But it was good enough for my purposes. Also, in those far-off days the no danger of an over zealous police officer hell-bent on showing one the red card and issuing a fixed penalty or whatever for exposure. Since then this sort of procedure has developed into a new moneymaking scam; fines have become taxes. They will tax anything. Was it Benjamin Franklin who said all one could be sure of in life was death and taxes? I wonder if they will slap a tax on telescopes? Well, they did on windows, did they not? Perhaps the tax-rate will depend on aperture size. Or perhaps based upon usage, with a spy satellite monitoring the telescopes computer activity. One can imagine lights burning late into the night in Whitehall as the powers work on methods to implement that government policy. There could well be a knighthood and a fat bonus for someone.

To the north the sky glowed. The city lay before and below me. What struck me was the number of illuminated public buildings. The City Council was playing its own enthusiastic part in ruining the skies. Yet they were not alone. In the centre I could see quite easily the huge towering pile of the ancient cathedral. This was hardly surprising. At its base must have been the equivalent of several batteries of WW II searchlights. A cynical thought struck me. Such a brain-event is, of course, nothing new with me, as my acquaintances will gladly confirm. It seemed to me that over the centuries the Church has always looked to the sky for inspiration. This has been reflected in Christian architecture. The beautiful slender gothic spires have for the uninitiated masses pointed the way to heaven. Not very difficult to grasp in the days when the Ptolemaic system was the received wisdom.

I have to point out that I am one of sufficient years to have been obliged to endure what in my very young days was euphemistically known as Sunday school. Being sent there was the dictat of my mother. It was a torture imposed after five grinding days at a village school where religious instruction in the form of Christianity was mandatory. It was the first lesson of the day. Called Scripture, this came *after* a religious based assembly that started on the dot at 9.00am. God help you if you were late!

A couple of hymns were bashed out an ancient worm-chewed harmonium. Well, there was a war on, you know. The music soared, the girls sang sweetly and we the boys raucously. A prayer was offered up by the headmaster, and then it was off to the classroom for Scripture where effectively I received my first insight into what much later I knew as Creationism. The schoolmistress who hammered this into us was a formidable six feet two tall, with short cropped greying hair, eyes like gimlets that could curdle the school milk and ones bowels from thirty paces, and the makings of a moustache. We were too terrified not to listen. I can still hear her resonant baritone. We never did understand why she favoured the girls but gave us boys a hard time. She drilled us in the traditional three Rs, for which I am eternally grateful, but I struggled with Scripture. One Biblical story I could never get my head around was Noahs

Ark and the Flood. Well, it didn't fit in with the Geography lessons! Quietly, I puzzled over how Noah managed to get hold of kangaroos in what we were told was Palestine. At home I read my father's science books and any others I could get my hands on. Thus was I saved.

So, I am well aware of the view of the psalmist who saw in the skies "the work of Thy fingers". All very poetical, of course but modern *astronomy* has exploded many myths. The universe is a truly awesome place with such violence and hostility towards life forms that it is difficult to see it as having been constructed specifically for our benefit or indeed any advanced life, never mind technological civilisations. It is not exactly "user friendly" - to give new meaning to that phrase. Perhaps the Church now sees it this way because what lies out there seems to be seen by our mostly secular society as a godless waste. The Church can no longer draw upon the skies for inspiration. So why not blot it out? Then again, probably the Church feels that if the modern concrete and glass civic buildings are given such publicity by illumination then it is only fair that so should its own timeless architecture. So, to hell with the night sky. Blast the ancient grey stones with photons and keep up with the Devil. Either that is the motive or the flood lighting is simply to prevent the lead from being nicked off the roofs.

I clambered back into my fourth-hand vehicle and drove on. It was then that I thought about the Campaign for Dark Skies. They were working hard and it seemed that they were getting some sympathy. But the only thing that was dark that night was my mood. I thought about the thrust to have more efficient street lighting. But the population was rising and this was before the UK became an open house. More people, more homes, more urban sprawl, and consequently there would be even more sprawling street lighting. Yes, I was having a bad night because I was thinking about the Campaign for Dark Skies and suddenly I thought the unthinkable:

What difference does it make?

The house was in total darkness. 'Er Indoors had long retired. She thought all astronomers mad. She has a point. Quietly I let myself in only to be mobbed by the dogs. Well, someone was pleased to see me, which was nice. When I had managed to exercise some control, I made myself another ritual drink, this time cocoa, and slumped down in my comfy chair for a think. I hadn't any slippers; the dogs had chewed my last pair, the ones I had just received at Christmas. 'Er indoors had not been best pleased. After a while, I stirred myself, having already done that to the cocoa, now cold, and found myself a notepad and pencil. It seemed worthwhile to jot down the basics of what I had been trying to get across to my companion. Later, it could be that these notes would serve as the basis for an article for the Society magazine. Either cosmology was to be the subject or instead I could pen something on light-pollution, a topic I had never attempted to discuss. For very different reasons both had made an impression on me that night. Cosmology won.

And indeed, I wrote the article but not that night, of course. On that occasion I began to scribble some notes, having gulped down the cocoa. Eventually it had its soporific way with me so that I actually nodded off in the great, true and honourable tradition of the armchair astronomer. Presumably, the video recordings of *Eastenders/Corrie* had been watched and the viewers were away to their beds as were those who had tumbled out of *The Moon & Stars* at closing time. And as we all slumbered, that tough dedicated bunch the proper astronomers had vacated their dark-sky sites; precious equipment ensconced in their car boots, and were making their own weary and frost blighted way back to the warmth and the bright sky polluting lights of civilisation.

A few weeks later the article was completed. All lovingly crafted in longhand, of course, because in those days I was too bloody-minded to own a PC or — according to my eldest son who eventually took pity on me and gave me his old one — too tight-fisted. Well, he has a point, I suppose. But in those days all was hand-written. So at the coffee break at the next Society meeting I forsook the old codgers in their usual huddle and sought out the Society's Editor to present him with my latest offering.

He sniffed and struck his usual languid pose. A few sniffs later he remarked that he thought he might make use of it at some later date. He peered at me over his glasses. "Not in the next issue", he intoned gravely. "You must understand that in the forthcoming publication the main slot is reserved for a resume of the treasurers trip to witness the last solar eclipse. Yes, I know you think that's old hat", he added. "But you must realise that an article about an exciting voyage by a long-standing Society member is preferable. And it's all his own work. Yes, yes, of course, I do realise that *this* is your own work but it is not your own experience, is it? In any case", he added, "it is doubtful whether members read any of the Society magazine articles with a view to actually *studying*. For Gods sake, were only amateurs", he snapped. "You're in cloud-cuckoo land." He warmed to that point. "It's the same with your ideas about the talks", he said. "Time was when we did have *lectures*", he mused, "but that was in the days when this Society was a *scientific* society. Now things are very different. Times have changed. People only want a night out, you know." He glanced down at my efforts, and sniffed once more. Then he handed it back and was gone.

Ouch! I slunk away, mouthing curses. Back home I licked my wounds, vowing never to write again. But two astronomical societies later I have accepted that Editors words. Now without a society, I am sort of freelance in my writing. I have produced some technical stuff but I am reconciled to the fact that the only reward for such material is the glow of satisfaction in crafting the article. Having it published is merely a bonus. But if it should appear in a society magazine, an article of a *'technical' nature* has no more worth than a few sheets of junk mail. It will not be read. That is my advice for any author aspiring to *make a difference*. As to the ramble written here, is any editor interested? Well, that remains to be seen! Doubt it! But at least its non-technical, all my own work, and based on my experiences. And writing it has been good fun!

The article in question was never published. Too 'technical'! The choice had been whether so to do or shelve it. It was shelved. That's a euphemism for being dumped. Today, I ask myself the question; do I continue to write anything?

After all:

What difference does it make?