Winter 2015/6 Number 10

Kielder Observatory Newsletter

KIELDER OBSERVATORY
Infinite Inspiration

It's gold!

NEWS
Top tourism award

SCIENCE
Dark Matter
Dinosaurs

OBSERVING
Highlights for Jan/Feb/Mar

CAN YOU SEE PRECESSION
over your lifetime?

EDITORIAL

New Year's greeting to you all. In this edition we finally find out what happened to the dinosaurs, take a look at that mysterious stuff Dark Matter, and follow one man's quest to view precession during his lifetime. Looking back, 2015 was an exciting year for the Observatory. We had the live broadcasts of the partial solar eclipse in March, and ended on a high by being awarded a gold medal at the North East Tourism Awards. Not that all has been plain sailing - as many of you will have experienced, severe weather hit the region in December, although the observatory itself was unscathed there were times when flooding curtailed access. Let us hope for better star-gazing weather in 2016!

Nigel Metcalfe

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newsletter@kielderobservatory.org

Kielder Observatory Astronomical Society

Registered Charity No: 1153570.

Patron: Sir Arnold Wolfendale 14th Astronomer Royal

Full Membership ..... £75 per annum

Friends of Kielder ..... £25 per annum

Kielder Observatory Astronomical Society is a Charitable Incorporated Organisation. Its aims are to

* Promote interest in the science of astronomy to the general public
* Facilitate education of members of the public in the science of astronomy
* Maintain an astronomical observatory in Kielder Forest to support the above aims

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DIRECTOR'S CUT

Happy New Year!

A great place to start with our first newsletter of 2016, I'm sure its going to be another superb year at the observatory with new staff and new events further demonstrating the importance of what we are doing. The new staff are now settling in. The new events are now taking bookings well into the new year, in fact we are experiencing a slight upturn in bookings, which is again testament to everyone's efforts in ensuring this wonderful facility continues to flourish.

As I said at our Christmas party, as well as in an email to all of our volunteers and staff, volunteer help is now needed more than ever. The increased staffing numbers does not mean that we can now no longer have volunteers - this is not the case at all. As the new events such as 'Planetarium in the Park' get started as well as the Wild Northumbrian events and Dilston , it is our intention to recruit more volunteers not less. So please think about joining us, your help is needed.

Early 2016 should see the construction of the new small observatory at the facility, the planning application is now in. We aim to have this up and running in the late spring early summer. It will comprise of a warm room and a small observatory with a high spec instrument - also the much needed coffee shop too. This will enable us to slightly increase visitor numbers at the observatory by 6 and also gives us the opportunity to do more during events, having the extra space to split groups and to be more specific on what we are discussing.

The main observatory redevelopment plan is still ongoing and is gathering pace now., I along with Rob Little and Jacqui Miller have been working tirelessly on the sales prospectus and, whilst this is a significant project, progress is happening and it is taking shape - any news and you will all be the first to know.

So I will end as I begun with wishing you all a happy New Year and I hope to see you all soon.

***Gary Fildes** (FRAS MSc Hon.Caus.)*

KOAS NEWS

AGM REPORT

The Annual General Meeting of the Kielder Observatory Astronomical Society took place in the Meeting Room at Hoults Yard on Saturday 31st October. Minutes will be circulated to members, but highlights included the report of a 35% increase in visitor numbers over the previous year, resulting in an extremely successful year financially. The Director reported on plans for a new building at the Observatory site, and also that it is the aim to expand outside the Observatory confines and deliver astronomy events elsewhere in and around the Park. On a slightly different tack, artist Tony Martin displayed some of his work and the idea of having artist-in-residence, or running art workshops was discussed.

TRUSTEE NOTES

The trustees met on November 9th at the KOAS office in Hoults Yard, Newcastle. Merchandising had been going well. and the calendar would be available for sale imminently. New products would be considered for next year. Two new staff were in the process of being appointed and interviews for an Operations Manager were to take place shortly. The plans for the new building at the Observatory were discussed - as well as a small observatory, it would house a purpose-built coffee shop, thus freeing up more seating space in the existing building. This would not impact on the main expansion plans, which were still very much ongoing, and the first draft of the brochure for the business case would be ready in December.

The 'Friends' membership scheme had not taken off as hoped, and ideas for improving this would be discussed at the next meeting.

The date of the next meeting will be February 22nd 2016.

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Want to help Kielder Observatory become one of the top astronomy attractions in the UK ?

For just £25 per year you can join the Friends of Kielder Observatory.
For £75 per year you can have voting rights at our AGM and access to two free events of your choice.
Contact membership@kielderobservatory.org for further details.

Gold Award

The big news since our last newsletter is that, following our silver last year, Kielder Observatory took the Gold award in the Small Visitor Attraction of the Year at the 2015 North East Tourism Awards held at the Civic Centre in Newcastle on November 24th. So a big well done to all our staff and volunteers! This gives us the chance to compete on a national stage against those winners from England's other regions at the VisitEngland Awards for Excellence. These are the most prestigious awards in English tourism and there are over 30 entries in the Small Visitor Category so it is going to be tough! We will know in February whether we have made it to the finals.

We have also welcomed two new members of staff, who are helping us to expand our delivery to the public. Luke Tyas, who used to work at the South African Astronomical Observatory (SAAO), has taken the post of Observatory Manager, whilst Becki Cooper has joined as a Science Communicator. Becki has worked mainly in the local tourism industry, and joins us from English Hertitage, but has always

OBSERVATORY NEWS

had a keen interest in astronomy. Luke is an astronomical instrumentation specialist, and did a postgraduate degree at Durham University on the 'Southern African Large Telescope High Resolution Echelle Spectrograph', before joining SAAO, where part of his role was Public Outreach.

Meanwhile, John Holmes should be joining us in the near future as Operations Manager, to take some of the load off the

Getting to Kielder has been proving a challenge at times!

Director and help us develop our ambitious expansion plans. John was the Director of Regeneration and Tourism at One North East, and is currently Head of Property at Durham Cathedral, so we are very excited to have John on-board.

We have various events coming up in the

2015 saw some surprise visitors to the observatory ...

next few months. 'Space Kids' (see http://www.kielderobservatory.org/events/winter-space-kids/ for details) will be running at half term (15th/17th & 19th Feb) and again at Easter (25th/28th/30th March and 1st/4th/6th & 8th April). Our popular events in the Ballroom at the Vermont Hotel in Newcastle will be held next on Sunday 31st January and Sunday 28th February. Tickets are now on sale for the January evening, which is entitled "The Solar System and Beyond", and will

run from 7pm to 9:30pm. Remember the Vermont are also offering a special room rate for those who wish to make a night of it. Also away from the Observatory, 'Wild Northumbrian' stargazing nights are planned throughout Feb, March & April - these will run fortnightly on Saturday nights and take place near Greenhaugh. Meanwhile, you can still find us at Dilston Physic Garden - dates will be announced shortly. Finally, a new venture for this year will be combined talk and planetarium shows at Kielder Castle using a mobile planetarium. Watch out on our website for further news on this.

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It's winter - that can only mean Orion!

* * * *

'Unfortunately the weather meant we couldn't do any telescope viewing which was disappointing, but what we learnt from the theory session was excellent and I hope to come back on a clearer night to be able to view everything through the telescope. The guys who led the course were excellent - we commented on the way home about how it was great that they were so passionate about their work, and SO YOUNG! A comment had been made about a Kielder mug making its way as far afield as Whitley Bay, you might like to know that my partner works in the Bahamas and he took his back over there with him to be pride of place on his desk in the Grand Bahamas shipyard!'

Rosie Whiteley

SCIENCE SPOT

Higgs, WIMPs and a time machine

If you hold an apple in your hand and let it go, then what causes the apple to fall to the ground? The answer of course is the force due to the gravity of the Earth acting on the apple. Isaac Newton was the first scientist to realise that the force making an apple fall to the ground in his garden also kept the Moon in orbit around the Earth. Today we take this for granted, but the realisation that a force affecting the lives of people also acted far beyond the Earth was a giant leap in our knowledge of the nature of the Universe. Newton in his book Philosophiæ Naturalis Principia Mathematica also explained that the gravitational force between two bodies simply depended upon two things: the masses of the objects and the distance between them. Newton's elegant theory of gravity was used to land man on the Moon over 300 years later.

In the intervening years we have made spectacular progress in our understanding of just how important gravity is. We now realise that not only does the force due to gravity keep the planets in orbit around our Sun, it also makes stars, moulds stars into galaxies, and determines the fate of our Universe. We understand everything there is to know about gravity and how it works.

Not quite. Whilst Newton told us that gravitational forces depend upon the masses of the objects involved, until recently all we had was an untested theory describing where mass came from. The mass of something tells us how much matter it contains, and we can measure this mass with amazing accuracy, but we couldn't say for certain what gave matter mass. This was a big hole in our understanding of the world around us!

Our best ideas of how things acquire mass are due to three scientists: the Belgian physicists Francois Englert and Robert Brout and the British physicist Peter Higgs. In 1964 they predicted that an invisible field fills the whole Universe, stretching from the room in which you are reading this to the most distant galaxies. This field would act like 'cosmic treacle' to all the matter in the Universe. This treacle is now called the Higgs Field. The theory says that all matter in the Universe notices this field, and the amount to which the field affects the matter determines it's mass. Think of a sky diver falling rapidly through the air. She notices the air rushing past her but the air does not slow her fall too much.

Figure 1: View of a city at night. We see only the lit rooms, but the unseen dark skeleton of the buildings must also exist. (Courtesy of Paulo Barcellos Jr., via Wikimedia Commons.)

In this analogy the Higgs field is the air filling the space around her. The sky diver moves easily through the air giving her a low mass. If the Higgs field acts like water this confers more mass to the matter moving through it; you have to work much harder to cut through the water when you swim a length of the pool than when running by the pool side. Finally, if matter feels the effects of a thick, jelly like, Higgs field it has to work very hard to push through it. The Higgs field confers a large mass to the matter in this case.

So how do we go about probing an invisible field that may fill the Universe? The theory tells us that if we shake the Higgs field hard enough we can knock out a particle, the Higgs Boson. The hot dense conditions in the early Universe would have constantly rattled the Higgs field, so Higgs Bosons would have been a common sight in the Universe just after it began in the Big Bang. If only it were possible to travel back in time.

There is a second serious gap in our understanding of gravity. We don't know what produces most of the gravity in the Universe! Our view of the night sky and a city after dark has a lot in common. For each building we only see the light coming from some of the rooms but we know that many more unlit rooms must be present (Figure 1). Looking up at the sky we see the stuff that shines but, like the building, astronomers know much more unseen matter must be present.

SCIENCE SPOT

About 90 percent of the Universe is invisible. We call the mysterious missing stuff ‘Dark Matter’. Revealing the nature of the dark matter is one of the greatest unsolved problems of modern physics.

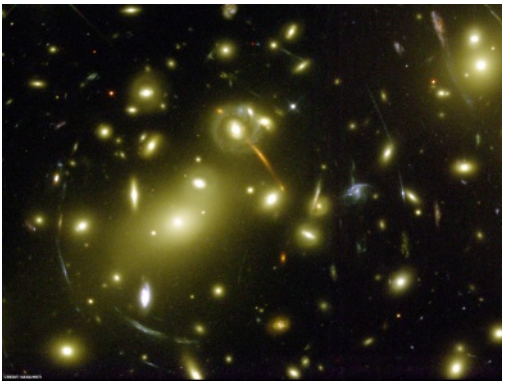

Figure 2: An ultra deep image containing a massive cluster of galaxies. The images of galaxies that are behind the cluster have been distorted by gravity with the mass of the cluster acting like an optical lens. The amount of distortion is much greater than that expected from the luminous cluster galaxies alone, suggesting that there is much more unseen mass in the cluster. (Courtesy of NASA/HST Science Team.)

If we can’t see it, then how do we know this dark matter is there? Astronomers can find an object either by observing it directly, or by seeing the effect that it has on other, more easily detected objects. All matter feels the attraction of gravity, with a strength depending on the mass according to Newton’s laws. By studying how stars move within galaxies and in turn how galaxies cluster together, it is possible to calculate the amount of matter lurking in the Universe. Stars orbit around the centres of spiral galaxies much like planets orbit around the sun, with the tug of gravity keeping the stars in their orbits. The mass of the stuff we can see in galaxies is not enough to hold them together. This implies that there is a great deal of mass that we simply can’t see. Cosmologists now think that a typical galaxy must be embedded in a vast halo of invisible dark matter whose gravity acts as unseen glue, stopping the galaxy from flying apart.

There are many objects that cannot be seen with telescopes, and early candidates for the dark matter in galaxies included ordinary material such as clouds of cold hydrogen and helium gas or Massive Compact Halo Objects – MACHOs – a class of objects such as planets, dead or unborn stars and black holes. Astronomers have detected the presence of MACHOs in our Milky Way galaxy, but recent surveys show that they account for no more than 20% of the dark matter making up its halo.

Einstein’s theory of gravity provides a more direct way in which dark matter can

reveal itself. Light is deflected when it passes through a strong gravitational field. This means that light reaching us from a distant galaxy is bent by the gravity of any intervening mass, such as the dark matter associated with a nearby cluster of galaxies. The distorted images of distant galaxies caused by this 'gravitational lensing' (Figure 2) are being used to map the distribution of dark matter on a cosmic scale.

Recent theoretical work in particle physics suggests that much of the dark matter may consist of as yet undiscovered subatomic particles – the so-called weakly interacting massive particles (WIMPs). These theories naturally propose a massive particle that feels the force of gravity but interacts only weakly with ordinary matter. Such particles would have been produced when our Universe was born in the Big Bang, and are now spread throughout the Universe. The heat

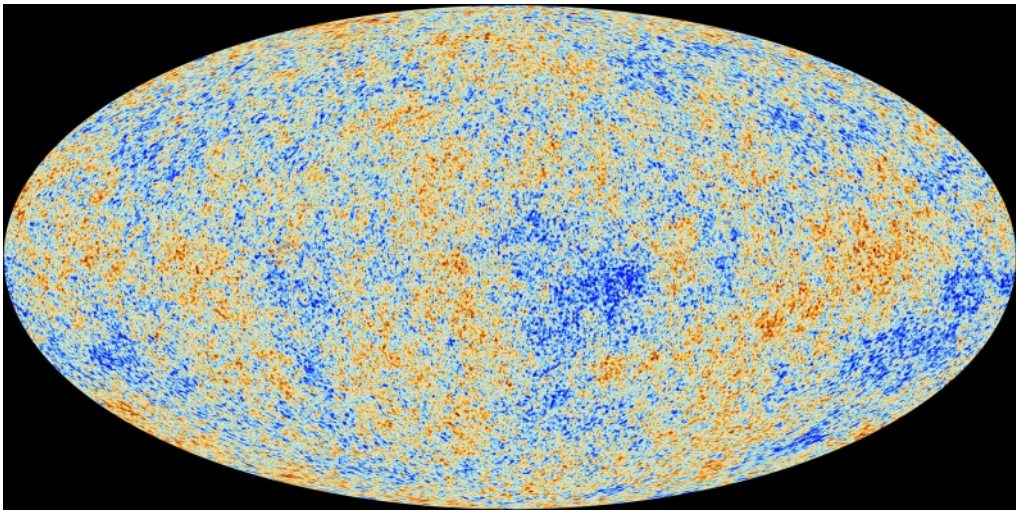

Figure 3: The cosmic microwave background radiation is a fossil relic from the Big Bang. For the first few hundred thousand years after the Big Bang, the mass in the Universe was ionised: no neutral atoms existed, as the radiation that filled the Universe was energetic enough to dislodge the electrons from hydrogen atoms as quickly as they formed. By around 380,000 years after the Big Bang, the expansion of the Universe had cooled the radiation so that it became too feeble to knock electrons out of hydrogen. The matter and radiation stopped interacting, but the radiation retained an imprint of the distribution of mass in the Universe at that early time. This imprint is seen as tiny fluctuations in the temperature of the cosmic microwave background radiation. (Courtesy of ESA and the Planck Collaboration.)

left over from the Big Bang, which was discovered by physicists nearly 40 years ago, carries information about the contents of the early Universe. Various experiments, including a recent ESA space mission, have shown that the early Universe contained small matter irregularities (Figure 3). These are exactly the kind of structures expected if the dark matter was made up of WIMPs. Furthermore, these ripples would help to explain the large scale structure of the Universe we observe today.

Figure 4: The Large Hadron Collider (LHC) at CERN, Geneva. Data from the LHC, the world's most powerful particle accelerator, revelaed the existence of the Higgs Boson in 2012. (Courtesy of the author.)

Consequently, both particle physicists and cosmologists are excited about the prospect of confirming WIMPs exist.

So how can we look for the Higgs Field and search for WIMPs? The answer is to build a time machine to take us back to the birth of the Universe where both WIMPs and Higgs Bosons should be plentiful. We don't have access to a TARDIS, particle physicists call their time machines particle accelerators. The job of a particle accelerator is to take the matter around us and give it energy, the more energy we impart the further back in time we travel, taking us closer and closer to the conditions that existed in the early Universe.

The Large Hadron Collider (LHC) is the latest in a long line of machines we have built to do this (Figure 4). The LHC takes ordinary matter, accelerates it, and bashes it together at energies higher than we have ever done, taking us back to the conditions a billionth of a second after the Big Bang. If our theory of mass generation was correct these collisions should have more than enough energy to jiggle the Higgs Field and dislodge a Higgs Boson, which would leave tell-tale signs in the detectors of the LHC.

Following initial problems the LHC finally began operation in earnest in 2009. After more than three years of data taking and careful analysis, the discovery of a Higgs Boson was confirmed in March 2013. Our

Universe is indeed filled with a Higgs Field that is responsible for conferring mass to all the matter around us! But what produces most of the gravity in the Universe? Are WIMPs streaming around you as you read this? The search for Dark Matter continues, but so far the LHC has produced no evidence that subatomic Dark Matter particles exist.

The existence of a massive particle that feels the force of gravity but interacts only weakly with ordinary matter is currently our best explanation for what produces most of the gravity in the Universe. However, don't think that we have spent twenty years building the LHC just to find the Higgs Boson and manufacture WIMPs, or that the machine will have failed if we don't find Dark Matter. If our ideas concerning Dark Matter are proved wrong, then the LHC will further our understanding of whatever it is that is responsible for generating most of the gravity in our Universe. The LHC has already proved the Higgs Field exists, future results are guaranteed to give us a better understanding of the workings of the force that's keeping you in your chair as you read this.

Pete Edwards

Dr P.J.Edwards co-ordinates a public outreach programme based upon the work of the Ogden Centre for Fundamental Physics in Durham (for details see www.dur.ac.uk/physics.outreach).

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Not been to Kielder yet?

Then why not book one of our events for you or your family?

Advanced booking is essential. Weekend events can fill up several weeks in advance. Please book online at http://www.kielderobservatory.org/events/ or call us on 0191 265 5510. We can also be contacted at admin@kielderobservatory.org

SPECIAL EVENTS:

Winter Space Kids at half term 15th/17th & 19th Feb

Easter Space Kids on 25th/28th/30th March and 1st/4th/6th & 8th April

NIGHT SKY

JANUARY 2016 (times in GMT)

Lunar phases

Last quarter	02/01/2016	05:30
New moon	10/01/2016	01:30
First quarter	16/01/2016	23:26
Full moon	24/01/2016	01:46

PLANET SUMMARY

Mercury is starting to close in on the Sun very rapidly and is no longer easily visible. Venus rises some 2.5 hours before the Sun and is also closing in on it. Mars is a morning object visible for about 5 hours before sunrise. Jupiter is approaching opposition and is now visible for about 6 hours after 11pm. Saturn is a morning object quite close to Venus in the sky. Uranus is an evening object.

THE STARS AT 8PM (GMT)

North – Cassiopeia shows up as a letter 'M' near the zenith. Cygnus is nicely placed in the north-west. Hercules and Lyra are low down.

East – Perseus and Auriga are high up, with Gemini and Orion well placed. Leo – with Jupiter, Cancer and Monoceros are low down.

South – Aries and Pisces are nicely placed, with Lepus – the Hare – near the SE horizon, below Orion.

West – Andromeda is high up with Pegasus nicely placed. Cygnus and Delphinus are low down.

METEOR SHOWERS

The major meteor shower of this month was the Quadrantids on the 4th Jan. Muralis Quadrans was a constellation introduced in the early 17th century, but as the use of the quadrant circle diminished it was absorbed back into Bootes. The shower is usually a very short, sharp peak of very bright and often colourful shooting stars.

COMETS

Comet C/2013 S10 Catalina continues its traverse of Bootes and through Ursa Major during January and is expected to fade as it pulls away from the Sun. It is currently around mag 6.5, so just below naked eye vsibility.

The Planets 15/01/2016

	Sun	Mercury	Venus	Moon	Mars	Jupiter	Saturn	Uranus
Rise	08:16	07:49	05:49	10:45	01:53	21:40	05:14	10:56
Transit	12:16	12:05	09:45	17:02	06:49	04:08	09:16	17:31
Set	16:18	16:21	13:41	23:32	11:44	10:32	13:17	00:11

FEBRUARY 2016 (times in GMT)

Lunar phases

Last quarter	01/02/2016	03:28
New Moon	08/02/2016	14:39
First quarter	15/02/2016	07:46
Full Moon	22/02/2016	18:20

PLANET SUMMARY

Mercury and Venus are in conjunction with the Sun and not visible this month. Mars is a morning object visible for about 4 hours before dawn. Jupiter is rapidly approaching opposition. Saturn is visible for a few hours in the early morning sky. Uranus is visible for a few hours in the early evening sky.

THE STARS AT 8PM (GMT)

North – Draco is nicely placed for viewing – splitting the two Bears

East – Gemini and Cancer are nicely placed with Leo visible later in the evening

South – Monoceros and Canis Major are low down with Orion, Gemini and Taurus all well placed for viewing. Jupiter sits just above the Hyades star cluster.

West – Perseus is almost overhead with Andromeda nicely placed for viewing. Pegasus and Cygnus are low down.

METEOR SHOWERS

There are no major meteor showers in February.

COMETS

Comet C/2013 S10 Catalina is fading as it recedes from the Sun, but should still be visible through a good pair of binoculars or telescopically.

The Planets 15/02/2016

	Sun	Mercury	Venus	Moon	Mars	Jupiter	Saturn	Uranus
Rise	07:27	06:40	06:25	10:50	01:20	19:25	03:25	08:55
Transit	12:21	10:45	10:27	18:31	05:47	01:58	07:25	15:33
Set	17:16	14:50	14:30	01:10	10:15	08:28	11:24	22:10

NIGHT SKY

MARCH 2016 (times in GMT)

Lunar phases

Last quarter	01/03/2016	23:11
New moon	09/03/2016	01:54
First quarter	15/03/2016	17:03
Full moon	23/03/2016	12:01
Last quarter	31/03/2016	15:17

PLANET SUMMARY

Mercury and Venus are in conjunction with the Sun. Mars is a morning object but not particularly bright. Jupiter is close to opposition. Saturn is a reasonable morning object and Uranus is a challenging evening object

THE STARS AT 8PM (GMT)

North - Cepheus and Lacerta are nicely placed with the two Bears easily viewable. Hercules is rising. Pegasus has set.

East - Leo, with Jupiter, is prominent with Virgo rising. Cancer is nicely placed.

South - Gemini, Taurus, Orion and Canis Major are all in good position for viewing. Auriga is near the zenith.

West - Perseus and Cassiopeia are both nicely placed. Pisces is setting.

METEOR SHOWERS

There are no major meteor showers in March.

COMETS

Comet C/2013 S10 Catalina has faded to 9th magnitude now and is in the constellation of the Giraffe - Camelopardalis.

Comet P/2010 V10 Ikeya-Murakami is also 9th magnitude and can be found in the constellation of Leo.

Night Sky credits: Lunar and planetary data sourced from Cybersky 5

The Planets 15/03/2016

	Sun	Mercury	Venus	Moon	Mars	Jupiter	Saturn	Uranus
Rise	06:21	06:24	05:56	10:16	00:31	17:10	01:36	07:04
Transit	12:16	11:51	10:58	18:16	04:40	23:47	05:35	13:44
Set	18:12	17:19	16:00	01:18	08:48	06:28	09:35	20:25

A What Killed the Dinosaurs? - Part 3 - Comparing Theories

As we've seen in the first two articles, both extreme volcanism and a large meteor impact could have catastrophically affected life on Earth in the Cretaceous-Tertiary interval. In this final article of the series, we compare some of the evidence that supports these two theories.

THE FOSSIL RECORD

Both impact and super volcanism explanations for mass extinction draw on evidence from the fossil record; however, this is incomplete, sparse and difficult to interpret showing a complex pattern of extinction events. Some species appear to have died out at around the same time as the dinosaurs while others seem to have survived this period relatively unscathed. One group are Amphibians. Present Day Amphibians are very vulnerable to changes in their environment so it would be expected that these would have been particularly susceptible to any global climatic upheaval but the evidence of this is mixed.

Some species of dinosaur seem to have been on the decline for several million years before the K-T impact which could have been due to local changes in the environment. In North America, for example, a large, inland sea (the Western Interior Seaway) was shrinking; a consequence of this was plummeting populations of two groups of Mollusc but this was happening more than 1 million years before the impact. Therefore, non-impact related environment change has been proven to adversely affect other species around this same period; it is perfectly reasonable to suggest that the same or similar environmental changes were adversely affecting populations of some dinosaurs too.

However, dinosaur remains are sparse; a 1997 New Scientist article "What Really Killed the Dinosaurs" put the number of available fossils at approximately 3000 with the dating of these spanning a time of around 150 million years. Therefore, the low number of fossils dated from around the end of the Cretaceous, that have been used to pin down the 'sudden' decline in the dinosaur population to a relatively precise age range is questionable given the low number of specimens available.

SCIENCE SPOT 2

In order to clarify the timing of the extinction, microfossils (remains of much smaller, microscopic, creatures) are used which are far more abundant and less susceptible to changes in oxygen levels as, being small, they require less of it to survive. Some of these microfossil species seem to have undergone mass extinction more than 100,000 years before the K-T impact, again making the likelihood of a single catastrophic event having occurred unlikely. As you can see, the fossil record is far from conclusive.

RADIOISOTOPES

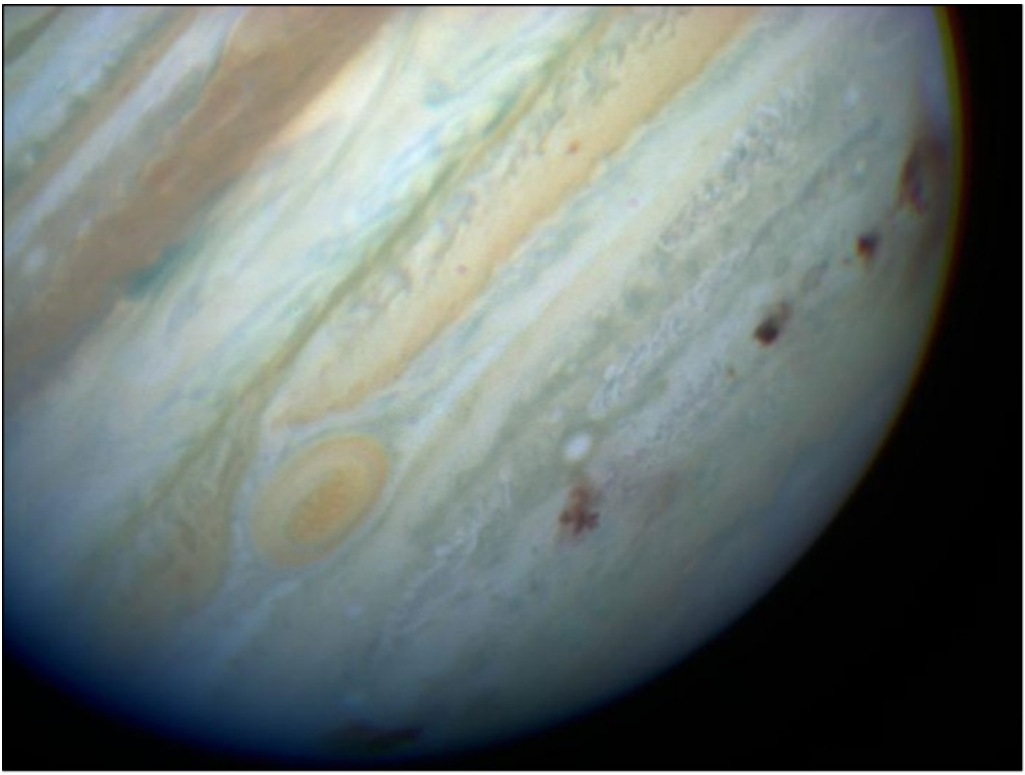
The relative abundance of Iridium can be explained by both theories (impact and super volcanism). Whilst Iridium is more abundant in meteorites than in Earth's crust, is it also relatively abundant in Earth's mantle. Therefore, wide spread volcanism could have erupted Iridium high into the atmosphere, thus spreading it around the planet.

ARE THERE OTHER FACTORS TO CONSIDER?

Another event that has been hypothesized, although theoretical with no hard evidence to support it, is that, around the end of the Cretaceous, the Solar System passed through a large cloud of molecular hydrogen; this cloud could have had a mass of up to a million times that of the Sun and could have been several light years across; however, slim evidence for this is available, e.g. analysis of air trapped in amber.

The Solar System could have spent several hundred thousand years within this cloud. During this time, the extra mass would have perturbed the Oort Cloud (a region of icy bodies that orbit the Sun well beyond Pluto) sending some of these bodies on random trajectories into the Solar System; this would have increased the chances of meteorite impacts hitting the Earth.

The abundance of molecular hydrogen as opposed to ionized hydrogen in the Solar System is a dangerous situation for life on Earth as our magnetic field is able to deflect ionized hydrogen but not molecular hydrogen. Currently in our Solar System, the amount of gas in between the planets is low enough for the Sun's energy to ionize their molecules; if the amount of hydrogen in the Solar System, particularly in the region between earth and the Sun, was sufficient enough, the Sun's energy wouldn't be able to ionize all of the gas, leaving a large



Scars on Jupiter made by fragments of Shoemaker-Levy 9 Comet
Image of Jupiter showing eight impact sites (dark brown areas) from Comet P/Shoemaker-Levy 9 collision with the planetary giant. Credit: Hubble Space Telescope Comet Team and NASA

amount of molecular hydrogen behind. Such hydrogen would not be deflected by earth's magnetic field.

Hydrogen could have become mixed within our atmosphere resulting in around a third of the oxygen being 'mopped up'; any electrical storms in the atmosphere would facilitate hydrogen and oxygen combining to make water. Less oxygen in the atmosphere due to more being tied up in water would lead to more pressure being exerted on Earth's ecosystems and more likelihood for species heavily reliant on oxygen to become extinct!

SCIENCE SPOT 2

WHY HAS THE IMPACT THEORY BEEN SO WIDELY PUBLICIZED

Coincidentally, in 1993 (a few years after the announcement of the discovery of the Chicxulub impact crater on Earth) a comet called Shoemaker-Levy 9 passed by Jupiter; due to the huge tidal forces exerted by Jupiter's gravity, it was ripped apart into at least 21 individual comet fragments, each one up to 2 km in diameter. Then between July 16 and July 22, 1994, each one of these fragments smashed into Jupiter while being watched by astronomers (and large elements of the media) here on Earth. The image shows eight impact sites, the dark areas in Jupiter's clouds. As an indication of scale, the Great Red Spot that can be seen in the bottom-left of centre has a diameter two to three times the diameter of Earth!

So, it's not surprising that Hollywood latched on to this dramatic event with two films (both referencing 'the impact that killed the dinosaurs') hitting the box office in 1998,"Deep impact" and "Armageddon", bringing the possibility of worldwide destruction (and possible human extinction) to everyone's cinema-going experience!

DO WE REALLY KNOW EXACTLY WHAT KILLED THE DINOSAURS?

This series of articles has only briefly examined the subject but it is clear to see that the evidence is mixed and inconclusive. In some cases the same evidence can be used to support both major theories; in other cases, evidence supports one or the other. In the author's opinion, given the evidence to date, the mass extinctions at the end of the Cretaceous period were probably due to a combination of environmental factors, including super volcanism, and the after effects of the Chicxulub meteor impact.

In order to give a clearer picture, what is needed are more fossil finds (so scientists will have a larger number of samples to provide evidence covering this period of time); material dating methods need to evolve and the global geology and environments of the Cretaceous and Tertiary need to be better understood. These factors will all help to more precisely define the period of each species demise and give us a clearer indication of the causes for the extinctions.

Lee Moorhead

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Does the Earth's Axis Really Precess?

Observations of Precession over a 40 year period 1975 – 2015

During a typical observatory event we often discuss the motion of the stars in the night sky and how they slowly circle the celestial pole with a period of one Sidereal day. This is dramatically illustrated using a star trail photograph where a long exposure (~1 hour or more) of a field of view centred on the pole star, Polaris, is obtained – see Figure 1.

Often we go on to discuss how it is a coincidence that the Pole Star – Polaris – just happens to be close to the centre of rotation and that far in the future this will not be the case. Over a long period of time the apparent position of the pole traces out a large circle on a star map caused by the precession of the Earth's axis. The Earth's axis wobbles around like that of a giant spinning top, it precesses, with a period of 25,800 years. After this long time Polaris will once again be close to the celestial pole. It is interesting to note that in 8000 yrs time the bright star Deneb will be fairly close (less than 10 degrees) to the celestial pole and in 10000 yrs time the even

Figure 1: Star trails around the north celestial pole.

brighter star Vega will be – although neither will be as close as Polaris is now. The full angular diameter of the circle traced out is 47 degrees – this being twice the angle of tilt of the Earth's axis relative to its orbital plane. It is important to realise

Figure2: A star trail photograph showing the constellation of Ursa Minor – the small bear – taken by the author in 1975 (a home developed black and white film image – those were the days!)

that as precession happens the angular tilt remains at 23.5 degrees and hence it has no climatic effects - the seasons remain the same as they are now (although the stars visible during different seasons will be different – e.g. in about 13,000 years Orion will be a summer constellation!)

I remember reading about precession some years ago and being astonished to find that it was first noticed by the ancient Greek astronomer / philosopher Hipparchus around 140 BCE (although he used a different method to that described here). I didn't imagine that it would be possible to see the effects of precession in a human lifetime (I later learned that Hipparchus himself used data gathered by himself as well as his predecessors over a period of 200 years).

I was recently looking through some old photographs and wondered if I may be able to observe the effects of precession myself by using my old – 1975 – star trails images and comparing the exact position of the celestial pole then with where it is now located – see Figure 2. The current location of the pole can be found accurately using, for example, Stellarium (http://www.stellarium.org/en_GB/) software – see Figure 3.

By comparing Figures 2 and 3 it is impossible to notice any difference in the position of the pole - I realised that in order to notice any effect an enlargement of the region close to Polaris would be required. Figure 4 shows an enlargement of the centre of Figure 2 which clearly shows how Polaris is not at the centre of rotation of the sky (it is currently ~ 0.7 deg = 40 arc minutes away).

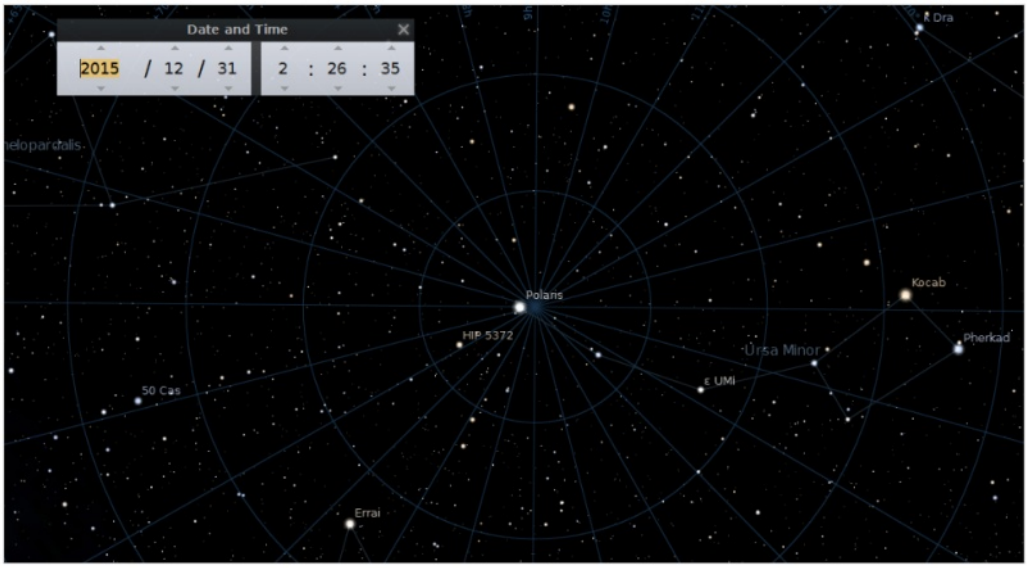

Figure 3: Stellarium software image of the current position of the north celestial pole.

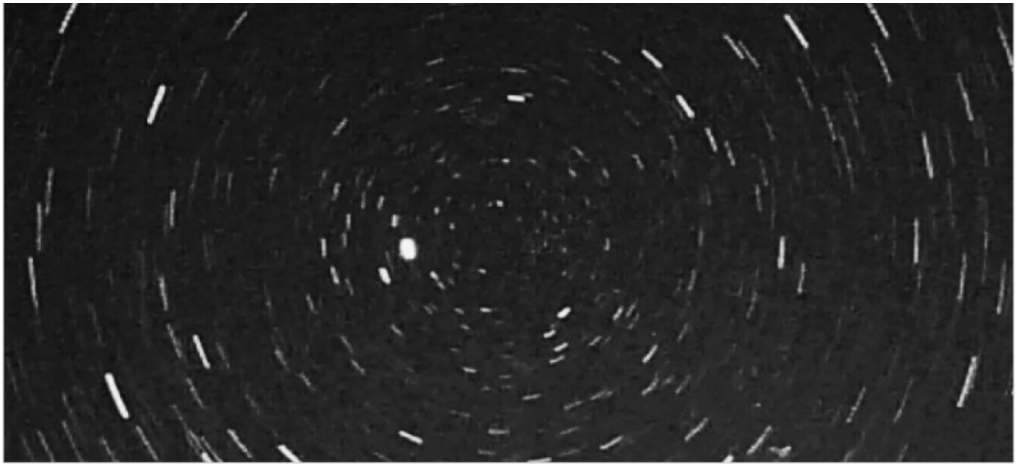

Figure 4: An enlargement of the centre of Figure 2

In order to find the position of the centre of rotation as accurately as possible I used two different techniques. First of all I used the idea that any line from the true centre of motion must cross the star trails at right angles. I therefore drew three lines spanning the centre of the image that crossed all star trails at right angles and crossed each other at a consistent point – this gave a surprisingly small tolerance as to where the centre must be. As a check, the second method was to fit concentric circles such that every star trail nearby was tangential to the circles. This also gave a consistent point both between circles and between the two methods. See Figure 5.

The next figure (Figure 6) shows the predicted position of the pole using the Stellarium programme for 1975.

It can be seen that the agreement with Figure 4 is excellent. *So now for the crucial test* – is this position distinguishable from the Stellarium map at the current time. This is shown in Figure 7.

Indeed it can be seen that the pole today is in a noticeably different position today than it was in 1975. Success! The current position of the pole is marked as the red cross on Figure 5.

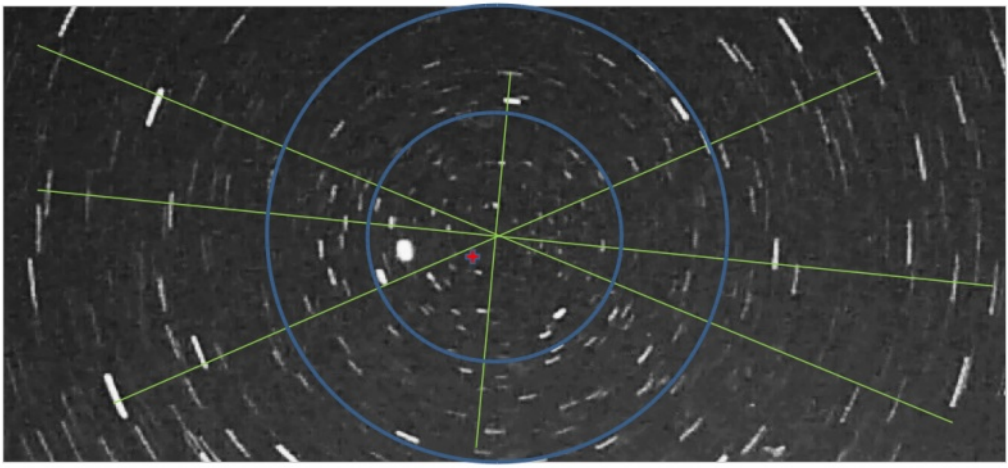

Figure 5: The centre of rotation of the celestial sphere in 1975 found using the two techniques discussed above.

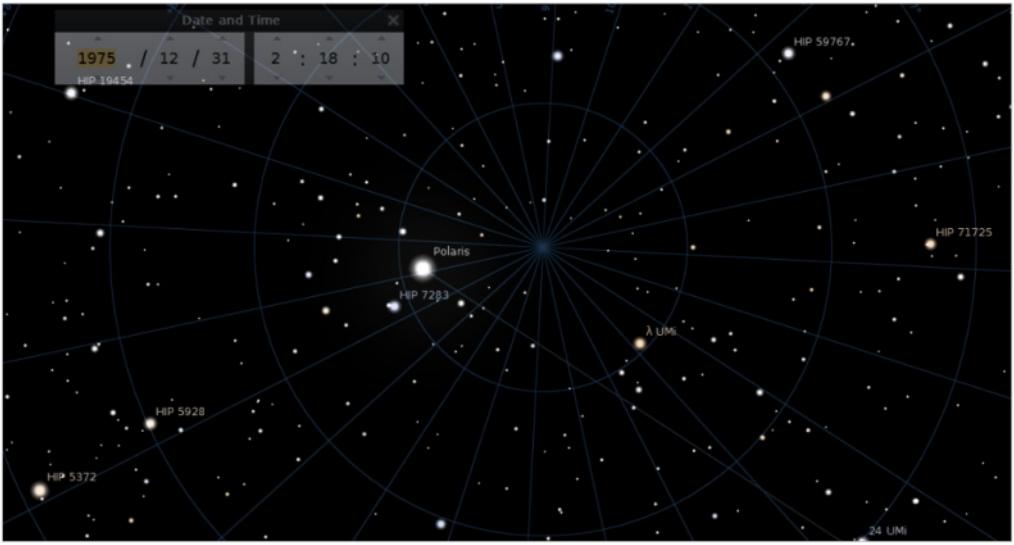

Figure 6: Predicted position of the pole using the Stellarium programme for 1975.

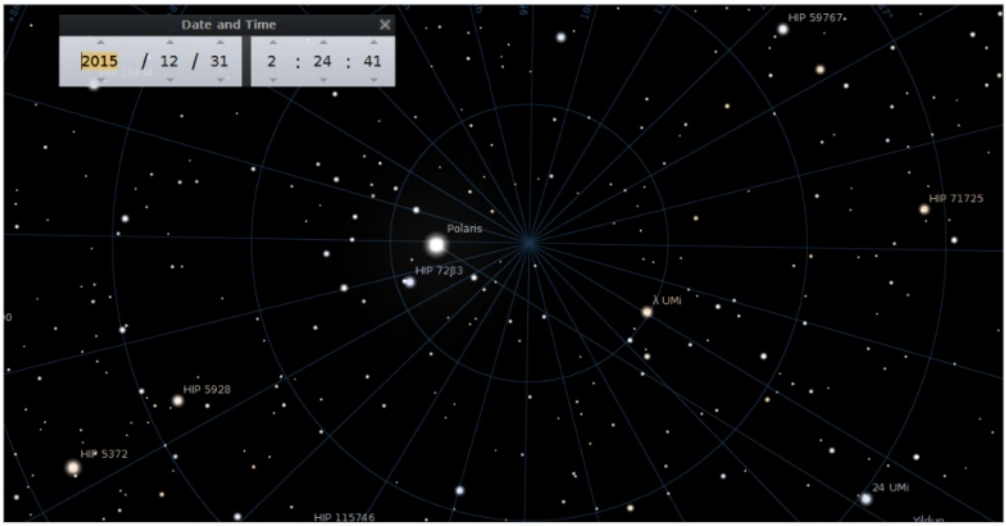

Figure 7: Polar region of the celestial sphere at the current time.

ASTRONOMERS' TALES

This was a satisfying result – precession really does happen – not that I ever doubted that it did (professional astronomers have to take precession into account as a routine correction to coordinates when working to sub-arc second accuracies!) but it is always good to try and prove things for oneself!

The above results are also consistent with Polaris being at its closest to the celestial pole in the year 2100 when it will be only 28 arc minutes away. It looks as though at observatory events we will be pointing to Polaris with our laser pointers, showing visitors this important star and remarking that it marks the pole of the sky, for many years to come!

Dr Fred Stevenson

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There were some great displays of the Northern Lights towards the end of 2015. This shot was taken on New Year's Eve.

'Gary's casual 'just ask me questions' was great, and they way he took apart the Big Bang for a 10 year old made us all ask questions, very very good! Dan has an unbelievable knowledge and was keen to share with everyone and answer any question asked. Luke had a very relaxed approach and watching him explaining extrons jumping shells of atoms was really great to watch! Gary was simply inspiring in his talking and his knowledge, his relaxed approach to the observatory and astronomy was fantastic and inspiring!'

Rob Humphries

GALLERY

With so many articles in this edition we have had to curtail the gallery, but we will be back to full size next time! Remember, we would love to display your images here - all the better if they are taken up at Kielder, but it is not essential. Please send them to

newsletter@kielderobservatory.org

along with a brief description of how and when they were taken.

This excellent shot of the Great Nebula in Orion (Messier 42) was taken from the Observatory on January 7th 2016.

The Solar System & Beyond...

Bringing Kielder Observatory to Newcastle

KIELDER OBSERVATORY
Infinite Inspiration

Starring: Gary Fildes, Director Kielder Observatory

Kielder Observatory is coming to the Vermont Hotel in Newcastle once again to bring alive the wonders of our universe.

Our Solar system started with the formation of our star the Sun formed out of a rotating cloud of dust and gas, it collapsed under the influence of gravity and formed our sun and its retinue of planets. Tonight Gary and the team will explain with stunning visuals the nature and relevance of the planets, then armed with this knowledge you can go off and find them for yourself.

This will be followed by a Q & A session and the Observatory team will be on hand to show you images, talk telescopes as well as astronomy.

- The Solar System & Beyond
- Physics with Dr Fred
- Telescope Workshop
- Finding and locating objects in the night sky

VENUE: Ball Room at The Vermont Hotel, Newcastle upon Tyne, NE1 1RQ.

DATE: Sunday 31st January 2016 7:00pm – 9.30pm

TICKETS: £16.50

FIND OUT MORE AND BOOK ONLINE:

www.kielderobservatory.org/events/kielder-observatory-comes-to-newcastle/

OR CALL US: 0191 265 5510

'My daughter Hope went to the science museum to hear Brian Cox talk at the Tim Peak launch day. She says she couldn't say who was better Dan at the observatory or Brian.'

KOAS: Your Window to the Universe

http://www.kielderobservatory.org

KIELDER OBSERVATORY
Infinite Inspiration