

Thanet Astronomy Group

Astronomy for Everyone in Plain English

NEWSLETTER

June 2015



Galactic Collisions

The Antennae Galaxies in Collision

Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration

Acknowledgement: B. Whitmore (Space Telescope Science Institute) et al.

This space is reserved for promoting member's businesses.
You can place an advert here for a donation to the group.

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About the Cover Picture

Galactic Collisions



The Antennae Galaxies in Collision

Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)-ESA/Hubble Collaboration

Acknowledgement: B. Whitmore (Space Telescope Science Institute) et al.

With a title like **Galactic Collisions** you would think that we were talking about something apocalyptic, but these are not collisions in the normal sense of the word. Gravitational interaction and merging are better descriptions.

The spacing of stars mean that when galaxies interact, the stars are unlikely to actually collide with one another.

If you look at the prediction of the Milky Way and Andromeda galaxies colliding, there are about 300 billion stars in the Milky Way and about 1 trillion stars in Andromeda but the stars are spaced at average distances of 160 billion km (100 billion miles).

When galaxies collide with one another this may lead to them merging. This happens when the galaxies do not have enough momentum to continue travelling after the collision. They fall back towards one another and after many passes through each other, they eventually merge. If there is one galaxy larger than the other, then this one will remain largely intact, but the smaller galaxy will be stripped apart and absorbed by the larger one.

There are other types of galactic interactions:

Satellite Interaction – It is common for a giant galaxy to interact with satellite galaxies. A satellite galaxy's gravity may attract one of the primary galaxy's spiral arms. Or the satellite galaxy could dive into the primary galaxy e.g. Sagittarius Dwarf Elliptical Galaxy. This could trigger a small amount of star formation.

Galactic Cannibalism – This is where a large galaxy merges with a companion galaxy through tidal gravitational interactions, which results in a larger, often irregular galaxy. It has been suggested that this is occurring between the Milky Way and the Large and Small Magellanic Clouds.

Galaxy Harassment – This happens in galaxy rich clusters such as Virgo and Coma, where galaxies are moving at high relative speeds and suffering frequent interactions with other galaxies in the cluster. This can disturb or radically change the shape of the galaxies involved.

Tracy Howes

About the Cover Picture

Galactic Collisions

NGC 2207 and IC 2163

These are a pair of spiral galaxies which are in the first phase of galactic collision. They are about 80 billion light-years away and can be found in the constellation Canis Major. They are expected to merge and become an elliptical or a disk galaxy in about a billion years.

Image Credit: NASA, ESA, and The Hubble Heritage Team (STScI)



The Mice Galaxies

The Mice Galaxies (or NGC 4676A/B) are two spiral galaxies in the constellation Coma Berenices, about 300 million light-years away. They are in the second phase of galactic collision. Their name is due to the long tails which are being created by gravitational pulls on the near and far sides of each galaxy. They will eventually merge to a single galaxy.

Image Credit: NASA, H. Ford (JHU), G. Illingworth (UCSC/LO), M. Clampin (STScI), G Hartig (STScI), the ACS Science Team, and ESA



NGC 520

This is a pair of spiral galaxies going through the third phase of galactic collision. They are about 90 million light-years away in the constellation Pisces.

Image Credit: NASA, ESA, the Hubble Heritage (STScI/AURA)-ESA/Hubble Collaboration, and B. Whitmore (STScI)



Milky Way and Andromeda Galaxies Collision

This is an illustration of what the view from earth could look like when the Milky Way and Andromeda galaxies collide. The two galaxies will start to collide in about 4 billion years and will eventually merge in about 6 billion years.

Science Illustration Credit: NASA, ESA, Z. Levay and R. van der Marel (STScI), and A. Mellinger

Tracy Howes

Thanet Astronomy Group Contact Details

Executive Committee

| | | |
|-----------|-------------|---------------|
| Chairman | Daniel Day | 01843 228 904 |
| Treasurer | George Ward | 01843 292 640 |
| Secretary | Gill Palmer | 07543 942 245 |

Committee

| | | |
|------------|---------------|---------------|
| Volunteers | George Cozens | 07970 181 395 |
| Members | Sheila Bull | 07791 892 057 |
| Newsletter | Janet McBride | 01227 364 092 |
| Newsletter | Tracy Howes | 07917 710 638 |
| Library | Janet McBride | 01227 364 092 |
| Web Site | Danny Day | 01843 228 904 |
| JAC & Gill | Gill Palmer | 01843 848 064 |

Member's Meeting Dates and Times

Thanet Astronomy Group **Member's Meetings** **Dates and Times**

3rd June 2015 at 8pm
1st July 2015 at 8pm
5th August 2015 at 8pm
2nd September 2015 at 8pm
7th October 2015 at 7.30pm
4th November 2015 at 7.30pm
2nd December 2015 at 7:30pm
6th January 2016 at 7:30pm
3rd February 2016 at 7:30pm
2nd March 2016 at 7:30pm
6th April 2016 at 7:30pm
4th May 2016 7:30pm

All Member's meetings will be held at the :-

West Bay Cafe,
Sea Road,
Westgate-on-Sea,
Kent.
CT8 8QA

Advertisement

WEST BAY CAFE

Sea Road - Westgate-on-Sea
CT8 8QA

Location :-

This Family Friendly Cafe is situated on the promenade just beside the sandy beach. Opposite the junction of Sea Road and Rowena Road. Westgate-on-Sea. CT8 8QA.

Access :-

via a flight of steps behind the cafe.

Disabled Access :-

via the main entrance to the bay and a slope at the cafe door.

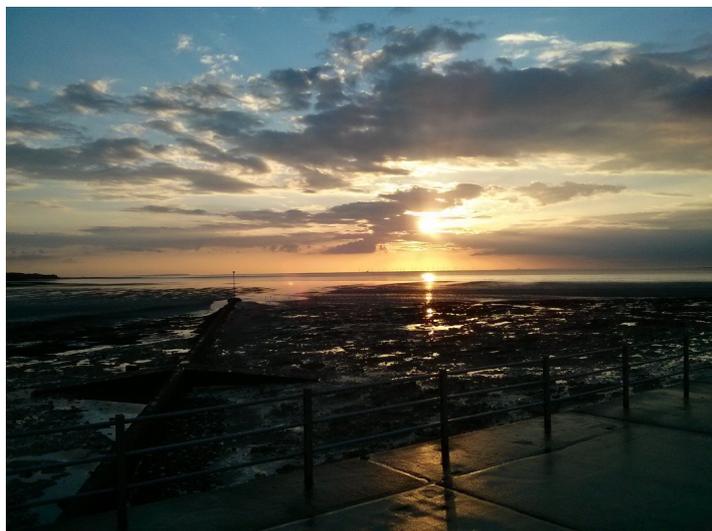
West Bay Cafe run by Alan and Kate and has a very friendly atmosphere.



Alan outside the new style West Bay Cafe

There is a wide variety of good food and drinks at very reasonable prices and there are always special offers.

There is seating both inside and outside for those extra hot days.



A Typical Sunset at the West Bay Cafe

The Sunsets at the West Bay Cafe are Spectacular.

**With a meal, some friends,
and a pint or two.**

What more could you ask for!

West Bay Cafe have hosted Thanet Astronomy Group since September 2013.

We would like to say a
HUGE THANK YOU to Alan and Kate
for all the help and support they have shown us over the last year.

Please use this Brilliant Seaside Cafe and Tell Your Friends.

What we did last month

Saturday 2th Public Outreach Meeting

Today was quite cloudy, so we weren't able to get a clear view of the sun for long. When the skies cleared enough for a glimpse, there were no sunspots visible. We had quite a few people stop by for a dull day to ask what we were looking at.

The JAC and Gill Junior club went on a walk to pace out the solar system, to a scale of one step per 1,000,000 miles. They started outside the cafe with the Sun, then walked along the seafront marking each planet out in chalk on the prom but only managed to get as far as Jupiter.

Wednesday 6th Members Meeting

We were hoping that some of the Stargazing course attendees would come to the meeting but it was not to be.

The meeting started with the usual notices which were followed by a look at the brilliant Astronomy.co.uk “The Sky Tonight” page <http://www.astronomy.co.uk/skytonight> This page has a fantastic video that shows you exactly what you can see in the night sky.

Then George W gave a talk on “Star Hopping” which was very well received by all. Star Hopping shows you how to use the constellations you know as pointers to other constellations to improve your understanding of the night sky.

Saturday 9th Public Outreach Meeting

This afternoon started off with a little bit of rain, so we didn't set up the telescopes till a little later. Several members came to help with the public. When the clouds cleared enough for us, we looked at the Sun and saw quite a few sunspots.

Danny was in charge of the JAC and Gill club today, and made rockets with the juniors, out of plastic drinks bottles and cardboard. They turned out great!



Part 1 of our new “It's NOT Rocket Science” project at the West Bay Cafe

Wednesday 13th Stargazing Course Part 3

This was the Advanced part that for some reason seems to have people worried. Maybe we should just call it “Part 3”. Needless to say the whole thing was in Plane English and everyone was OK.

We looked at the measurement systems used to locate objects in the sky such as Altitude & Azimuth - Right Ascension & Declination - Astronomical Units - Light Years – Parsec's – The Celestial Sphere and loads more.

Now all the course members are well equipped to understand the last part Stellarium Stargazing which will turn them into Expert Stargazers.

Danny

What we did last month

Saturday 16th Public Outreach Meeting

What a glorious sunny day! We had the telescopes pointed at the Sun all afternoon, looking at the amazing array of sunspots. Members turned up and helped out with the public as we had quite a lot of people stop, ask us questions and look at the Sun Spots through the telescopes.

The JAC & Gill Junior club went on another walk to mark out the planets of the solar system on the promenade because the recent rain had washed away all the planets, they still only managed to get as far as Jupiter before they couldn't go any further round the seafront. I'm sure they'll keep trying until they get to the next planet!

Wednesday 20th Stargazing Course Part 4

This was the last part of the Stargazing course at the cafe where all the info from parts 1 to 3 are put into use and we did just that. Stellarium was used to locate all sorts of objects in the sky and to identify some objects we had seen for real during the tea break.

We hope all that attended both members and public alike will come to the Saturday meetings and continue to improve their knowledge of stargazing and the sky.

Saturday 23rd Public Outreach Meeting

Saturday was a nice day with plenty of clear sky, but most notably the air was as clear as we have ever seen. We were able to see tall structures well beyond the horizon that we have never seen before. There were also some nice sun spots to look at.



One of the Cormorants

For the bird lovers among us, one of the cormorants that sun themselves on the far post came and sat on the red and white post at the end of the break water. So we had some fantastic close



ups through the telescopes. 3... 2... 1... *Lift Off at JAC & Gill*

The JAC & Gill club had a second mass Rocket building session, producing many fantastic rockets.

Saturday 30th Public Outreach Meeting



Saturday 30 -5 2015 Meeting

Today was another nice day. We had loads of people interested in what we were doing. We spent some time looking at the the sun and its sun spot. The JAC & Gill group were very busy learning all about astronomy and space.



JAC & Gill Club 30 05 2015

With only 8 meetings this was a quiet month at Thanet Astronomy Group.

Our thanks go out to all that helped to make all this possible !

Danny.

Junior Members Page

This month, the schools have had another Half Term break, so to fuel the Junior Clubs' interest this holiday we've been making rockets to take into space on our journey through the Solar System! (See the JAC & Gill page 18).



We've just puzzled out the Solar System



Rocket Making (you can't have too many rockets)

Thanks to the Adult Members, we had a good supply of plastic bottles of all shapes and sizes so that each rocket was unique to each child. It's amazing what a roll of tin foil, a plastic cup and some space stickers can turn into after half an hour with JAC & Gill!

I'm sure NASA could use some good advice from the children when they make their next rocket to go into space!



More Rocket Making at West Bay Cafe



In a ROCKET at West Bay Cafe

I think the photos tell the whole story when you see the faces of the JAC & Gill Astronauts as they finally reached the countdown at West Bay for launching their rockets...

10...9...8...7...6...5...4...3...2...1...0...BLAST OFF!!!!!!

Reach for the stars!!!

Gill P.

Messier

From the beginning of the recording of comets right up to 1759 only 10 comets were known.

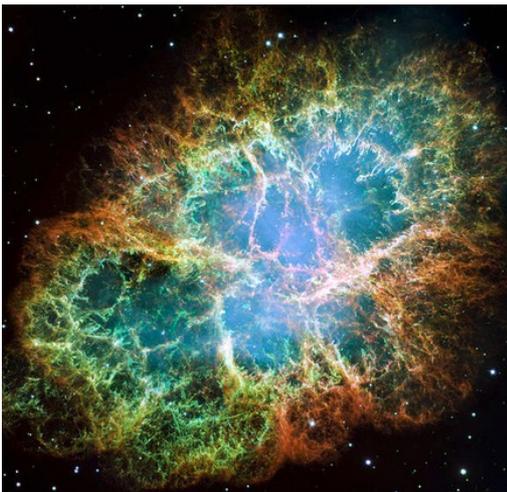
In 1754 the return of Halley's comet was predicted. Messier was employed at that time by an astronomer named Joseph Delisle as an astronomical recorder.



Halley's Comet

Delisle set Messier to work searching for Halley's comet and gave Messier a map of the heavens to help him. For 18 months Messier searched for the comet. Unfortunately Delisle's map was inaccurate and it was first seen on its return, not by Messier, but by a farmer in Saxony. A month later, Messier found the comet himself.

When Delisle retired Messier became obsessed about finding comets. For the next 15 years practically every comet discovery was by him. He himself claimed to have discovered 21 comets. In looking for comets he realised that there were "fuzzy" areas in the skies that are now called nebulae. Messier decided to create a catalogue of his discoveries of not only comets but nebulae, eclipses, transits, globular clusters and more.



M1 The Crab Nebula

In 1801 Messier himself recorded why he decided to catalogue these. He said, "What caused me to undertake the catalogue was the nebula I discovered above the southern horn of Taurus on September 12th, 1758, while observing the comet of that year. This nebula had such a resemblance to a comet, in its form and brightness, that I endeavoured to find others so that astronomers would not confuse these same nebulae with comets just beginning to shine."

The supernova remnant in Taurus that Messier was talking about is listed as M1. This is the Crab nebula, an expanding cloud of gas from the explosion of a brilliant supernova observed in AD 1054 by Oriental astronomers.

Janet Mc Bride

Book Review

UNIVERSE

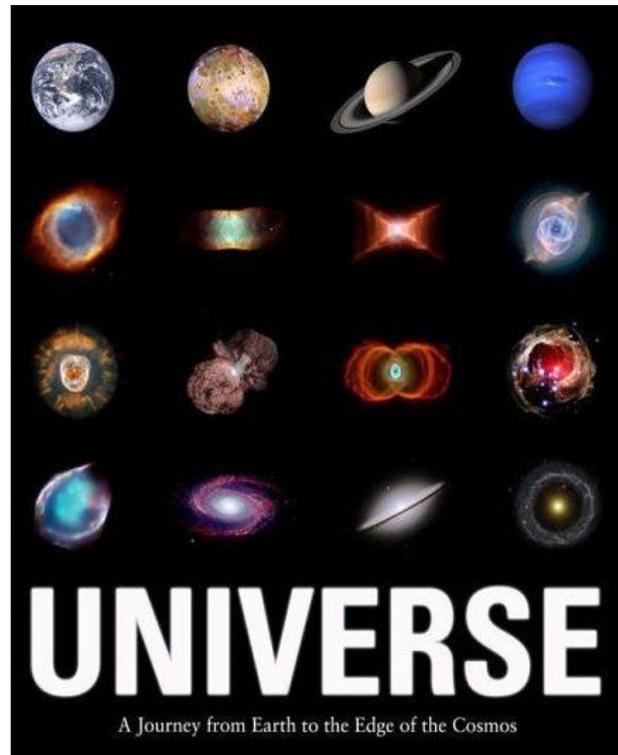
A Journey from Earth to the Edge of the Cosmos

This is without a doubt is my favourite book.

As you know I am not shy of reading a book with a whole load of words in it. But this is not one of those books. It is a book of staggeringly beautiful pictures with just the right amount of words. It was given to me by my brother as a Christmas 'stocking-filler' a couple of Christmases ago. He had spotted it at his partners charity shop and thought I might like it (lol).

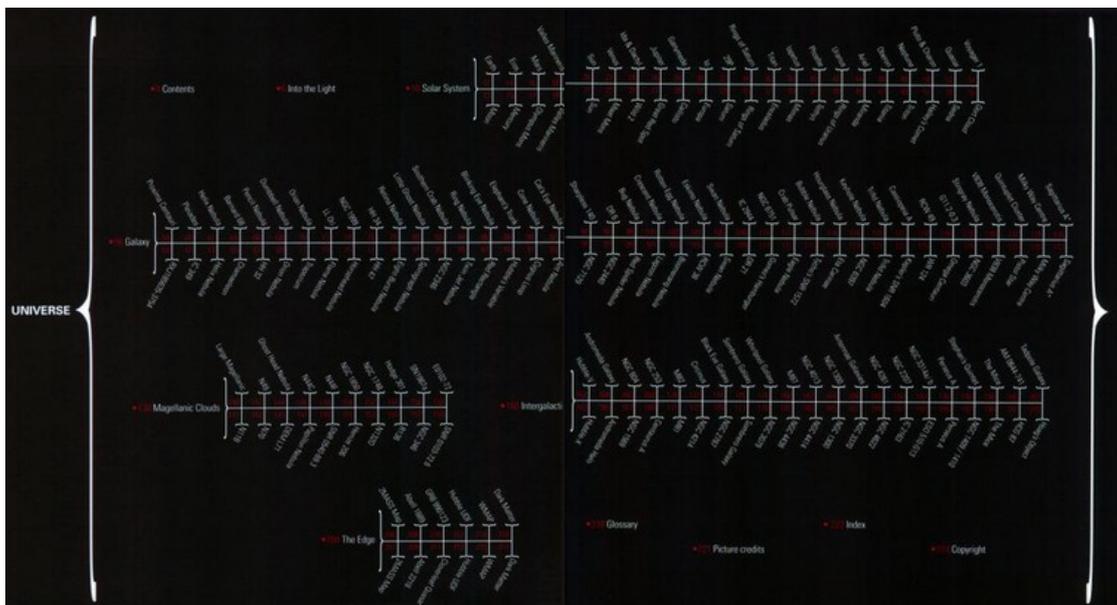
This book is available on Amazon now for £2.80 and you should buy it !

The book will take you on **A Journey from Earth to the Edge of the Cosmos** just as it says on the cover. The contents are arranged as a 'time-line'. This is because the book is ordered in distance from Earth measured by the speed of light. To start with in 'light-seconds' then as distances increase in 'light-minutes' then in 'light-years'. You get a feeling of (at first) leaving the Earth at a steady pace and as you read through the book the speed gets faster and faster.



The Universe cover

You get a feeling of (at first) leaving the Earth at a steady pace and as you read through the book the speed gets faster and faster.



The contents Time Line

Danny.

Book Review

UNIVERSE

A Journey from Earth to the Edge of the Cosmos

The time line of course deals with our Solar System as the start point is Earth. It works its way out to the Voyager 1 space craft and the Oort Cloud. On its way it covers **42 objects in our Solar System!** I am guessing more than most people knew were there, and that only scratches the surface of what is really there !

Each object has a fantastic colour picture and an information panel showing its distance from Earth at the speed of light, its Name, its Type (i.e. Planet, Moon etc.) and a very informative paragraph or two about the object. All of the pictures are fantastic but some are totally stunning !

Now the speed starts to really increase, as we move out of our Solar System into our Galaxy 'The Milky Way'. Starting with Proxima Centauri the second nearest star to Earth (not forgetting the Sun) at a distance of 4.2 light-years from Earth. Over the next **Seventy Nine Pages** it zooms you faster and faster across our galaxy. Covering a huge number of objects on the way.

Next the time line jumps across the void between our galaxy and on to the Large and Small Magellanic Clouds two satellite galaxies at **One Hundred & Sixty Thousand Light Years** away. Over the next 20 pages we travel through our 'local' galactic space to a distance of **Two Hundred Thousand Light Years**. Passing through Star Forming Nurseries, Neutron Stars, Emission Nebulae, Supernova Remnants, Pulsars and Star Clusters. All with amazing detailed full page colour pictures.

Then the big leap into Inter Galactic Space, where the distances become truly mind boggling! Here we start off with the last of the near by (relatively speaking) Nebulae and on through the truly vast chasms of space between countless Galaxies.

We pass by Spiral Galaxies, Star-burst Galaxies, Active Galaxies, Lenticular Galaxies, Ring Galaxies, Black Holes and Galactic Collisions where one Galaxy passes through another and the utterly massive gravitational forces tear the structure of the Galaxies to pieces, strangely almost always without any star or planet ever colliding with another !

Finally we come to the last section in the time line **The Edge** this is where the distances start at **1.3 Billion Light Years** with the Local Universe Map. A map of 1.6 Million Galaxies. Here the word 'local' becomes truly absurd, these 1.6 million Galaxies are within **1.3 Billion Light Years** of Earth and that is just the start of this section.

We move on through massive cluster upon cluster of Galaxies, the odd Quasar here and there. The Hubble Ultra Deep Field and the WMAP, the background radiation from the Big Bang its self. This is a must have book!

Danny.

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What's in the sky this month

What to see Saturday 6th June at 10pm
Planet (Saturn)

Good news ! Saturn is back.

At about 10:00pm look South South East (Azimuth 152°) on your compass and (Altitude 16°) above the horizon and enjoy this magnificent sight, Saturn. It's very close to the horizon at this time but will be a little higher up later in the night.

By 11:50pm Saturn will be directly South and will have risen to its maximum height (Altitude 20°) above the horizon, before again descending towards the horizon as the night progresses. If you have a telescope it's truly a jaw dropping sight !!! You may even see Dione, Tethys, Enceladus, Rhea and Titan, just some of Saturn's many moons.



10pm Saturn's position in the night sky



A Close up of Saturn and some of its Moons

Noctilucent clouds mid May to mid August

Noctilucent clouds can be seen in the late evening after sunset and in early morning before sun rise and appear brightly lit while the lower weather clouds appear black in the darkening sky.

This phenomenon takes place between 76,000 and 85,000m at which height the temperature plummets to -120°C causing any clouds to crystallize and reflect the Sun.

Noctilucent means 'night shining' in Latin. These clouds are called Noctilucent because they appear bright against the darkening night sky. They are the highest clouds in Earth's atmosphere.

Weather clouds are 10 times lower in the atmosphere and will appear silhouetted against the evening sky but Noctilucent clouds are still lit by the Sun even after sunset, therefore the best time to observe them is about an hour after sunset and in the pre-sunrise sky.

They are generally colourless or a pale blue, but can be red or green. They can be featureless bands but frequently have patterns such as streaks, whirls and wave-like undulations. Sometimes they have been mistaken for the aurorae.

For more information on Noctilucent clouds see the Did you know article on page 15.

George Ward / Tracy Howes

Member's Page



Alan outside the newly decorated West Bay Café

The West Bay Café is situated on the promenade, Sea Road, Westgate-On-Sea, CT8 8QA and is a delightful, bright, open family orientated business. The café offers something for everyone including after-hours private parties. The opportunity to sit and have a drink (the café is licenced as well) or perhaps browse the internet (free super fast fibre optic Wi-Fi), or read a news paper (supplied by the cafe) or just sit and gaze out to sea. This cafe is not to be missed !

Alan Dolan; owner of the West Bay Café; kindly agreed to be interviewed for the Thanet Astronomy Group newsletter, as he and his partner, Kate have been so supportive of the Group I thought other members may be interested in how the Group and the café became associated so we met on Thursday afternoon 28 May 2015 at the café.

Alan explained that he was born in Dublin and left there for England when he was about 21 years old. His partner Kate is English and they have two children, Matilda and Isolde. Their family home is near to the café and he is very interested in cars and actually has four. One is a very nice older MG a white soft top and another newer model in red colour. His main interest and focus is his family. I asked him if he liked football and he said he does but does not support any particular team as when working in bars it was prudent to be neutral when talking to customers.

Alan told me that when he was around 16-17 years old he worked as a waiter in pubs in Ireland and did an apprenticeship in an Irish bar in Germany, he then went onto manage bars. Alan went to University in Brighton and gained a degree in Business Management – he also worked as a planner and buyer in Brighton and lived there for seven years.

Alan is very interested in renovating listed buildings and worked for two years in Ireland on two projects. He generally project manages and uses skilled craftsmen for the work.

Sheila Bull.

Member's Page

When Alan and Kate returned from Ireland – they were in the café one day and the owner happened to be there. Alan mentioned to the owner that if he ever decided to sell the café he would be very interested and left his business card.

This was a very strategic move as the owner quickly decided to take them up on their offer and the deal was done very quickly. Alan and Kate took over the cafe on 01 June 2011, so this is their fourth year there. They have completely renovated and updated the place and the outside of the building has been completed this year.



West Bay Cafe Old Outside



West Bay Cafe New Outside

Alan's other business interests include a building company that concentrates on building reinforced concrete steel walls. He also has some flats locally that are rented out and one in Dundee, Scotland.

I then asked him how he became involved in the Thanet Astronomy Group. He explained that he was talking to Danny one day about him wanting to start a group and that was it.....I wanted to find out how Alan felt now after being involved for over a year and had the Group had an impact on the café.

Alan explained that free publicity is good for any business and the two seem to fit like a glove. I said that we took every opportunity to promote the café as we were so grateful for his and Kate's support.

I asked Alan about the future as the club is growing and he said that he was currently happy with the relationship and whilst willing to support us he is not that interested in astronomy but did not foresee anything changing.

Alan also told me that he is expanding his café business and is opening another premises the other side of the bay.

I thanked Alan for talking to me; I have not had an opportunity to talk to him before and I found him to be a charming, friendly and fun person. I would like to thank him for his and Kate's continued support for the Group and every success for his current and new venture.

Sheila Bull.

Did You Know ?

Noctilucent clouds

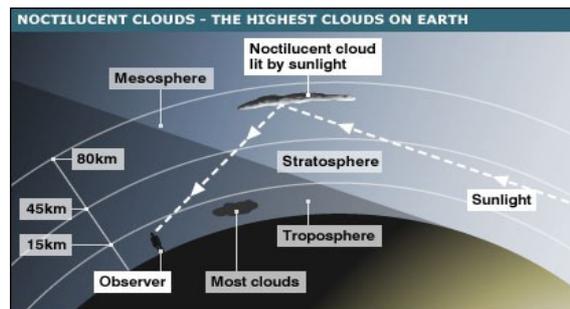


Noctilucent Clouds Over Sweden
Credit: P-M Headen

Noctilucent roughly means 'night shining' in Latin, and these types of clouds are called this because they appear bright against the darkening night sky.

They are located in the mesosphere and are the highest clouds in Earth's atmosphere, at altitudes of around 76,000 to 85,000 metres.

Weather clouds, as they are 10 times lower in the atmosphere, will appear silhouetted against the evening sky but Noctilucent clouds are still lit by the sun even after sunset (for the same reason we can see satellites), therefore the best time to observe them is about an hour after sunset and in the pre-sunrise sky.



They are generally colourless or a pale blue, although other colours can occur like red and green. They can be featureless bands but frequently have patterns such as streaks, whirls and wave-like undulations. Sometimes they have been mistaken for the aurorae.

Noctilucent clouds are made of crystals of water ice and as the mesosphere contains very little moisture and is extremely thin, the ice crystals can only form at temperatures below about -120C. The mesosphere is at its coldest during summer (strangely!) so in the Northern Hemisphere these clouds can be observed from mid-May to mid-August.

George Ward / Tracy Howes

Junior Astronomers Club (JAC & Gill)

As ever, the Junior Astronomy Club is going from strength to strength as more children are dropping in each week to find out about the amazing subject of Astronomy and Space. The youngest age we have had so far is a little boy of just three years old who knew all his planets and even the names of some of the moons around Jupiter!

The average age is between 5 and 11 and each child has their favourite subjects in Astronomy they want to learn about and share with their peers. Most are more interested in the Planets and love all the interesting facts they can then throw at their parents to blind them with Amazing Science.

However, a small dedicated group who have been turning up regularly, are now starting to learn about the fascinating star constellations, their names and the patterns they can identify them with!



Waiting for everyone to be ready



Starting at the Sun at the Cafe



Ages later we got as far as Jupiter

Danny's "Journey across the Solar System" where we pace out the Solar System to a scale of 1,000,000 miles to one step, drawing the planets in chalk on the prom, at their correct scale distances from each other, seems to be becoming a regular event. It keeps the kids engaged in mathematical discussions for ages...as well as keeping us all fit once we've walked from one side of the Solar System (Westgate Bay) to the other...and back!!! Then when it rains and washes the planets away we just have to do it all over again.

We still haven't got to Saturn yet as the prom has been shut for repair work...but when it is all open again, we may even reach Uranus and Neptune in the next bay on our Journey through Space (although judging by Danny's paces compared to the children's...it may be even further!)

"Reach for the Stars" Junior Astronomers!!!

Gill Palmer.

Executive Committee Messages

Mini Course

We are thinking of putting a mini course into the newsletter maybe a couple of pages a month to run for as long as it takes. We would like to know what sort of things you would like to learn about. Please come and talk to us or email us, if you have any ideas. This is your chance to guide us in the direction you want to go.

Basic Stargazing

We are pleased to report that the fourth run of the ever popular Basic Stargazing Course was again well attended. We had almost 50% members and 50% public attending the course and we raised another £555 for the group.

Catch-ups

For those of you that were unable to attend all four parts, please let me know as we will try to arrange to work through the missed parts over the coming Saturdays.

Donations

For several months now we have been receiving donations of many astronomy and space related books from Thelma Bedford for which we are very grateful. Thelma's late husband Ronald was born blind in one eye and had limited vision in the other eye. At the age of 12 he had intentions to become a news paper journalist. Which he accomplished and was for many years science correspondent for the Daily Mirror. During which time he became well known to many people in the field, such as Sir Bernard Lovell, Sir Patrick Moore, and many NASA astronauts among others. With whom he was on first name terms. Last week we also received a cheque for £100 towards our group fund, in memory of their friend Mrs. Maureen Mariott who was always very interested in astronomy and ran a restaurant in Broadstairs called Mariott's for 25 years. We would all like to express our thanks to Thelma for these kind donations.

Membership Renewal

Most members have now renewed their subscription and there are only a couple that are still outstanding. We have sadly lost a couple of members due to ill health and the ever increasing pressures of work and family commitments. But we have also gained a few new members from the regular Saturday meetings and from the Stargazing course. The current membership stands at 33.

We are all looking forward to the new membership year and all the amazing sights we will be looking at.

(-: Wishing you all Clear Skies :-)

Danny, George, Gill.

Adult Word Search

ALTITUDE
CASSIOPEIA
CYGNUS
HEMISPHERE
MESSIER
PHOTON

APHELION
CELESTIAL
DOPPLER
INTERSTELLAR
METEORITES
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 R L D C D N E B U L A E O L I B S P K O
 H L Q U G A O Z Z A S J P E C R L D L L
 S A P O T N E O S R A C P T M Y S K A O
 E I F P B I J O M T N J L S P G E R T F
 T T G V Z U T C P N O U E R Z O O E E X
 I S V M C V D L K Y A P R E A L W I H N
 R E L A I R O T A U Q E S T C O G S G M
 O L Q R T O M O E Z I X L N O R I S Z D
 E E F E L Z N O T O H P A I U T M E N A
 T C A S S I O P E I A E E S L S A M M Z
 E P W C H R O M O S P H E R E A R M I O
 M A G N E T O S P H E R E U B X G P E G
 C S T Z X F Q S K A N V S J F E I J A L
 V O J Q U D R Y A W Y K L I M T L L T R
 J E H W G T N K G V T G E K Z G L T R U

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G O C O L P O G S
J M A B U L R A M
U E P L U A I L L
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