The Jeety Starn

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Welcome to Issue 6 of *The Jeety Starn*, the quarterly newsletter of the Stirling Astronomical Society (SAS). Included in this issue are articles on Will Hay, actor and amateur astronomer, music in space, the Blue Ghost mission, the Hayashi Track, and Earth's quasi-moon Kamo'oalewa, as well as our regular quota of quotes and literary scraps. We start with an update on the recurrent nova, T Coronae Borealis.

T Corona Borealis update

By Alan Cayless FRAS

In 2024, we reported on T Coronae Borealis, a *recurrent nova* that brightens significantly approximately every 80 years. With the last event having taken place in early 1946, the next brightening is expected soon.

Based on the light curves from previous events, the rapid brightening is normally preceded by a characteristic dip in brightness from its usual magnitude of about +10. For a couple of months prior to each event, the brightness has dipped to around +11 before brightening rapidly to a magnitude of around +2.

In the summer of 2023 the American Association of Variable Star Observers (AAVSO) announced that just such a dip had been seen, prompting speculation that the next outburst might be imminent, a year or so ahead of schedule (AAVSO 2023).

More recently, AAVSO and the University of Kentucky have published data from August and September 2024, showing that T Coronae Borealis has returned to its usual brightness (University of Kentucky 2024). It appears that the 2023 dimming may have been part of a normal oscillation in output, rather than the anticipated pre-eruption dip. It appears that we may once again be on track for the full 80 years, with the next event now expected in late 2025 or early 2026.

With a declination of +25° 55', T Coronae Borealis has been low in the northeastern sky over the winter months, making observation difficult from Stirling. As we head from spring into summer it will become more easily visible, and we will continue to keep a close eye on the light curve for any sign of an impending outburst, with updates on the Society website.

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AAVSO (2023) *Announcing T CrB pre-eruption dip*, https://www.aavso.org/news/t-crb-pre-eruption-dip.

University of Kentucky (2024) *T Coronae Borealis*, https://observatory.as.uky.edu/t-crb.

The Legend of Corona Borealis

By Sandi Cayless

The constellation Corona Borealis (Northern Crown) symbolises a crown inlaid with precious stones given to Ariadne, daughter of Minos of Crete, by Dionysus (Bacchus). Corona Borealis contains nine major stars that form a semicircle. (Corona Australis, the Southern Crown, represents a crown given by Dionysus to his mother Semele). As the legend goes, Ariadne fell in love with Theseus and gave him the thread that helped him find his way out of the Minotaur's Labyrinth, after he had slain the beast. He promised marriage, sailed off with her from Crete to Naxos, and deserted her, leaving her marooned. She was found by the god, who married her and took her as his queen:

"Deserted and weeping bitterly, as she was, Bacchus-Liber brought her help and comfort. So that she might shine among the eternal stars, he took the crown from her forehead, and set it in the sky. It soared through the rarified air, and as it soared its jewels changed to bright fires, and took their place, retaining the appearance of a crown, as the Corona Borealis, between the kneeling Hercules and the head of the serpent (Serpens) that Ophiuchus holds" [Ovid, Metamorphoses, Bk VIII:152-182].

Melodies in Space

By Sandi Cayless

Music has touched the farthest star – or is at least on the way there or back. Whether beamed from Earth's surface, taken with astronauts to be played aboard spacecraft, or sent from spacecraft into space or back home, the sound of music has long been part of the space programme. For example, the test-run for playing a track on the lunar surface by the Apollo 11 crew was Frank Sinatra's *Fly Me to the Moon*, which went up with Apollo 10 (Powell 2024). The wake-up call is, however, a long-standing NASA tradition extending back to the mid-1960s Gemini programme. Each day during a mission, Mission Control aims to greet the crew with an apt musical tribute (Fries 2015).

Wake-up calls are chosen by flight controllers or friends and family of crew and most are musical, ranging from rock, country, classical and jazz to children's and songs from crewmembers' countries. Themes recurring over the years include references to spaceflight and the view from up there, with classics such as Louis Armstrong's *What a Wonderful World*, The Beatles' *Here Comes the Sun* and various versions of *Fly Me to the Moon*. Movie themes have included *2001: A Space Odyssey* during the Apollo missions, and *Star Wars* and *Star Trek* for several shuttle missions. Astronauts away from family during holiday times have often been greeted with *I'll Be Home for Christmas* and similar appropriate jingles. Most of the following data comes from NASA's *Chronology of Wakeup Calls*, collated by Colin Fries (2015).

The 1965 Gemini VI mission awoke to *Hello, Dolly!* In 1972, the first wake-up call for Apollo 17 astronauts Gene Cernan and Jack Schmitt on the Moon was Wagner's *The Ride of the Valkyries*. On the morning of leaving lunar orbit for the trip home, they heard *Home for the Holidays* and The Carpenters' *We've Only Just Begun*, in the belief that the end of the Apollo programme was not the end of the lunar adventure. Splashdown morning was a dual selection of the Navy's *Anchors Aweigh* and *The Star Spangled Banner*. Skylab 3 and 4 crews in 1973 were treated to favourites such as *Girl from Ipanema*, *Come Fly With Me*, *Moonlight Becomes You*, *The Lonely Bull*, and over Christmas, seasonal tunes. The Apollo crew of the Apollo-Soyuz Test Project (ASTP) from July 15 to 24 1975 heard wake-ups including *Good Morning Sunshine* and *Midnight in Moscow*.

With the dawn of the Space Shuttle, wake-ups had to be very familiar to the crew, as speaker units on board a shuttle are designed to communicate alarm tones rather than reproduce music; they are thus arranged pre-mission. Non-musical wake-ups have included The Muppets' *Pigs in Space* routine for the crew of STS-2 in 1981, preceded by *Columbia, Gem of the Ocean*. The STS-3 crew heard *On the Road Again* by Willie Nelson, whilst *Up, Up and Away* greeted the crew of STS-4. The team on STS-8 in September 1983 heard *Tala Sawari* performed by Ravi Shankar on the sitar, to honour the release of the Indian INSAT satellite. Crew on mission STS-51-A in November 1984 listened to, amongst others, *Good Morning Starshine*. Songs for STS-51-D in April 1985 included *Stargazer* and *Skybird* by Neil Diamond, the Carpenters' *Top of the World*, Wagner's *Ride of the Valkyries*, and *Rocket Man* by Elton John. *Waltzing Matilda* awakened the crew of STS-51-I in 1985 as they passed over Australia. Personal tributes to crew members have included Mendelssohn's *Wedding March* and *Get Me to the Church on Time* by Lerner and Loewe in honour of STS-51-G's pilot John Creighton's forthcoming wedding in 1985.

When *Discovery* (STS-26) made the first post-*Challenger* flight in September 1988, the astronauts awoke to a parody of the Beach Boys' *I Get Around* called *We Orbit 'Round* by radio disc jockey Mike Cahill; the astronauts clowned for TV cameras in bright Hawaiian shirts. The STS-27 (*Atlantis*) crew later that year awoke to a message in Darth Vader's

voice against a background of the *Star Wars* theme music, followed by satirical lyrics to The Beatles' tune *Do You Want to Know a Secret*? Such antics upset NASA, as the few minutes' play tended to get more airtime than the hours of hard work put in by the crews. Future crews were thus ordered to tone things down when cameras or microphones were in use. Nonetheless, shuttle *Discovery's* (STS-29) crew in 1989 woke Mission Control with the *Star Trek* theme followed by congratulatory comments from William Shatner; Mission Control replied with a medley of school songs from crew members' alma maters and an ad lib from Capcom G. David Low: "*Discovery*, Houston – beam me up, Scotty."

The *Star Trek* theme is a common one. To the intro music of *Star Trek – the Next Generation*, the STS-44 *Atlantis* (Nov 24-Dec 1 1991) crew heard "Space – the final frontier. This is the voyage of the Space Shuttle *Atlantis* – its ten-day mission: to explore new methods of remote sensing and observation of the planet Earth; to seek out new data on radiation in space, and a new understanding of the effects of microgravity on the human body; to boldly go where two hundred and fifty-five men and women have gone before. Hello Fred, Tom, Story, Jim, Tom, and especially Mario. This is Patrick Stewart, choosing not to outrank you as Captain Jean-Luc Picard, saying that we are confident of a productive and successful mission. Make it so." This wake-up call was particularly for mission specialist and avid Star Trek fan Mario Runco Jr. On 15 January 1996, the crew of STS-72 heard the *Star Trek Next Generation* theme by James Horner; STS-111 in June 2002 was treated to *Where My Heart Will Take Me*, the theme from *Star Trek: Enterprise*, performed by Russell Watson. The STS-114 crew in August 2005 also got *Where My Heart Will Take Me*, while the crew of STS-115 in 2009 heard the original *Star Trek* theme by Alexander Courage on May 20, and *Where My Heart Will Take Me* three days later. During their final mission in 2011, the *Discovery* crew (STS-113) listened to *The Ritual/Ancient Battle/2nd Kroykah* (aka the Star Trek fight song) from the original TV soundtrack on 4 March, and the original *Star Trek* theme, voiced-over by William Shatner, on March 7.

The crew of STS-48 *Discovery* in September 1991 had *Please Release Me* by Elvis Presley in anticipation of the deployment of UARS, the Upper Atmosphere Research Satellite, and then later Presley's *Are You Lonesome Tonight?*, chosen for the line *Are you sorry we drifted apart?* in reference to *Discovery's* separation from the UARS payload. This was followed by Presley's *Return to Sender* in honour of the expected landing. Presley's *Please Release Me* also featured aboard STS-51 (*Discovery*) in September 1993 – it was sung by Elvis impersonator and astronaut Carl Walz, who, aboard on his maiden spaceflight, had the rare experience of hearing his own voice singing for his first wake-up in space.

Other appropriate pieces have included STS-52 (*Columbia*) waking to Hawaiian music in honour of the day's planned discussion between *Columbia's* crew, students at the University of Hawaii and the Polynesian sailing canoe *Hokulea*, located in the South Pacific. During the same mission, *Monster Mash* by Bobby Pickett was played on Halloween and Control included a pattern for a cut-out mask in flight plans radioed to the shuttle. The first Russian cosmonaut to fly aboard a US spacecraft, Mission Specialist Sergei Krikalev, was honoured with Russian folk tunes as a wake-up aboard STS-60 in 1994. Only one wake-up call was included by Control to STS-68 in October 1994, as the crew worked two shifts around the clock: there was a problem with the galley water system putting bubbles into the crew's drinking water, so Capcom Bill McArthur sent the song *Tiny Bubbles* to Blue shift. The crew of STS-70 in July 1995 awoke to the theme from *Woody Woodpecker*, the cartoon character adopted as mission mascot (real woodpeckers had bored holes in protective insulation on *Discovery's* external fuel tank the previous month, delaying the mission).

Mission STS-84 from 15 to 24 May in 1997 set a record for the number of different countries in which crew members were born: Precourt, Collins and Lu (United States), Kondakova (Russia), Clervoy (France), Foale (UK) and Noreiga (Peru), and wake-ups included the British, French, Peruvian, Russian and US national anthems. The *Superman* TV theme was played in 1998 (STS-91) to honour Franklin Chang-Diaz's record-breaking time in orbit aboard a shuttle, a total of over 51 days in orbit during six shuttle flights. Aboard STS-96 on 4 June 1999, *Good Morning Starshine* was played to acknowledge the deployment of the Starshine satellite, whilst astronaut Culbertson on STS-105 in August 2001 heard *Back in the Saddle Again* (Gene Autry) to celebrate his third flight into space, eight years after his last. The STS-111 crew in June 2002 were treated to *I Got You Babe* by Sonny and Cher from the *Groundhog Day* film soundtrack, a recurring theme for wake-ups on missions which are extended for two days, with the astronauts having to repeat de-orbit activities each day, to be told that because of bad weather they will have to go through the same tasks again the next day. This was Commander Ken Cockrell's third mission in a row where he had to remain in orbit for an extra two days because of poor landing weather in Florida. STS-111 eventually landed at the alternative California site. This theme was also played for the crew of STS-113 in Nov-Dec 2003, who set a new record for the number of landing tries, as well as for the crew of STS-114 (Jul-Aug 2005) to commemorate its first day out of quarantine.

STS-114 was the first space shuttle mission following the *Columbia* disaster. On 31 July 2005, astronauts Steve Robinson and Soichi Noguchi woke up to prepare for the mission's second spacewalk to *Walk of Life* by Dire Straits, in honour of their upcoming repair work on the International Space Station. On 3 August, wake-up was *Amarillo By Morning*, not dedicated to the crew in space but to the *Columbia* STS-107 crew commanded by Amarillo native Rick Husband. The day included a dedication to the *Columbia* crew and other space explorers who died during their missions. A few days later, on 7 August, Houston called up with Dexy's Midnight Runners' *Come On, Eileen*, in honour of Commander Eileen Collins.

Most Earth-to-space wake-ups are of necessity short, two to three minutes, but the longest, almost 14 minutes, was a live wake-up mini-concert by Paul McCartney in 2005 to International Space Station astronauts Bill McArthur and Valery Tokarev. McCartney played *English Tea* and *Good Day Sunshine* in the first-ever concert link-up to the space station, the call observing the crew's 44th day of a planned six month mission. The concert was beamed from the West Coast to the station 220 miles above Earth and broadcast on NASA television. However, to mark their final day in space on 8 March 2011, the crew of STS-113 *Discovery* were given a live wake-up call chosen by the public, the hit *Blue Sky* by Big Head Todd and the Monsters.

Other planets have also received a taste of music. On July 12, 2024, NASA beamed the lyrics from the song *The Rain (Supa Dupa Fly)* by hip-hop artist Missy Elliott to Venus via the Deep Space Network (DSN), from its Jet Propulsion Laboratory (JPL) in Southern California (JPL 2024), a distance of 254 million km (158 million miles). And other than human ears have been the recipients of wake-up calls – the robotic explorers on Mars have been listening to their own since 1997, when mission controllers at NASA's JPL played *The Final Frontier* theme from the American sitcom Mad About You for Mars Pathfinder and the Sojourner rover. Pathfinder and Sojourner have also heard tunes such as *Follow You, Follow Me* (Genesis), *Let the Good Times Roll* (Ray Charles) and *Love Me Like a Rock* (Paul Simon). The Spirit and Opportunity rovers have also had their share: *Dust in the Wind* by Kansas was played as Spirit tried to capture dust devils spinning across the Martian surface. Other hits for Spirit included: *(I Can't Get No) Satisfaction* by the Rolling Stones (Spirit's air bags not cooperating); *Get Up, Stand Up*, by Bob Marley (lift mechanism actuated); *Reach Out* by the Four Tops (first robotic arm activity); *We Will Rock You* by Queen (first arm activities and observations on a rock); *S.O.S.* by Abba (the objective was to regain contact with Spirit after a loss of communication – they did); *Baby, Talk to Me*, from the musical Bye Bye Birdie (the objective was to get Spirit to send data – she did); *We Can Work it Out* by The Beatles (beginning debugging activities to get Spirit back to normal); and, *I Still Haven't Found What I'm Looking For* by U2 to pay homage to Spirit's twin rover Opportunity's astounding findings of evidence of water at Meridiani Planum. Opportunity "heard" *Stand* (REM) and *I'm Still Standing* (Elton John) at stand-up, *Release Me* (Elvis Presley) at middle wheel release, *Born to Run* (Bruce Springsteen) at wake-up and *Going Mobile* (The Who) at egress. These were followed by, among others, *Pictures of You* (The Cure) for the first MI image, *Please, Please Tell Me Now* (Depeche Mode) at first MB data readout of soil, and *The Flintstones* Theme Song for the arrival at the 'bedrock'. On Mars day (Sol) 29 of the

mission, *Riders on the Storm* by the Doors was played in recognition of heavy weather at Deep Space Stations (DSS) DSS-63 (Madrid) and DSS-14 (Goldstone, California) and on Sol 39, *Bad Moon Rising* by Creedence Clearwater Revival was played in honour of the eclipse caused by Martian moon Deimos. The transit of Martian moon Phobos on Sol 45 was recognised by Pink Floyd's *Eclipse*.

Such robotic explorers have also been given the capacity to return music to Earth: ESA's Mars Express spacecraft carried a recording called *Beagle 2*, performed by pop band Blur (Blur helped raise funds for the British Beagle 2 lander mission). It was supposed to be played back to Earth on Christmas Day 2003… Beagle 2 was located on the Martian surface in images from the Mars Reconnaissance Orbiter HiRISE camera in January 2015, alas too late for head of the Beagle programme, Professor Colin Pillinger (1943-2014) of the Open University, to know: Beagle *had* landed safely but two of her four solar panels failed to deploy, blocking the communications antenna (Bridges et al. 2017). The first music beamed back to Earth from the surface of another planet (that we know about!) *was* from Mars, and was *Reach for the Stars*, especially written by will.i.am and sent home by the Curiosity Mars rover in 2012, a distance of 480 million km (Powell 2024).

Songs into space have gone further. On February 4, 2008, NASA beamed The Beatles' song *Across the Universe* directly into deep space, to commemorate a number of events: the 40th anniversary of The Beatles recording the song, the 50th anniversary of NASA's founding and The Beatles' beginnings, the launch 50 years before of Explorer 1 (the first US satellite), and, the 45th anniversary of the founding of the Deep Space Network, an international antennae network to support missions to explore the universe (JPL 2008). The transmission was aimed at Polaris (the North Star). But can we hear non-Earth made music from out there? As space is virtually a vacuum without atoms or molecules to carry sound waves, it was once thought the answer was *no*, but we *can* hear sounds from various bodies in space. The sounds of Jupiter, discovered in 1955, are caused when volcanoes on Io emit electrically conducting gas into Jupiter's magnetic field. The gas collects in a torus around Jupiter, and Io moves through it, generating Alvén waves (i.e. a moving oscillation of ions and magnetic field in a plasma). These move along the force lines in Jupiter's magnetic field, transmitting the 40 trillion watts of power to its poles that power the *radio lasers* that reach Earth. Other naturally-derived sounds have also been heard from Ganymede, the Sun, various stars and other phenomena (see Hawksett 2022 for many examples of such *sonification*). In August 2022 NASA amplified and mixed the acoustic signals generated by the hot plasma of the black hole at the centre of the Perseus galaxy cluster (found in 2003 data from NASA's Chandra X-ray Observatory), to bring it within the range of human hearing (Hawksett 2022). This sonification meant that the original, 57 octaves below middle C, sounded like an eerie growl. That and other examples of visual phenomena from beyond our solar system, from nebulae, stars, galaxies, clusters, the Hubble Deep Field, the Pillars of Creation, and from the centre of our own Milky Way, have been transformed by NASA through data sonification, into sound (NASA 2023), allowing audiences, including those visually impaired, to listen to these songs of the Universe.

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To The Moon Slowly

By Alan Cayless

On 15th January a SpaceX Falcon 9 rocket lifted off from Kennedy Space Center in Florida carrying two commercial Moon lander missions. After a successful launch, the two spacecraft – one built by Texas-based Firefly Aerospace, and the other by Japanese iSpace – were delivered safely into Earth orbit, with the first-stage Falcon 9 booster returning to Earth for a safe touchdown at sea, ready for re-use (SpaceX 2025).

Firefly's Blue Ghost Lander is carrying a package of ten instruments built and operated by NASA as part of NASA's Commercial Lunar Payload Services program, which sees private companies bidding to launch and deliver NASA payloads to the Moon. Blue Ghost will touch down in Mare Crisium where the various instruments on board will sample the lunar surface and also make measurements aimed at understanding the Moon's internal structure and environment. Some of the experiments on board will also carry out tasks aimed at testing technologies to be used in future missions (NASA 2025).

The iSpace Resilience lander carries two experiments designed by commercial companies aimed at hydrogen extraction and algae-based food production, together with a deep space radiation probe built by the National Central University in Taiwan. There is also a miniature rover, *Tenacious*, which will explore the landing site and collect samples of the lunar regolith, sending results back to the main lander. The lander also carries a commemorative plaque and the rover a small model of a house (iSpace 2025).

The two spacecraft are following rather different routes to the Moon. After carrying out system tests and commissioning in Earth orbit for a little over three weeks, Blue Ghost transferred to a lunar transit orbit, taking four days to reach the Moon. Currently in lunar orbit, Blue Ghost is scheduled to touch down in Mare Crisium in early March. Resilience and Tenacious are taking a more leisurely but more energy-efficient route and will take several months to reach the Moon, with touchdown in Mare Frigoris planned for early summer this year (Space.com 2025).

Several further commercial missions are planned over the next year. We will watch their progress with interest.

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Blue Ghost Mission Details and Some Highlights	
Mission name	Ghost Riders in the Sky
Mission Type	Lunar Mission
Customer	NASA
Spacecraft	Blue Ghost lunar lander
Launch Time/Date	1:11 a.m. EST, Jan 15, 2025
First engine burn	Jan 18, 2025
Earth eclipse captured	Jan 21, 2025
New LuGRE Payload Milestone*	Jan 21, 2025
Second engine burn	Jan 24, 2025
First Moon image	Jan 27, 2025
Earth eclipsing Moon image captured	Jan 31, 2025
Earth selfie captured	Feb 3, 2025
Trans lunar injection burn	Feb 8, 2025
Trajectory correction	Feb 9, 2025
New Earth + Moon images captured	Feb 12, 2025
Lunar orbit insertion	Feb 13, 2025
First Moon images in lunar orbit	Feb 14, 2025
Second lunar orbit complete	Feb 18, 2025
Landing Date	March 2, 2025
Landing Time	TBA
Landing Site	Mare Crisium near Mons Latreille
	Data: © Fireflyspace.com

*Lunar GNSS Receiver Experiment (LuGRE) payload acquires signal from Earth-based Global Navigation Satellite System (GNSS) at a record-breaking distance of 205,674 miles.

Poetic Licence

Frost, Robert: The Freedom of the Moon
I've tried the new moon tilted in the air
Above a hazy tree-and-farmhouse cluster
As you might try a jewel in your hair.
I've tried it fine with little breadth of luster,
Alone, or in one ornament combining
With one first-water star almost as shining.

Houseman, A.E.: Astronomy
The Wain upon the northern steep
Descends and lifts away.
Oh I will sit me down and weep
For bones in Africa.

Keats, John: On First Looking into Chapman's Homer
Then felt I like some watcher of the skies
When a new planet swims into his ken…

Montgomery, Lucy Maud: Harbor Moonrise
Lo, in the east is a glamor and gleam,
Like waves that lap on the shores of dream,
Or voice their lure in a poet's theme!
And behind the curtseying fisher boats
The barge of the rising moon upfloats,
The pilot ship over unknown seas
Of treasure-laden cloud argosies.

Sandburg, Carl: Moonset
Leaves of poplars pick Japanese prints against the west.
Moon sand on the canal doubles the changing pictures.
The moon's good-by ends pictures.
The west is empty. All else is empty. No moon-talk at all now.
Only dark listening to dark.

Sandburg, Carl: Under the Harvest Moon
Under the harvest moon,
When the soft silver
Drips shimmering
Over the garden nights,
Death, the gray mocker,
Comes and whispers to you…

Thoreau, Henry David: The Moon Now Rises To Her Absolute Rule.
The moon now rises to her absolute rule,
And the husbandman and hunter
Acknowledge her for their mistress.
Asters and golden reign in the fields
And the life everlasting withers not.

Shelley, Percy Bysshe: To The Moon
Art thou pale for weariness
Of climbing heaven and gazing on the earth,
Wandering companionless
Among the stars that have a different birth, –
And ever changing, like a joyless eye
That finds no object worth its constancy?

Thou chosen sister of the Spirit,
That gazes on thee till in thee it pities ....

Stevenson, Robert Louis: The Moon
The moon has a face like the clock in the hall;
She shines on thieves on the garden wall,
On streets and fields and harbour quays,
And birdies asleep in the forks of the trees.
The squalling cat and the squeaking mouse,
The howling dog by the door of the house,
The bat that lies in bed at noon,
All love to be out by the light of the moon.

Dickinson, Emily: Ah, Moon – and Star!
Ah, Moon – and Star!
You are very far –
But were no one
Farther than you –
Do you think I'd stop
For a Firmament –
Or a Cubit – or so?

Dryden, John: Annus Mirabilis
Instructed ships shall sail to quick Commerce;
By which remotest Regions are alli'd:
Which makes one City of the Universe,
Where some may gain, and all may be suppli'd.
Then, we upon our Globe's last verge shall go,
And view the Ocean leaning on the sky:
From thence our rolling Neighbours shall we know,
And on the Lunar world securely pry.

Ghost Walkers*

By Sandi Cayless

The world is old, so old…
Base metals turned to rust;
The land is barren, cold,
Its people gone to dust…

A new star lights a dawn
That still in splendour glows
In colours rich and warm,
In shades of dusky rose.
But cold eyes watch the skies
Where fire's the blossom borne;
As scream of retros dies
A ship disturbs the dawn.

They've come again for more—
Rapacious, callous, cold,
With predatory claws
To rake red ash for gold.

They once brought end of time—
Through light and air they came.
Their weapons shook the sun
And left a world aflame.
As firestorm limned the land
And turned the seas to wrack,
They changed rich earth to sand
And fertile green to black.

They've come again for more—
Rapacious, greedy, cold
With predatory claws
And eyes alight for gold.

Boundless ages pass
And yet they haunt the dust;
Still is there spoil to grasp,
And profit for their lust.
But now – a strange unease,
A shiver, born in fright,
As one looks up to see
A shape at edge of sight.

But yet the world is old…
Its metals turned to rust;
The land still barren, cold,
Its people gone to dust…

The darkness, stilled, is dim;
One turns back, unafraid:
The ghost at shadow's rim
Was trick of light or shade.
The world is old, so old…
Base metals naught but rust;
The land is barren, cold,
Its people less than dust.

Yet out of loss grew hate:
Ice-crystalled, deathless, bright;
Formless first, to wait
Beyond both air and light.
Shaped of that hatred, we
Who haunt the edge of sight,
We know our time is near…
Our cold eyes wait the night.

Our world is old, so old, so old…
Base metals less than rust;
Our land is barren, barren, cold—
But now *we* walk the dust...

* First published in: Strom-Martin, H. & Underwood, E. (2013) Futuredaze: An Anthology of YA Science Fiction. Underwords Press, Marblehead, Massachusetts, USA, pp 184 – 186. ISBN 9780985893408.

Will Hay: The Actor, Comedian and Amateur Astronomer

By Mark Butterworth FRS

(This article was by our late, much-missed friend, Mark Butterworth FRS and is reprinted from an SAS Mercury newsletter of 2007, by kind permission of Mrs Pat Butterworth).

Will Hay starred in many comedy films, the most well-known being Convict 99 and Oh! Mr Porter, in which he played a hapless station master on a country railway. He was famous for his radio comic character, the headmaster Dr Muffin – referred to by his students as Old Crumpet. Born in 1888, during childhood he lived variously at Stockton, Lowestoft, Hemel Hempstead and Manchester. His first job was in engineering at the Westinghouse Company in Manchester; from there he went on to the printing trade. Around the age of twenty one he began to give after dinner speeches and work in the music halls.

Astronomy was a passion for Will Hay, although he kept it a jealously guarded secret for fear his status as a celebrity comedy actor undermined his credibility as an astronomer. He joined the British Astronomical Association in 1932 and was elected a Fellow of the Royal Astronomical Society later the same year. He served on the BAA Council and was an active member of the Comet Section. His main observational work was the visual determination of cometary positions using a home-made micrometer. Using his earlier engineering experience, he built a chronograph from Meccano parts and a gramophone motor (described in the BAA Journal in 1932) and also a blink microscope.

Towards the end of the 1920s Hay acquired a 12" reflector made by George Calver. The 1895 vintage instrument had been found in a derelict state and was restored by Hay and the well-known astronomer W. H. Steavenson, who lived nearby. Hay built an observatory at his home in Norbury, South London, although it appeared to have no roof or dome cover. He also owned a 6" refractor by Cooke, Troughton and Simms which he housed in a second building, and it was with this instrument that he made a celebrated discovery.

On the evening of 3 August 1933 (22h 35m GMT) while observing Saturn, he noticed a large bright

elliptical spot in the equatorial zone, just after it crossed the central meridian of the planetary disc. He immediately telephoned Steavenson to inform him and a BAA circular was issued. Observers at the US Naval Observatory in Washington independently saw the phenomenon, but they were about 30 hours behind Hay. He made five further observations of the spot up to 18 August, and as a result of these and observations by others, including observations of associated smaller spots that had been variously noticed up to mid-September, astronomers established a mean value for the planet's equatorial rotation period of around 10 hrs 14 min. The spot was prominent while it lasted.

The Daily Mail reported: Mr Hay works at night when he gets home from the theatre, but is more than willing to give you a look through his beautiful telescopes in the daytime. Mr Hay told me: "I found the spot on Saturn quite by accident. I was doing some work of my own – research for the British Astronomical Association – and I took a look at Saturn because he's always an interesting planet to study. He has nine moons, you know, and it's always amusing to see how many you can find… and there it was, the spot, looking me straight in the eye. There hasn't been one seen for thirty years, so I was

pretty startled. Of course, there's no telling what it might be. It's only a spot on Saturn's atmosphere; he's so closely shrouded in heavy clouds that we hardly ever get a glimpse of the planet's actual surface."

Full details of his observations were published by the Royal Astronomical Society, under the name W.T. Hay – Monthly Notices of The Royal Astronomical Society, 94 (1933), p85.

In 1948 Hay donated much of his observing equipment to the BAA, and after his death the following year his 12" Calver reflector passed through several hands and was still in regular use at least up to the early 1990s. Mystery surrounds what became of the 6" Cooke, Troughton and Simms refractor, although it is rumoured to have ended up at University College, London. His private observing notes are preserved in the RAS library.

Hay was also one of Britain's first private pilots and gave flying lessons to Amy Johnson. He was an accomplished translator – fluent in French, German, Latin, Italian, Norwegian and Afrikaans. As a favourite trick for friends, Hay would write rapid, seeming nonsense on a blackboard, look at it thoughtfully for a minute with a puzzled expression, then turn the blackboard upside down, and there would be a perfectly written statement of some kind. He could also take someone's dictation, and repeat the trick. He wrote one astronomy book, *Through My Telescope*, complete with a number of his observational drawings.

During World War Two Hay served in the RNVR Special Branch and also as an instructor in navigation and astronomy. Illness forced him out of the service before hostilities ceased and he never fully recovered. He died of a massive stroke in 1949. His fame today is mainly that of a gifted comic character actor, although his astronomical achievements were well known during his lifetime.

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A Quote or Two...

Donne, John (1572-1631)
Man hath weaved out a net, and this net throwne upon the Heavens, and now they are his own.

Dyson, Freeman (1923-2020)
The question that will decide our destiny is not whether we shall expand into space. It is: shall we be one species or a million? A million species will not exhaust the ecological niches that are awaiting the arrival of intelligence.

Eddington, Sir Arthur (1882-1944)
Something unknown is doing we don't know what. (Comment on the Uncertainty Principle in quantum physics, 1927).

It is sound judgment to hope that in the not too distant future we shall be competent to understand so simple a thing as a star.

Every body continues in its state of rest or uniform motion in a straight line, except insofar as it doesn't.

Einstein, Albert (1879-1955)
The most incomprehensible thing about the universe is that it is comprehensible.

Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius – and a lot of courage – to move in the opposite direction.

Politics is for the present, but an equation is for eternity.

We are slowed down sound and light waves, a walking bundle of frequencies tuned into the cosmos. We are souls dressed up in sacred biochemical garments and our bodies are the instruments through which our souls play their music.

Imagination is more important than knowledge. Knowledge is limited, imagination encircles the world.

There are only two ways to live your life. One is as though nothing is a miracle. The other is as though everything is a miracle.

The most beautiful thing we can experience is the mysterious. It is the source of all true art and science.

Interesting Asteroids (4)

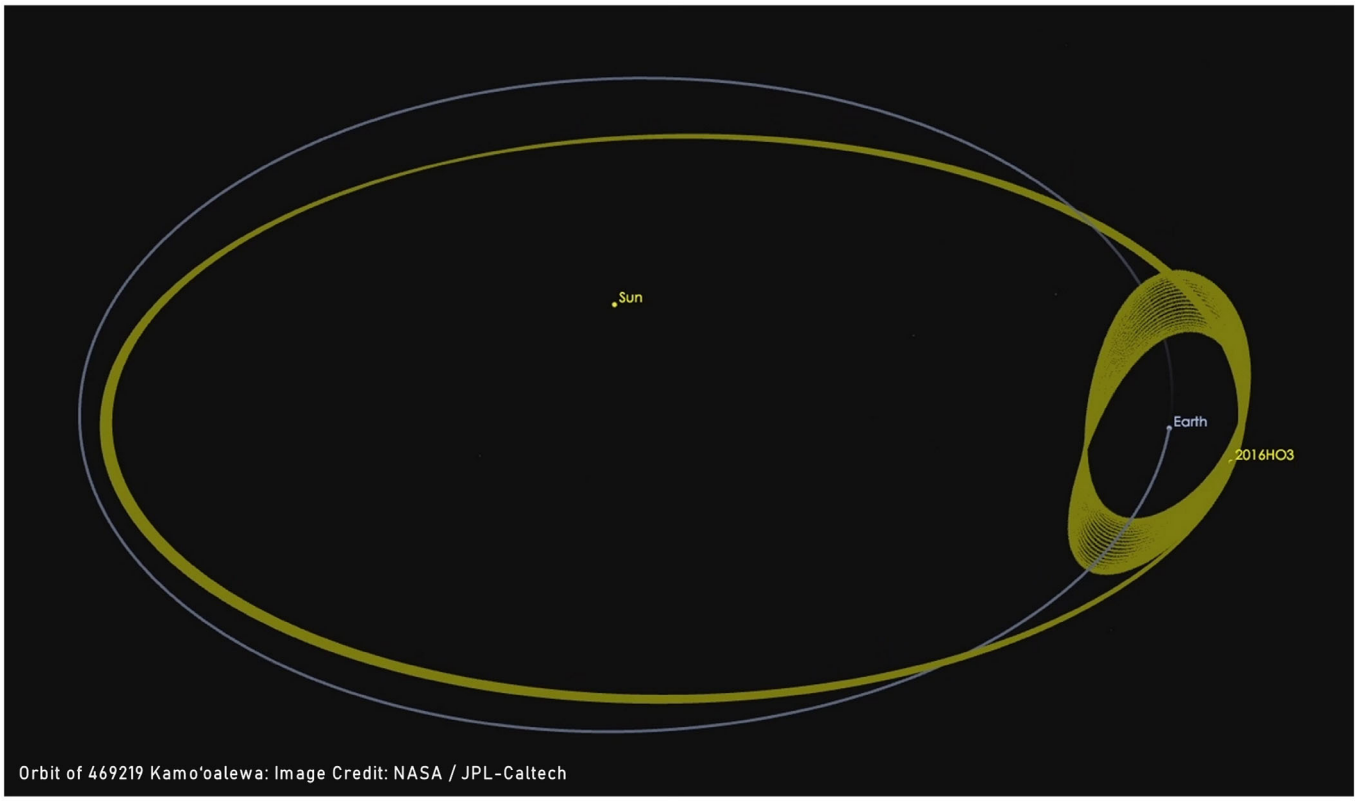
By Sandi Cayless

In the fourth part of an occasional series on interesting asteroids, we look at the main belt asteroid 469219 (2016HO3). Asteroid 469219 Kamoʻoalewa (2016 HO3) is a curiosity as it is (for now), a quasi-moon of Earth. It is the second-smallest found so far (after 2023 FW13), and the closest, and was the most stable known, until 2023 FW13, which may prove even more stable (Chandler 2023). Earth has seven quasi-moons thus far known (Stahl 2024). Quasi-moons are so-called because they seem to act like moons from a certain viewpoint, although on a larger scale they are clearly asteroids (Earth co-orbital asteroids). Each one looks to be orbiting the Earth, but it is actually following almost the exact same orbit around the Sun.

A near-Earth object (NEO) of the Apollo group (MPC 2024), Kamoʻoalewa follows quasi-satellite motion, which means that as it marks out its orbit, it is influenced slightly by Earth's gravity, tying it into a close position. As it sometimes drifts ahead of Earth and sometimes trails behind, from the Earth's viewpoint, it seems that Kamoʻoalewa is orbiting the Earth rather than the Sun. The image below (Credit: NASA / JPL-Caltech) illustrates its movement: the large yellow (inner) circle shows one of its orbits round the Sun, but over numerous orbits, it also draws out a series of loops around the Earth (shown on the right). Kamoʻoalewa is probably between 0.024 to 0.106 km in diameter (Sharkey *et al*. 2021).

All Earth's known quasi-moons are temporary, and most will transition to trojan or horseshoe orbits over time, such dynamical behaviour occurring due in part to the gravitational influence of other planets. Kamoʻoalewa shifts repeatedly between the quasi-satellite and horseshoe configuration; its present quasi-satellite state began almost 100 years ago and will end about 300 years from now (de la Fuente Marcos & de la Fuente Marcos 2016). Asteroid (469219) 2016 HO3 was discovered by Gibson, Goggia, Primak, Schultz and Willman on 27 April 2016 as part of the Pan-STARRS Project, using the 1.8 m Ritchey-Chretien telescope at Haleakala Observatory on Maui. It was named in 2019 by A Hua He Ino, of the 'Imiloa Astronomy Center of Hawai'i, and comes from words in the Hawaiian chant *Kumulipo* (MPC 2019, 2024).

The research of Sharkey *et al*. (2021; 2022) identified three possible sources for Kamoʻoalewa: a near-Earth object recently pulled into its current co-orbital position, an origin from a more stable population of Earth co-orbitals such as Trojans, or an impact origin in the Earth-Moon system. The team supported a lunar origin, based on analyses of the combination of the quasi-moon's current orbit and its reflectance, which match lunar-like silicates rather than usual silicate-rich near-Earth asteroids.



Orbit of 469219 Kamoʻoalewa: Image Credit: NASA / JPL-Caltech

This lunar-ejecta origin has been substantiated (Castro-Cisneros *et al*. 2023; Kareta *et al*. 2025; JPL 2025), and the object's origin and red appearance has been related to the lunar crater Giordano Bruno (Jiao *et al*. 2024).

The asteroid is the object of a number of proposed missions, including a NASA solar-sail mission (Heiligers *et al*. 2019), and a flyby and impact experiment by the University of Colorado using a low-thrust, solar electric propulsion craft with two optical cameras, two spectrometers, an altimeter and a low-velocity impactor (Venigalla *et al*. 2019). Kamoʻoalewa has also been selected as a target for China's forthcoming Tianwen-2 asteroid sampling mission (*Jiao et al*. 2024).

Asteroid 469219 Kamoʻoalewa	
Argument of Perihelion (°)	305.04789
Ascending Node (°)	65.79062
Orbital Inclination (°)	7.79619
Orbital Eccentricity	0.1026886
Perihelion Distance (AU)	0.8981574
Tisserand w.r.t. Jupiter	6.1
ΔV w.r.t. Earth (km/sec)	5.6
Semi-Major Axis (AU)	1.0009428
Mean Anomaly (°)	175.15273
Mean Daily Motion (°/day)	0.98421490
Aphelion Distance (AU)	1.104
Period (years)	1.0
Absolute Magnitude	24.33
Rotation Period	0.467
Phase Slope	0.15
	Data: IAU/JPL

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Young Stars and the Hayashi Track

By Alan Cayless

Stars are formed when a cloud of interstellar gas and dust contracts under the influence of gravity (Cayless 2024a). As the cloud becomes denser under contraction it will generally break up into a number of smaller fragments, each of which will continue to contract and eventually form into individual stars. Stars are therefore typically formed in clusters, with many stars of differing sizes but similar compositions formed at the same time.

Stars in the early stages of formation are not yet stable and are known as *protostars*. The temperatures and pressures in their cores are not yet high enough for nuclear reactions to take place. However, as they condense and become hotter these young protostars begin to shine by the release of gravitational energy as they collapse.

What happens next depends largely on the mass of the star. Smaller stars (up to 3 solar masses) continue to collapse until their surface temperature reaches about 4000K, at which point they enter the T Tauri phase (Cayless 2024b) and the contraction slows. During this later stage of contraction, the balance between the release of gravitational energy and radiation of energy into space means that the surface temperature of these lower-mass stars remains roughly constant. With a constant surface temperature but decreasing surface area, the overall luminosity of the star will decrease as the contraction continues.

This phase of a protostar's evolution was first mapped out by Professor Chushiro Hayashi (1920-2010). Hayashi studied Physics at Tokyo University in the 1940s and subsequently moved to Kyoto University, where he was appointed professor in 1957. In the early 1960s, Hayashi developed astrophysical models of the evolution of stars in the early stages of their formation, publishing a simple but definitive paper in 1961 (Hayashi, 1961; Hayashi and Nakano, 1963). When plotted on a chart of luminosity (vertical axis) against temperature (horizontal axis), low-mass stars follow an approximately vertical path during these early stages of their evolution. Based on Hayashi's analysis, this path has become known as the *Hayashi Track*.

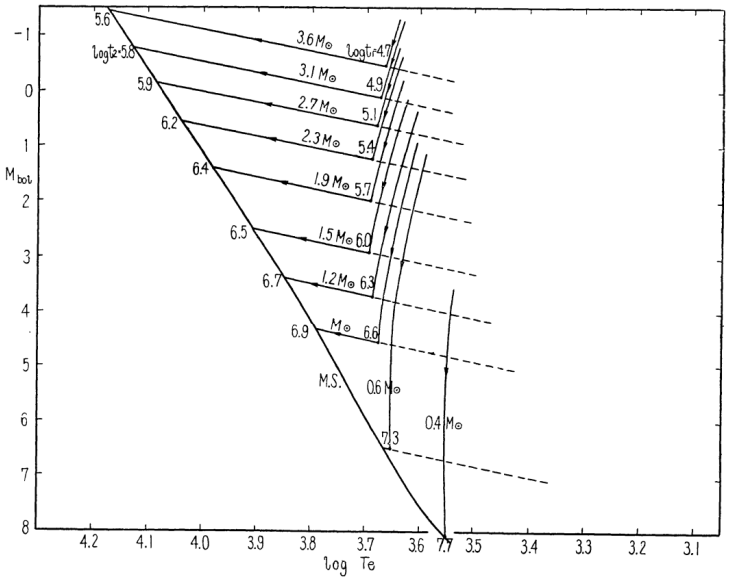

FIG. 2. Evolutional tracks and ages of stars with different masses in gravitational contraction. t_1 and t_2 denote the ages (in yeasr) at the turning point and on the main sequence, respectively.

Hayashi Tracks from Hayashi's original 1961 paper (Hayashi, 1961)

Heavier stars release more gravitational energy than can be radiated away from the decreasing surface area. For these stars, the surface temperature begins to rise in the later stages of contraction, and they diverge from the vertical Hayashi Track onto a horizontal *Heyney Track*, characterised by increasing temperature. Although the star is still contracting, the increase in surface temperature compensates for the reduction in surface area, resulting in a constant or slightly increasing luminosity on the Heyney Track.

For stars of all masses, the endpoint of the contraction phase occurs when the temperatures and pressures in the core become high enough for nuclear fusion, which then takes over from gravity as the main energy source for the star. Eventually the outflow of energy produced in the core is sufficient to support the star against the inward pull of gravity and the star enters the main stable phase of its life.

For his work on the pre-main sequence evolution of stars, Hayashi was awarded the Eddington Medal of the Royal Astronomical Society in 1970. His life and work are summarised in an obituary article published in *Astronomy and Geophysics* in 2010 (Sugimoto, 2010).

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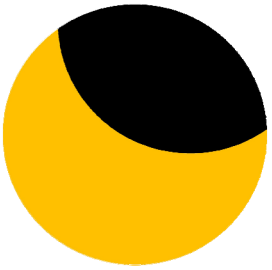
Happy Observing!

The Sun's 11-year cycle of activity is peaking, and gives us opportunities for aurora spotting over the next three months. On March 8 Mercury reaches its greatest eastern elongation of 18.2° from the sun, and will be at its highest point in the evening sky. Look low in the western sky just after sunset. March 14 brings us the Full Moon, often known as the Worm Moon by early Native American tribes, because at this time of year the ground begins to soften and earthworms reappear (see *The Jeety Starn* issue 5, pages 10-15 for a fuller description of Full Moons and their names). There is a total lunar eclipse on March 14, but alas only fully visible in the Americas, Russia, Africa and parts of Europe. Here in Scotland we will see a partial, at Moonset. The Moon moves into Earth's penumbra at 03:57 GMT and the eclipse will last for 2 hours, 43 minutes. The maximum we *may* see in Stirling will occur at 06:35 (actual maximum 06:58, after Moonset), but a very low Moon plus the total eclipse phase makes the Moon so dim that it might disappear before it sets.

The vernal equinox on March 20 heralds the first day of spring for the northern hemisphere, and on 23 March we have an event that occurs once around every 15 years – Saturn's rings will appear to disappear. As the Earth's orbit crosses the plane of the rings, their flat disk will be edge-on from Earth's perspective. Unfortunately, Saturn will be very close to the Sun in the sky on March 23, which means we will not have a view of the planet during the crossing of the plane of the rings.

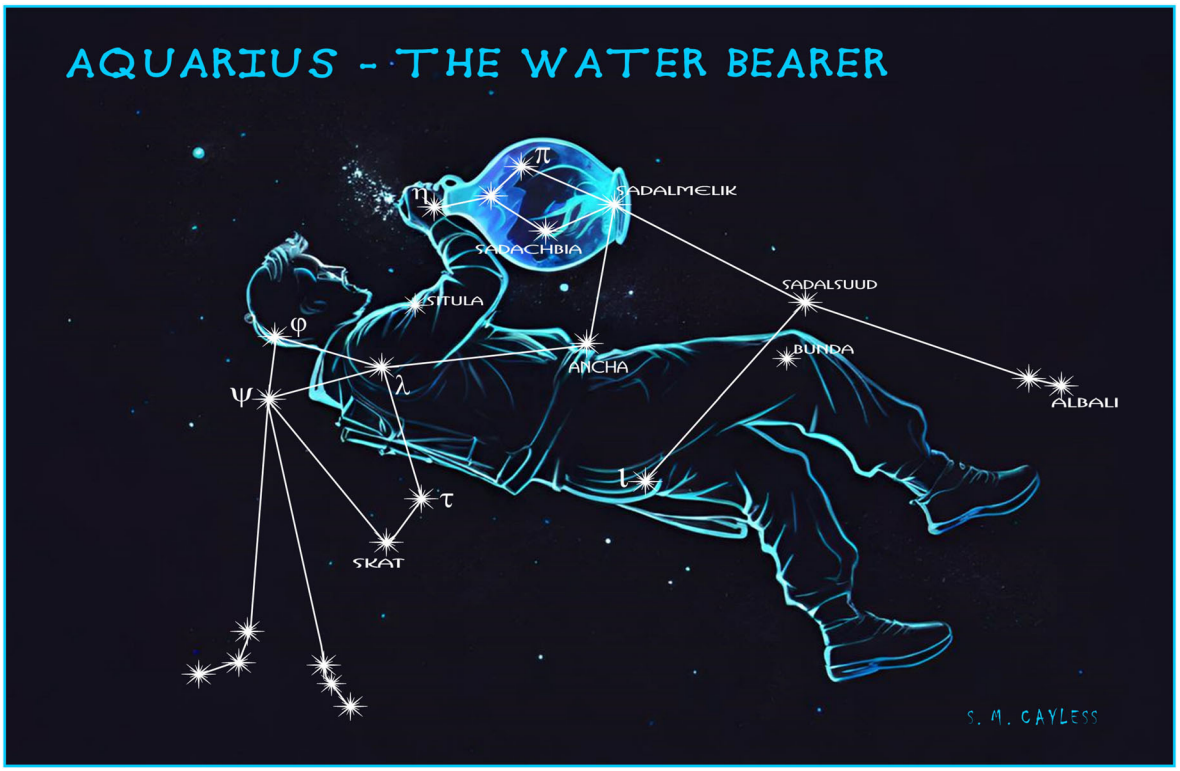
Partial Solar Eclipse 29 Mar 2025

The big event for March 29 is the partial solar eclipse. The best view will be in Canada, at 93% coverage. For those of us who can't travel so far for a better ringside seat, this view of the event is what we may expect to see from Stirling: 42% of coverage (barring cloud) between 10:07 and 12:06h (max. 11:06h). However, this depends on the cloud cover being atypical for that time of year! Based on historical data, the average percentage of cloud on March 29 in Stirling varies over the day (Ref: Weatherspark.com), with the cloudiest time being around 05:30 (74%). The least overcast time of day is around 13:30, when we may expect a 40% chance of clear, mostly clear, or partly cloudy conditions. So in Stirling, we may be lucky enough to see some of the action between 10:07 and 12:06h.



April 13 brings us the Full (Pink) Moon, and on April 21, Mercury will be at greatest western elongation (27.4°). Look low in the eastern sky just before sunrise. The Lyrids meteor shower (April 16-25) is best seen on the night of April 22-23, and although not the most abundant annual shower, we may see around 20 meteors per hour. These are the product of dust particles from comet C/1861 G1 Thatcher and they sometimes have bright dust trails lasting several seconds. Most radiate from Lyra but meteors can appear anywhere in the sky. The thin crescent moon at the peak will be below the horizon until about 04:00, which should make ideal observational conditions. The Lyrids meteor shower is the oldest chronicled that we can still see, being first recorded in 687 BCE. Slightly later in the month, the New Moon of April 27 offers a good time to observe faint objects such as galaxies and star clusters.

May 6-7 brings the peak of the Eta Aquarids meteor shower (the shower runs from April 19 to May 28), but most activity is in the southern hemisphere. Here in northern latitudes we can expect about 30 meteors per hour, most radiating from the constellation Aquarius. They will appear low in the eastern sky in the early hours before dawn, and it should be possible to see some activity even when the radiant dips below the horizon.



The shower originates from the dust particles produced by comet Halley (which also produces the Orionids) and is named for the bright star Eta Aquarii (η) in the Water Jug asterism of the constellation. A waxing gibbous moon will block out fainter meteors but hopefully a few brighter ones will be visible.

May's Full Moon occurs on the 12th and is known as the Flower Moon, Corn Planting Moon or Milk Moon; the New Moon of May 27 will be a good time to observe faint stellar objects. May ends on the 31st with Venus at its greatest elongation west before sunrise (45.9° from the sun).

Many thanks to all our contributors over the first year of *The Jeety Starn*. Members, please hand over submissions to the editor, or send them via the Society's contact email address. Illustrations also welcome!

S.C.

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