Staring at the sun

By Big Skies Collaborator and guest blogger **Tracy Sorensen**
as part of her BSC project, **From Narrabri to Carnarvon: a literary journey**, 2018/19

I'm in a silver car speeding north to see a man about the sun. My mother is sitting in the passenger seat next to me. Through the windows, paddocks are empty of livestock, eaten down to dirt. There are tumbleweeds caught in wire fences. The roadsides are covered in strange white drifts, like snow, like tiny failed clouds that have dropped to earth.

The white stuff is balls of cotton, shaken out of vibrating semitrailers barrelling down the Kamilaroi Highway on the way to market. I get out of the car and souvenir a bit of it. It's like shop-bought cotton wool, lightly soiled with red earth, with hard black seeds embedded in it.

On my way back to the car, I pause to look at a dead kangaroo. The animal is splayed in an almost comical pose of death, bloated, legs in the air. The roos are strewn at close intervals all along the cotton-covered roadside. Some are decapitated, their heads hurled quite an impressive distance from their bodies. Nobody is mourning them out here. In drought, they're the farmer's sworn enemy, competitor for edible pasture.

As we head north, Mum and I go over old memories, comparing notes, arguing over detail. Same events, different stories. Was it this beach or that beach? Before or after?

We return to uncontroversial memories, fishing in places without snags.

Turn on the sun, turn on the sun
Light up the world, come everyone

We used to watch the Nana Mouskouri show on a black and white television set. Nana was always modestly dressed and her glasses and dark hair were similar to Mum's. When we got our school recorders, I learned to play one of Nana's hits.

Turn off the wind, thunder and rain
Turn on the sun, let's smile again.

The song, written by a damp Englishman, was hardly relevant to Mouskouri, who was born on a sun-drenched Greek island, or to us, living in a baking town on the earth's driest continent. These were the days before critical thinking. We accepted

that stories about the world were at odds with what we could see out of the window.

I drew the sun at the top of all of my pictures. Green grass below, houses and trees and flowers and people in the middle, blue sky in a line at the top. The sun might or might not have a face in it, but always had long rays reaching down over all.

In high school we studied a diagram labelled "The Greenhouse Effect". It went with other similar illustrations of how the earth works: The water cycle. Volcanos. Layers of sedimentary rock. There was nothing problematic, then, about learning that carbon dioxide and other gases trapped heat from the sun. Fortunately, like Goldilock's porridge, it trapped not too little, not too much, but just the right amount.

The sun was simple then, uncontested. Now, in an era of climate change, facts about the sun and the earth, greenhouse gases and emssions, are all tangled up in social identity and politics. The words "climate change", and how you use them, are now code for what tribe you belong to.

We arrive at Breeza, a railway siding with an enormous grain silo next to it. There are giant hand-painted words on the silo: FARMS NOT COAL. Next to it, in neat tableau, is a parked coal train, the piles of black stuff visible in the wagons. As I take a photograph, a semi trailer pulls up, bearing great rolls of plastic-wrapped hay, perhaps all the way from Western Australia, to hand-feed starving livestock. It's all there, in one neat snapshot: Coal, climate change, drought.

Grain silos and a coal train at Breeza on the Liverpool Plains, New South Wales, Australia. Photo: Tracy Sorensen.

We pass the Pilliga forest to our west, where protesters camped out for months to protest a $3.6 billion coalseam gas project. But it's getting late, now. We drive past the forest in the dark, watching out for any remaining living kangaroos. The lights of Narrabri finally appear. We settle in to our cabin at the Big Sky caravan park.

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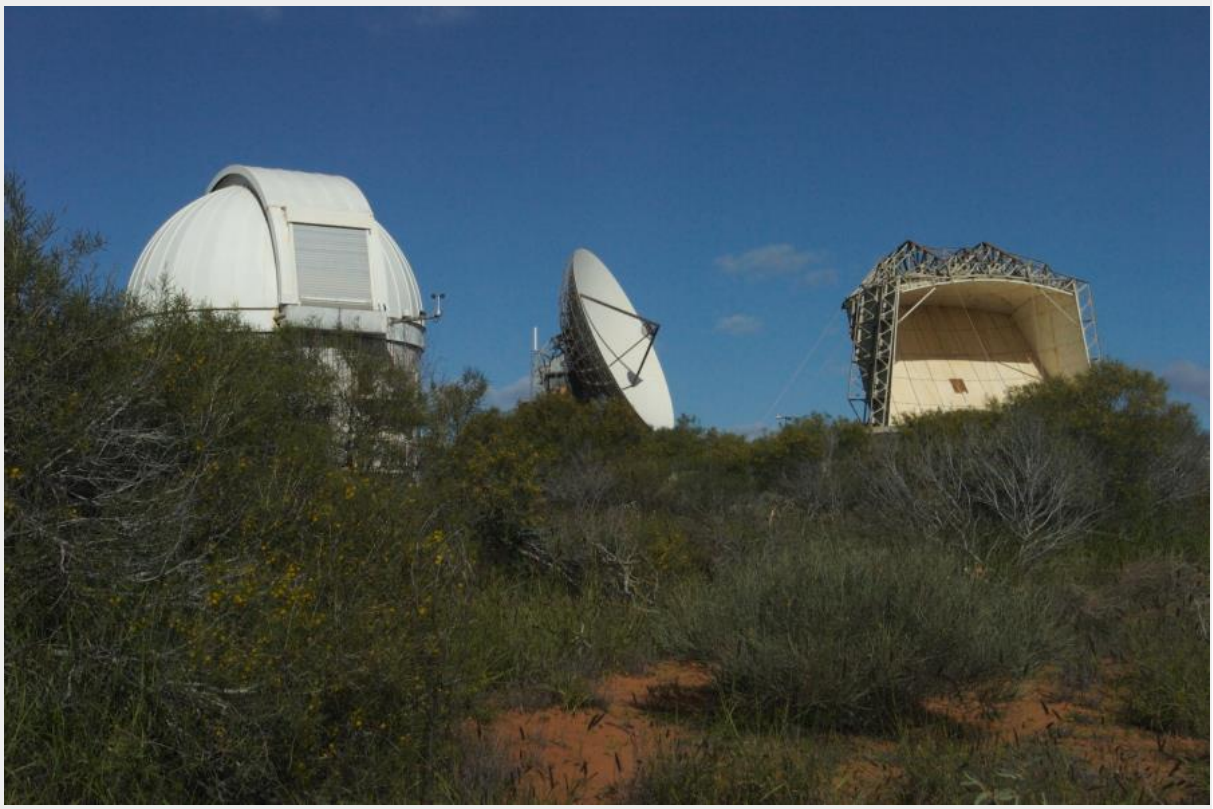
The **Paul Wild observatory** is just out of Narrabri, about six and a half hours north west of Sydney by car. I've never been here, but it feels familiar. The dry earth, the cries of corellas in the distance, the white dishes against a big blue sky – all of these are sensory reminders of my earliest years.

The Paul Wild Observatory, near Narrabri, New South Wales, Australia. Photo: Tracy Sorensen.

Around the time of the Nana Mouskouri show and my peeping recorder, we lived in Carnarvon on the coast of Western Australia, almost 1000 kilometres north of Perth. In the 1960s, it had been the site of a NASA tracking station, and played a role in the moon landing. After the NASA era, it continued to be a site for other space-age projects.

The biggest dish on the dune was built by the Overseas Telecommunications Commission (OTC). As a child and teenager in Carnarvon it had seemingly always been there. I'd assumed – like many other Carnarvonites – that this was the very dish that had tracked the Apollo 11 astronauts to the moon. We all knew the story about how the moon landing was seen by townspeople on an ordinary domestic

television set sitting on stage in the Memorial Theatre, with 'roo shooters down the back using their rifle sights to get a better view of the tiny screen. I guess I'd assumed that the signal was somehow beamed directly from the Moon into the OTC dish and thence to that little television set. Not that I thought about it much. A teenager's curiosity is a very selective thing.



The BiSON dome (left) and decommissioned OTC dishes at Carnarvon, Western Australia, in 2005. Photo by Steve Woodhall.

I only filled in some of the gaps years later, on a trip back to Carnarvon in 2005. I discovered, to my amazement, that the NASA tracking station had been further south along the dune and that the big OTC dish I'd grown up with had not even been built at the time of the moon landing. Nothing remained of the dish that actually did track the Apollo mission; it had been dismantled in the early 1970s, once the NASA technicians had left. This was the **FPQ6 radar**, quite modest in size and shape compared to the OTC dish.

It was from the Carnarvon tracking station that the Apollo 11 astronauts received their signal to **GO for Translunar Insertion** (TLI): to leave earth orbit, and head for moon orbit.

In March 2018 I returned to Carnarvon with my novel, *The Lucky Galah*, which was essentially a long riff on some of the basic elements to be found in my childhood home: A galah, a Dish, a clear night sky, a voyage to the Moon. It's a story of childhood and place and luck. It is resolutely careless about technical details. I argued (to myself, when troubled) that the story of the technical feat of landing men

on the moon has been told often and well. *The Lucky Galah* is all about women and children and animals. The voices of The Other.

Also: Science was never my forte. I always loved the idea of science, the beauty and clarity of it. I always loved the figure of the scientist, the agronomist or technician, the type of man wearing long socks and dress shoes and shorts, an open-necked shirt with a biro in the pocket and horn-rimmed glasses. But the work, the long, absorbed work in which such men were engaged? Let's make do with impressions, broad outlines, the feel of it. In *Negotiations with the Dead*, Margaret Atwood notes that writers "steal the shiny bits, and build them into the structures of our own disorderly nests."

In 2018, as soon as I got off the plane and secured my hire car, I went round paying my respects to the places of my childhood: the One Mile Jetty, the Gascoyne River, the spraying coastline where the Indian Ocean smashes against pinkish rock, the OTC Dish.

For decades after it was decommissioned, the big Dish had stood on the dune, quietly deteriorating, with little interpretive signage. You could drive up to its foot, mount the metal stairs and get a bird's eye view of the town and the river stretching out to the sea, but if you wanted to know more about it you had to go away and look it up yourself. It wasn't until 2012 that the **Carnarvon Space and Technology Museum** opened on the site. The Museum quickly became the town's premier tourist attraction, helped by its spot on the highway between the dolphins at Monkey Mia and the whale sharks at Ningaloo Reef.

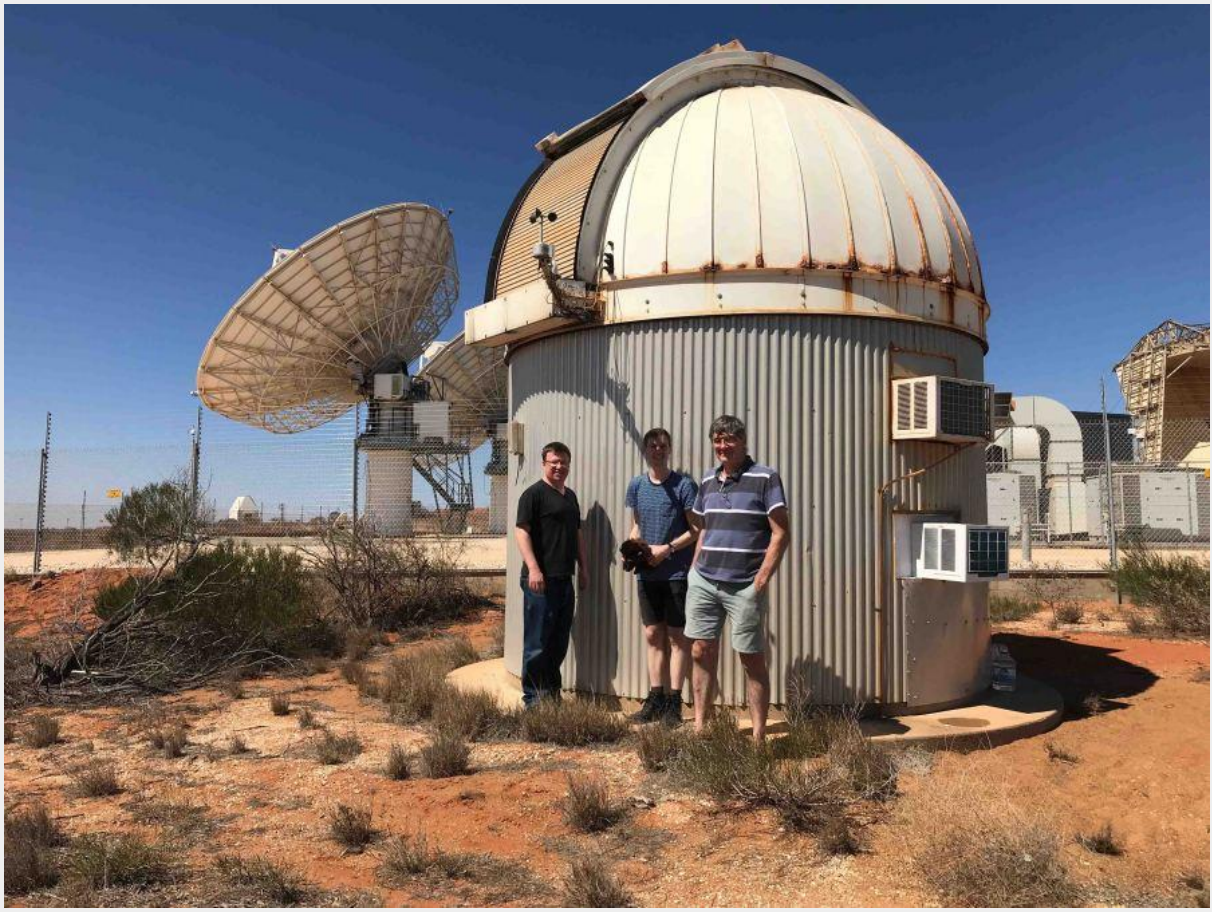
At the museum I met up with Les Bateman who had been a young technician back in the tracking station days. We sat down for a chat in the kiosk with the sound of squealing children and the recorded countdowns to blast-off in the background.

It was in conversation with Les that I learned that space science was still alive on Brown Range. I'd assumed all the visible infrastructure on the dune was long out of use. But just down the hill, **Error! Hyperlink reference not valid.**, there was a contraption pointing at the sun, taking measurements. It had been installed in 1984 by scientists from the University of Birmingham and had operated (largely automatically) ever since. Les's role was to keep an eye on the equipment, fix minor problems and keep the scientistis informed.

I was ridiculously pleased to hear about this. So much of the Carnarvon I'd known as a child was now, quite literally, in ruins. The One Mile jetty, beloved fishing spot for generations, was boarded up and unsafe to walk out on. The prawning jetty was little more than stumps dissolving into the sea. The prawning factory, where a girl could always get a job on the production line, was now sinking into the sand dune. Even my old state high school was about to close forever, leaving the solid bricks and mortar building with its science lab, art room, home ec. kitchen, woodworking studio – all built with such confidence in the future – to long grass and vandals.

But here was something still going!

In my hired Mitsubishi Outlander, I followed Les's vehicle down the hill, and waited while he unlocked the gate. He knocked on the door of the little building and out came the scientists themselves, Dr Steven Hale and postgraduate student Eddie Ross, all the way from the UK. They were only here for a short time on one of their infrequent maintenance visits; I was lucky to have caught them.



Dr Steven Hale (left), postgraduate student Eddie Ross and technician Les Bateman at the BiSON station in Carnarvon, Western Australia. Photo: Tracy Sorensen.

We stepped inside. I noted that particular combination of shabbiness, DIY solutions and expensive high-tech often found in scientists' dens. The interior walls were clad in 1970s wood veneer; there were bundles of wires running this way and that. There was a metal ladder up into the dome and a square of clear blue sky.

I asked what it was all about, and recorded their voices on my phone. I was delighted that scientific research was being done on this spot, but I was also at the end of a long, wearying trek from Bathurst to Sydney to Perth to Carnarvon and distracted by the whole business of being back in town, with its waves of feelings and memories and people to meet. I caught the gist of it but let most of the detail

go over my head. I could always come back to the recording later, and listen properly.

The gist that I caught was this: This contraption is engaged in a field known as **helioseismology**. Helio – to do with the sun. Seismology – to do with earthquakes. The "earthquakes" of the sun? Yes, the deep vibrations of the sun.

It turns out that the ancient poets who spoke of the music of the spheres were on to something. The sun, a sphere of molten plasma and burning gas, can also be likened to a giant musical instrument, full of reverberating sound waves. The sun expands and contracts all over itelf, as though shivering, as the waves, caused by the heat and turbulence of nuclear fusion, reach the surface and bounce back inside.

We can't hear the sun's symphony directly because sound needs to travel through a medium, like earth or air, and the space between the sun and the earth contains nothing for sound to hitch a ride on. But we can "hear" it indirectly, by looking at the surface of the sun, noting how it expands and contracts to the "tune" of its internal vibrations. In other words, we can use light to measure sound.

Data at the Carnarvon BiSON station is recorded in daylight, starting as soon as the sun pops over the horizon. The dome shifts, following the sun, allowing the instrument inside to record information taken across the orb of the sun, left to right, up and down, until sunset. And again the next day, and so on, through the decades. To fill in the overnight gaps and get more data for cross-reference, there are five similar automated stations across the globe: at Sutherland in South Africa, Las Campanas in Chile, Mt Wilson in California, **Izaña on the island of Tenerife**, Spain, and a second Australian station at Narrabri in northern New South Wales.

It's called the Birmingham Solar-Oscillations Network, or BiSON. There's a shaggy bison soft toy on the desk, as mascot.

My eye is drawn to the graffiti on the door, written in felt-tipped pen:

WE WERE HERE FIRST Barry Scott and Co Builders
THIS DOME WAS ERECTED IN 1985

I know Barry Scott. I went to school with his daughter. He built the drive-in theatre where we saw *Chitty Chitty Bang Bang* and *Apocalypse Now*. Below that, dated by year, the history of the enterprise unfolds, in a series of geeky in-jokes. There's TURNED INTO A DOS-HOUSE ANDREWS/NEW 1990, referring to the newly-installed Microsoft Disc Operating System, later to be replaced by a custom-made system called ZOO. "Fed the sandflies" (self-explanatory) is dated June 1996 and from August 2005 there's "Gascoyne Refrigeration Saved the Solar System" (they saved a faulty air conditioner). I take a snap, to study later.

Steve, Eddie and Les agree to be photographed outside, in front of the dome. Eddie brings the bison mascot. And then I'm off, a little better informed than I was before my arrival, but not much.

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And now, six months later, I'm at it again, this time with Mum along for the ride.

The giant dishes here at the Paul Wild observatory are all alive and in excellent health. Completed in 1988, five radio telescopes can be moved back and forth on their own rail tracks while a sixth, also on its own track, sits a few kilometres away in the bush. Working together as one, they've given us information about how stars form, how old ones explode, about black holes, magnetic fields in galaxies and molecules in space.

It is magnificent, but I'm not here for the array. I'm here to visit the more modest premises around the back: the BiSON dome.

The BiSON station at Narrabri, NSW, Australia. Photo: Tracy Sorensen.

Mum opts to sit and watch documentaries in the movie room in the visitors' centre while I meet up with Mike Hill who is, from BiSON's point of view, Les Bateman's equivalent. We hop into his vehicle and head off past the array, past some old white abandoned buildings, and pull up at the small dome.

Just inside the door, I'm delighted to see a photograph of the Carnarvon BiSON dome taped to the wall. It's like a family photograph, not just for BiSON, but for me: an old friend from my own childhood. But there's a stab of guilt, too. I still haven't done my homework.

I'd intended, by now, to have given myself a refresher in high school science. About sound waves, light waves, electrons, **photons**, the workings of a spectrometer, what the hell might be meant by "Doppler shifts in the potassium line". If I'd done my homework, I might be in a position to make a little more sense of my second visit to a BiSON station. Sadly, though, I have not advanced much further than the basic idea that the network is *measuring vibrations inside the sun*. The details about *how* and *why* one might do this are still uncomfortably hazy. In my defence, I've been stupidly busy for six months: teaching, being a climate change activist, flying around the country (burning carbon all the way) promoting *The Lucky Galah* in libraries and bookshops. Still, I could have swotted.

But here I am again, delighted by the general vibe but still woefully ignorant.

The decor inside the Narrabri dome is similar to its sibling's in Carnarvon. There are trays for nuts and bolts and soldering wire. Bundles of electric wire run up and down the walls. The same DIY problem-solving approach is evident from the car radiator bolted to the wall up near the ceiling. This, explains Mike, was installed because the spectrometer was running hot and adding noise to the data. The fan would cool things down.

Mike Hill, electronics technician, with the car radiator he installed to cool the spectrometer at the BiSON station in Narrabri, NSW, Australia. Photo: Tracy Sorensen.

Originally from South Africa, Mike has been working in electronics for 40 years, "from the days of valves". "I've managed to hang on since then," he says. His main job is to maintain the Array, but he is also charged with keeping an eye on the BiSON station.

We climb the metal ladder and crouch around the business end. Mike points at a tiny hole containing the autoguider and explains how a motor drives the instrument up and down and side to side to capture light from the four quadrants of the orb, at regular intervals. The instrument measures tiny changes in the colour of the Sun as it expands and contracts. These changes, explains Mike, are captured by shifts in the potassium line.

I look out of the window at the whirling wind gauge and beyond that, at the brown dirt and outcrops of cactus. Mike follows my gaze. He says it's the driest he's ever seen it.

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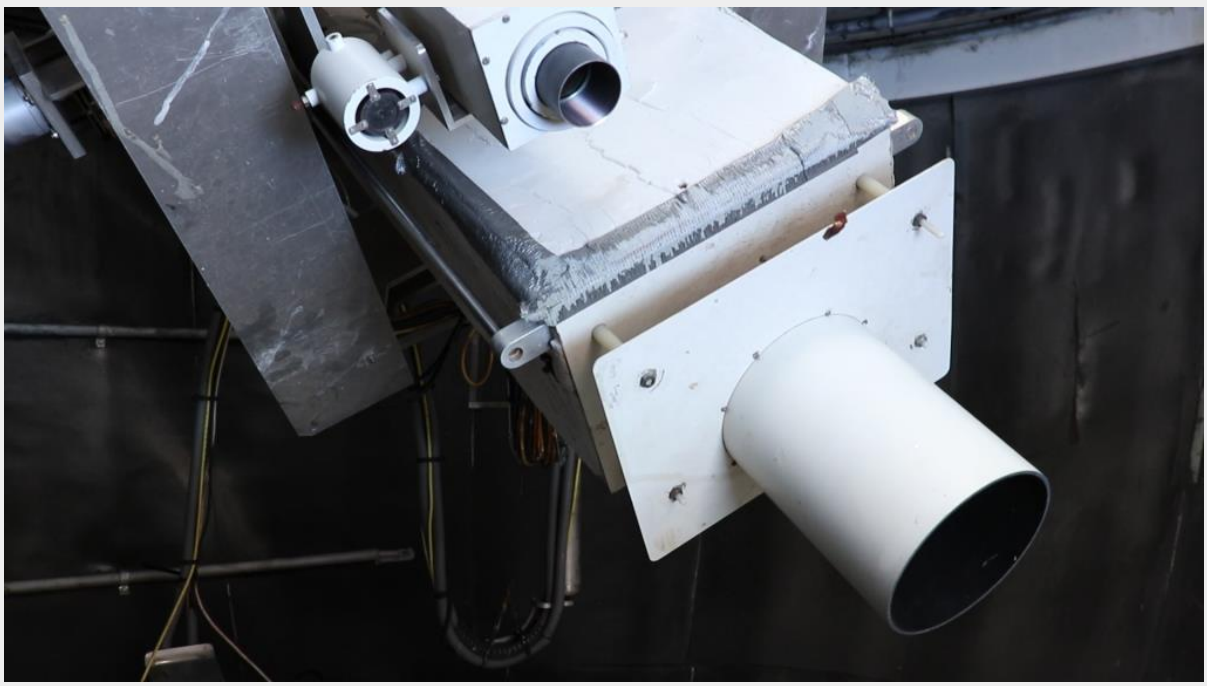
Back at home in Bathurst, it's long past time to do some homework. I listen to Steve Hale's voice, recorded a year ago in Carnarvon. I promise myself that if there's something I don't understand I will pause and look it up, not give in to the temptation to write around it. I will give this thing a red hot go.

What we have here, says the recorded voice of Dr Steven Hale, is a fibre optic cable collecting light from the sun. "That red dot you can see here is sunlight."

Wow, I'm heard to say.

So far so good. But Steve's next sentence takes a bit more work. "It's got a 770nm filter at the top," he says. In real time, at the time of the recording, I let this one pass. But now that I'm in homework mode I need to stop and Google.

The visible spectrum of light resides between 380 nanometres and 760 nanometres. So at 770 nanometres we're going beyond the frequencies visible to the human eye and into the realm of infra-red radiation. We're at the less energetic end of the electromagnetic spectrum, where you find long, lazy radio waves, microwaves and infrared. At the other end, where the waves crowd together until they're almost on top of each other, where you find ultra-violet, x-rays and even higher frequency gamma rays.



The spectrometer at the BiSON station at Narrabri.

I think of a kid flicking a garden hose on a warm summer day. A low-energy flick sends out big long waves. A more high-energy action, the kid's arm pumping, will give you the shorter wavelengths.

So the filter is allowing some near-visible infrared light waves to go on through while keeping others out.

I'm ready for Steve's next sentence. Click play.

"And the light goes through this lens," saith Steve. "It's recollimated, which means it's like in a straight beam." I get "lens". I get "straight beam". I think I'm good. I assume that he is saying the light is *recolumnated*, or put into a nice column, but further research – fingers flicking over the keyboard, twenty tabs open on my desktop computer – shows how the word is actually spelt. Still, I'm on the right track. We're lining things up into a straight narrow beam.

We've only just begun, but already I'm heard to beg Steve not to get too technical. So he skips through *controlling polarisation* and the functions of a series of other lenses to the very threshold of the spectrometer.

"Now this is the heart of the instrument," says Steve proudly, in his Birmingham accent. "This is a potassium vapour cell. It's a little glass cube that's got some solid metal potassium in it and we heat it and it becomes a vapour and when you pass light through it you get absorption at the potassium wavelength."

"Right," I'm heard to say, weakly.

"It re-emits!" says Hale. "So imagine, you've got an atom – "

I say "Yep", because everyone has an atom.

"It absorbs some of the light, it gets into an excited state and then it decays and re-emits that light."

"Okay. Yep." This is me giving up entirely, but Steve is not to know that. I sound quite enthusiastic. I pause the recording.

I dredge up some high school science. Here is my atom with its protons and neutrons in the centre and electrons buzzing around the outside. It's the electrons that go into a merry jig when excited; the others just sit there, watching. I do remember this.

But here's something I either missed or have long forgotten: The electrons buzzing around the centre of the atom can't get excited by simply buzzing faster or jiggling about randomly. Instead, they can only hop straight from one energy state to another. It is not a continuum. It's a staircase, not a ramp. *There's no in-between.*

I find this vaguely disturbing. I think of the world as "really" analogue, with change happening incrementally, like a continuous recording on vinyl as opposed to the jagged sampling of the digital sound clip. The world as ramp, not staircase. The behaviour of these excited electrons is feeling *natively mathematical*, somehow. *Exsiting* as numbers rather than being *represented* as numbers.

But I have no or little maths.

To help myself, I imagine an electron as a drunk lounging at the bottom of a staircase. Excited by a photon, a little packet of pure light, he grabs hold of her, as if to dance. But he can only skip up the stairs with her, using her energy to get going. He has to land on one stair or another; he can't be half-way between two stairs. He quickly runs out of puff and starts falling back down the stairs. As he falls, he lets go of the photon and she escapes into the distance, like Tinkerbell, or a firefly.

Year 9 science class, Carnarvon Senior High School, circa mid to late 1970s. Benches, bunsen burners, working in groups. The young science teacher, soft-voiced, shoulders hunched, cannot be heard over the racket made by excitable, hormonal teenagers. Two kids jump out of the window. There is a complete loss of control. There are no rules.

Later, we're scolded by another teacher. We're told that Mr T. has left his job, has decided not to pursue teaching, and this is such a shame because he was *brilliant*.

That gives us pause. For a moment.

It's possible that what we were doing that day was a flame test. You hold a paste made up of an elemental metal over the flame from a bunsen burner. Atoms get excited as they absorb energy and then emit light as they run out of puff. The light will be emitted as photons of particular wavelengths according to the atomic structure of the atom. And those wavelengths are registered by our eyes as different colours.

Or, to put it another way, each element **emits** its own characteristic colour fingerprint when it gets excited. If you heat a bit of helium you'll see a yellow glow. Neon – red. Mercury, blue. Copper, green. Potassium burns lilac.

So if you shoot a beam of light through potassium vapour, some photons will dance the potassium dance, if they're in just the right frequency range, exciting just the right atoms. They'll be absorbed and re-emitted, and allow us to measure the tiny shifts in the wavelength of the light caused by the motion of the sun. This is because, relative to the observer – in this case the exact position of the BiSON instrument – that bit of the sun is moving closer or further away. It is, in other words, a **Doppler** shift that is being measured, not in sound, as in a train whizzing by on its tracks, but in light frequencies and intensity.

The problem is that the re-emitted Tinkerbells do not stay in a nice straight line.

"The beam's going this way," says Steve. "When the atom re-emits the light, it goes in any direction which means that it can go out here or out here or wherever."

The solution is two detectors capable of rounding up the errant emitted light. “What they’re doing is looking at the light that is scattered,” says Steve. “We can make very precise measurements of the sunlight intensity at 770nm, the wavelength of one of the absorption lines of potassium.”

Steve explains how sound waves are being constantly generated by the sun’s heat and turbulence in the outer layers. The oscillations of the sun occur in different modes. There’s the “breathing” mode, a steady expansion and contraction, and then there’s more high frequency modes that are like waves on a choppy ocean.

The study of solar oscillations is not the same as the study of solar flares, or storms, that can affect the health of astronauts and play havoc with earthly power grids and electronic systems. No, that is a different field of enquiry. The BiSON network is studying the interior of the sun, not the stuff shooting off it into outer space.

The data streaming out of the BiSON station at Carnarvon is sent back to Birmingham and used by scientists all over the world. The instrument’s “little envelopes of different frequencies” can help scientists determine the properties of the sun: What it is made of, how it works, how it was born, when it is likely to die.

The study of our own local star can tell us much about the myriad stars in our own galaxy and the galaxies beyond. This knowledge is beautiful in itself, even if we must sometimes revise earlier ideas, which is what science has always been about.

But there are also practical reasons for finding out more about the sun. Not least of these is that human civilisation faces an existential threat from climate change. Not only must we support scientists in their work, but the popular imagination must be engaged by the problem, not encouraged to disengage through terror, cynicism or resentment.

One way in, it strikes me, is through beauty. The sun is breathing in and out, it is chiming like a bell, it is sending out photons that dance in different colours: these things can be interrogated by advanced mathematics and physics, but they are also pure poetry.

I jumped in the car to get a coffee today, to fuel these last paragraphs. As I got back in with my KeepCup, I noticed a beautiful prism in a patch of light on my lambswool seat cover. The sun and my windscreen had joined to create this little gift with all the colours of the rainbow.

The photon is almost impossible for me to grasp. It is a packet of energy, it has a frequency, but it has no mass. It behaves partly like a wave, partly like a particle. It gives things colour but it doesn’t have colour, because colours are all in our minds. It travels at the speed of light, which is unimaginably fast, and yet at the speed of light, time is experienced as zero.

If time has warped and collapsed then I'm seven years old, playing my recorder, the instrument reverberating under my fingers. Mum still has dark hair, like Nana Mouskouri. We live near a big white dish in a Time of Dishes, under a singing sun.

Find out more about the BiSON Network **here**.

References

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