NOVA
NEWSLETTER OF THE VANCOUVER CENTRE RASC
VOLUME 2013 | ISSUE 5 SEPTEMBER OCTOBER 2013

The Eagle

by Bill Burnyeat

He clasps the crag with crooked hands;
Close to the sun in lonely lands,
Ring'd with the azure world, he stands.

The wrinkled sea beneath him crawls;
He watches from his mountain walls,
And like a thunderbolt he falls.

– Tennyson

The Eagle is a special constellation. Taking to the air in spring, later than the Harp and Swan, this bird hurries to join the others after winter slumbers. Aquila calls the Summer Stargazer, announcing it's time to put away mundane and hopeless tasks and seek the open road; dust off the star chart, open and inspect the eyepiece box. Make sure there are eyepieces inside. Leave, says the Eagle, forsake landlord, city smells, dull and ridiculous company and sail to a lonely land of skies, trees, mountains ring'd with the azure world.

Each summer I obey. Only ill health, or city-engendered melancholy can stop the trip out into the countryside. I'm a disciple of the Roman hero Germanicus. Seeing fear in the faces of his troops, he looked up and saw eagles flying confidently towards the enemy. Drawing a sword, Germanicus shouts to his officers: "Follow the Roman birds!" The day was won. I brandish no sword but do the contemporary equivalent. The truck goes in for an oil change and new tires before the day's departure. Once, just once, I ignored the Eagle and returned to city habits of egotism and sloth while on the road. The scene of the backsliding was Valemount, B.C., some few hours north of Clearwater and the last town before Mt. Robson Provincial

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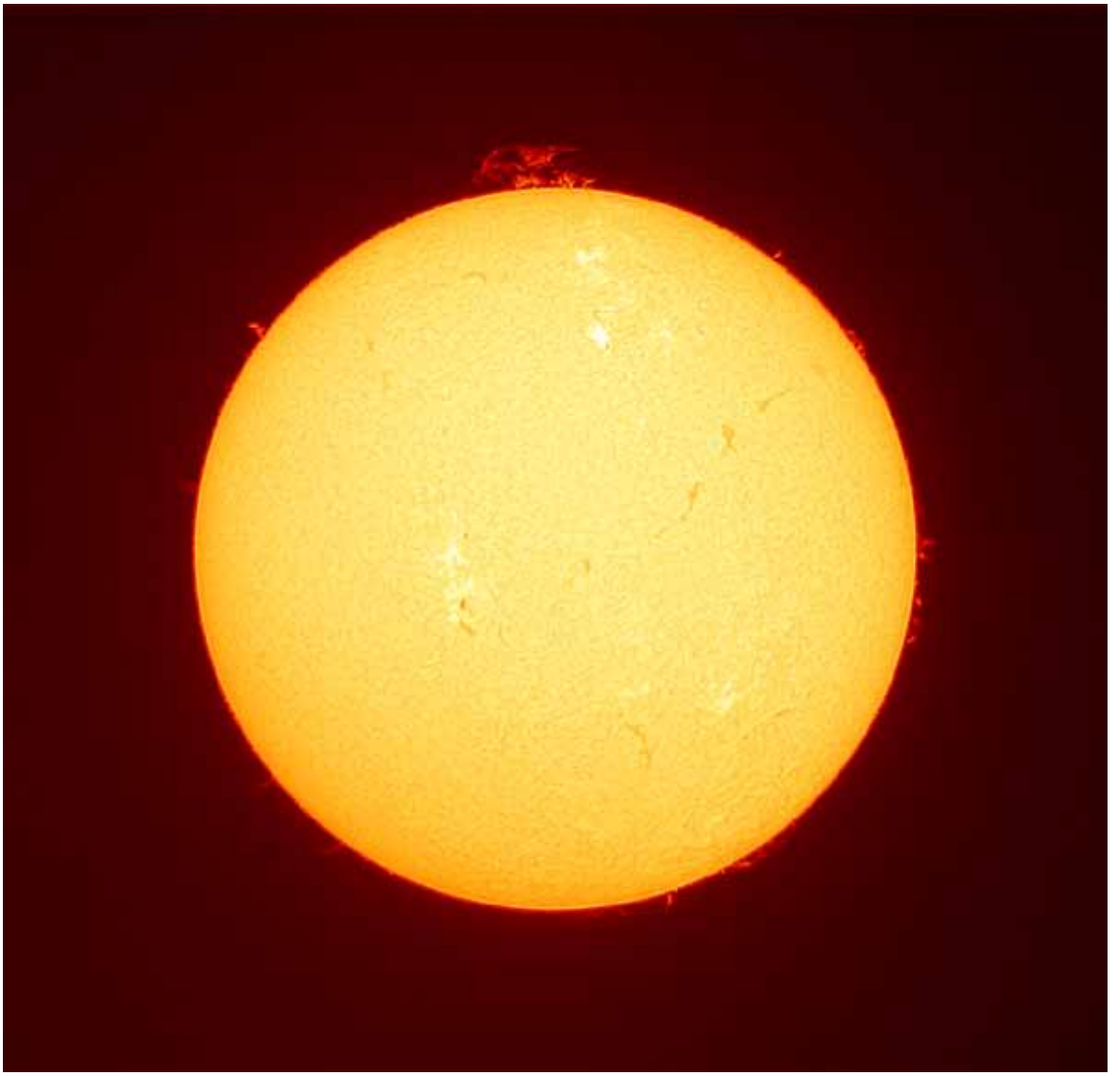
SEPTEMBER 12 — **SFU**
Alan McConnachie from UVic: Big puzzles with small galaxies: Galaxy formation and the problems with the tiniest galaxies. Room B9201 SFU

OCTOBER 10 — **SFU**
Vancouver Past-President Howard Trottier will discuss his astrophotograhy efforts. Room TBA (see Meetup for updates) SFU

NOVEMBER 7 — **BCIT**
Speaker to be announced. Watch Meetup for details.
BCIT

Members' Gallery



Sun with prominence
by Gordon Farrell

A bit of luck and a fair amount of processing resulted in the above image, taken in July 20, 2013. Original images acquired with a Canon 40D mounted to a Lunt 60mm solar scope, with alignment and initial image processing in Shake, stacking in RegiStax, and final processing in Photoshop.

President's Message

by Mark Eburne

The past few months for the RASC has been a flurry of activity locally and nationally.

On the national scene, with the new council elected and in place, the focus has been to implement our new structure. Over the last two years, the discussion and planning across the country has got the RASC a very enviable position in the non-profit world. Of course, with any major change like the one we have gone through, there will be challenges to overcome but it's nice to see the efforts from across the country at the national level that will support our local vision. As always, more information is available on the RASC web site, www.rasc.ca.

A new feature for membership is the family membership. Joining the RASC as a family is much more affordable and allows everyone to enjoy the benefits. Take a moment and talk to Rohit, Membership Chair, or visit the RASC web site for more information.

On the local level, RASC Vancouver Centre has hosted numerous events, both scheduled and spur of the moment. Scott's

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About RASC

The RASC Vancouver Centre meets at 7:30 PM on the second Thursday of every month at various locations in Metro Vancouver (see page 1 for meeting locations and page 4 for maps). Guests are always welcome. In addition, the Centre has an observing site where star parties are regularly scheduled.

Membership is currently $73.00 per year ($41.00 for persons under 21 years of age) and can be obtained by writing to the Treasurer at the address on page 5. Annual membership includes the invaluable Observer's Handbook, six issues of the RASC Journal, and, of course, access to all of the club events and projects.

For more information regarding the Centre and its activities, please contact our P.R. Director.

NOVA, the newsletter of the Vancouver Centre, RASC, is published on odd-numbered months. Opinions expressed herein are not necessarily those of the Vancouver Centre.

Material on any aspect of astronomy should be e-mailed to the editor or mailed to the address below.

Remember, you are always welcome to attend meetings of Council, held on the first Thursday of every month at 7:30pm in room P8445.2 of the Physics wing of the Shrum Science Centre at SFU. Please contact a council member for directions.

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Trustees Ron Jerome
Pomponia Martines
J. Karl Miller

Library

The centre has a large library of books, magazines and old NOVAs for your enjoyment. Please take advantage of this club service and visit often to check out the new purchases. Suggestions for future library acquisitions are appreciated.

On the Internet

http://rasc-vancouver.com or
http://www.rasc.ca/vancouver
http://astronomy.meetup.com/131/
http://www.facebook.com/RASC.Van

@RASCVancouver

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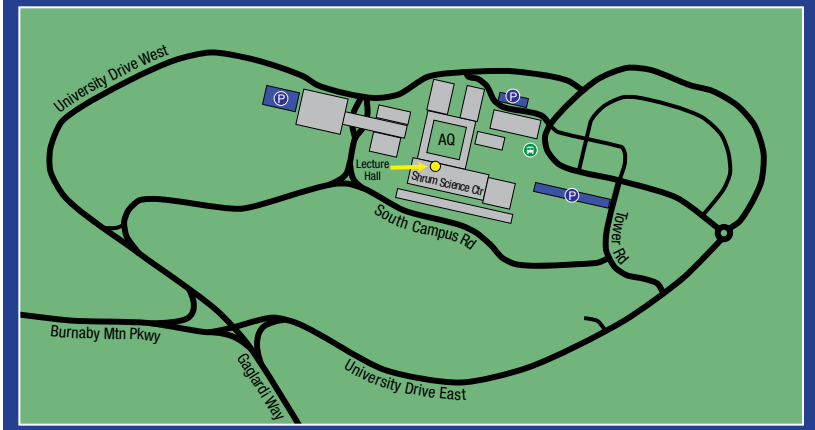
Maps to Meeting Sites



SFU

Our September meeting is in room B9201, in the south concourse of the 3rd (main) level of the Academic Quadrangle (indicated by the arrow on the map at left).

Pay parking is available at several locations around campus (indicated as "P" on the map).

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efforts to connect on Facebook, Twitter and Meetup to members and the public is paying off. If you are looking to get out under the night sky with a group of like-minded people, be sure to connect with Scott. Scott also handles the popular loaner scope program which is highly active but we still have scopes to lend.

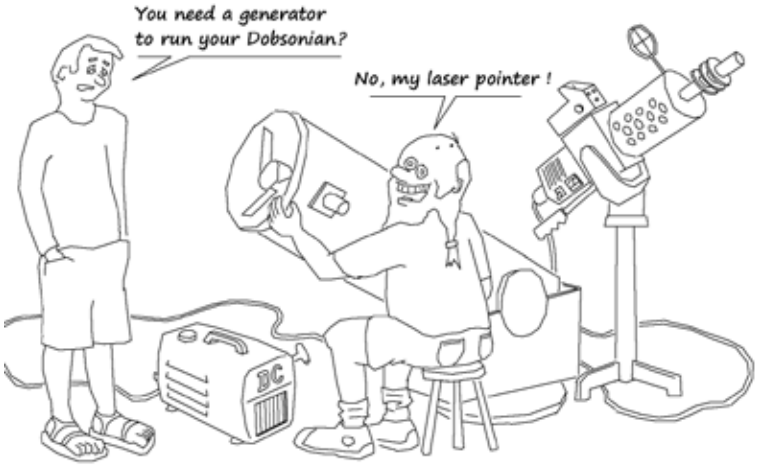
Thanks to the efforts of our local RASC councillors and volunteers, we, in conjunction with the Metro Parks, hosted 850 enthusiastic stargazers to watch the Perseid meteor shower. Unfortunately, no one brought a cloud filter so seeing any meteors and stars was left to the imagination. However, several activities and talks did fill the evening so most of the people came away with a better understanding of local astronomy opportunities, plus those who stayed had an enjoyable night of camping in the park.

Campbell Valley was the home to another successful event in August where several members of the RASC Vancouver Centre had set up solar scopes of all sizes and let the public see the solar activity first hand. Judging by the WOWs and COOLs at the scopes, the visitors to the park enjoyed their time. RASC also set up solar scopes in the downtown park in Maple Ridge where the same wow factor existed.

Public outreach is what we do and it is so rewarding to be able to be part of the experience. Remember, if you are interested in attending any of the events, be sure to check out Meetup at www.meetup.com/astronomy-131 to see where the next event is. If you are interested in volunteering, contact Suzanna Nagy, our Events Coordinator.

Your Vancouver Centre will soon be accepting nominations for the next year's council positions. If you have an interest to be involved in council activities, please send your name forward to any current council member.

Clear Skies. ✸



cartoon by Dan Collier

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Park. I had decided to stop and use a cash machine in the local bank. As I got to the spot, the whole town lost all electrical power. The machine world was instantly idle. Gas couldn't be pumped, nothing was ready for purchase in the unlit stores, clerks couldn't see their cash registers; they stood around forlorn like cats facing empty food bowls. A couple of ladies wheeled out a portable gas range to the side of the road and started making burgers as they furiously chain smoked. I had a bad cup of coffee and thought, well, the Eagle's arranged this. He's teaching me a lesson. I moved on to where the bird directed. It's a wildflower-strewn meadow just a few metres from the Fraser River, where that river is just a creek. Before setting up the big telescope, I amused myself pitching stones to the far shore, so I could say, back in Richmond, that I had thrown a rock across the Fraser. Overhead, the Eagle sat in a tree watching the flying stones.

Leader of Aquila the Eagle is the star Altair. Altair is the 12th brightest star in the heavens and an electric white star, most southerly of the summer triangle stars with Vega and Deneb. Altair can be recognized by two fainter stars that sit, one on each side. The starry trio are sometimes called the belt of summer, in imitation of Orion's belt of winter. Look to Gamma, the northern star of the three. It resembles a little orange pumpkin, even to the unaided eye. Altair is about 17 light years away and is therefore a neighbour to the sun. When straddling the meridian, it is the nearest bright star visible at night. Altair is sometimes said to be the eagle that Zeus assumed when he kidnapped Ganymede. The unfortunate shepherd ended up waiting table eternally on Mount Olympus.

This constellation is ancient and a reference to Aquila is made in the *Oresteia*, in the first act, when the soldier watching for signal fires announcing the fall of Troy is also waiting for the eagle to attain its greatest height, for then his watch ends.

Each constellation has its own charms and evokes differing moods. Some are decked out in bright stars that appear when the sky is fading blue and they stand promising the dark. Other constellations have

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For Sale

Orange tube C8 in excellent condition. Includes drive corrector, counter weight set, 8x50 finderscope, 3 eyepieces, 1 1/4" diagonal and instruction manual. Also have the storage trunk. Primary mirror and corrector plate are pristine. Email me for pics. Asking $495.

Keith Eisler, phone 604-539-8690

• • •

Nagler Eyepiece Type 4 17mm - $350.00

- Focal Length: 17mm
- # of Lens Elements: 7
- Apparent Field: 82°
- Eye Relief: 17mm
- Field Stop Diameter: 24.3mm

Williams Optics 2" Diagonal - $125.00

Contact Ron Jerome at jerome3292@shaw.ca

Membership has its Privileges!

New members, did you know? The Vancouver Centre has 8 telescopes available for loan free of charge! We have telescopes ranging from 60mm to 10" diameter. For more information see the Director of Telescopes after the members meeting. The loaner period is for one month, to be returned after the next meeting. Telescopes are not allowed to circulate outside of these meetings. You can now reserve two different telescopes per year and use what is left at the end of the meeting anytime.

Your greatest opportunity as a member of the RASC is to take advantage of the company of other enthusiasts to increase your knowledge, enjoyment and skill in astronomy.

The best thing you can do to gain the most from your membership is to get active! Take in the club meetings; engage other members with questions; come out to observing sessions (also known as "star parties"), and, by all means, volunteer to take part in our many public events.

For the usual observing sites and times, visit our website at http://rasc-vancouver.com/observing-sites/ or contact the Observing Chair at observing.rascvancouver@gmail.com.

Upcoming Events

October
5 – Paul Sykes Lecture at 8pm at SFU. William Borucki, principal investigator for the Kepler Mission, will be our speaker. See Meetup for details.

December
12 – AGM

Nova Delphini 2013

by Dan Collier

Arrowed is Nova Delphini 2013 in this image acquired at 0648 UT Aug. 18 at Vancouver. I mounted the Centre's Finger Lakes CCD camera on a tripod and attached a Wetzlar 85mm *f*/2.8 projection lens. The field is 6 degrees.

Exposure was 4 seconds. The bright Moon was as close to Delphinus as it ever gets. Because a desiccator is not installed, the CCD cooler was set to +16C to keep dew off the silicon. Deeper cooling was not warranted.

Phil Morris alerted me to the nova, which was discovered 1400 UT Aug. 14 while still brightening. The nova is just south of the border with Vulpecula, 4 degrees east of Eta Sagittae. Eta is the mag-5 star that puts a 1.5-degree extension on the pointy end of Sagitta. I recall seeing a red tint in some novae. The tint is discussed in Burnham's notes for Nova Cygni 1975 and is attributed to hydrogen-alpha emission from an expanding shell. However, Nova Delphini appeared white to me.

I judged it to be as bright as Eta Sge. By the early hours of the 21st, the nova had faded to mag 6. By the time you read this, you may need go-to to find it. Slew to the star SAO 88610 and look 10 minutes southeast. No star appears on Palomar survey plates, so the nova has erupted 12 magnitudes or more.

Delphinus has hosted a nova before, in 1967, and it was in this field. Nothing is visible of it. The other image, assuming Gord has space to print it, snagged a bright satellite during the one-second exposure.

The prominent object at lower left is EU Delphini, a semi-regular variable star about 360 LY distant and 1 AU in diameter. It varies between mag 6 and 7 over a period of about two months. A class M5 red giant, EU Del puts out more infrared than visible light. So its image has spread out and lost focus. From EU Del, scan right past the wide diagonal pair of bright stars. You will come to a triangle consisting of two faint stars and a brighter star. The latter is HD195019, one of the first stars discovered to host an exoplanet.

This is the camera that was supposed to replace the Cookbook unit built by Victor Amey for the Overton Telescope. It never worked dependably and twice was returned to FLI in New York. The camera was loaned to me since I have a reputation for turning around basket cases. The circuitry seemed sensitive to twisting and probing by instruments, and in due course I found the cracked diode that was making the cooler uncontrollable. The fabric desiccator was unable to keep the CCD dry, so I built a brass one that can be oven-baked. Fresh desiccant material is not easy to come by. When I explained my need to a druggist, she saved me some desiccant "pills" that had been put in bottles to keep drugs fresh. The desiccant looks like pink clay beads and comes from a distributor in Belen, New Mexico. The climate there is good for both astronomy and the desiccant business. ✸

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wonderful forms of triangles, dippers or suggest the outlines of armed men, great whales, menacing snakes and miscellaneous monsters. Some constellations have special traits that are hidden from casual view. I place Aquila in the latter camp. This is the place of the planetary nebulae.

The planetary nebulae (singular is an "a" ending while the plural terminates in "ae") are a class of the general nebulae, or cloud like objects, but the encompassing gaseous medium is not a general cloud but is sloughed off by one star. The name, which has nothing to do with planets, is another one of astronomy's nomenclature puzzles like "falling stars" or the "morning star." Neither of these terms refers to a star. The planetary nebula is sometimes, in casual reference, called an exploding star but this is not the case. It's more precise to compare them to a tire with a slow leak.

When stars grow old, they swell up and undergo selective burning and rekindling of the central fire. The conditions are often ripe for the loosely-held outer layers of the star to be ejected and a cloud is generated about the star. This cloud is extremely thin—its capture and placement in a sealed container on Earth would be called a vacuum. The nebula shines due to the fierce irradiation from the hot central star. Circles, rings and bipolar lobes are the most common shapes seen in telescopes. The planetary nebulae are a fleeting astronomical feature since the matter in the cloud is in the state of drifting into interstellar reaches and its replenishment is far from certain. From start to finish, the career of planetary nebulae is about 10,000 years—very brief on the cosmic time scale.

After learning a bit more about these exotic objects, I set as my task the finding of some earthly analogy, a mundane equivalent of the strange objects above. The scene of my contemplations was Porteau Cove Provincial Park, just south of Squamish, BC. This park, a regular stop of mine with an amphitheatre and large lawn in view of the sky, is also favoured by the Eagle. The day after the night program for campers—about sixty saw Saturn through my 10-inch reflector—I was up in the morning, preparing the first cup of coffee and wondering what it is around me that is similar to a planetary nebula. My first thought was a waterfall. Shannon Falls is just up the road and the gushing water is a constrained form of movement just as the ejection of gas from a central star is like a waterfall but with more degrees of freedom. It's a bit of a stretch; it didn't seem quite what I was looking for. Walking out of my campsite, I looked up for the Eagle to offer some advice. The large bird sat on the dead limb of a cedar pondering the ocean. I sauntered to the beach to see what the Eagle was watching. The large, smooth ocean of Howe Sound was calm and one could look across and see Anvil Island, first charted by Captain Vancouver, and the mainland of the opposite shore covered in trees. I ran my eyes over the waters. Something was out of place. A tree was standing alone about two kilometres out in the middle of the inlet. The water is good and deep where the tree sat, apparently anchored by some magical agency. At Britannia Beach just north of the park, when the copper mine operated, miners deep underground could hear the cries of killer whales above them as pods passed by. A claustrophobic experience if ever there was one. A couple of campers also stood perplexed, watching the tree standing right out in the middle of the deep blue grey sea. It was as though this one tree had been seized with a show-off bent, and, perhaps on a dare, left the forest and was wading where none had been before.

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Among the onlookers was someone who had seen this before and had a bit of local knowledge. It seems, the inlet is fed by a number of small creeks. Trees grow right down to the edge of these streams, and, in times of heavy spring runoff, the creek bank can be undercut and a good sized tree mounted on a large tuft of soil can be sent down the creek like a thrill seeker going down a tube in a waterpark. The tree arrives at the creek mouth and usually simply joins in the debris that pile up sticks and logs on the shoreline. But sometimes the tuft of dirt and brambles is just the right size so that the tree arrives in the sea able to stand up like a cork supporting a pin in a glass of water. Since the tree makes a tolerable sail, it is carried around the inlet, going on a sightseeing tour but with none except perhaps an astonished squirrel on board to bear witness.

This then is what planetary nebulae are "like." It's a rare sight, the confluence of accident, a certain vulnerability to time and place and it can't last very long. Soon the tree, its turfy support eroded, will topple into the water and instantly lose any claim to being remarkable. It's the same with the star at the centre of the planetary. Once the cloud is dispersed, will anyone want to see the progenitor again?

The sight in the eyepiece of the round nebula, in either its circular or ring formation, always seems magical and strange. It's the roundness that gets you. The Ring Nebulae, called M57, in the nearby Harp is one of the most loved deep-sky objects. As it begins to get dark at Alice Lake, I turn the 10-inch homebuilt telescope to the Ring Nebula. Selecting a low-power eyepiece giving about 40 power, I see a very faint smudge, like a water stain on the element of a glass. I'm trying to observe M57 under the most unfavourable circumstances. It's not yet dark, and too low a magnification is being used. Why? It's because this is the view of planetaries that are quite faint, or seen in small refractors.

NGC 6781 is a large planetary nebula in the constellation of the Eagle. Aquila is an excellent hunting ground for these elusive objects and a dozen are within the boundaries of this constellation. 6781 is probably the best of the bunch. In small telescopes, this nebula looks like an oval, fairly large, but dim.

In 200 mm telescopes, it is suspected that nebula is dimmed near the middle and that its true shape is that of a donut like the famous Ring Nebula in the nearby Harp. The hole in the middle is clearly seen in a 400 mm telescope.

A sample of the Eagle's planetary nebulae:

Nebula	Distance*	Radius*
NGC 6803	3000	0.041
NGC 6804	1700	0.130
NGC 6807	5100	0.025
NGC 6781	700	0.018
NGC 6772	1250	0.197
NGC 6778	3100	0.120
IC 4846	3300	0.018

(*in parsecs)

Dr. James Kaler is the man to talk to about planetary nebulae. His work is cited in the *Webb Society Deep-Sky Observer's Handbook* back in 1979. The above list is kindly furnished by him and contains Aquila planetaries, with distance and radius (or semi-diameter). The units here are parsecs, one of which is approximately equal to 3.26 light years. Jim cautions that the distances and therefore sizes should be taken with a "grain of salt" and we lack good parallaxes

Image credit: ESO

NGC 6781

to these objects making the table only correct as a ballpark measure. Some accounts claim most of these nebulae are about one light year in diameter and therefore the range can be directly calculated. It's not so simple, says Dr. Kaler. Sometimes, very occasionally, we get lucky and the distance to the planetary is given away by the context it is within. A planetary sits nestled within the globular star cluster M15. Since the distance to the globular is known reasonably well by its variable stars of known luminosity, the distance to the planetary is revealed. That's luck.

Yet we aren't completely in the dark about planetary nebulae. Answers to questions about them can be found if we use a source of information that is largely independent of range. The spectrograph is such a tool. The

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lines in the spectrum will look the same irrespective of our lack of a good distance. These gas envelopes show emission lines at certain wavelengths. These wavelengths tell us about the behaviour of the atoms within the cloud. The gas within is heated to ionization by the very hot central star that is becoming a white dwarf. It is the atoms giving off specific wavelengths that give the colours we see in the telescope. Particularly visible is the doubly ionized oxygen atom, the so called OIII. This gives a pale greenish blue colour. It's how the dumbbell M27 looks on a good sized scope. The Saturn nebula (NGC 7009) is another very blue looking object. It's not the case that the cloud is largely or even significantly made of oxygen. It's mainly composed of hydrogen since its origin is unprocessed gas at the star's surface. The OIII stands out because it is near the middle of the eye's range of sensitivity. The reds seen in colour pictures of these objects are never seen at the eyepiece. Some wavelengths are known to be present, but we are unable to see them even photographically from the ground since they are emitted in the infra-red and the Earth's atmosphere absorbs the light. So, observing these objects is strongly dependent on the eye, the night and the equipment.

Looking at the planetary nebulae always puts me in mind of the central star that has created all the fuss. The white dwarf is a super-hot star only slightly bigger than the Earth but with the mass of a star. At the amphitheatre meeting, a few people commented on how it would be to live under the sky of one of these stars. Its form shrunk to a point and the dismal gloom and icy prospects for inhabitants. Is this the case? Snatching a branch from the ground—for the Eagle's territory tolerates no blackboards—I cleared a flat place on the dust and with the stick made the following marks in the earth: T^4R^2. A few people crowded around to get a better look. Some kids, sensing they weren't going to be entertained, started to cry. The letters refer to the temperature and radius of a body emitting light and quantify the luminosity; the matter is open to calculation, rather than guess work or rumour. Imagine a newly minted white dwarf of an initial mass of that of the sun. In its new configuration, its radius has decreased from about 700,000 km to only 8000 kilometres. However, the temperature at its surface has now climbed to about 100,000 K from 6000 K. Admittedly, this is a somewhat ideal situation, the kind of thing I avoid in fact, since a real white dwarf would quickly cool off. But some are at this temperature. Next, notice again the relation. The temperature is under sway of the fourth power, which makes a number get big very steeply. For example, the number 5 when squared is 25, but 5^4=625. When the math is done, it turns out our fictional white dwarf, in spite of its pint size, is 10 times as luminous as the Sun. This tiny dot in the sky would be intolerably bright and the inhabitants would face a perpetual Sahara Desert.

Also, this relation has a real observational effect on our night sky. Go outside and look at the stars. Most stars look colourless or whitish-blue. That's the power of the T^4 making blue stars stand out and shining into our awareness over huge distances. So, the visible star retinue is strongly biased in favour of the hot blue stars. Yet there are red stars. On hand is Antares in the summer, Betelgeuse in winter and for us northern observers, Kochab in the Small Dipper, at any season. These stars have low temperatures and to be on display they rely more heavily on the feeble R^2 term. In order to be seen, the radius must be huge and so, any red-coloured star visible to the unaided eye must be a hugely inflated gas bag or, colloquially, a red giant. The situation can be seen at a glance by comparing the list of the brightest stars and the closest stars in an astronomical data book such as the *RASC Observer's Handbook*. The closest and therefore most representative stars in the galaxy are red dwarfs. Most fall below the threshold of visibility: they have low Ts and tiny Rs, a recipe for invisibility.

Suppose we could assume the job description of the Deity and meddle with the laws of physics. What if we interchange the exponents on the relation, and imagine a world in which T^2R^4 was the rule. There would be many bizarre consequences. One thing that would instantly change would be the look of the night time sky. Now, visibility would be tied to the star's size. The bright blue stars would be largely gone and in their place ruddy and orange high radius stars would litter the celestial sphere. Poets would no longer compare

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stars with "diamonds in the sky" but would draw metaphors from embers glowing in the fireplace or candle flames flickering behind thin drapes.

With these speculations in hand, I returned from the land of the Eagle and back to town. It happened that there was a party and I dropped by. I hate parties but I came to this one for no conscious reason. It was on the west side of town. Those attending were associated with space science, and, in some derivative way, education. Although most of the money in the province is concentrated here, at the end of a small peninsula, they are cheap with liquor. A sign at the bar said one complimentary drink. After that, see the stuffed shirt at the cash register. Naturally, I was put off. Also, the glasses were small, mean and cheap plastic. On the table, next to the drinks, was a good-sized glass vase holding a few dusty plastic flowers. No one was looking so the pseudo-flowers went in the bin and I poured a good stiff drink into the vase. Everyone pretended not to notice. Next to the door, with its fierce sign barring undergraduates from entry, was a large placard on which a felt marker had inscribed: T^4R^2 along with a Greek sigma (σ) which is the Stefan-Boltzman constant. I stood wondering how and why this had appeared and what it had to do with the activities of the late afternoon. A few stragglers told me the party was to celebrate our host's great victory over an enemy.

Here's what had happened. The host had visited Cape Canaveral and sat in on a dinner with NASA officials. As he was seated, he saw with dismay that the speaker was his deadly foe. A lifelong enmity incarnate, the two had been at each other's throats from university days when they competed for the same grants, positions and dates. They applied for the same jobs, even voted for differing parties just for the sake of differing. Our hero looked sullenly into his plate and tried to ignore the hated rival at the head of the table. The discussion turned to spacecraft and what should be considered as a proper payload. Our host suggested that anyone might come up with a science experiment and add it to a space mission, even on one day's notice. This challenge was instantly taken up by the table and the main instigator was the smug enemy. Our host left the dinner facing a seemingly impossible task. The next day was the scheduled launch of a small rocket and the pad crew had been informed that he was expected to add a science package which was to be dreamed up in one evening. He returned to his motel, nurturing the presage of humiliation and certain defeat. Entering the room, he made a survey of its contents. It had a wainscoting of a strip of Disney cartoon characters. The bed had a funny smell like it had been regularly rolled in a gigantic ash tray then perfumed with sweat. The television didn't work for, judging by the scuffs on its side, it had been violently kicked. Someone had carved into the table the word: Hate. In other words, it was a typical Florida motel room. Our hero set to work. In a cupboard he found a large-size cylindrical coffee tin. He took the tin and cut a slot in its side. He took a good-quality thermometer and secured it into the tin along with a cell phone whose camera imaged the scale on the thermometer. Sheets of oven aluminum foil, to protect the phone from overheating, and he was ready for liftoff. The next morning, riding an upside down candle flame, the tin can went into Earth orbit.

Here's where T^4R^2 comes in again. Imagine a sphere centred on the Sun. This sphere is one astronomical unit (AU) in radius, so Earth is located on the ball. Then, given the radius of the Sun, we can write: $T^4R^2 = T^4R^2$. This means that as the light of the Sun spreads out into space, it is reduced in steps, always conserving the equality of the equation. As the tin went around the Earth, the thermometer peaked at about 300 K. This is the temperature of a body at the Earth's distance from the Sun. Putting the value into the T of the term with the one AU radius, we can solve for the other T which is the temperature of the surface of the Sun.

Our host returned in utter triumph, only slightly clouded by the bed bugs in his clothes courtesy of the state of Florida. I joined in a round of applause when this story was related. Not only was this a science triumph but the despised foe at the Cape was in complete defeat. He was now the butt of jokes, sidelong sarcastic glances and coffee shop slanders. As I learned more, I wondered about the sudden plunge of an official whom one suspected to be armour plated against failure by the very vagueness and unfocused nature of government work. Then came the epiphany. It

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seems the miscreant was in charge of the grounds around the launch site. Some trees lining a creek were condemned by him and cut. A few protesters came out to warn against this vandalism. The trees, said the local naturalist, were frequented by eagles fishing.

The eagles must be obeyed. They cannot be ignored. You will come to grief unless you drop everything, take to the road and keep the bright star before you, both in your eye and in your heart, and follow the Roman birds.

This writer wishes to acknowledge the aid of Dr. James Kaler for his communication on planetary nebulae. Any errors herein are my own. ✸

Doug Montgomery (bottom) Rohit Grover (left), and Leigh Cummings (right) enjoy a view of clouds at the 2013 Merritt Star Quest.