BPAA Newsletter

Battle Point Astronomical Association, Bainbridge Island, WA

Issue 72 | December-January-February calendar | Winter 2005–2006

(Unless otherwise noted, all events are at the Edwin Ritchie Observatory, Battle Point Park)

December

December 1: New Moon
December 3: Star Party Battle Point Park;
Beginner session 5 p.m.
December 7: BPAA Board Meeting 7 p.m.
December 8: First-quarter Moon
December 10: Members' Tutorial: Ritchie Telescope
December 11: First Anniversary,
Mars Rover Opportunity, Mars Landing
December 13: Geminids Meteor Shower Peak
December 14: Member Meeting 7 p.m.
December 15: Full Moon
December 21: Winter Solstice
December 22: Ursids Meteor Shower Peak
December 23: Last-quarter Moon
December 30: New Moon

January

January 3: Quadrantids Meteor Shower Peak
January 4: BPAA Board Meeting 7 p.m.
January 7: Members' Tutorial: Ritchie Telescope
January 6: First-quarter Moon
January 11: BPAA **Annual Meeting** 7 p.m.
All Members Invited
January 14: Full Moon
January 21: Star Party Battle Point Park;
Beginner session 5 p.m.
January 22: Last-quarter Moon
January 27-28: *Winter Coast Weekend Under the Stars*; Astoria, www. starstuff.com
January 29: New Moon

February

February 1: BPAA Board Meeting 7 p.m.
February 4: Members' Tutorial: Ritchie Telescope
Clyde Tombaugh's 100th Birthday (1906)
February 5: First-quarter Moon
February 8: Member Meeting 7 p.m.
February 13: Full Moon
February 21: Last-quarter Moon
February 25: Star Party Battle Point Park.
Beginner session 6 p.m.
February 28: New Moon

Calendar Notes

Harry and I are back from Bryce Canyon National Park, where we spent a month as volunteers in Bryce's astronomy program. We'll write more about the experience in the next issue of the newsletter, but let me say for now that it was fantastic. The skies at Bryce are wondrously dark; Bryce Canyon is called one of the last great sanctuaries of dark skies in North America. The rangers involved in the astronomy program are dedicated and passionate about the cause of protecting dark night skies. Their message is reaching thousands of persons each season.

Since we returned, there has been nary a clear night. I'm hoping it will clear in late January, if not before. There's a winter star party on the Oregon Coast, near Astoria, on January 27 & 28. It looks like fun. Many activities are planned in the event the weather doesn't

Paul Below on Sports Field Lighting, Page 4

cooperate. They will even have a portable planetarium. Check it out at www.starstuff.com.

BPAA's Annual Meeting is scheduled for January 11, starting at 7:00 p.m. All members are invited. The annual meeting will displace the member meeting in January, but member meetings are scheduled in December and February. Speakers and agendas will be announced via our email yahoogroup.Note that our monthly star parties in December and January are scheduled for 5:00 p.m., but that the star party in February will begin at 6:00 p.m.

Should our Northwest winter skies miraculously clear, additional star parties may be scheduled at any time via our email yahoogroup. Any member who plans to observe can invite others to join in by sending an email to bpaa@yahoogroups.com. To join our email group, send an email with your name to bpaa-owner@yahoogroups.com and we can enroll you. If you want to also have web access to the messages and files, you can join the yahoogroups by clicking the register link for new users on http://groups.yahoo.com/, and then you can request to join our group on http://groups.yahoo.com/group/bpaa/. The system will send us a message, and we'll approve your request after we verify your membership.

Diane Colvin (dtcolvin@comcast.net)

In Brief

SEEING STARS Astronomy 0.001

Anna Edmonds

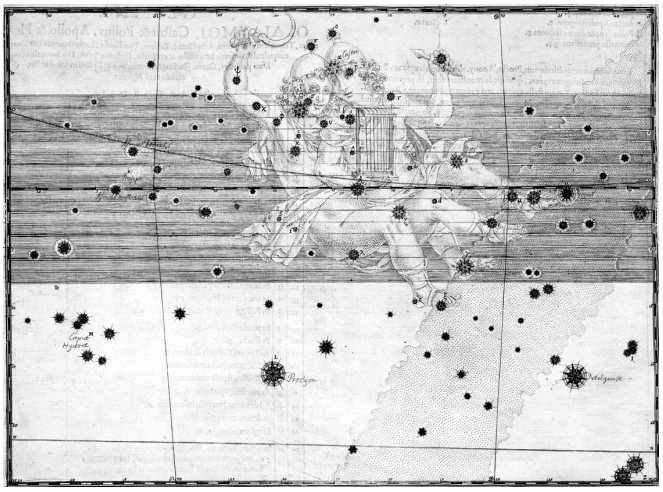
The Twins and Mnemonics

In legends the Twins—Gemini—are thought of as helpers. The Kiowa tribe of the western United States see them as part of the constellation of the Bear's Lodge where girls who were about to be eaten by bears were rescued by the stars. For the Romans, they were the guardians of their city, having intervened for Rome in the battle of Lake Regillus. Sailors have thought that the electrical glow called "St. Elmo's Fire" that sometimes appears in a ship's rigging during a storm was a sign of the stars' protection and the end of the storm. Then there's the story of the Twins, a poet, a king, and a memory aid.

The constellation with the twin stars is overhead at midnight about January 15. It was appearing in the east late at night most of the fall. Besides the two bright stars, there is also one Messier object in Gemini, the star cluster M35; there is a second star cluster NGC 2158, and a nebula NGC 2392 known as the Eskimo or the Clown-face Nebula.

Castor, the dimmer of the two Twins, has a magnitude of 1.93. Its light is of varying intensity. This prompted astronomers to discover that it wasn't one star. When they found a second revolving around it, they were able to show that the force of gravity applies beyond our planet. Not only does Castor itself have a twin with almost the same luminosity, it also has a third, red dwarf that is part of the system, and – each of three is a double, making the whole not merely one part of the

Gemini from Uranometria, courtesy of Linda Hall Library of Science, Engineering & Technology



Eskimo Nebula, Courtesy NASA

Twins but in themselves a sextuplet.

The revolving stars of Castor and other binary stars have been particularly important because their varying luminosity has helped astronomers study their physical properties. From these studies scientists have gone on to discoveries about the relative mass of objects in space, their distances, and their ages.

Pollux is a brighter yellowish star with a magnitude of 1.16, making it the 17th brightest star in the sky. It's thought that one of the two Twins' luminosity has changed significantly since they were named because Castor is called "alpha" and Pollux is "beta." Pollux is about 4.5° south-southeast of Castor. This separation is about the distance measured by the second joint of your index finger held out at arm's length against the sky. It's this nearness to each other that has made them "the Twins."

In Greek myth Castor and Pollux were sons of Zeus and Leda, and also brothers of Helen of Troy. They had several adventures rescuing Helen from Theseus (not Paris!), and going with Jason on his Argonaut. Castor was known as a horseman, Pollux as a boxer; and they were in charge of the public games. Perhaps because they were patrons of hospitality they were both considered handsome.

The Twins and memory tricks

The story goes like this, according to the Roman essayist Cicero: Simonides, a 6th century Greek poet, was hired by Scopas, a rich, self-important king, to sing his praises at a party. However, the poet decided not to pander to the king's vanity, but instead included more references in his song to Castor and Pollux than to Scopas. Incensed, Scopas exploded, "You think I'm going to pay you for that? Go try to get your pay out of the Twins. If they're still around."

Just then, a servant called Simonides out, saying that a couple of boys wanted to see him. He went, but no one was there. At that moment the dining room collapsed and everyone inside was killed, their bodies too smashed to be recognizable. Naturally Simonides believed that the Twins helped him escape.

The story has an interesting twist: Because Simonides could recall where each person had sat at the banquet, he was able to identify the bodies. Cicero says that the poet was the first one to realize "that order is what brings maximum light to memory" and to come up with the idea of "the art of memory," or mnemonics. Do you think he thanked his lucky stars for that also?

How's the Ritchie Telescope?

Malcolm Saunders

The Ritchie telescope continues to work well. I have continued holding monthly tutorial sessions even though clear nights have become rare. These sessions have normally included three or four people, and consist of hands-on practice and lots of question and answers, beginning at 7 p.m. and lasting as long as there is interest. Much of what you need to know to operate the telescope you can learn without actually looking at stars. In fact, we sometimes keep the lights on in the dome during beginning lessons. After attending a lesson or two, star party nights are a good opportunity to practice and explore more advanced features of the system. The Ritchie telescope is available for any qualified member to use. I encourage any BPAA member who is interested to attend these tutorials and learn to use this spectacular piece of equipment. Tutorial sessions in the coming months will be Saturday December 10, January 7 and February 4 at 7 p.m..

We recently exchanged the hand pad for another that operates without a hard wired connection to the telescope ....a radio hand pad. The new hand pad has a number of advantages, the best of them being that there is now one fewer wire to tangle during a dark night in the dome.

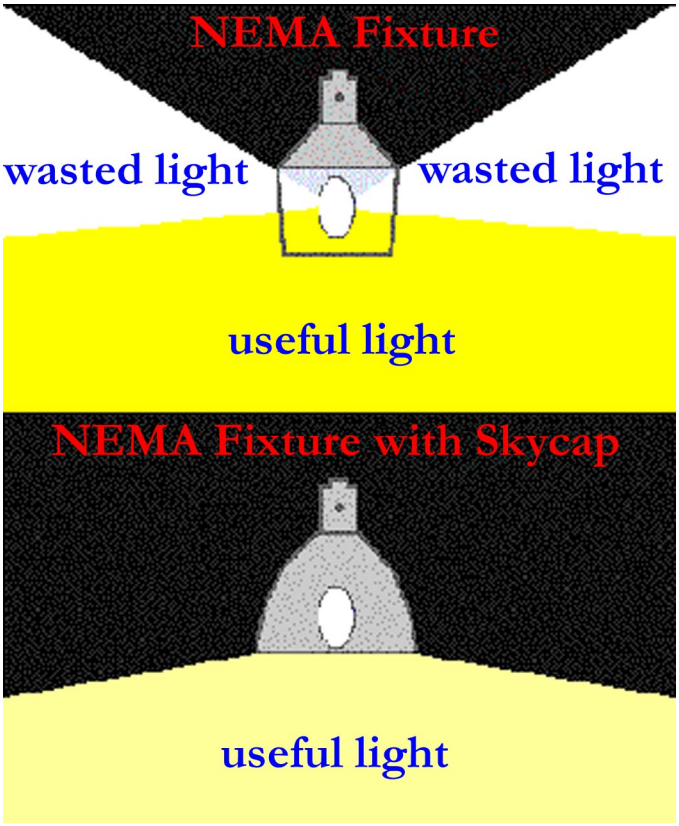
The telescope control software (Scope II) includes some very handy advanced features which we are learning to use, bit by bit. For example there is a function called "spiral search" for those times when you know that you have the telescope pointed very near some faint object, but not quite on it. The spiral search automatically and slowly moves the telescope in an expanding spiral pattern which you can stop as soon as you see what you are hunting for.

The telescope is very sensitive to balance. A heavy piece of equipment added to the top of the telescope must be balanced by a counterweight at the bottom of the telescope. Otherwise there is too much load on the motors and, also the gears start to bind leading to unreliable tracking. With that in mind one important question has been whether the SBIG CCD camera is so heavy that we will need extra counterweights when we use the camera. I tried this out and the good news is that it looks like we will not need extra counterweights.

Sports Field Lighting

Paul Below

Sports lights can be placed into one of three categories: fully shielded, shielded, and unshielded. One might think of them as good, bad and ugly. Fixtures used on courts are very similar to those used on fields and in some cases may be used interchangeably. The major difference is the area that needs to be lighted. Fields are generally wider than courts, so lights mounted on the sides of a field need to reach a longer distance. This is probably why field lights are rarely fully shielded.



To understand more, first consider what light pollution is. The components of light pollution include:

- Glare, which can blind pedestrians and drivers, harming visibility. Glare is never good.
- Light trespass, which is outdoor lights that trespass onto other's land.
- Urban sky glow, which is destroying our view (and our children's view) of the universe (it would be a shame if our children thought that the Milky Way was only a candy bar). Sky glow is the atmospheric phenomenon caused by stray ground-based light being scattered and reflected by airborne particles suspended in the atmosphere. The result of this scattering diminishes the view of the cosmos, much like turning on the lights in a movie theater while the film is showing.
- Energy waste, shown to cost over one billion dollars a year in the USA alone.

To qualify as fully shielded, a luminaire must have zero light emitted above 90 degrees from straight down. This means that fully shielded lights contribute very little to sky glow.

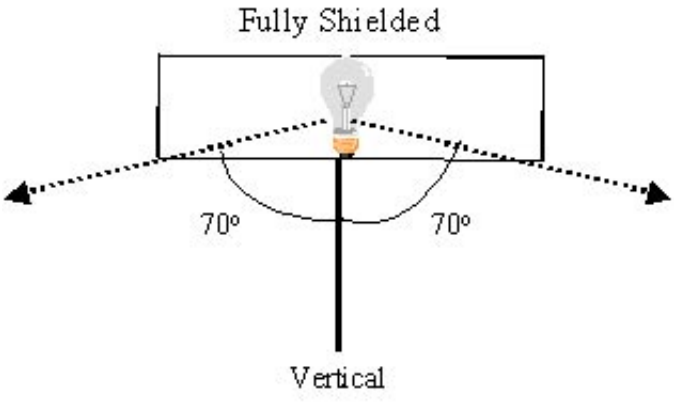
Light emitted above 90 degrees only illuminates the bellies of birds and airplanes.

However, fully shielded lights can still cause glare and light trespass. It is best if the light emits zero light above 70 degrees. Light emitted above 70 degrees (as in the top half of the NEMA fixture diagram) is wasted: by the time the photons finally reach the ground (if ever) they do no good.

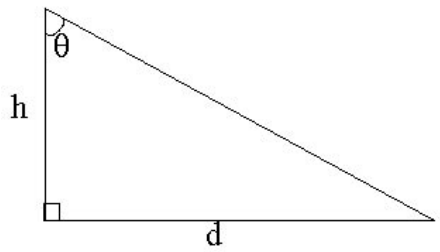
The lower half of the NEMA diagram shows a light that is limited to no more than 70 degrees from the vertical. This is the ideal type of light for outdoor use.

The second figure shows how a flat bottomed luminaire can be configured such that no light goes above 70 degrees. However this could still cause glare or light trespass, depending on where the light is located, the terrain, and the height of the pole.

Bainbridge municipal code states that all light trespass is prohibited, and that "All light sources shall be hooded or shielded so the lamp is not visible from adjacent properties or public rights-of-way."



How far would a person have to be from a fully shielded lamp so that it would not be visible? It depends on several factors, but for a light pole of height h, and a luminaire that emitted light no more than 70 degrees above vertical (angle 0 in the following diagram), then distance d is equal to the tangent of 70 degrees times the height h. For example, if the height is 60 feet, then d would be almost 165 feet. If the height is 90 feet, then d



would be a bit over 247 feet. These examples assume level terrain. The above computations demonstrate why sports fields need to be carefully located, to avoid glare and trespass, even with full cutoff luminaires. And if light is emitted above 70 degrees, and especially above 90 degrees as with most sports lighting, then it may not be possible to comply with the municipal code.

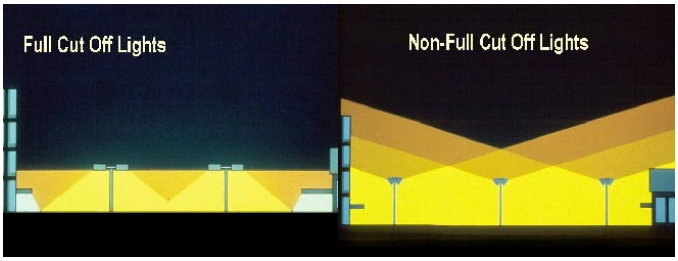
A few examples of fully shielded and shielded luminaires may be worth a thousand words of explanation. A fully shielded luminaire has a flat bottom, and looks like this example.

On the other hand, shielded luminaires, which emit light above 90 degrees, look like these examples.

These lights have shielding, but because the fixture is at an angle, some light escapes into the sky. This precludes them from being called fully shielded.

And, since sports lights need to be very bright, using unshielded luminaires, or partially shielded luminaires, leads to excessive light trespass and glare. Nearby buildings will be illuminated as if it were daytime.

See http://www.darksky.org/fixtures/sports.html for lists of sports and field lighting that have the IDA Fixture Seal of Approval.



The web page http://www.darksky.org/infoshts/is027.html describes a situation at Wesleyan University, near the site of a disused observatory. The replacement of inefficient lighting both reduced nighttime crime and allowed students to see some constellations for the first time in many years.

When done wrong, a sports field is bad for everyone: players, neighbors, pedestrians, drivers, and those that love the night sky.

Interbay Sports Field, Seattle

The 2005 Oregon Star Party and Hurricane Katrina

Harry Colvin

I have close emotional and physical ties to Louisiana. I was born there and lived the first 30 years of my life in Baton Rouge. Family members live in Baton Rouge and New Orleans and on the Mississippi Gulf coast. While I attended the Oregon Star Party (OSP), Hurricane Katrina, although 1500 miles from Indian Trail Springs in eastern Oregon, had a sobering and distracting effect on me. What follows is my journal of that week.

Friday: Packing. Of major concern to me this year was the problem of 12 volt power to operate my computer and imaging equipment. As generators are not allowed at OSP because of fire danger, I was going to rely on a solar panel to keep my four deep-cycle batteries charged.

Saturday: We arrived at Maryhill State Park on the Columbia River around dark. NPR news reported a Category 2 hurricane in the Gulf of Mexico, expected to hit the Louisiana Gulf coast.

Sunday: As we drove out of the Columbia Gorge near The Dalles NPR reported that Hurricane Katrina was

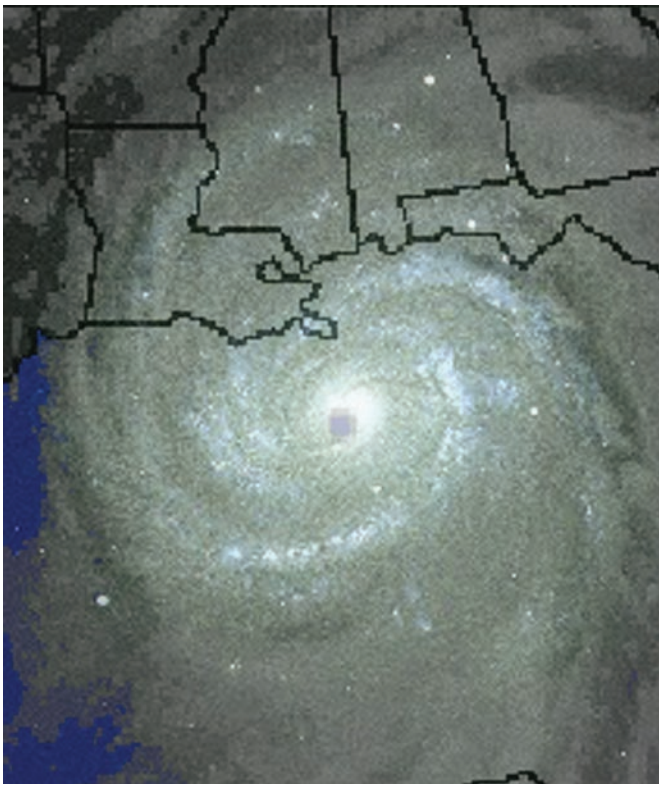
now a Category 4 storm, predicted to make landfall Monday morning south of New Orleans. I called my stepmother in Baton Rouge who told me that my stepbrother and his daughter were evacuating New Orleans, that roads were jammed and cell phones were not working. We checked into a motel in Prineville to watch CNN's coverage of Katrina. The storm went to Category 5. By early Monday it was turning north: good news for New Orleans, but I knew it could still be bad if the levees failed. For New Orleans, the northwest quadrant of a hurricane is the most dangerous, because Lake Ponchartrain lies to the north. For some time this has been known as the "Doomsday Scenario."

Monday: From all reports, New Orleans had dodged the bullet and the levees had held. By early afternoon we were at OSP. Even though it was three days before the official opening, the high plateau was filling up with trailers, tents, and assorted telescopes.

The terrain at OSP is similar to Mars, consisting mostly of dust and sharp rocks, large rocks, small rocks, submerged rocks, etc. It was tough clearing a site for my newly acquired Kendrick tent, but by dark I had the tent and all equipment set up for a night of imaging Abell galaxy clusters. After polar and drift aligning, I collected a set of dark and flat frames for image processing. My first target was Abell 2589, a group of over 17 Mag. 15 galaxies in Pegasus, tightly grouped in a field of view of less than 30 arc minutes. I was able to capture all of them in one exposure but 20-knot winds proved too much for serious work, so I retired around 1:00 a.m.

Tuesday: We were up to catch the 8:00 a.m. news. The levies around New Orleans had broken during the night and the city was filling with water. We sat stunned. All attempts to contact family in Louisiana via cell phone failed. I had a difficult time concentrating on imaging. The wind had dropped, so I re-imaged Abell 2589 and went on to image Abell 2593, another closely packed galaxy group in Pegasus, consisting of about 30 galaxies. Another Pegasus grouping, Abell 2634, proved difficult, requiring five separate images to acquire all 18 galaxies. Completing this group around 1:00 a.m., I moved on to Abell 2666 and Abell 76. By 4:00 a.m. the sky was beginning to lighten, so I retired, with five Abell groups and over 100 galaxies recorded.

Wednesday: After five hours of sleep I was up and trying to contact family in Louisiana. No luck. New Orleans was 80% flooded and the destruction on the Mississippi Gulf coast was total in several towns where I had relatives. The Internet truck was due to be in operation later in the day, but we drove back down to Prineville



Satellite image of Hurricane Katrina superimposed on a Hubble image of M100 (M100 courtesy the Anglo-Australian Observatory).

to watch CNN. The images were shocking. Around 5: 00 p.m. we returned to Indian Trail Springs where we were finally able to get a cell phone connection to my stepmother in Baton Rouge. All family members in New Orleans had made it out, but two elderly aunts who did not evacuate a small coastal town on the Mississippi Gulf were missing and presumed dead.

Wednesday night's imaging session did not go well. By now we had full Internet access: I kept surfing the net for Katrina news. I did image Abell cluster 2147 and part of Abell 262 before the sky began to brighten around 4:15 a.m. The night was surreal. Here I sat in a tent in the middle of nowhere imaging galaxies hundreds of thousands of light years away, in between reading and viewing images about one of the most destructive storms in U.S. history. Sleep did not come easily.

Thursday: By 10:00 a.m. the shower truck was in full operation and we took advantage of it. The news just kept getting worse.

As night fell I prepared for the adult mentoring class that I was teaching. The concept of using CCD imaging for near real time observing is beginning to attract interest.

My mentoring class between 12:00 and 1:00 a.m. consisted of a demo of observational imaging techniques with three students in my tent. Crowded, but things

went well. After completing the class I finished imaging the Abell 262 galaxy cluster —a monster with over 30 galaxies spread over 60 arc minutes. Consulting Internet DSS images as I worked was almost essential. I retired around 4:00 a.m. almost too tired to sleep.

Friday: I was awakened around 9:00 a.m by the loud voices of elderly neighbors. If they had been younger, I might have roared out of the trailer. But I let it pass, got up, and staggered down to the espresso stand for caffeine. I attended George LaBelle's lecture on imaging--George spends big bucks on his imaging equipment and his RV, and complains about the NSF generator restrictions at OSP. As always, Mel Bartels' walkabout to review telescope design and construction was informative. That night I gave another imaging class session. Richard Berry dropped by and lent his expert help. I made a note to order his new book, AIP for Win. I completed imaging Abell galaxy cluster 347 and retired early, around 3:00 a.m.

Saturday: Around 10:00 a.m. the weather began to turn cloudy and reports for Saturday night were unpromising. I tried to get through by phone to Baton Rouge and to my surprise my stepmother answered. The two elderly family members had been found alive on Wednesday, and were in a hospital. She said there was very little food in the stores and gas was hard to find.

Richard Berry's presentation on our galaxy was outstanding, as usual. The night was hazy, so bad that they were showing the movie Contact in the big meeting tent. Although they stopped the movie because of clearing. I did not see much clearing. I only had one student—the others cancelled because of clouds. By 1:30 a.m. most had retired or were in full party mode.

Sunday: We packed up early. Richard Berry and I had a discussion about the future of imaging, and we talked about doing some work with the Meade DSI Pro camera. All in all, it had been a mixed week, with the trauma of trying to keep abreast of one of the worst storms in this century, and the joy of imaging at one of the best star-viewing events in the country.

Cobolide Impact Extinctions

Ted S. Frost

And the third angel sounded, and there fell from heaven a great star, burning like a torch . . .

Revelation 8:10

Astrobiologists teach us Earth is a superior environment for the development of complex organisms such as us. At the same time, geobiologists point out bad things happen, as evidenced by twenty or so known mass extinctions.

Soon to become extinct Tyrannosaurus Rex witnessing the impact of the KT asteroid. Courtesy of John Sibbick.

The most famous was the day the dinosaurs checked out, 65 million years ago—the Cretaceous Tertiary (KT) extinction. This extinction is noteworthy not only for giving mammals a big break, but also because in the Gulf of Mexico, off the Yucatan Peninsula, there is evidence of a big crater in the sea floor known as Chicxulub that geologists tell us is 65 million years old.

Fractured rocks, fossil beds evidencing massive mayhem, and a world-wide layer of extraterrestrial iridium clinched it: the crater is the impact site of a very large asteroid. An asteroid so large (≈ 10 km) energy from its impact would have devastated Earth's lithosphere, at least as far as multi-cellular organisms are concerned. Fires, floods, dark skies, choking atmospheres, and downpours of acid rain would have ensued. All land animals larger than a turkey disappeared. Only small mammals, birds, and a few cold-blooded reptilian and amphibian orders survived.

Because the asteroid aspect of KT's extinction is so well documented, scientists have searched for evidence of similar impacts that might have caused other extinction events. The one engendering the most attention is The Big One—the Permian-Triassic extinction 251 million years ago. At that time, some ninety percent of all animal orders became extinct. The die-off was so extensive that life was nearly reduced to the level of one-celled bacteria.

Did a giant asteroid cause the Permian-Triassic extinction? Unfortunately, the farther back in time we go, the sketchier geological artifacts become and 251 million years is a long, long time. Mechanisms such as plate tectonics, volcanism, erosion, uplifts, and metamorphism smudge the evidence. All of which leave

plenty of room for differences of opinion Which is why the Permian extinction has generated a rip-roaring debate in the scientific community.

Barringer crater, Arizona. From a one km asteroid impacting ≈ 49,000 years ago. NASA photo by D. Roddy

The chief proponents of the theory that an extraterrestrial impact caused the Permian extinction are Luann Becker and her colleagues. Professor Becker, until a few years ago, was a University of Washington faculty member. She is currently with the University of California, Santa Barbara.Peter Ward and Roger Buick, University of Washington astrobiologists, disagree.

Being clobbered by bolides is a fact of life for the Solar System's inner planets. During Earth's Hadean period (4.5 to ≈ 3.8 Ga) impacts were so severe that some are calculated to have been large enough to cause the oceans to boil, thereby sterilizing the planet of any life except microbes existing deep underground. Fortunately, major impact events decreased after the Hadean period.

But Earth and its sister planets have continued to be bashed from time to time by asteroids and comets large enough to survive their plunge through planetary atmospheres. Because of Earth's dynamic geology, much of the evidence has been obliterated. However, one has only to look at the cratered surfaces of Mars and the Moon to see what Earth has endured.

Luann Becker and her colleagues first arrived at their impact theory for the Permian extinction a few years ago while examining ancient soils from Meishan, China. The soil samples were thought to have been laid down during the Permian-Triassic extinction. The Becker team found evidence of geochemical markers indicative of a severe impact event. Their results suggested it could have been the cause for the Permian-Triassic extinction.

The ensuing academic paper[1] brought both fame and notoriety to its authors. The results of the Becker team were not duplicated by other researchers and a Japanese scientist even claimed that some of the soil samples were improperly dated and not from the Permian-Triassic extinction boundary at all. But the Becker team stood by their research.

Last year, Becker et al claimed to have made another startling discovery—evidence of a giant impact crater off the north shore of Australia known as the Bedout High[2]. They tentatively dated the crater's age at 251 Myrs. The data for their conclusion came from analysis of core drilling samples accumulated by oil drilling companies. The samples once again included geochemical markers evidencing an impact. Was this the cause of the Permian-Triassic extinction?

Another spate of publicity ensued as the Becker Team sensed vindication. But criticism of their conclusions came quickly. Some claimed their geochemical markers could have resulted from non-impact causes. Some pointed out lack of coroborating evidence of an impact. (Where was the iridium layer?) Some once again questioned dating of the site.

951 Gaspra, a 20 x 10 km asteroid in the inner Asteroid Belt, 1.2 AU's from Earth. The Galileo Project, NASA

Then, early this year, a paper came forth authored by Peter Ward, Roger Buick, and others[3] documenting fossil evidence that the Permian extinction was not as sudden as had been supposed. Instead, it was most likely drawn out over hundreds of thousands of years and could have been caused by environmental degradation of volcanic origins. Ward's paper, like Becker's, has been criticized, but recently its extinction conclusion has been backed up by research involving fossil beds in China[4].

Regardless of whether or not an impact caused the Permian-Triassic extinction, it's tempting to speculate impacts have been involved in extinctions. An interesting peculiarity of mass extinctions is their periodicity. Analysis of fossil records shows they occur in regular cycles of 26 million years[5] and 62 million years[6]. Some researchers have posited this is due to extra-terrestrial phenomena causing perturbations of asteroids and comets. Phenomena such as our solar system's periodic passage through an exceptionally massive arm of the Milky Way, or influence from an unknown planet "X" with an exaggerated elliptical orbit cruising beyond the outer planets, an idea given credence by discovery this year of what might be the solar system's tenth planet—object 2003 UB313, larger than Pluto,

which is 97 AU's away, with a wildly eccentric and inclined orbit.

As the accompanying chart illustrates, there does appear to be a rough relationship between the periodicity of extinction events and known impact craters.

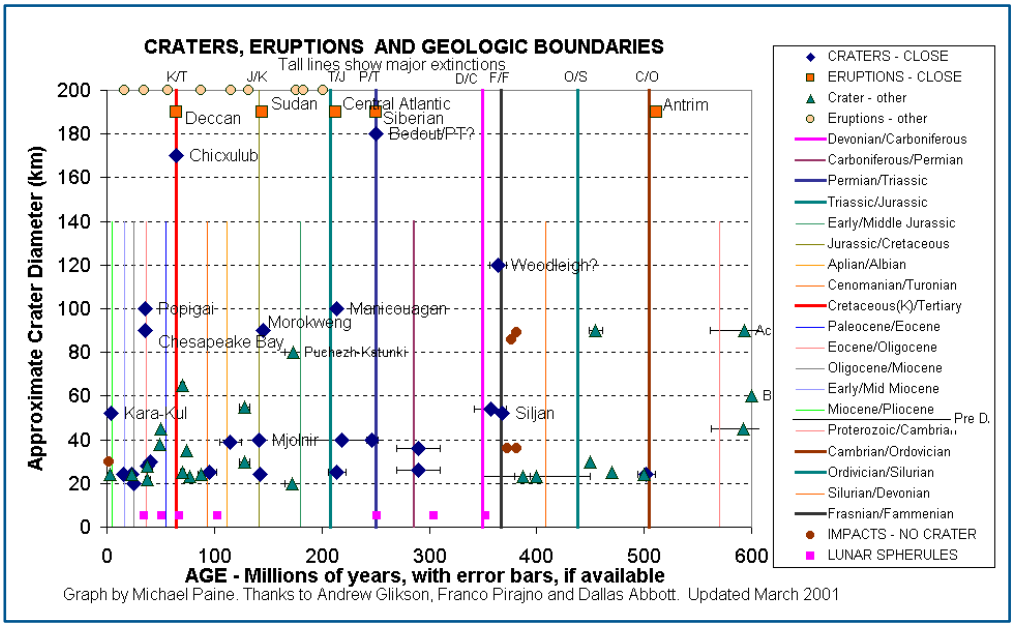
Certainly large impacts have occurred and will continue to occur . Plenty of impact ammunition is out there. Between Mars and Jupiter is the Asteroid Belt (2–4 AU's). Beyond Neptune (35–50 AU's), Kuiper Belt objects circle the Solar System. And way, way out there (50,000–100,000 AU's), is the Oort Cloud, home base for many comets. All that is needed for one of these objects to draw a bead on Earth is appropriate perturbations from a large gravitational body, such as a passing star or a planetary object. In addition, between Jupiter and Neptune are dozens of so-called planetoids astronomers term"Centaurs." These are asteroid/comet type objects such as 148 x 208 km Chiron. Centaurs are scary because anything that size would sterilize the planet. However, even bolides that are only one km (about one tenth the size of the KT asteroid) are considered significant threats to human life. And objects 10 km or more are believed to be full-blown extinction threats. Hence the activity seeking to identify large objects with potential Earth crossing orbits.

Since 1995, NASA has sponsored a survey program aimed at discovery of 90% of the one km or more Near Earth Objects (NEO). ('Near Earth' means having a perihelion of less than 1.3 AU's.) Over the past ten years, this program has uncovered 594 previously unknown NEO's. Most have been discoveries by NASA and U. S. Air Force funded GEODSS[7] telescope observatories in New Mexico and Hawaii—the Lincoln Near Earth Asteroid Research project (LINEAR) and the Near Earth Asteroid Tracking project (NEAT).

At present, there are approximately 710 known Potentially Hazardous Asteroids (PHAs). A PHA is an asteroid projected to intersect Earth's orbit and come within .05 AU's or less. That is, closer than 20 Earth-to-Moon distances, the distance considered too close for comfort.

None of the currently recognized NEO's or PHA's are an immanent threat. The most dangerous so far is a 1.1 km asteroid known as 1950 DA that is given a 1/300 chance of hitting Earth by year 2880. However, plenty of undiscovered objects are lurking out there with unknown orbits. Most astronomers agree there is an orbiting rock somewhere with Earth's name on it. But when and where will it arrive? And what do we do if we do find one on course for Earth? Blow it up? Nudge it off course? Direct it into the Sun? And if so, how? And who? And how much time will we have? Current thinking is that any NEO in the form of an asteroid will likely swing by many times before it actually hits. But what about comets with wildly eccentric orbits that may come at us from out of nowhere?

These are serious questions. Because one thing we do know for certain is that if a large extra-terrestrial object does arrive, Tyrannosaurus Rex is likely to have company.



Graph by Michael Paine. Thanks to Andrew Glikson, Franco Pirajno and Dallas Abbott. Updated March 2001

References and notes:

1. "Impact Event at the Permian-Triassic Boundary," Luann Becker et al, Science, Vol. 291 (Feb. 2001).
2. "Bedout: A Possible End-Permian Impact Crater Offshore of Northwestern Australia," Luann Becker et al, Science, Vol. 304, (Jun 2004).
3. "Abrupt and Gradual Extinction Among Late Permian Land Vertebrates in the Karoo Basin, South Africa," Peter D. Ward et al, Science, Vol. 307, (Feb. 2005). Also, "Repeated Carbon-cycle Disturbances at the Permian-Triassic Boundary Separating Two Mass Extinctions," R. Buick et al, unpublished.
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5. "Periodicity of Extinctions in the Geological Past," J. Sepkoski, Jr. et al, Proceedings of Natl. Academy of Sciences, Vol. 81, (2/1/84).
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7. GEODSS (Ground-based Electro-Optical Deep Space Surveillance) is a telescope designed for the Air Force to observe Earth orbital spacecraft.

In This Issue

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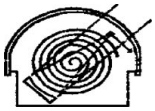
Attach graphics as separate files.
Include 'BPAA Newsletter' in subject line.



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