REFLECTIONS / REFRACTIONS

University Lowbrow Astronomers

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Kuiper Belt Objects and the Re-Organization of the Solar System

By Douglas Warshow

The article is the second of three parts covering Dr. Alan Stern's lecture on the discovery of Kuiper belt objects (KBOs) and their importance in the Solar System.

In the previous article, we saw how the KBOs form a numerically significant portion of our planetary system. Can the Kuiper belt tell us anything else about the Solar System?

Continuous study of the Kuiper belt shows that it possesses a dynamically complex system. In spite of the large average distance between any two KBOs, the occasional close encounters render any long-range **orbital** predictions useless. Any slight **error in determining** an object's position and/or velocity would eventually lead to vastly different results. Sure the KBOs are relatively small and (for the most part) far away from each other, but there are thousands of them and even small effects can add up given enough time.

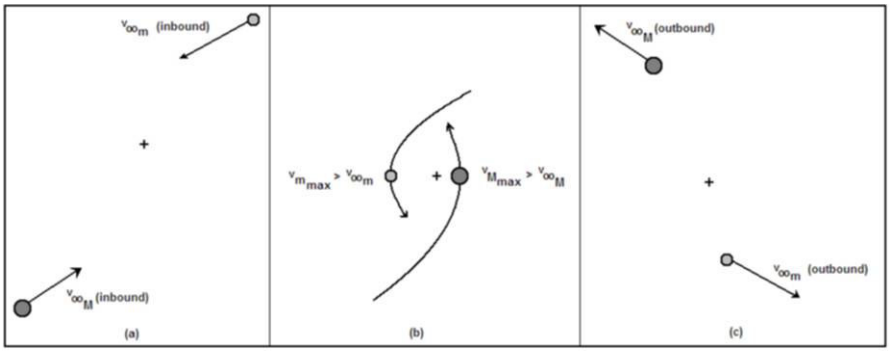
There are, however, some KBOs that do have predictable orbits. As an example, there are a number of them that orbit the Sun twice for every two times that Neptune completes **one** orbit. These particular objects are said to be in 2:3 orbital resonance with Neptune. (Incidentally, Pluto happens to be one of these objects.)

Now, before proceeding further, let me first present a small primer on one of the most abused concepts in orbital mechanics: the slingshot effect (otherwise known as gravity assist).

You may have either read or seen some instance in a "space opera" where the main character's ship is in orbit about some distant world. Some emergency then occurs, so the hero quickly responds by having his/her ship dive close to the planet's surface. Their "reason" for doing this is to increase speed so that they employ the "slingshot effect" to accelerate the ship to an incredible (literally) speed and break orbit. The hero then proceeds to save the day. And all of this takes place without using a drop of fuel.

Sorry, Defenders of Galactic Freedom, that's not how it works.

What the hero (and the author, I might add) does not seem to realize is that gravity never stops acting on the ship, no matter how fast the ship is moving. The same force that accelerates the ship on the inbound leg also decelerates the ship on the outbound portion.



(a) Bodies M and m approach each other.

(b) Gravitational interaction changes velocities of the two bodies. Each body attains its maximum speed at closest approach.

(c) Bodies depart, leaving with the same speed as they had before the encounter.

○ ~ Mass m

● ~ Mass M

\+ ~ System center of mass

$v_{\infty M}$ ~ Velocity at infinity of M

$v_{\infty m}$ ~ Velocity at infinity of m

v_{Mmax} ~ Maximum velocity of M

v_{mmax} ~ Maximum velocity of m

Figure 1 Two-body gravitational encounter.

Consider the scenario in Figure 1(a). Two bodies having masses *M* and *m* are moving through space with velocities $v_{\infty M}$ and $v_{\infty m}$, respectively, relative to the system's center of mass*. (The infinity symbol indicates that the body is far enough away for its velocity not to be **significantly** influenced by the gravitational field of any other mass.) As long as the velocities are not pointed directly at the center of mass, the bodies will accelerate until they reach their maximum velocities, v_{Mmax} and v_{mmax}, when they are at their minimum separation [Figure 1(b)]. Figure 1(c), shows (as described earlier), the bodies heading away from each other with the same speeds they possessed before they **first** encountered each other. Only their directions have changed.

How then does the slingshot effect actually work? The answer is to bring in a third body. Figure (2) shows *M* and *m* orbiting a more massive **body -** we'll call it the Sun to simplify matters. The body that orbits closer to the Sun will have the greater orbital velocity. Notice, in this case, that *M* and *m* revolve about the **Sun;** they do not revolve about each other. This means that the only base velocity they share is that of the Sun. The actual shapes of the respective orbits do not matter for qualitative purposes.

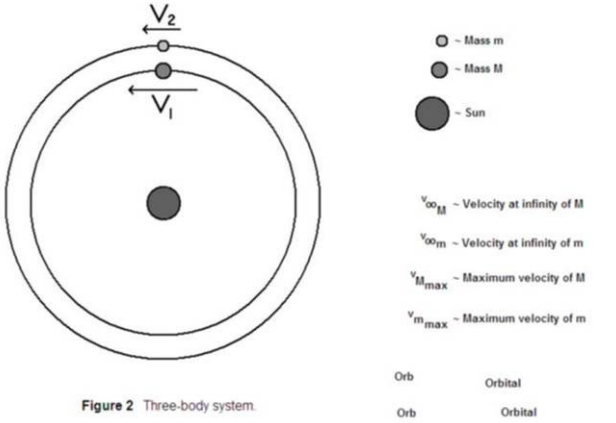


Figure 2 Three-body system.

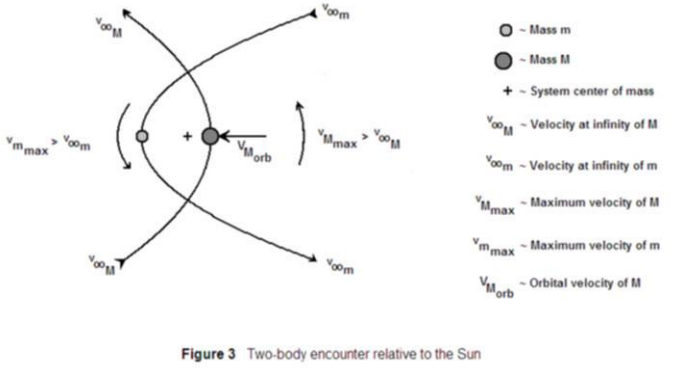


Figure 3 Two-body encounter relative to the Sun

Now examine Figure 3. It is generally the same as the combination of Figures 1(a), (b) and (c); but with one important addition: the orbital velocity of *M* (v_{MOrb}). If we were watching this encounter while floating with the center of mass, the paths would look exactly the same as in the case depicted in Figure 1. But since the center of mass is moving with relative to the Sun, we must add the system's velocity to the others. If M has a much greater mass than m (which we shall assume for the rest of this article), the system's orbital velocity is essentially the same as v_{MOrb}. This velocity will be added to $v_{\infty m}$ to arrive at a different outbound velocity.

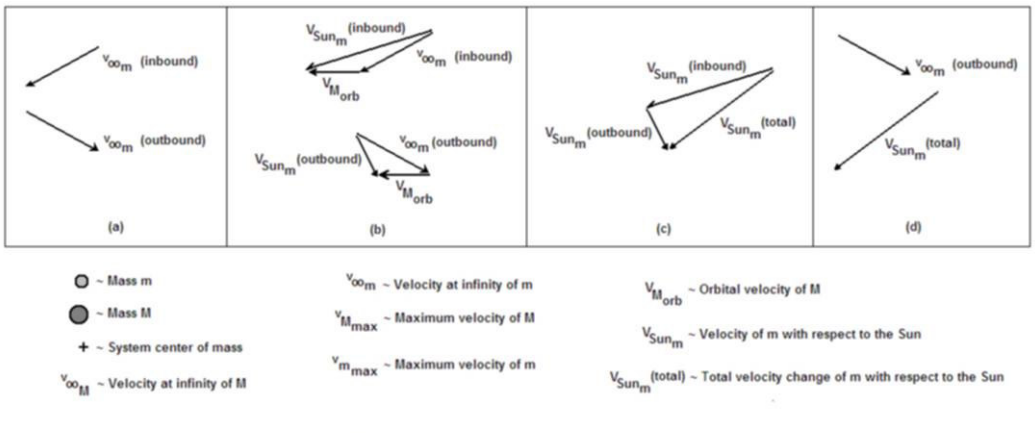


Figure 4 Velocity vector diagrams

Figure 4 shows the above two scenarios in terms of velocity vectors. Figure 4(a) shows the inbound velocities of $v_{\infty m}$ described in Figure (1). As before, only the direction has changed.

Figure 4(b) shows how adding** v_{MOrb} to $v_{\infty m}$ creates the inbound and outbound vectors of *m* relative to the Sun [V_{Sunm}(inbound) and V_{Sunm}(outbound), respectively]. The final result, V_{Sunm}(total), is shown in Figure 4(c). Figure 4(d) shows a comparison of vectors $v_{\infty m}$ and V_{Sunm}**(total).** Notice that V_{Sunm}(total) is the longer of the two. This is how the slingshot effect truly works.

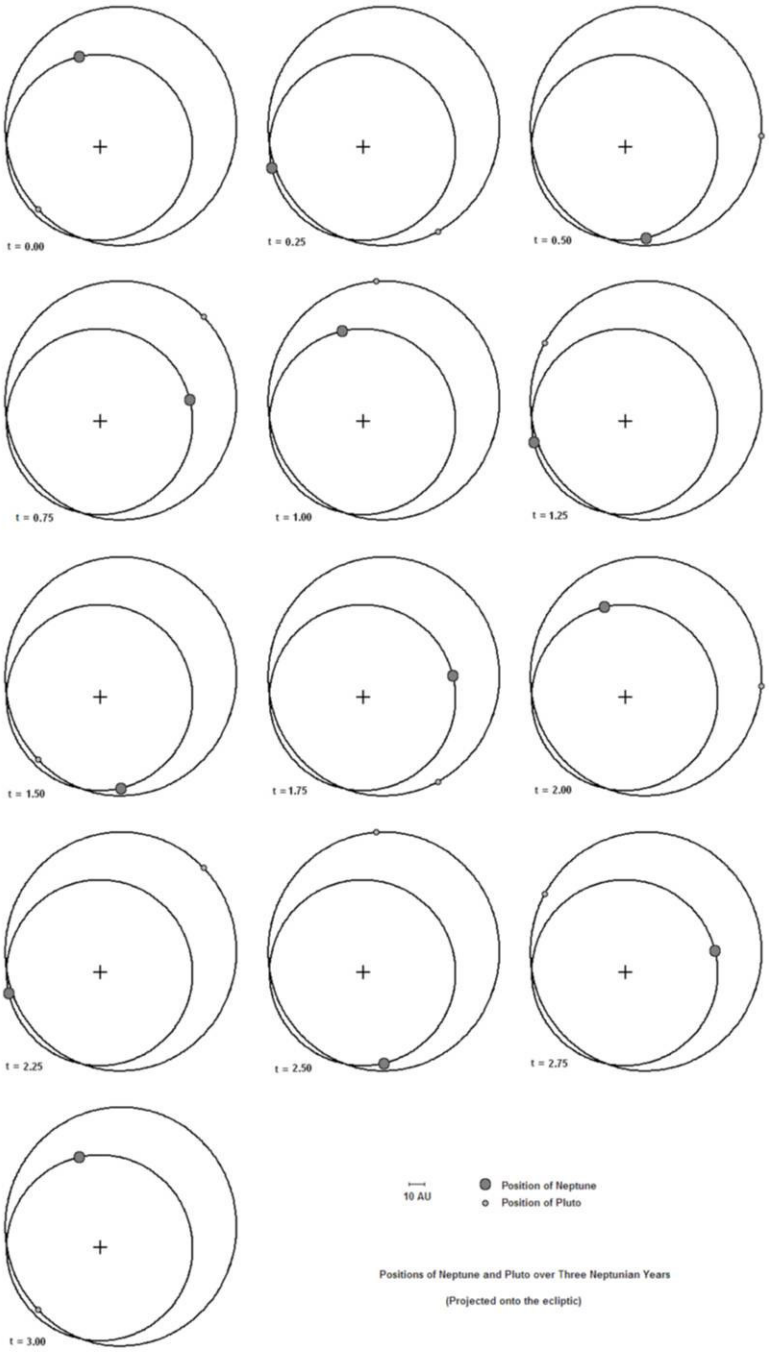
Two factors that determine the velocity change are the angle of approach of *m* (with respect to *M*) and how deep into *M*'s gravity well *m* enters. For instance, if m approached M practically head on and M's gravity caused m's path to turn 180°, m's new heliocentric velocity would be v_{MOrb} plus *two times* $v_{\infty m}$. Similarly, if m approached from M's trailing end, m's new heliocentric velocity would only be $v_{MOrb} - v_{\infty m}$.

Another important aspect of the slingshot effect: it does not actually provide a "free" boost; the increase in velocity of *m* comes at a cost of a **proportional** decrease in **the** velocity of *M*. Since the proportion is *m*/*M* and, as stated earlier, we're assuming that *M* >> *m*, the cost will be small. But it is not zero; this will be important later.

And now, back to our featured discussion.

Orbital resonance can have one of two effects on the less massive of two bodies experiencing it. First let's look at Jupiter and the asteroid belt. While you might think that the asteroid belt has basically smooth distribution of bodies within its region, there exist a number of gaps, almost akin to the Cassini division in Saturn's rings. (The Cassini division, though, is formed due to a different arrangement.) These depopulated areas are named Kirkwood gaps after their discoverer.

The Kirkwood gaps are created by Jupiter in the manner illustrated in Figure 4, though with Jupiter in the outer orbit. Normally each asteroid would only acquire a minor velocity boost from Jupiter. The Kirkwood gaps, however, mark the orbital regions that are in a particular resonance with Jupiter (2:1, 3:2, 3:1, etc.). So as they orbit, asteroids which start in those areas will receive repeated boosts from Jupiter at the same locations. Over time, the asteroid's orbit becomes more and more eccentric (i. e., elliptical) until the asteroid leaves the region altogether.



Pluto, however, resides in a 2:3-resonant orbit with Neptune and has obviously not been ejected. How come? As you'll see in Figure 5, Pluto is in an elliptical orbit (plus it is inclined with respect to the plane of the ecliptic) and is positioned such that it never receives **increasing boosts** from Neptune. **As a matter of fact, any** perturbations Pluto might receive would be corrected by Neptune gravitational influence. So, in a sense, Pluto is "locked" into this relation with Neptune. I suppose one could refer to it as an "anti-boost" resonant orbit.

Okay, you may be wondering, but what has all this to do with KBOs? Well, astronomers have found that the Kuiper **belt** is **also** non-uniform in its member distribution but, unlike the asteroid belt, the orbits that are resonant with Neptune are regions of **clustered bodies**, not **of** depopulation.

To figure out what would cause this scenario, several astronomers have run what are called N-body simulations; these are computer programs that calculate the velocities and distribution of multiple numbers of masses over time. (The "N" refers to some general number of bodies in the simulation.) In these simulations, the astronomers wanted to see what the effects on the KBOs would be if Neptune migrated away from the Sun. The result: as Neptune moved outward it actually collected KBOs in its resonant orbits and "pumped up" their respective eccentricities. By examining the degree of "pumping" at the 3:2 resonant orbit, the astronomers determined that Neptune's must have originally started off 9 AUs closer to the Sun than its present position. That difference is almost the **same distance as** from the Sun to Saturn.

So what would cause Neptune to migrate outwards?

According to theoretical any computer models, the early Solar System formed by the collapse of a proto-planetary nebula. Over the course of time, the nebula's gas and dust accreted to form larger clumps of matter called planetesimals. Although the majority of these worlds themselves accreted to become the planets, far more of them remained than the current sum of asteroids, comets and KBOs. The models did predict the existence of planetesimals beyond Neptune's orbit, but only in orbits that were nearly circular; these results run counter to observational evidence.

New models were created that took into account the planetesimals' gravitational influence on the planets. The results showed than when (on average) planetesimals possessed an angular momentum component perpendicular to the orbital plane greater than that of a planet, the planet would migrate outward. Similarly, when said component was less than that a planet, that planet would migrate inward. In fact, the models depicted the outward migration of Neptune, Uranus and Saturn and the inward migration of Jupiter.

The new models also show the cause of the non-circularity of the KBO orbits. As in the case of Pluto, Neptune can occasionally "lock" a body which is an orbit resonant with that of Neptune. As Neptune migrated outward, its resonant "zones" crossed the orbits of more planetesimals, some of which **were** also carried outward. (This process is called resonant dragging.) While this space regatta went sailing outward, resonance with Neptune kept adding energy to the captured bodies and, thus, increased their respective eccentricities. Since different planetesimals entered the different resonant zones at different **times**, a wide range of **orbital** shapes would be the outcome.

So the current KBO orbits act as "fossil" evidence for the past migration of the gas giant worlds. Once again the supposedly insignificant bodies have given astronomers a new view of the Solar system.

I should note, however, that a new puzzle has arisen from these simulations: the models predict that Neptune should have migrated farther than is evident. Apparently some depletion occurred at a distance of about 30 AUs from the Sun. No plausible explanation has been given as yet.

Next time: Alan Stern's discussion of Pluto, KBOs and their roles in regard to the controversial term "planet."

Note: Many thanks again to John Causland for providing me with a DVD of Dr. Sterns' lecture.

** In describing or analyzing a system of particles, it is always easiest to use the system's center of mass as the reference point. In a two particle system, if one particle has a non-zero velocity with respect to the center of mass, then so must the other in order to balance the system.*

***To add vectors, just place them together point to tip, without changing their lengths or orientations. Their sum is a vector that begins at the tip of the first vector and ends at the point of the last one.*

Okie, Tex and Chris Sarnecki (Chris is wearing the Lowbrow shirt) at OTSP 2009.

Chris presents his impressions of Okie-Tex '09, so read on!

Okie-Tex Star Party 2009 Report

By Christopher Sarnecki

The Trip…

Traveling from Ann Arbor to Camp Billy-Joe, in Kenton, Oklahoma (home of the Okie-Tex Star Party (OTSP)) is a 1,250 miles experience that many would ask why make this trip? Months earlier the e-mail buzz started amongst Lowbrows Mark Deprest, Don Foley, Nathan Murphy, Doug Scobel, Robert Wade, and a reluctant yours truly. I was won over by an opportunity to observe in skies reported to be darker than our other recent annual haunt at the Black Forest Star Party (BFSP) deep in the mountains of central Pennsylvania; and, a guarantee of no recent hurricane tracking over the observing field as we experienced at the last 2 of 3 BFSPs. Driving was a day and half experience. One has to overnight on the way, and I landed in the small town of Abilene, Kansas, home of the Dwight D. Eisenhower Library and Museum. No I didn't see it, I didn't have time, and I was driving. They say half the fun of traveling is getting there. My fun found me the next morning when I woke to find the weather was in a fowl mod. The clouds were laying on the ground and prospects for the first night's observing was not looking good. We all traveled separately to OTSP and eventually I caught up to Camp Lowbrow West already established by Mark and Nate on Saturday, the opening day of OTSP.

Day One and First Night Observing

When driving in the Oklahoma panhandle, one notices the driver of every passing pick-up waves to you as they go by; and, the expectation is you will do the same. Don't ask me how I know this, but I did confirm it with my fellow Lowbrows. So, when traveling in the Oklahoma panhandle, don't forget to wave. I landed at Camp Lowbrow on Sunday, at 2:00 PM, set up camp, had a beer, caught a bite to eat; and, made the scope ready for a night's Observat'n. Yes, you heard it right. I had a beer. OTSP is very laid back. Having a brew is not prohibited, just don't flaunt it and no one will bother you. The weather wasn't as billed by our previous Lowbrow OTSP veterans, but was still promising. Got the cool down fan going on the scope's mirror, and proceeded to collimating the scope. Now you can imagine that after driving half way across the country for a day and a half, that one wouldn't be at the top of your game. Well, that was me on the first night. The sky wasn't exactly cooperating either. A mix of upper level clouds and marginal seeing lowered our expectations right away. Someone decided to dial up **Jupiter**. The view of old Jove was incredible. "Best Jupiter ever seen", was the cry from the assembled Lowbrows. We witnessed Jupiter's belts as never seen before. The Great Red Spot was huge, festoons were numerous, mini belts were seen between the South Equatorial Belt and polar region; and, colors such as brown, terra-cotta, black, and green were displayed on the belts big and small. Definitely a peak experience. The sky closed down somewhere after midnight, and so did the Lowbrows.

Day two, Eye Candy, and beyond the Milky Way

Woke up the next morning late after a restful sleep on the ground only to find our clan ready to go to breakfast at the Kenton's 'Merc'. Kenton is the small town adjacent to Camp Billy-Joe and is reported to have a population of 26. The 'Merc' or Mercantile is the only business in evidence of operation in Kenton and serves as the local food store, restaurant, and family room for the community. The food was filling. So after breakfast, Mark, Robert, and I decided to go a mesa walk around the perimeter of Camp Billy-Joe. During this 3-hour scramble we witness strange geology (Hey, anybody seen my rock?), high mesa flora, and cow pies. Don't ask me how cattle get on top of these mesas, but obviously they can and did as evidenced by leaving their calling cards. Night two was shaping up to be better than the first night, but not the 'effing' darkness that I was promised. The assembled Lowbrows made ready their scopes. Before we new it, the darkness was upon us. Previously many of us expressed a wiliness to spend some quality time looking at some bright eye candy in addition to the usual faint fuzzies. I was ready to put to the test a new wide field eyepiece that I recently procured. So it made sense to start the evening in the Milky Way stream beginning in Sagittarius. OTSP is almost 37 degrees north latitude or about 7 degrees farther south than Peach Mountain. That puts those objects in the southern Milky Way that much higher in the sky for our viewing enjoyment.

After the sky was fully dark, **M8, the Lagoon Nebula** was first up. M8 is a massive dust/gas cloud and stellar nursery. As luck would have it, I was observing at the clearest, steadiest, darkest time this night would offer. The new eyepiece

easily revealed the Lagoon's famous dark lane. Completing the view was a generous sprinkling of stellar jewels from the embedded open star cluster **NGC 6530**. One didn't have to try to imagine the nebulosity surrounding the dark lane, as is often the case on Peach Mountain; the cloud formation was obvious. Next up was **M20, the Trifid Nebula**, like the Lagoon, the Trifid was visible to the unaided eye in the night's sky. In the telescope with the wide field eyepiece, observing at Okie-Tex, the view was heart stopping. The name Trifid comes for the dark nebula **Bernard 85** which subdivides the nebula **NGC 6514** into three, no four divisions. The Open Star cluster **Collinder 360** is superimposed next to the nebula and completes the view. The view of the cloud nebula in both M8 and M20 was like a black-and-white photo. The effect was 3-D.

Intermission: Today's beer is brought to you by me, but made by New Belgium Brewing, Fort Collins, CO. (Note to self – Best brew tour ever, must go back again). ***Abbey*** *Belgian Style Ale – Sweeeet Belgian sourness and carmelishiness, Mmmm, I'll have another.* ***1554*** *Black Ale – Refreshing smoky darkness w dry notes.* ***Hoptober*** *Golden Ale – Crisp fruity goodness, Looooong dry ending (that's good by the way).*

At the OTSP or Black Forest Star Party, skies are so dark you can see nothing at all. I'm talking about dark nebula here. Dark nebulas are dust/gas clouds that are positioned in front of background star fields from our viewing position. Appearing like a hole in space, dark nebula block out the star light from stars behind them. The best place to look for these objects is in the southern Milky Way sky. The **M24 Scutum Star cloud** is a vast bright, and dense star field forming a bright knot in the southern Milky Way. Two dark nebulas, **Bernard 92 and 93** are located on the north side of this star cloud. Easily seen at OTSP, but one really has to use your imaginary seeing to view these objects at Peach Mountain or even Hudson Lake.

Next up were some paired objects. In Sagittarius the 9th magi globular cluster **NGC 6440** is paired with the much fainter 11th mag planetary nebula **NGC 6440** in the same wide field view. In the dark OTSP skies, the planetary looks almost as large as the globular even though the glob is listed about four times larger. Another pair is located near M11, the Wild Duck Cluster in Scutum (Yea, I thought M11 was in Aquila, but it's in Scutum). The 8th mag globular **NGC 6712** shares the same field of view with the very dim 12th mag planetary nebula **IC 1295**. The OTSP skies help us out in locating this faint planetary.

In preparing for this star party, I was reading on the Skyhound web site (www.skyhound.com) and noticed a misplaced object on the March Deep Sky listings. The 13.8 mag **Quasar PHL 1811**, located in Capricornus and is a fall object, not a spring one. Well I thought, why not try this one. Armed with the fine star chart from Skyhound, I found this one too easily. Imagine, the look back time on this object is 2.4 Billion light years. That's more than half the age of the Earth. As the night wore on, Lowbrows and others were dropping off the observing field and falling into slumber land. About 3 AM, Nate Murphy shuts down his scope and I'm thinking I'm observing alone. Nate comes over and inquires what's next on my list. Well, **NGC 1049**, the extra-galactic globular cluster in the Fornax dwarf galaxy has been on my observing list for way too long. Time to dial this one up. Even at the OTSP's 37 degrees north latitude, this object would be grazing in the grass; no, make that "grazing in the rocks" as Nate indicated. Using a photo from a Sky & Telescope October 2002 article, we managed to bag this one, but had the share the field of view with rocks on the mesa behind Camp Billy-Joe. As the night wore on, it was getting time for last call. The Skyhound site had another quasar listed. **Quasar MSH 04-12** is a 14.9 mag pinpoint in Eridanus that's 4.9 Billion light years away. It also happens to be near the fine Planetary Nebular **NGC 1535**, also known as Cleopatra's Eye. Observing this planetary at high power will reveal the 'eye' and some late night eye candy. Quasar MSH 04-12 wasn't a cakewalk, but with the combined skills present, we found it. Nate - Thanks for hanging with me on this one! Wow, 2 quasars and an extra-galactic glob in one night!

Third Night Observing challenge

At a major national star party you never know whom you'll be running in to. Waiting in the dinner line, I had a change to talk with Al Nagler, (or 'Uncle Al' as he affectionately known) of Televue fame. Robert Wade and I noticed Dave Kriege of Obsession Telescopes setting up a prototype 22-inch Ultra Compact scope behind Camp Lowbrow in order to use the distant Mesa as a background for a photo shoot. Later that evening after the Lowbrows decided not to set up scopes due to the questionable weather, we had the opportunity to spend a significant amount of time observing with Rick Singmaster of Starmaster Telescopes. That night found the Lowbrows sitting around the camp bemoaning about

the lack of stars and clear skies. We decided to take a walk around Camp Billy-Joe and see if anybody had scopes set up. As luck would have it, a couple of new fast focal ratio scopes (f/2.55 and f/3.3) where set up in the Starmaster Telescope camp. The sky did manage some sucker holes on and off for a couple of hours, so we hung out with Rick and used his scopes. The final observing opportunity can at Jim Lawrence's camp and looking through his fine 6-inch binocular scope. I have never had good luck viewing through bino viewers, but this Jim's binocular scope the view was a show stopper. Jupiter was 3-D. The Double Cluster was dazzling. I understand Mark Deprest went back the next day to get some pictures of this amazing scope. Perhaps we will see them at the next club meeting.

Too soon my time at OTSP was up and I had to leave Camp Billy-Joe to return to reality (darn ☹). The buzz has already started amongst the Lowbrows about returning to OTSP next year. I hope to return and get my dark sky fix yet again. If you think you need the same, then you too should make OSTP next year's destination. It is schedule for October 2nd thru 10th, 2010.

Okie-Tex Star Party Experience

By Donald R. Fohey

My wife and I attend the Oklahoma Texas Star Party near Kenton Oklahoma this year. It was a very interesting experience. Amateur astronomers of course go to such events for dark sky observing. However the distance from Michigan and the duration of the event provides experiences beyond just observing the skies.

The journey is part of the adventure. Many who enjoy road trips drive the 1260 miles in two days. A big long drive of 800 miles or so the first day and a long drive of 400 miles or so the second enjoying the roadside scenery along the way. We pulled a pop up tent camper and chose to set up camp before dark each day.

The first stop was Springfield Illinois where we spent three nights. Springfield is a delightful tourist destination where we spent our time visiting the Lincoln Museum, Lincoln Home, New Salem Village, the Dana Thomas Frank Lloyd Wright home, and the Lincoln Memorial. Springfield is highly recommended if your itinerary can spare the time. Driving some 500 Miles the next day put us at I-70 exit 244 and the Sundowner RV Park. The last day we drove 355 miles on route KS 156 which is the most desolate highway I have ever driven. That desolation although not beautiful is very interesting and we never were bored but were continually amazed by the miles of unusual landscape. Lunch at the infamous Dodge City gave a new perspective to the old west.

We arrived at Okie-Tex about 5pm and were surprised to see that most of the fields were occupied! Many thanks go to those early arriving Lowbrows who had selected a section of the field on the north edge with lower horizons. They had saved room for us to set up our tent camper. The lesson learned is that if you have a group who you want to be together you must have early arrivals to stake your claim!

The camp is well organized with power distributed for telescopes, roads marked in chalk and porta johns distributed throughout the grounds. The fields were newly mowed which in our new section of the filed provided for chopped up cactus all over the ground.

The permanent facilities provided showers, restrooms, water and accommodations for the kitchens and vendor tables. A large tent provided space for eating meals and attending lectures.

Despite the remote and desolate location of the Okie-Tex party, there is plenty of sight seeing and activities in the area. My wife and I were busy every day. We visited Black Mesa State Park, Picture and Carrizzo Canyons, drove the Dry Cimmaron Valley looping back through Clayton New Mexico. We hiked part of the trail to the Back Mesa summit. We walked into Kenton, visited the Kenton Mercantile, the Kenton Museum and hiked up the ridges around the campground. Some of the best times were spent in camp with fellow Lowbrows sharing astronomy information, stories and beverages. It was indeed a time to relax away from the bustle of everyday life

I enjoyed observing galaxies, planetary nebulas, and dark nebula that I had never before seen. The observing evenings, after waiting all day for sunset, went by so fast! It seemed that after only a few objects were located and sketched it was midnight and a trip to the red lighted cosmic café was welcome. Star hopping was fun because I could see stars not normally visible to me. My wife, not an amateur astronomer, found the evenings difficult spending time in the camper reading with only a red headlamp which she considered, with a smile, cruel and unusual punishment.

Walking the grounds and visiting the owners of other telescopes was very rewarding. I wish I had spent more time visiting with other astronomers as all were very interested in sharing their ideas and experiences with me. It seemed being in such a remote location together made everyone eager to be friendly and all seemed to revel in the comradery of being at Okie-Tex. The lectures were interesting and I would like to have attended more of them. We had planned to leave Friday morning missing the Friday and Saturday lectures. Next time, with a limited amount of time, I will come late and stay for the last weekend and miss the first weekend.

The skies weren't as good as I had hoped for. The combining of two low pressure systems in the Gulf produced a ccw rotating weather pattern which brought us winds from the East with clouds and moisture. I would like to experience the dark skies that Okie-Tex is famous for so I will attend again, just not sure when. Okie-Tex is a unique and interesting experience for those who can commit to the time and distance.

We continued our trip into Colorado which was only a short day's drive. We stayed until cold and rainy weather forced us down out of the mountains and we returned home.

Above: Al Nagler of Televue, John Joseph of Starlight Instruments and Rick Singmaster of Starmaster Telescopes with a 22" f/3.3.

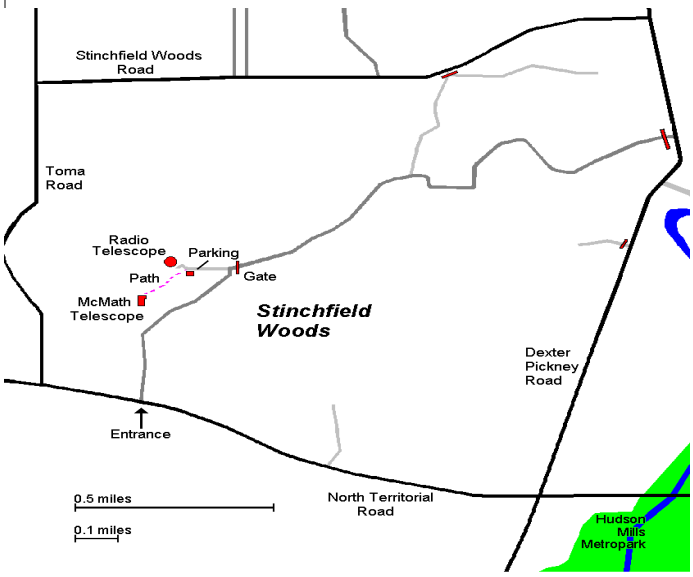
Right: Dave Kreige of Obsession Telescopes with a 22" UHC f/4.2.

Some of the biggest names in Amateur Astronomy come to the Okie-Tex Star Party to test and show off their latest!

Places & Times

Dennison Hall, also known as The University of Michigan's Physics & Astronomy building, is the site of the monthly meeting of the University Lowbrow Astronomers. Dennison Hall can be found on Church Street about one block north of South University Avenue in Ann Arbor, MI. The meetings are usually held in room 130, and on the 3rd Friday of each month at 7:30 pm. During the summer months and when weather permits, a club observing session at the Peach Mountain Observatory will follow the meeting.

Peach Mountain Observatory is the home of the University of Michigan's 25 meter radio telescope as well as the University's McMath 24" telescope which is maintained and operated by the Lowbrows. The observatory is located northwest of Dexter, MI; the entrance is on North Territorial Rd. 1.1 miles west of Dexter-Pinckney Rd. A small maize & blue sign on the north side of the road marks the gate. Follow the gravel road to the top of the hill and a parking area near the radio telescopes, then walk along the path between the two fenced in areas (about 300 feet) to reach the McMath telescope building.



Public Open House / Star Parties

Public Open Houses / Star Parties are generally held on the Saturdays before and after the New Moon at the Peach Mountain observatory, but are usually cancelled if the sky is cloudy at sunset or the temperature is below 10 degrees F. For the most up to date info on the Open House / Star Party status call: (734)332-9132. Many members bring their telescope to share with the public and visitors are welcome to do the same. Peach Mountain is home to millions of hungry mosquitoes, so apply bug repellent, and it can get rather cold at night, please dress accordingly.

Membership

Membership dues in the University Lowbrow Astronomers are $20 per year for individuals or families, $12 per year for students and seniors (age 55+) and $5 if you live outside of the Lower Peninsula of Michigan.

This entitles you to the access to our monthly Newsletters on-line at our website and use of the 24" McMath telescope (after some training).

A hard copy of the Newsletter can be obtained with an additional $12 annual fee to cover printing and postage. Dues can be paid at the monthly meetings or by check made out to University Lowbrow Astronomers and mailed to:

The University Lowbrow Astronomers

c/o Liz Calhoun

P.O. 4465

Ann Arbor, MI 48106

Membership in the Lowbrows can also get you a discount on these magazine subscriptions:

Sky & Telescope - $32.95 / year

Astronomy - $34.00 / year or $60.00 for 2 years

For more information contact the club Treasurer. Members renewing their subscriptions are reminded to provide the renewal notice along with your check to the club Treasurer. Please make your check out to: "University Lowbrow Astronomers"

Newsletter Contributions

Members and (non-members) are encouraged to write about any astronomy related topic of interest.

Call or Email the Newsletter Editor: **Mark S Deprest (734)223-0262 or msdeprest@comcast.net** to discuss length and format. Announcements, articles and images are due by the 1st day of the month as publication is the 7th.

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Lowbrow's Home Page

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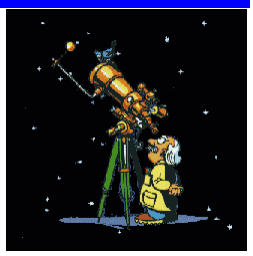
Reflections & Refractions



Website
www.umich.edu/~lowbrows/

Okie—Tex Star Party 2009 taken by Don or Jan Fohey. The Lowbrows in attendance at this one were Don & Jan Fohey, Nathan Murphy, Robert Wade, Doug Scobel, Chris Sarnecki and Mark Deprest. There are two articles in this issue and at the October Lowbrow meeting there will be a presentation of pictures and stories from some of the names listed above!

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Check your membership expiration date on the mailing label