Observatory Update – Special Edition, by Rick Johnson

It's not often an amateur observatory gets to correct the astronomical literature but it appears my little project of imaging in color the Arp galaxies I can reach from my latitude apparently got the ball rolling to do just that. Early astronomers only had their eyes and thus were often fooled. Many NGC objects are just stars for instance, Mars canals don't exist nor does Vulcan. Photography helped eliminate the errors but if you don't take a second image they can lead you astray as well. This happened to Arp with his 192nd entry. Time on the 200" was difficult to come by and his project ate up a lot of it. It appears he rarely if ever, was able to take two images of his objects. But many other images of Arp 192 have been taken since yet no one seems to have noticed the main feature of the galaxy pair doesn't exist! Well it does but not as Arp and others using his image thought. This will be a long post as the story is rather long. I'll start with the basics as Arp and others saw them.

ARP 192 NGC 3303, two interacting galaxies with a huge tidal spray. Arp classed it in his category, Galaxies (not classifiable as S or E): Narrow filaments. Indeed his often reproduced image shows a great jet or spike that probably caused it to be put in this classification. Also notes at NED say things like: "Very peculiar spiral with a compact companion and a spike. Very faint outer extension." and "Main body 0.5 x 0.4 with stellar companion superimposed, loop + sharp jet, enormous irregular plumes." Arp said; "Diffuse faint arms off both sides, spike comes from stellar companion." Here's his image a bit reduced and converted to a positive print.

There things stood for 46 years until I imaged it and had a "What the #&*@" reaction looking at my image and comparing it to Arp's. Others, including Sloan had imaged it but somehow overlooked the obvious. Here is the above image overlaid on my image as it switches back and forth between the two images.

The famous spike doesn't exist! Over all these years and references to the spike no one seems to have noticed! I was sure my image would have shown it if it did exist. I find imagers saying that it apparently is below their resolution ability. But the SDSS image is of sufficient resolution and it doesn't show it yet no one noticed that I can find. Still my image goes as deep and does have about the resolution of Arp's image yet there's not even the slightest hint of the jet. Galaxy sized events don't vanish this quickly.

This is where things stood for a while. I put out a few feelers but nothing came of them. Finally I blindly emailed one of the contributors to the Jeff Knipe and Dennis Webb book on the catalog who contacted the authors. The best suggestion we could come up with was that it was an asteroid but to confirm that we needed to know the exact date and time of Arp's image. Then it would take a special request of Brian Marsden of the Minor Planet Center to run known asteroids for that date. This wasn't an easy task. But despite a Cal Tech librarian's best efforts Jeff Knipe managed to get the date and Marsden confirmed the spike is really asteroid (84447) 2002 TU240. It wasn't discovered until 2002. Problem is the trail is atypical on Arp's image of what you'd expect an asteroid would create. Still, the position matches and given the weird characteristics of 103 emulsions this can happen when a moving object is seen over a galaxy. Brian Skiff suggests reciprocity as the reason. I disagree in a way. With 103a emulsions I used true reciprocity is a time thing. When first hit by light the film is "fast" but slows down as

further photons hit that part of the film. Since the asteroid is moving I don't agree that's what's happening here. I've used 103a emulsions and they have another effect. They can be sensitized by flashing with light prior to exposure. This is a very sensitive process. Too much and it fogs the film, too little and no effect. Getting it right is difficult and temperature sensitive. I used to use the process so am well aware of it. I think the trail peters out away from the galaxy because the galaxy itself "flashed" the film. The trail appears slightly curved but this is due to an illusion since the trail is stronger on the side with more "flash" from the galaxy. In any case the literature will need to be changed and a footnote added to Arp's catalog. Even though I only got the ball started it was a fascinating experience.

Below is the email I received from Jeff Knipe. Since then I've learned from him that this will be announced at the January at the AAS meeting.

Dear Rick,

Dennis Webb first brought to my attention your observation of the curious incident of the galactic spike that did not appear in Arp 192, and so first off, we greatly thank you. I apologize for not getting back to you sooner. An answer, however, was not readily forthcoming, as you will appreciate. It has taken a lot of footwork and image processing, not a little computation and measuring, and some serious archival mining-in fact, all the way back to Arp's original observing log. But we now have an answer as to why this feature appears to have vanished. It was an asteroid, minor planet (84447) TU 240, in fact. According to Brian Marsden of the SAO, it was discovered by NEAT from their Haleakala site on 6 Oct. 2002. It is not an NEO but a main-belt asteroid with a = 2.5 AU, e = 0.02, i = 10 deg. Prediscovery observations of this asteroid have been noted in 2000 (Catalina and LINEAR), as well as a single ESO image on 1 Mar. 1992. But, according to the digitized log book of Arp's Atlas observations (and just locating this took nearly a month) the Atlas image, taken on 19 Feb. 1964, is the earliest known prediscovery image. It is astonishing that for forty-five years, this feature was thought to be part of the structure of this peculiar galaxy. You may be pleased to know that I sent Chip a note congratulating him on discovering an asteroid. He was very much interested in this little mystery, but I think he was hoping for a more exotic outcome.

Many of the astronomers I discussed this with (and there were at least ten) considered that the spike might be an asteroid, given 192's position near the ecliptic plane. But others argued that it did not look like an asteroid track, in that it appears to fade at its greatest distance from the galaxy, which is more characteristic of a bridge or tidal tail, and appeared slightly curved. All agreed, however, that, since the feature no longer exists, it couldn't be something intrinsic to the galaxy. At that distance (90 Mpc), its length would have to be on the order of many kpc, and a structure like that wouldn't evaporate within 45 years' time. Because the spike looked like something other than an asteroid, some astronomers speculated that it could a flaw in the emulsion or some sort of artifact. Had it been any of the latter, we would have had to examine the original plate. Fortunately, we did not have to do that because the original plates cannot be located. According to Chip, they should be locked in a steel vault in either the basement or attic of the Carnegie

Observatories' office in Pasadena, but apparently they are not there! This is another mystery.

Brian Skiff suggests that the fading of the trail is what you might expect from reciprocity-failure in the emulsion, which makes sense given that the asteroid was in retrograde, thus its track began over the galaxy when the emulsion was fresh and "petered out" northwest after 40 minutes when the emulsion grew "tired." Some of the spike's apparent structure, too, could have come from emulsion effects. The trail is stronger while it is on top of the galaxy simply because the galaxy (or the galaxy + asteroid) has bumped up the background and hence the track has greater density.

The slight curvature is more problematic. Skiff thinks it may be due to field rotation, something you are, no doubt, very familiar with. If the guide star is on the edge of the field (the one at the bottom of the Arp plate is V = 15.09 and would have made a tempting guide star), the center of the field ends up rotating a bit during a "perfect" exposure. It could also be due to a slip in the guiding using the slow-motion buttons on the hand paddle. But I cannot believe Arp would be so slipshod in his guiding. (After all, Arp learned everything he knew about long-exposure guiding from none other than Walter Baade!) It is my belief that the slight curve is an optical illusion caused by the fizzled out track "blending" with background stars and/or other sources. If you look closely at the image with a magnifying glass, you can actually see where the dark track transects the bulbous part of the galaxy. If you lay a ruler across the whole thing, the track is straight.

Below is the daily ephemeris of where this asteroid would have been at the time the image was made. It was prepared by Marsden.

(84447) a,e,i = 2.52, 0.02, 10 Elements MPO143061

Date TT	R. A. (2000)	Decl.	Delta	r	Elong.	Phase	V
1964 02 17	10 38.90	+17 46.5	1.499	2.476	169.1	4.3	19.0
1964 02 18	10 38.06	+17 56.2	1.498	2.476	169.8	4.1	19.0
1964 02 19	10 37.22	+18 05.8	1.497	2.477	170.3	3.8	19.0
1964 02 20	10 36.36	+18 15.3	1.496	2.477	170.7	3.7	19.0
1964 02 21	10 35.50	+18 24.8	1.496	2.477	171.0	3.6	19.0

The coordinates given in the Atlas for Arp 192 are: 10 35.4 +18 17. Very close indeed, considering Arp's coordinates are epoch 1970.

There's a lot more I could tell you about this adventure-the frustrating searches for archival images, the librarian at Caltech who couldn't have cared less, the many iterations of image processing, and the back-and-forth discussions I had with Dennis and all the astronomers, but that would make for a long email indeed. You may congratulate yourself on noting that something was (literally) amiss and thus contributing to galactic literature. Thanks to your keen observation, all the catalogs will now have to be updated! I have proposed presenting a poster paper on this at the upcoming American Astronomical Society meeting in D.C., and Brian and I have also discussed writing a

joint paper for either *The Observatory* or the *Journal of Astronomical History and Heritage*, but all this remains to be seen. If nothing else, resolving this mystery was enough fun for me!

If you have any other questions, please do not hesitate to contact me or Dennis.

Sincere regards,

Jeff Kanipe
http://www.cosmicconnectionbook.com/index.php
http://www.willbell.com/HANDBOOK/arp.htm

The galaxy pair appears to be about 300 million light-years away. Both galaxies are classed by NED as Sb which seems a bit surprising as well.

There are two fuzzy patches east and a bit below Arp 192. I see the first barely showing in the SDSS image, the bigger and brighter one further east is out of that frame. If not for the SDSS image I'd have thought these some sort of reflection. I get them occasionally but they look somewhat different than these. I still don't know if they are real or not but suspect they are. I can't find any identity for them however. Are they tidal pieces from Arp 192, separate galaxies of some sort or galactic cirrus? I just don't know. They are in no catalog I can find.

There is a galaxy cluster of about 15' diameter in the image, ZwCl 1034.8+1820. It is centered about 1 minute NE of the brightest star SE of Arp 192. Few galaxies are there but there's one clump to the NE of this position and another below it running off the bottom of the image. A scattering of galaxies connects the two regions. This may be the cluster. It is listed as having 103 members but no distance.

The very blue galaxy just north of the star is CGCG 094-098 at 300 million light-years. Even though this area has been covered by the SDSS nothing else in the image has a distance estimate.

It's quite ironic (though not unexpected) that my image shows two asteroids both with about the same inclination as Arp's "spike". This is because Arp 192 lies well within the asteroid belt's position in the sky. The bright one is (11031) 1988 RC5 at magnitude 18.1. The dim one above and slightly right of it is (114750) 2003 HP40 at magnitude 19.2 That's a bit dimmer than the predicted magnitude of Arp's misidentified asteroid.

Prior to his catalog Arp was a "normal" astronomer who followed the main path that red shift was a distance measurement, newly discovered QSOs were distant objects, the big bang happened etc. But after the catalog he changed. It appears the change was due to his idea that some peculiar galaxies, those in the middle of his catalog, were likely ejecting material including QSOs. He slowly changed to what most would likely call a "crackpot" astronomer throwing out virtually all his basic beliefs and replacing them with his rather unorthodox views. I can't help but wonder how much this particular "spike"

might have played in this "conversion." Would his change of course even happened if he knew this was an asteroid? How would his future have been changed if he'd just taken a second image to confirm it? Maybe not at all. But I can't help wondering.

SDSS http://cosmo.nyu.edu/hogg/rc3/NGC_3303_UGC_5773_ARP_192_irg_clean.jpg
Arp's image with the false "spike":
http://nedwww.ipac.caltech.edu/level5/Arp/Figures/big_arp192.jpeg

14" LX200R @ F/10, L=8x10' RGB=2x10'x3, STL-11000XM, Paramount ME

All this brings up the question; Did I discover an asteroid by not imaging it when I didn't intend to image it in the first place?