The View From Arunah

Arunah Hill Natural Science Center

Summer 2000 The Journal of the Arunah Hill Natural Science Center, Inc. Volume 30

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Summer 2000

Front Cover: A new picture of the summit landscape taken at the June observing session.

Regular Sections

Pictures from last month, Arunah Hill hosted The Astronomical Society of Greater Hartford. The weather was a 10 that evening!

Mt. Tom (center of picture) 35 miles away!

Summer 2000 Arunah Hill Calendar: July-Aug-Sept activities at Arunah Hill and a map with directions to Arunah Hill is on the back of the calendar. Stick it up on your refrigerator.

Articles

Foucault Tester Part 1: So What Is A Foucault Tester, and Why Might I Want One, Anyway?

Amateur Telescope Making

by Brad Vietje

Many people start making their own telescope mirror, and everything goes along smoothly until they have to build a knife-edge tester to evaluate the curve they have imparted on the mirror. Some persevere, and go on to produce a very nice telescope, but most are confused, and many intimidated by the prospect of building one of these devices. The project is set aside, often for years; some are never completed. I had just this sort of experience as a teenager years ago, and only finished the mirror in 1998. Had I known how easy it is to build a tester described on the following pages, I would have finished my first mirror 20 years earlier. Many thanks to Ken Slater for his excellent article, which will appear in our next (Fall) issue of "The View from Arunah".

Making a telescope mirror consists of 5 steps:

1. Deciding the aperture and focal ratio desired (and thus, the focal length).
2. Rough grinding.
3. Fine grinding.
4. Polishing
5. Figuring or Parabolizing

In steps 2 and 3, a spherical curve is generated (not as hard as it may sound) and smoothed buy finer and finer abrasives. The mirror is tested by rather crude, but effective means, and no tester is needed. In step 4, the surface of the mirror is polished to remove any residual pits from the grinding process, but the curve is still a sphere. Toward the end of step 4, and for all of step 5, a Foucault tester is a must.

A knife-edge tester is a device for the precise evaluation of your mirror surface. It gives the illusion of seeing your mirror illuminated from the side, with every bump or scratch greatly magnified so as to cast shadows, much like looking at a snow-covered surface at sunset. This image is called a shadowgram. With some practice, you can see a lot of detail about your mirror, and use this information to correct the shape of the curve to produce the elusive parabola.

The most common type of knife-edge tester was invented and improved by Leon Foucault, so it bears his name; I am taking the liberty of using these terms interchangeably. Foucault testers are very simple in principle, but explaining the shadows seen is another matter. The tester consists of a light source, a knife edge, and an accurate way of measuring changes in position of the knife relative to the mirror. In practice, you look past the knife edge at the light reflected off the surface of your mirror to see a pattern of light and shadow. The apparent light will appear to come from the left if the knife edge is on the right, and vice versa. Assuming the knife is on the left, then, the apparent light will come from the right, and the resulting shadows will reveal any hills and valleys on the surface. A hill on the mirror would be light on the right and dark on the left, due to the illusion of side lighting from the right.

A perfect sphere looks flat in a Foucault test, no hills and no shadows. The parabola is a little deeper than the sphere in the center (shorter focal length), and a little flatter in the outer zones (longer focal length). As seen in the Foucault test, it looks like it has a slight depression in the center, and is turned down slightly at the edge, relative to the sphere. In our example, with the knife on the left, the outer ring will look on the left and light on the right, while the center zones will be light on the left, and dark on the right. The precise amount that the perfect parabola deviates from the perfect sphere depends on the focal ratio of the mirror. The knife-edge testing allows you to measure exactly how much your mirror deviates from a sphere, so you can achieve just the right shape, or figure. Very short mirrors (f/4 or f/5) deviate much more than longer mirrors (f/8 or f/10). By paying close attention to the shadows on your own mirror, you too can produce a beautiful parabola and study the sky with a telescope you made yourself. Ken and I have done it, what are you waiting for?

Coming in the Fall Edition: Springfield Telescope Maker Ken Slater will show us how to make a Foucault Tester. Look for it next time in the ATM section of “The View from Arunah”.

Twisting The Tail Of The Scorpion

The Observer's Notebook

by John Davis

One of the supreme glories of the summer sky is the ethereal glow of the luminous band of the Milky Way as it arches ever-higher with the advancing season. In previous columns, we have explored a number of its jewels soaring high overhead in and near Cygnus and Lyra. But now we'll turn our gaze southward past the center of our galaxy in Sagittarius, where the bulge of the heart of the galaxy has always, to this observer's eyes, resembled billows of smoke rising perhaps from some distant celestial campfire. Actually, we'll look at a few objects in Scorpius near the stinging tail of that celestial critter.

Despite their low southerly positions from our northern skies, two of these, M6 and M7, are magnificent open clusters, beautiful in binoculars and easily seen even with the naked eye on dark, clear nights. I vividly recall, as a young 13 year old in southern New Hampshire back in the 40's, marveling at their glittering beauty revealed only by 3x opera glasses, along with the Lagoon Nebula (M8) and others among those "smoky"celestial billows in Sagittarius. After spotting the "Cat's Eyes", 1.6 magnitude Shaula (Lambda Sco) and 2.7 magnitude Lesath (Mu Sco) marking the "stinger" at the tip of the Scopion's Tail, you can locate M6 just 5 degrees to the NNE, while the two stars practically point to the brighter and larger M7, less than 5 degrees ENE. Though recognized centuries later as star clusters, both M6 and M7 were known in ancient times, recorded in Claudius Ptolemy's "Amalgest" in the 2nd century, A.D. The descriptions roughly translate as "cloudy patches following the sting".

Shining at magnitude 4.2, **M6** is a gorgeous cluster of over 120 stars, popularly known as the "**Butterfly Cluster"**, as its several chains of magnitude 6 to 10 stars in somewhat parallel patterns seem to outline a butterfly's wings, with a small, delicate V-shaped pattern of magnitude 10 and 11 stars near the center as the antennae. Most cluster members are hot, blue-white B type suns shining from a distance of about 1500 light years; but look for one bright orange K type variable, BM Scorpii, ranging from 6th to 7th magnitude over about 850 days. It marks the eastern tip of the butterfly's wing. As it spans all of 33 arc minutes, you can enjoy M6 with either binoculars or rich field scopes, and larger apertures at low power will, of course, reveal still fainter stars and more detail.

Even back in those early years, the sight of **M7** in those tiny opera glasses was a thrill. As it is today, my impression of it then was as fine diamond jewels glittering on black velvet. Of course, today, more than a few observers will tell you the best view of M7 can be had with binoculars, either the standard size, or giant binoculars.

Veteran amateur Phil Harrington achieves a three-dimensional effect viewing this cluster with his 7 x 50's. Certainly an RFT, or any size 'scope at low power, even large aperture ones, will give you interesting glimpses of this fascinating array of over 80 stars shining at an overall magnitude of 3.3, and covering well over one full degree of sky. Studies have placed M7 at about 820 L.Y. from Earth, resting in front of a bright Milky Way star cloud at just over half the distance to M6. Though there are a number of fainter ones, the cluster contains 80 stars all 10th magnitude or brighter. In fact, much of the attractiveness of M7 owes to its stars' contrasting colors and brightnesses, ranging from about magnitude 5.5 to 10. The age of M7 is estimated at about 250 million years, more than twice that of M6, pegged at 100 million years. Thus you may notice more yellow G-type stars in M7, along with the blue and white ones, contrasted with the younger, predominately blue-white stars in M6. Some of the brighter luminaries of M7 stretch out in various directions from a rectangular central grouping that looks like a fat bow tie or an hourglass lying on its side. While enjoying the beauty of M7 in your scope, try to spot the faint 10th magnitude globular NGC 6453, just over 1/2 degrees WNW of the center of M7.

Now for a hop away from the tail, to the heart of the Scorpion and the red supergiant star Antares, our guidepost to a third Messier object in Scorpius, the superb globular cluster **M4**, lying just 1.3 degrees W of Antares and forming a triangle with it and 3rd magnitude Sigma Sco, 2 degrees WNW of Antares. Glowing at magnitude 5.8, and presenting a challenge because of the glare of nearby Antares, it can be glimpsed with the naked eye, as it frequently was by the late Walter Scott Houston, especially from the dark southerly skies of Central America and Florida. It was at a gathering at the Winter Star Party in Florida, as related in his recently released book "Deep Sky Wonders (edited by Steven O'Meara), that Scotty observed: "the huge ball of M4 is mighty impressive". Even from more northerly latitudes, medium to large apertures will bear this out, revealing magnificent views showing beautiful convex and concave chains of stars and resolving the cluster right to its core. The cluster spans a broad 26.3 arc minutes and, although definitely less luminous than a number of other globulars, M4 makes up for it by being probably the most easily resolved globular in the sky. Some observers have remarked that there is a distinctive scintillation effect, with its fainter stars popping in and out of view in front of the luminous background glow. Its easy resolution, even with small apertures, results from M4's rather unique position vying with NGC 6397 in Ara for first place as the nearest globular in the sky at between 5700 and 6200 L.Y., certainly far less than half the distance to "nearby" Omega Centauri, 16,500 L.Y. away! There is one very distinctive feature you'll see when you observe M4 in just about any instrument that sets it apart from any other globular cluster. This time, we'll let you discover just what this remarkable feature is when you train your scope onto this unique globular cluster; let us know what you see!

For a little more of a challenge, we'll drop back now to the "tail" and our "stinger" stars, the "Cat's Eyes", Shaula and Lesath, and from Lesath (Mu Sco) the westerly star of the pair, slide to the W 3 1/2 degrees, crossing over the upper of two vertically aligned 6th magnitude stars 1.2 degree apart, located just half way along that path. This should put you just about on top of **NGC 6302,** a neat little bipolar planetary nebula, aptly named the **"Bug Nebula"**.

After viewing those larger clusters, you'll see a marked contrast in this diminutive (83 x 24 arc seconds) magnitude 9.6 beauty, and it may remind you of a galaxy, with its subtle yet visible detail in medium or larger sized scopes; remarkable considering this object could be as remote as 5000 L.Y. A bright nebulosity covering its energetic, white hot central star is bounded on either side by two "wings" of fainter nebulosity, each showing bright knots. While the W end is longer and tapered, the E end is wider, showing a wispy tendril or two in larger apertures, overall somewhat suggestive of a figure eight in appearance. See also the photo of NGC 6302 on page 36 of the July 2000 "Sky & Telescope".

Backing up again to our "stinger" stars, we'll begin a starhop to two of our favorite asterisms, and jump just 3 degrees NNW from the stingers to find, evenly spaced, one 6th and four 7th magnitude stars tracing out over half a degree of the unmistakable outline of a **Hockey Stick**, sitting by itself on a somewhat darker spot in the Milky Way, in front of a large obscuring dust cloud. What is interesting about this figure, easily glimpsed in binoculars, is that the upper two stars of the hockey stick are involved in faint emission nebulosity designated NGC 6357, patches of what can be seen in scopes 10 inches and up using a narrow band (i.e. OIII) filter. The tiny open cluster Pismis 24 near the top of the handle of the hockey stick partially excites the glowing nebulosity.

Now, by moving 3 degrees NNE from magnitude 2.3 Epsilon Sco (9 degrees SSE of Antares) we'll come upon the delightful asterism that I call the **"Garden Trowel"**. Over a dozen 6.5 to 8th magnitude stars trace its form with the triangular, wedge shaped blade down and its slightly twisted handle a full degree to the NNW; possibly put there to dig out more celestial treasures, such as the globular cluster M62, 1 1/2 degrees NE of the "trowel".

Finally, we'll turn our gaze to what I believe is truly the "feature stellar attraction" of this part of the sky, a region at and just N of the 3.5 and 4.8 magnitude pair: Zeta 2 and Zeta 1 Sco, where from vertical, the Scorpion's tail turns abruptly east. It is called the "Table of Scorpius", named by John Hershel on his observing expedition in the 1830's after Table Mountain near Feldhausen in South Africa. Here is located the dazzling and spectacular "showpiece" open cluster **NGC 6231** among others including chains of stars and nebulosity. A number of years ago, on an eclipse trip to Baja, Mexico, the full grandeur of the region totally overwhelmed me as I gazed with 12 x 50 binoculars at the splendor and richness of the clusters and swirls of stars in the dark desert sky. Were it not so far south (-42 degrees declination), and therefore down into the atmospheric extinction near the horizon for northern observers, there would be little doubt that NGC 6231, shining at magnitude 2.6, would be ranked as one of the finest open clusters in the sky. It sits just .5 degrees N of Zeta 1 and 2 Sco, in a rather confined grouping about 15 arc minutes across and contains over 120 mostly blue-white O and B type stars including twenty O and B supergiant stars of exceedingly brilliant luminosity's ranging from 5th to nearly 9th magnitude in and scattered around the central grouping. When you consider their extreme distance of over 5900 L.Y., it becomes evident that were this cluster as near to us as the Pleiades, to which they've been compared, those O and B supergiants would blaze away as brightly as Sirius!

The dazzling gems in this cluster truly define it as the showpiece of Scorpius. One reason for this is that, along with NGC 6231, chains and swirls of stars lead from Zeta 1 and Zeta 2 N and NNE over two full degrees and include another wide and rich cluster **H12** (or Tr 24). These stars are known as the Scorpius OB I Association of which NGC 6231 forms the core. The more widely spread members of the H12 cluster are immersed on the NE in nebulosity visible in a narrow band UHC or OIII filter, and known as **IC 4628.** The whole arch of this array is beautiful in binoculars, and from a dark sky location looks very much like a comet, its tail fanning out to the north away from its "head" at the Zeta stars - so much so that it has been called "the False Comet". Faint nebulosity which narrow band filters may bring out in scopes under ideal conditions actually pervades the whole area, forming, along with the Scorpius OB I Association, what has been found to be a bright knot, or H II region along the edge of a section of the next inner spiral arm, the "Sagittarius Arm" or our Milky Way galaxy.

You'll definitely want to try for this area while observing this summer. Although the region is quite southerly, it could pay you nice dividends with pleasurable observing if you make the effort to seek out a dark sky site with a low, southerly view, and enjoy the treasures of Scorpius along with the other more frequented glories of the summer sky!

Coordinates of Featured Objects

Object	R.A.	DEC.
M6 "Butterfly Cluster"	17h 40.1m	-32 deg 13 min
M7	17h 53.9m	-34 deg 49 min
M4	16h 23.6m	-26 deg 32 min
NGC 6302 "Bug Nebula"	17h 13.7m	-37 deg 06 min
"Hockey Stick"	17h 25.2m	-34 deg 34 min
"Garden Trowel"	16h 54.8m	-30 deg 59 min
NGC 6231	16h 54.0m	-41 deg 48 min
H12 (Tr 24)	16h 57.0m	-40 deg 40 min

The Editor's Desk

by Steve Pielock

Welcome to the 30th issue of The View from Arunah! As always, in addition to our regular columns, we have new "guest" articles. You telescope makers will find a piece by the editor, Brad Vietje, introducing you to a Foucault mirror tester which can be made at home, the first of a two-part series. Also, Ed Faits' "Night Birds" article will help you plan spotting satellites like the bright Iridiums via a special web site. And as we speed into summer, we should remind ourselves of all the observing and other adventures to be had at the great summer star parties scheduled:

The Rockland Summer Star Party
Stellafane
The Conjunction
Arunah Hill Days
The Connecticut Star Party
The Astro-Assembly in Rhode Island

These events should take care of all your New Moon weekends! Also, don't forget "Star Watch", coming this fall. For the dates of these events, be sure to check the Astronomy Association Events Calendar pull out in this issue.

If you're like a number of active Arunah Hill members, you might want to take advantage of the opportunity on the first Saturday of each month to help out at our work sessions on the hill, then enjoy the camaraderie and great dark sky observing that follows on clear nights. A group of 15 individuals from the Astronomical Society of Greater Hartford did just that on a recent first Saturday!

As the new grass grows in on our once stump-strewn hilltop, plans are shaping up for our annual Arunah Hill Days - this year, four full days worth over Labor Day weekend! Excellent speakers and activities are being lined up for this great star party... Be sure to mark your calendars for the "stellar" event!

Clear Skies and great observing!

June 23, 2000 EXTRA View From Arunah

Late Breaking Word From The Dudley Observatory:

12 inch Class, Refracting Telescope

To Be Housed At Arunah Hill

Plans are underway to add a third historical refractor to the growing collection of large aperture operational telescopes at Arunah Hill with the arrival of the Pruyn Refractor from the Dudley Observatory

By Joe Zuraw V.A.

For the past two years, negotiations have been underway between the Board of Directors of the Dudley Observatory in Schenectady, New York and the Arunah Hill Natural Science Center, Inc. The subject of the negotiations was a 12 inch Warner & Swasey telescope.

Due to the delicacy of these talks, very little has been said about them publicly. That has now changed. In a unanimous vote, the Dudley Board has agreed to a long term loan of the instrument to Arunah Hill.

The President of the Board of Trustees, Samuel C. Wait, Jr., was pleased to find a home where the telescope could find a new life.

History

The Warner & Swasey telescope was fabricated in the machine shops of the famous Warner & Swasey Company of Chicago. The telescopes being produced by the Warner & Swasey company were considered to be state of the art. It was then shipped to Albany for installation. It was officially named the Pruyn Refractor after Robert H. Pruyn, who was on the Board of Trustees of the Dudley Observatory, as listed in a report from the year 1863.

The optics for the telescope were ground and polished by the Brashear Company. Brashear was the foremost optician of his day. His work took up where Alvin Clark & Sons had left off, and some of his telescopes are considered to be among the finest refracting instruments ever made.

The Pruyn telescope was used for scientific research for many years. Over time, the role of the Dudley Observatory changed from a pure research institution to one also concerned with education and community service. The organization moved several times and eventually the telescope was mothballed.

Negotiations

Late in 1998, in conversations with Susan and Alan French of the Albany Astronomy Club, it was learned that the Dudley observatory was seeking to "close the book" on it's 12" refractor.

Among the options being reviewed was to donate the instrument to the Smithsonian Institute in Washington, D.C. where it would undoubtedly disappear forever.

It is not clear who broached the subject, but wouldn't it be fitting if the telescope could find new life as an educational tool within a short drive of Albany? Alan French, a member of the Dudley Board of Directors, was intrigued by the idea and approached the board with it.

Arunah Hill sent a formal proposal to the board outlining an arrangement that would allow Dudley to maintain ownership of the instrument while Arunah Hill would oversee restoration, operation and long term housing. The end result would be that school children and adults would once again be able to use the telescope

The agreement was hammered out and closed with two final stipulations. The first was that Arunah Hill would carry an insurance policy on the instrument and the second was that a plaque would be fixed to the base of the telescope stating:

> *The 12" Pruyn Refractor*
> *Of the Dudley Observatory*

The closing stages of the agreement will involve the signing over and release of the telescope into the hands of Arunah Hill members who will oversee the beginning of the restoration while work progresses on the observatory building that will house it.

Connections

Aside from the obvious, there are many reasons why Arunah Hill would be interested in a 12 inch refracting telescope built by the Warner & Swasey Company.

During one of our many visits to the Town of Cummington Community House, Steve Pielock and I noticed a large sterling silver vase standing in a glass case in one corner of the meeting room. We were early for the meeting, and, curious, we wandered over to look at it. It was an exquisite example of the machinist's art. I noticed the small plaque on it's base. It read:

Worcester Warner Machine Company

Then we saw a large oil painting of Worcester Warner hanging on the wall. Below it was an inscription stating that the Community House was a gift to the town from Worcester Warner himself.

It seems that Warner was a native son of Cummington. Our organization had inadvertently settled in the home town of a turn of the century telescope maker.

Imagination ran wild. Arunah Hill already had an example of a Brashear telescope built by the Gaertner Company, and a Fitz telescope that had been refigured by Clark. Wouldn't it be great to add a Warner & Swasey instrument to the growing collection?

As many of our readers already know, Arunah Hill became the owner of the largest surviving Fitz refracting telescope in the world several years ago.

This historical 13 inch telescope was built in 1862 for the Dudley Observatory, then located in Albany, New York. There it stayed until about 1906, when a decision was made to purchase a brand new state of the art Warner & Swasey telescope to replace it. The old Fitz telescope disappeared and began a long journey that led to Arunah Hill in 1995 (see View From Arunah volume 14).

When negotiations began with the Dudley Observatory, we were well aware that the telescope that Dudley had purchased to replace the Fitz might find itself under that same roof as its predecessor.

Future

Arunah Hill has inadvertently become a treasury of historic refractors. But it was never intended to become a museum of exhibits behind glass. We are dedicated to the restoration and use of these instruments for education.

Not surprisingly, the Town of Cummington Historical Society has been keenly interested in this development. They see it as a boon for the community that this instrument find a home in the town of Worcester Warner's birth. The benefits to Arunah Hill of hosting this telescope may become obvious in the years to come.

It is Arunah Hill's goal to become a point of community pride. If political issues adversely affecting Arunah Hill come up for vote at town meetings, we want the community standing behind us. Other dark sky sites have failed to make such community connections, and have paid the price!

And so Arunah Hill has become the host of historical working educational telescopes.

With that in mind, we have worked to prepare a site for a large observatory building. This building will be large enough to house four operational 12 inch class refractors, one 24 inch class refractor, and numerous smaller instruments, simultaneously.

Fund raising is underway to amass the thousands of dollars that will be needed to pay for the construction.

Many of us serve the dream of Arunah Hill with blood, sweat and tears, because it is all we have to offer. There are others who could serve through their check books. Such gifts are always welcome and our history shows that we make every dollar count.

Arunah Hill is our Legacy to the future. Future generations will judge our actions. Worcester Warner is remembered by his community to this day.

How to Submit Material to *The View from Arunah*

The View from Arunah welcomes material submitted by guest contributors. The strength of this publication is its writers and photographers, so we are always on the lookout for new contributors. If you have an idea that you think might make a good article, or if you are an astrophotographer who would like others to enjoy your work, then please consider contacting us. Our staff would be happy to provide any assistance that you might need to get your work published in *The View From Arunah*.

To submit articles, photographs, or drawings, please send to them to:

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Materials submitted via electronic mail should be sent to "Pielock@acad.umass.edu". Comments and criticisms are always welcome. Letters to the Editor or any of the section editors are also welcome.

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Guest Article: Night Birds

by Ed Faits

Once darkness descends on Arunah Hill, a nightly parade begins: a dim point of light arcs smoothly and silently overhead. Someone shouts "satellite in Draco, heading south". Eyes turn, pick up the "moving star", and watch the point of light drift across the sky until it abruptly fades out when the satellite reaches the darkness of Earth's shadow. Since Sputnik shocked the world in October, 1957, catching a glimpse of an artificial satellite has had a powerful emotional effect on people, obvious proof of mankind reaching into the realm of the stars.

Occasionally, a slowly rotating satellite will put on a more interesting show, when a slow tumble causes the satellite to vary in brightness, as solar panels and other shiny parts of the spacecraft alternately direct sunlight onto our vantage point on Arunah Hill.

> Other than manned spacecraft - MIR and an occasional Space Shuttle sent into an inclined orbit, there hasn't been an easy way to identify exactly which satellite were we seeing. Was that point of light a Russian spy satellite, now snapping our picture? What would Russian security agents make of our little clearing? Maybe the bird is just a benign GPS beacon, or a weather satellite!

Now, a great web site can provide all the information a celestial bird watcher could want. The http://www.heavens-above.com site will give a listing of all satellites visible... just punch in your location and tonight's satellites will come up. A link from the top of the Arunah Hill home page is already preset to our West Cummington location. With just a few additional clicks, you can even find out a bit about the history and mission of each satellite visible.

The web site has a special section on the real "stars" of the satellite parade: the Iridium "satphone" satellites. The fleet of 66 Iridiums can put on a spectacular flash when various geometries conspire to direct the big bird's shiny panels to sunlight onto our humble hill, like a bored child playing with a mirror on a long car trip. The web site will provide a list of scheduled Iridium flashes for up to the next seven days.

A perfectly aligned Iridium flash can reach a spectacular magnitude of minus eight! Any spot in New England might be lucky enough to have two or three good flashes in a week. Just remember, unlike other satellites, Iridium flashes are focused to a small area: a great flash for West Cummington might be barely visible from Amherst (and vice versa). Be sure to "bookmark" the Iridium flash page for each of your observing sites, even if your backyard is light polluted. A good Iridium flash is spectacular even from Manhattan. Alas, the Iridium is a bird scheduled for extinction... Bankruptcy has forced Motorola and the other backers of Iridium to safely crash the fleet of sat-phone birds safely into the Pacific Ocean. Over the next two years, the whole fleet will meet this fate... Make sure you catch this spectacular high flyer while you still can!