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For the fortieth anniversary of the Apollo 11 landing, I decided to make a painting of Neil Armstrong taking the famous shot of Buzz Aldrin of the lunar surface. The very one used in the July 2009 issue of Astronomy Now. The NASA frame number of that shot is AS11-40-5903, made on a Kodak colour transparency film. In the original photograph, Neil chopped off, at the very top edge of the frame, a small part of the top of Buzz's backpack and his radio aerial. So most reproductions have added a bit of black to the top of the frame, but no aerial. This happened because the Hasselblad cameras had no viewfinder mirrors and screens to save weight and improve reliability in a vacuum. The cameras were just aimed at the subject and the distance ring set to the guessed distance. A set of exposure guides was set on top of the camera body. The painting was done in acrylics on thick art paper 16" x 12" in size. The biggest problem I had was finding detailed pictures of the Lunar lander and I was surprised at the amount of detail I needed in the Lunar Landing Module "Eagle" and how the legs were attached to it. Also the space suits used on the moon evolved, with the ones worn in later missions changing in some details. Ivor Clarke, Editor

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Rue Cassini

By Mike Frost

For my summer holidays this year I thought about going to China to see the solar eclipse of July 22nd. The prospect of seeing the world's largest tidal bore, the Guan Chao (or wonder Tide) on the Qiantang River was appealing, as was the chance to revisit Wuhan, where I worked during 2007. Then I saw the weather forecast – monsoon season in India, typhoon season in China. As it turned out, some tour groups to the west of Shanghai and in the Wuhan area did see the eclipse, usually through cloud, but an awful lot of people were clouded out.

So instead I went to the Cote d'Azur for a few days. The weather was a lot better – I'm sure the citizens of Shanghai would have loved the weather I had in Nice and Cannes. My hotel in Nice was in the museum area, some way back from the beach but convenient for the bus station. Of course I was intrigued to see that the street from the hotel to the harbour was named Rue Cassini and I was intrigued to know if there was any connection to the astronomer who lent his name to the spacecraft currently in orbit around Saturn.

I didn't have to search long before I found a connection. In Place Garibaldi, just outside my hotel, is a plaque commemorating Giovanni Domenico Cassini (1625-1715). But I was surprised to see four other members of his family. Below Gio. Domenico Astronome come the names of Jacques Cassini Astronome (1677-1756), Cesar Francois Astronome Geographe (1714-1784), Jean-Dominique Astronome (1747-1845) and Alexandre Henri Botaniste (1784-1832). All apart from Giovanni Domenico were born and died in Paris or the family estate in Thury-sous-Clermont (in Picardy, north of Paris).

So what did this illustrious family achieve? And why did they end up with a monument in Nice, southern France?

Giovanni Domenico Cassini, the family patriach, was born in Perinaldo, Italy, which is only 30 miles to the east of Nice. Cassini Senior was an astronomer at the Panzano observatory in Bologna between 1648 and 1669, and Professor of Astronomy at the University of Bologna. He was then offered the post of Director of the Paris Observatory. Cassini spent the rest of his life in France and became a French citizen.

Cassini's career at the Paris Observatory was very successful. He discovered four Moons of Saturn (Tethys, Dione, Rhea and Iapetus), as well as the gap between the A and B rings of Saturn, which bears his name, the Cassini division. Arguably, he discovered the great red spot of Jupiter (some authorities believe that Robert Hooke saw it a year earlier; others that Hooke observed another feature on the planet; others still that our Great Red Spot did not appear until the nineteenth century). Certainly he was the first to note that Jupiter's belts and bands rotate at different speeds. Additionally, in 1672 he sent a colleague, Jean Richer, to Guyana, South America, to measure the exact position of Mars in the sky. By comparing the apparent position of the planet with that measured from Paris, he was able to measure the parallax of the planet, and from that to make an estimate of the Astronomical Unit, the distance from the Earth to the Sun.

Giovanni Domenico Cassini began a dynasty of directors of the Paris Observatory. His son, Jacques, succeeded him as director in 1712. Although Jacques was also a member of the French Academy of Science, he was not as notable an astronomer. His main achievments were an accurate measurement of the Arc of Meridian between Dunkirk and Perpignan, and the production of The Elements of Astronomy in 1740. Cesar Francois, Jacques's son, was also director of the Observatory, but is best known for his work in surveying; in particular the production of the first topographical map of France.

In the fourth generation, Jean-Dominique visited England, and met William Herschel at his Slough Observatory. Like his colleagues across the Channel in Greenwich, Jean-Dominique was involved in the solution of the Longitude problem. In 1768 he sailed to America on a voyage to test a sea watch. But unlike English astronomers, Jean-Dominique also had to deal with a revolution. His plans to renovate the Paris Observatory in 1793 were thwarted – instead, a year later, he found himself in prison. On release, he fled to Thury, and spent the rest of his life there, ending the family's long association with the Paris Observatory. Jean-Dominique's eldest son, Alexandre Henri, had a career in botany, and had a plant, Cassiniae asculatea, named after him. He was the last member of the Cassini family with a scientific reputation.

So why do the Cassinis have a memorial in Nice? As far as I know, they had no direct connection with the city. But when Giovanni Domenico Cassini was born, Perinaldo was administered from Nice. So perhaps the city is commemorating a "local family made good".

Further Reading
John Lockerbie has an excellent website on the Cassini family on
www.catnaps.org/cassini/home.html

THE END OF A CONTROVERSY?

By Dennis W Spratley

After many years of quite inexplicable delay, NASA finally turned the HST (Hubble Space Telescope) on to the enigmatic pair of extra-galactic objects, the galaxy NGC 4319 and Markarian (or Mark) 205. In October 2002, the Space Sciences Telescope Institute issued a press release of a picture of this "close" pair, which are separated in the sky by a mere 43" (seconds of arc).

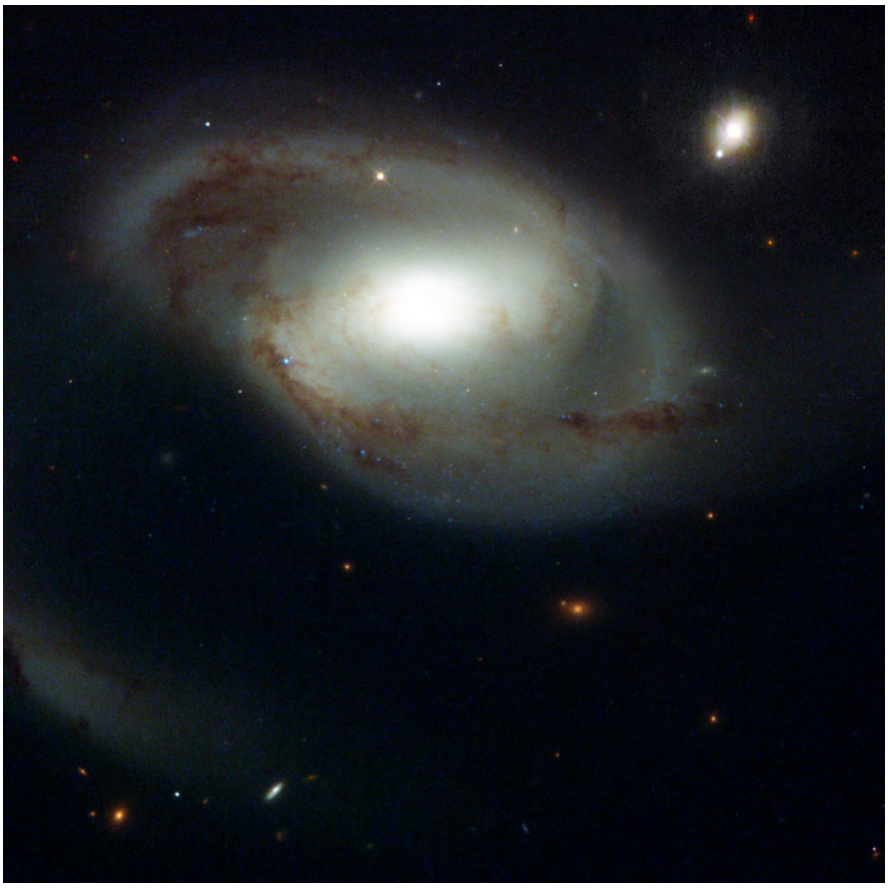
Many science magazines published this picture. The author's attention was drawn to *Astronomy Now,* March 2005 (page 16) where part of the picture was published. Since the time of the launch of the HST there had been a demand in certain quarters for far improved images that the Space Telescope could provide over the earliest photographs of the objects which were, of course, taken by ground based instruments. By this means it was hoped that a long-standing controversy could be settled. At first sight, the pictures that have appeared in such magazines as *Astronomy Now* appear to show the resolution of the 30-year dispute that has raged about this pair of objects. However, on closer examination of the HST image it is abundantly clear that this is not the case.

The controversy surrounding NGC 4319 and Mark 205 arose out the work of the Armenian astronomer Markarian after whom such objects as Mark (or Markarian) 205 are named. His survey for galaxies whose continuous spectra appeared unusually blue began appearing in 1967. Using a small Schmitt telescope he surveyed the sky for objects with strong UV continuum radiation. Amongst the hotly radiating objects that he discovered was the QSO (quasi-stellar object) now dubbed Mark 205. Interestingly, as seen projected against the sky, it is close to the edge and only 43'' from the nucleus of the galaxy NGC 4319. In 1970, Daniel Weedman pointed out that the chance of this being an accidental configuration was very small; that is, both NGC 4319 and Mark 205 should not be just close as projected on the sky but are physically close. The implication was that the two objects would be gravitationally bound and in orbit around their common centre of gravity. However, Weedman also drew attention to the fact that the red shift of the much larger galaxy NGC 4319 is 0.0057, whilst that of the QSO and smaller Mark 205 is 0.07. Assuming that the red shift of 0.0057 is due to the cosmological expansion and is shared by both objects, this leaves an excess red shift for Mark 205 of about 0.0643. Translated into a speed, this is a prodigious 19,300 km/sec which would mean that the magnitude of the velocity of Mark 205 relative to NGC 4319 is at least and likely to be in excess of this value. This is far too great for the objects to be gravitationally bound; for this to be the case, the mass of NGC 4319 would have to be enormous. It seemed that, despite the very small chance of finding two such objects separated in the sky by only 43'', it had to be concluded that NGC 4319 was closer to the Earth and Mark 205 a factor of approximately 12 times more distant (0.07/ 0.0057). This was and still remains the viewpoint of mainstream cosmologists.

This conclusion was not the opinion of other astronomers including Halton C. Arp, at that time a first-class observational astronomer at Mount Palomar. Already he was concerned about what he has called discrepant red shifts and his claim – which is very impressive once one has studied both the observational data and its analysis – of an association between QSOs with large red shifts and "local" galaxies with modest red shifts, a viewpoint that was and, of course, is hotly denied by what Arp refers to as *"the establishment"*. As is well known, because of their large red shift values, which are assumed to be due to the cosmological expansion, QSOs are regarded by mainstream cosmologists as being very distant, it being taken for granted that they obey the Hubble Law. The history of the discovery of QSO's (or quasars) is well known and appears in all texts on cosmology whether they are written for the professional or amateur. The part played by dissenters like Arp is regrettably invariably omitted. This exclusion from standard texts is not at all surprising because Arp and others have consistently asserted that matters are far more complicated than the establishment would have us believe.

The first point Arp claimed was that the galaxy NGC 4319 was highly disturbed. The spiral arm of the galaxy on the opposite side to Mark 205 was, in his own words, *"coming off at the roots"*. He was interested in whether there were any visible effects within the two objects that might provide evidence that they were close together in space. In his book of 1987, *Quasars, Redshifts and Controversies* he writes: *"To make sure, I took the deepest photograph possible, using the high-detectivity IIIa-J film that Eastman Kodak had manufactured especially for astronomy. It required a four-hour, sky-limited exposure at the prime focus of the 5-metre (200-inch) reflector at Mt Palomar. When I developed the photograph I was surprised and delighted to find a luminous connection between the quasar and the galaxy."* Arp continues by describing his investigations aimed at making sure that the 'connection' is real. The now-famous photograph of 1971 is Figure 3-1 in the above quoted book but the very first publication was: 1971, Arp, H., *Astrophysical Letters*, 9, p.1.

As can be imagined by those unaware of this saga, the response was predicable. It was asserted that the red-shifts of both NGC 4319 and Mark 205 were both cosmological with Mark 205 lying at a vastly greater distance. Firstly, other photographs appeared that did not show the connecting 'bridge' – as it has also come to be called. Moreover, Arp's abilities as an



NGC 4319 and Markarian 205, from a Hubble Heritage reproduction.

observational astronomer were called into question – as they still are to this day. This charge of incompetence persists despite the fact that other astronomers, including gifted amateurs, have photographed the 'bridge'. By 1973, he felt that the deteriorating situation was bad enough to merit his demonstrating that he was not an incompetent photographer. He did so by producing and showing at a meeting held in Australia that year a short exposure of the system that did not show the 'bridge'. The whole point of this exercise was to demonstrate that the appearance of the faint apparently connecting material is not revealed unless the photograph is deep. In layman's terms this means that the images of both NGC 4319 and Mark 205 must be grossly over exposed. In Arp's picture of 1971, the nucleus of NGC 4319 and the image of Mark 205 can be seen to be "burnt out". This technique was, of course, not new. Astronomers had used it from the outset of astronomical photography in order to detect any faint object lying close to a very bright one.

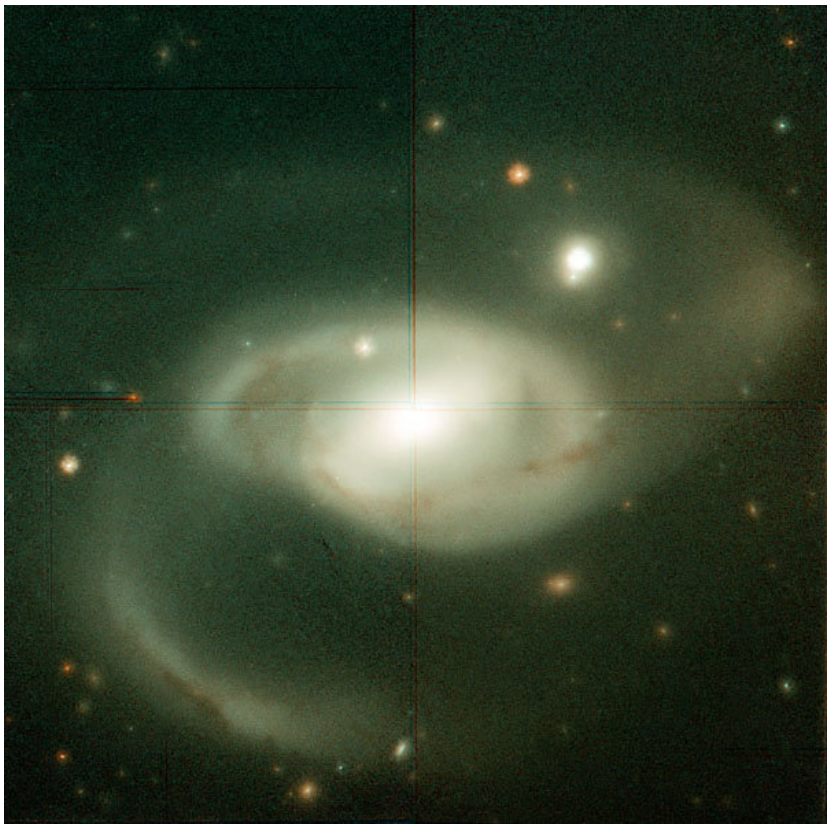
The drama continued. At another observatory, using a 2-metre telescope – as compared with the 5-metre used by Arp – two researchers indulged in what Arp describes as *"a rather pretentious effort"*. As described by Arp, their report on their observations took the following approach: ***(1)*** the connecting bridge was non-existent; ***(2)*** in the event of it being real, it was explained by the supposition that it was a distant background galaxy seen edge-on and lying in just the right position. Why the authors made the statement in ***(1)*** is hard to understand because their picture did show the 'connection'! As for ***(2)***, well, apart from it being very unlikely, the idea was flawed. Arp writes: *". . . the connection had much too low a surface brightness to be a galaxy seen edge-on. The connection was also straight-sided, whereas an edge-on galaxy would have to taper at its ends. But the taper of an edge-on galaxy would have to be opposite the hourglass-shaped cusp of two images optically melding together, which was the third favourite explanation advanced for the feature."*

Clearly, here was a set of contradictory explanations. However, mainstream astronomers and cosmologists – Arp's establishment – found them completely acceptable for allowing the conventional view to be maintained, that is: that the red shift of Mark 205 places it far behind NGC 4319. Which explanation an individual chose to adopt as giving a so-called definitive refutation of Arp's investigations was merely a matter of taste. Others simply accepted what they heard; that Arp's work was spurious. What was obvious was that they never took the trouble to personally investigate his claims. He was accused of crazy theorising when in fact he was reporting observations. This remains true to this day and is something of which the present author has had experience when attempting to discuss the matter with a professional astronomer. The general consensus of opinion is that Arp's work has been "refuted" – the misuse of this word is rife – when the simple truth is that Arp's observations have been summarily rejected.

Eleven years later the reality of the 'bridge' appeared to have been resolved by means of the powerful image-processing facilities at the Jet Propulsion Laboratory (JPL) in Pasadena. Halton Arp did not perform this analysis. On this occasion the researcher was Jack Sulentic. The research facilities at JPL included powerful computers – for that time, of course – designed to process the images of planets and their moons sent to Earth by space probes. The computers had been programmed with complex algorithms designed to extract the maximum of information from the pictures beamed to Earth. Sulentic had been tutored in what were at that time the most advanced techniques in image processing. During the elapsed eleven years, further photographic plates had been made of the controversial NGC 4319 and Mark 205. These had been taken using the 5-metre telescope at Palomar and the 4-metre telescope at Kitt Peak National Observatory (KPNO). The importance of this material was that it was both new and independent. Sulentic selected the four best plates from Palomar and the three best from KPNO. This is in the sense that the

"seeing" conditions at the observatory were best on the nights these plates were made. He proceeded to extract by means of the JPL image-processing techniques the maximum amount of information contained within the seven photographic plates and produce a composite picture using false colour.

Sulentic's imaging-processing work was published (1983) in *Astrophysics Journal (Letters)* 265, p. L49. Also, it appears in monochrome as Figure 3-2 on page 34 of the 1987 edition of *Quasars, Redshifts and Controversies* and in colour (dark blue, scarlet, white, and pale green) on the jacket of this text. Without doubt, the 'connection' between NGC 4319 and Mark 205 is clearly visible and more apparent than in the original discovery photograph by Arp. The 'connection', which is quite thick, also exhibits a distinct curvature. In addition, by means of the mathematical filtering technique, Sulentic demonstrated the existence of what Arp described as: *"a very narrow sinuous connection inside the broad connection which can be traced well back though the inner regions towards the nucleus of NGC 4319."*



A very deep image of the pair, NGC 4319 and Markarian 205

As was to be expected, this was not the end of what had now developed into a something of a feud. Three observers in Hawaii, A. Stockton, P. Wehinger, and S. Wyckoff, taking and analysing their own photographs, declared that the 'connection' was not real. Wehinger and Wyckoff wrote a brief article that, with their own pictures in pseudo-colour, appeared in *Sky and Telescope*, 61, page 200, (March 1981). The authors insisted that their observations had established "beyond doubt" that Mark 205 must be a background object. Halton Arp stated: *"Their article caused some amusement because their pseudo-colour pictures showed the connection between the two objects quite plainly – in fact, it you held the magazine at arm's length the connection virtually leapt off the page!"*

Arp and others were keen to continue their investigations. Access to the 5-metre telescope at Palomar was now denied to Arp and Sulentic but what they required were better facilities than those available at that observatory. Both made application for telescope time at the KPNO using the 4-metre instrument which was now equipped with what was then the latest technology in CCDs. It was by no means certain that Arp and Sulentic's request would be granted; by now fierce opposition to their work was widespread. In fact, it was fortunate that the director at the KPNO was the British-born Geoffrey Burbidge who, being sympathetic to their investigations, personally intervened to give them two nights on the 4-metre facility. The few hours on the telescope enabled them to obtain images of the system NGC 4319/Mark 250 in different colours. At that time Arp was no longer in the USA; he was now in Munich at the ESO (European Southern Observatory) that had excellent computer reduction facilities. Consequently, using the new CCD frames, he was able personally to handle the image processing. The result was very much akin to Suletic's picture – Arp used identical pseudo-colour – and the same 'connection' between NGC 4319 and Mark 205 was clearly visible. Unfortunately, at KPNO on the nights of the observations the quality of the atmospheric steadiness was not good enough to confirm Sulentic's *"thin sinuous connection back to the galaxy's nucleus"*. This was a disappointment.

The optical investigations of both Halton Arp and Jack Sulentic were rapidly coming to an end. Once again they rushed to obtain more time on the 4-metre at KPNO to obtain spectra of certain new features that had been revealed but it was unclear as to whether they were successful. However, there was one very interesting surprise concerning the spectra throughout the disc of NGC 4319. One expects to find in spiral galaxies the characteristic hydrogen-alpha emission. Arp describes this as being almost completely absent and that instead the entire disc showed only emission from ionised nitrogen. This discovery served to convince Arp that NGC 4319 was an unusual galaxy. Opportunity of a follow up was not forthcoming.

A final attempt made by Jack Sulentic to investigate the enigmatic 'connection' was at radio frequencies. Halton Arp describes Sulentic's dedicated perseverance as heroic in obtaining 6 hours of observing time on the Very Large Array (VLA) radio telescope. The sensitive radio map demonstrates extended lobes of radio emission on either side of NGC 4319, strongly suggesting

that, like many ejecting galaxies, this particular galaxy has ejected material on either side of its nucleus, which is very rare for a spiral galaxy. A line – which may be taken as a datum – drawn connecting the lobes passes though the centre of the nucleus. However, Mark 205 does not coincide with the lobe on its side of the galaxy being nearer to the nucleus of NGC 4319. Moreover, a line drawn from Mark 205 to the centre of the nucleus is rotated forward with reference to the datum line by about 30 deg in the direction of rotation of the galaxy.

When in 1990 NASA launched, on behalf of the Max Planck Institut fur Extraterrestrische Physik (MPE), the X-ray telescope ROSAT (Roentgen Observatory Satellite Astronomical Telescope), Halton Arp had been in Germany for four years and was in a position to submit proposals to the German selection committee for observing time with this instrument. He was to receive some time on what he describes as "hot" objects and one of these was Mark 205. This particular proposal had the clear aim of investigating whether the – by now – infamous "bridge" of connecting material between NGC 4319 and Mark 205 revealed itself by X-ray emission. It did not. This was, like Jack Sulentic's result with the VLA, a disappointing one. Yet as is often the case, a serendipitous discovery was made which, although not part of the saga of the "bridge", is worth a brief mention if only to emphasise the remarkable nature of the pair NGC 4319/Mark 205.

What was revealed was the X-ray emission of Mark 205. In appearance both the contour map and the false-colour image are akin to some amoeba-like life form with a pair of almost opposite prongs extending away from the main jelly-like body. In reality these extensions are filaments of X-ray material that end on point-like, bright X-ray sources. Immediately, Arp sought for optical identification of these two point-like sources by superposing the X-ray maps – with suitable scaling – on sky survey prints. These sources were shown to be optically blue stellar objects of an unusually bright apparent magnitude. Arp had no doubt as to what they were. His experience told him that they were QSOs or as they are more commonly called: quasars. Others could have interpreted this discovery as being the final proof that NGC 4319 and Mark 205 are unconnected. It would mean also that Mark 205 and its attendant QSOs would all have the same red shift. That is, that of the already measured value of 0.07 for Mark 205. Nevertheless, it was necessary to obtain the spectra of these two QSOs. This was Arp's problem; being refused optical telescope time.

He was fortunate. Already another research team had investigated the fields around strong X-ray objects. They had discovered an excess of sources around Mark 205 that were shown to be mostly QSO/quasars with higher red shift. The two optically blue objects discussed above were QSO/quasars with red shifts of 0.464 and 0.633. In addition, within the filament that extended to and ended on the QSO with red shift of 0.633 was a third QSO with red shift of 1.259. This was in 1994. Thus were laid the seeds of further controversy!

Halton Arp made an attempt to publish these important results but he was thwarted by the referee who reviewed the paper. Arp writes: *". . . the referee complained that the data tables were not arranged in a certain order and the objects were not discussed in a certain sequence and it had not been "proved" that the connections and extensions were not noise. The inevitable ritual was upheld and the paper was stalled indefinitely."* Once again the peer review system had failed scientific enquiry (see the author's: *The Scandal of Peer Review,* MIRA 81).

However, none of the X-ray discoveries discussed above helped in any way to resolve the controversy of the "bridge" since at X-ray frequencies there was no indication of it. The two sides in the dispute held to their respective positions. Amongst other interested parties such as amateur astronomers and the world's journalists there was the strong view that the major facilities should be used to settle Halton Arp's many claims of which NGC4319/Mark 205 was but one. Naturally, one such facility was the HST that was regarded outside the professional astronomical community as being able to provide all the answers to outstanding problems. The HST had been launched into orbit in 1990 and a Shuttle space mission had corrected the spherical aberration defect of the main mirror in 1993. Arp and Sulentic were urged by many people to observe NGC 4319/Mark 205 again but now and for the first time using the Space Telescope.

Apparently, this enthusiasm for the HST was the outcome of a meeting at the International Astronomical Union (IAU) four-day symposium in Holland in August 1994. Halton Arp had been invited to attend and realized that he was presented with an opportunity to expound the important new observational data on X-ray QSOs associated with low red shift galaxies. There was also the fact that his short paper would be published. It would not appear in a prestigious journal but in the little-read *Proceedings* and publication would take more than a year. Nevertheless, it meant that those researchers with interest would find the reference and be able to access the pictures and X-ray data. In addition, there would be other dissidents at the meeting with whom to exchange views. Even if the establishment figures would not be particularly pleased to see him, there were two sympathetic colleagues at the symposium; in attendance was the Indian theoretician Jayant Narlikar as was the formidable, no-nonsense Geoffrey Burbidge, the latter scheduled to give what was always his latest assessment that some QSOs at least were much closer than their cosmological distances derived from their red shifts. By now Geoffrey Burbidge once a sceptic was now a convert. One establishment figure was the then Astronomer Royal, Professor Sir Martin Rees. He was present to give the customary so-called defence of the Big Bang theory and assessment of the present state of knowledge, despite that fact that the vast majority of members present were establishment and – as Arp expresses matters – *"everyone knew what was going to be said"*. Such a talk would invariably last nearly an hour whereas new observations, such as those of Arp and Burbidge and which were uncomfortable for the received wisdom, either had no time at all or were

confined to 15 to 20 minutes. Arp is quite scathing; he writes: *"Clearly the main purpose of these 'review of the theory talks' was to fix firmly in everyone's mind what the party line was so that all observations could be interpreted properly."*

On the final day came the infamous meeting. A large audience, which included members of the international press, was present. Facing them was a panel of some nine IAU members chosen to represent the topics that the symposium had covered during the previous three days. Included on the panel were Halton Arp, Geoffrey Burbidge and Martin Rees. As the senior member on the panel it was Martin Rees who opened proceedings. He began with a vigorous attack on the observations that had been shown in the short presentation given by Halton Arp earlier in the symposium. Rees did not like them. This is understandable; they cut across all the beliefs to which he has devoted most of his professional life. Undeterred by the attack, when it became his turn to make an opening statement, Halton Arp gave the audience even more observational images that contradicted conventional wisdom. At that juncture the meeting was opened up for the audience to participate in the discussion and Govert Schilling, a Dutch journalist, rose to his feet to ask a question of Martin Rees. It was a very obvious question to ask. Arp gives what he calls a rough paraphrasing: *"In view of the evidence Dr. Arp has shown, why have not major facilities been used to further observe these objects?"* Whether the questioner had the HST in mind is unclear but others certainly had. After all, the HST was the panacea, was it not? What happened next was quite astounding.

A very angry Martin Rees turned and launched on Halton Arp what the latter has described as a vitriolic personal attack. Without going into detail, the gist of Martin Rees' outburst was that Arp was accused of gross incompetence. This takes some understanding because on the panel that day was the imposing bulk of Geoffrey Burbidge, one of Arp's colleagues and closest supporters. Much of what Martin Rees' totally unfair remarks contained could have been aimed equally at Burbidge, a veteran astronomer of impeccable credentials. Perhaps the sheer physical size of Geoffrey Burbidge was a deterrent! Clearly, Martin Rees must have been rattled by the question posed by Schilling. In reply to this outburst Halton Arp made a statement with which all of us can agree: *"I feel it is the primary responsibility of a scientist to face, and resolve, discrepant observations."*

Apparently what had already upset Martin Rees, even before Govert Schilling posed his question, was the disclosure at the meeting that an amateur astronomer, using the HST, had observed NGC 4319/Mark 205 and verified the so-called 'bridge'. The idea of an amateur using the HST seems unbelievable. Yet according to Halton Arp, in the early days of the HST the administrators had allocated 10% of instrument use to worthy and well-informed amateurs who were acknowledged by the professional astronomers as being important contributors to the science. Rumour had it that a request had been made to observe Mark 205. Arp was more than just sceptical about this circulating story. However, several years later he was visited in his office by the author of the proposal, a competent and knowledgeable high school teacher who was able to show Arp the observations that confirmed the 'linking' material between NGC 4319 (low red shift) and Mark 205 (high red shift). The teacher left, with Arp having exhorted him to publish these results but nothing ever appeared in print and Arp never saw or heard from him again. What difficulties the amateur may have faced remain unknown. Another amateur was allocated time for spectroscopic observations on the QSO/quasar which definitely has a luminous filament extending from it to the galaxy 1327-206. Unfortunately, NASA "accidentally" pointed the HST at the wrong object! Not long after this debacle, the 10% allocation time for amateurs on the HST was suspended/cancelled. The official reason given by the Space Telescope Allocation Committee was that it was: *"too great a strain on its expert personnel"*. There are several important conclusions that can be drawn from this sorry tale; one being that NASA had in fact observed the NGC 4319/Mary 205 connection by means of the HST albeit not officially!

Officially, it was clear that at that time NASA had no intention of so doing. It is also clear that this was because no proposals were put forward by the mainstream astronomical community, they being implacably hostile to such observations. The reason expounded was that it was a waste of a valuable resource such as the HST. However, as was stated above, after the IAU symposium, many interested parties felt otherwise and urged Halton Arp and Jack Sulentic to collaborate again on the NGC 4319/mark 205 Project but this time by using the HST.

Obtaining observation time on any of the big telescopes, including the HST, is a tortuous process. It is not like telephoning one's local friendly amateur astronomer with a request for a few hours viewing through the finest instrument in the district. It necessitates the writing and submitting of a detailed observing proposal. Halton Arp and Jack Sulentic prepared a complex proposal that was submitted to the allocation committee. It was a complete waste of time. Not only was the request turned down flat but also the written proposal was subjected to a scathing attack. Arp writes that later a letter informed him *"it was NASA's policy not to release the names of scientific assessment panels"*. Clearly, he was attempting to ascertain exactly whom amongst his colleagues had voted against the proposal. Their anonymity meant that they could not be confronted directly.

This seems to have remained the situation until October 2002 when the Space Science Telescope Institute issued their press release and the picture of NGC 4319 and Mark 205 taken with the HST. Finally, after 30 years, the Space Telescope had been used to observe this enigmatic pair. One wonders what had brought about this change in policy. In the press release NASA asserts that the so-called 'connection' was non-existent and that all the previous evidence had now been refuted. Most science magazines published the picture and simply accepted the NASA statement. In the March 2005 issue of *Astronomy Now* only part of the picture is shown as an illustration for an article

that contains a reference to Halton Arp's claim that NGC 4319 and Mark 205 are visibly connected. There is nothing in the text stating that the evidence of the picture now refutes this claim but any reader will conclude that the picture shows no 'connection' for the simple fact that there is nothing to be seen! One hopes that there is no intention by any magazine to allow the reader to fall into the obvious trap.

The trap is that this picture as published by the Space Science Telescope Institute and reproduced in magazines, including *Astronomy Now*, March 2005, is not a deep photograph. In fact, the image as published was not even deep enough to show the spiral arms of NGC 4319. As discussed above, only such a deep photograph will reveal the 'connection'. All the investigations by Arp et al have produced pictures where the images of NGC 4319 and Mark 205 are all "burnt out". The current situation is akin to that in which Arp found himself in 1973 when at a meeting in Australia he showed that he was not an incompetent observer by showing that he could, like his critics, produce pictures that did not show the 'connection' but at the same time he emphasised that the images had to be deep. These crucial facts have been and continue to be blatantly ignored by his critics.

It would seem that the problem is now for the Space Telescope Allocation Committee to be persuaded to take such a deep picture using the HST. Fortunately this is unnecessary! All that need be done by any amateur astronomer who has the facilities is to download the web image and increase the contrast at faint levels. This produces the same effect as taking a deep photograph. The result is dramatic. The 'connection' between NGC 4319 and Mark 205 can clearly be seen. For those who wish to avoid this exercise refer to Halton Arp's website where can be found the press release picture and a deep picture produced from it by Jack Sulentic of the University of Alabama. It is now abundantly clear that, as seen projected on the sky, the existence of a thin, slightly curving – in the same sense as Jack Sulentic's 1987 picture – image of a faint luminosity lying between NGC 4319 and Mark 205 has been confirmed without any doubt. Consequently, in that respect Arp and his fellow workers have been completely vindicated.

The question now arises as to whether this 'connection' is real. Throughout this article 'connection' has been used to imply apparent connection and the present author is in no doubt that this has been demonstrated. The problem now is to understand the nature of this wisp of luminous material. There are several possibilities. It could be a third object that is independent of both NGC 4319 and Mark 205. It could have been ejected from either NGC 4319 or from Mark 205. However, Halton Arp and others are confident in regarding this luminous material as a real physical connection between NGC 4319 and Mark 205, which if true would have profound implications for cosmology.

Part of their assurance lies in the fact that the pair NGC 4319/Mark 205 is not unique. Other enigmatic galaxy/quasar pairs exist. For example, a combined print from two survey plates taken with the UK Schmidt telescope in Australia shows the quasar PKS 1327-305 with a red shift of z = 1.17 lies at the very end of a luminous filament extending from a close neighbouring galaxy. This galaxy, which has a red shift of z = 0.018, can be seen to be violently disrupted. This apparent visible link between a quasar and a galaxy with very different red shifts has never been disputed; however, it has never been investigated but simply ignored. The official explanation is that what is observed is merely a coincidental alignment, that the quasar, as indicated by its red shift, is distant far beyond the galaxy. The official policy is that, as a consequence, further investigations are a waste of valuable telescope time. Yet because of the case of PKS 1327-305 and the luminous 'connection' to its adjacent galaxy, it is difficult to understand the relentless and protracted attempts to discredit Arp and others over NGC 4319/Mark 205.

In the case of NGC 4319/Mark 205 and the question of the reality or otherwise of the 'connection' any further progress is in the hands of the professional astronomers. It is they who have all the sophisticated equipment at their disposal to settle this issue. Since they have fought long and hard to silence Arp and others and, judging by the Space Sciences Telescope Institute press release of October 2002, remain adamant that nothing has been found between the images of the galaxy and the quasar. This hard-line attitude is despite the fact that they have been aware for years of the necessity of the photographic image being deep. As stated above, this can be achieved by downloading the web image and increasing the contrast at faint levels. Yet the press release picture of 2002 continues to be published. It seems that there will never be an admission that Halton Arp, Jack Sulentic and others are vindicated and consequently no further research by the professional astronomers is to be expected. Moreover, if they continue to behave as they have done for decades they will thwart others who would wish to try. Whatever the final outcome of this controversy, the whole sorry saga is a bad reflection on cosmology as has been conducted over the last forty years by those Halton Arp has dubbed *"the establishment"*.

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THOMAS HARRIOT AND SYON PARK

By Mike Frost

Have you ever heard of Syon Park? It's one of London's eight royal parks, and has been described as "one of England's historic, hidden treasures". Syon Park sits on the north bank of the Thames, across the river from Kew, just to the west of Brentford. And on July 26th 1609 it was the site of the first ever telescopic astronomical observation, by Thomas Harriot. I visited for the first time exactly 400 years later, on Sunday July 26th 2009, to see an unveiling of a plaque to an unsung hero of astronomy.

At the centre of Syon Park stands Syon House, built between 1547 and 1550 by Edward Seymour on the site of a medieval monastery. Syon House has an eventful history. Lady Jane Grey began her short reign as queen here. Catherine Howard spent her last few days before execution in the house; her husband, Henry VIII, lay in state there en route to burial at Windsor, and according to legend his bloated body exploded in its casket and was eaten by stray dogs, in fulfillment of a gruesome prophecy by one of the monks.

In 1604 James I gave the house to Henry Percy, 1st Earl of Northumberland, and it has been in the family ever since. Robert Adam remodeled the interior in Italian style during the eighteenth century. Capability Brown redesigned the grounds, turning a backwater of the Thames into an elegant and sinuous lake. Between the house and the river lies one of London's very few flood meadows, separated from the formal gardens by a ha-ha.

So where does Thomas Harriot fit in to this story? He was born in 1560, probably in Oxfordshire. Harriot attended St Mary Hall, Oxford, and was awarded a BA in 1580. We know of him initially because of his first patron, Sir Walter Raleigh, who during the 1580's was at the height of his influence in the court of Queen Elizabeth. Harriot was part of Raleigh's household and taught navigation to his sea captains, many of whom fought the Armada a few years later.

Harriot's navigational expertise served him well. In 1585 he was part of Raleigh's expedition to Roanoke Island in America. Harriot surveyed the island and its resources, including previously unknown plants such as potatoes and tobacco. Harriot wrote an account of the expedition, *"A Brief and True Report of the New Found Land of Virginia"*, notable for its sympathetic portrayal of the Algonquin. Harriot learned the Algonquin language and his account of the tongue is of interest to students of linguistics.

A Brief and True Report... was published in 1588 and reprinted two years later, and it made Harriot's name. Perhaps it was the reason why Harriot came to the attention of Henry Percy. During the 1590's Harriot moved into Syon Park and into the Percy household. Harriot did not fall out with Walter Raleigh, rather Raleigh's influence at court waned during the last years of Elizabeth's reign, and he was imprisoned in the Tower of London by the next king, James I.

At Syon Park Harriot had keen intellectual

In Syon Park stands Syon House, built between 1547 and 1550 by Edward Seymour on the site of a medieval monastery.

Ann Mills book on Harriot

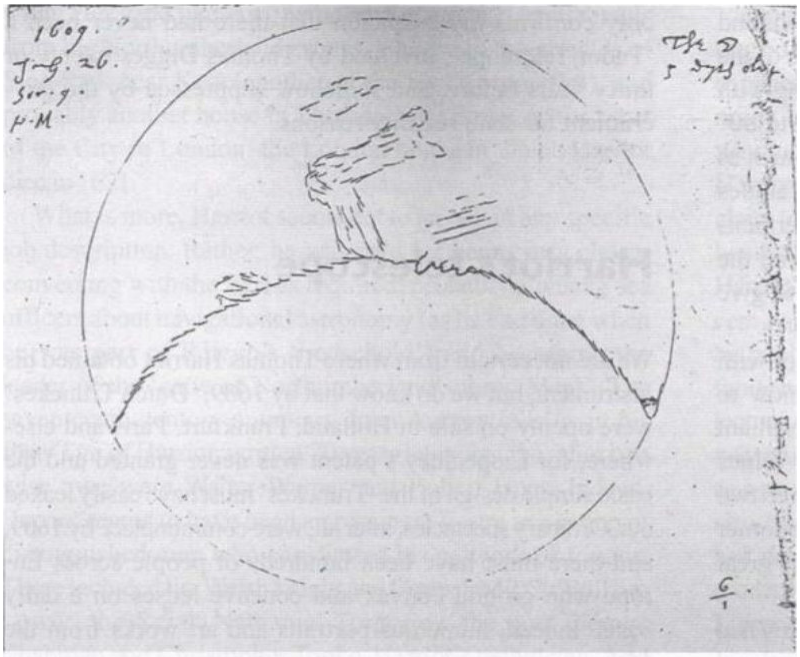
company; fellow members of the Percy household included Walter Warner and Sir William Lower, leading minds of the time. Additionally Harriot corresponded widely in England and Europe, most notably with Johannes Kepler on topics in optics.

In 1609, like others around Europe, Harriot began to hear about the new optical tubes which had been invented in Holland. Like Galileo in Italy, he made experiments with his own tube. On the night of July 26th 1609, Harriot raised his "Dutch Truncke" to the sky and observed the Moon. We know this because he left behind a dated drawing, crude but identifiable with the lunar phase, indicating that he had observed the Moon at 6x magnification. This beats Galileo's first astronomical observations by around three months.

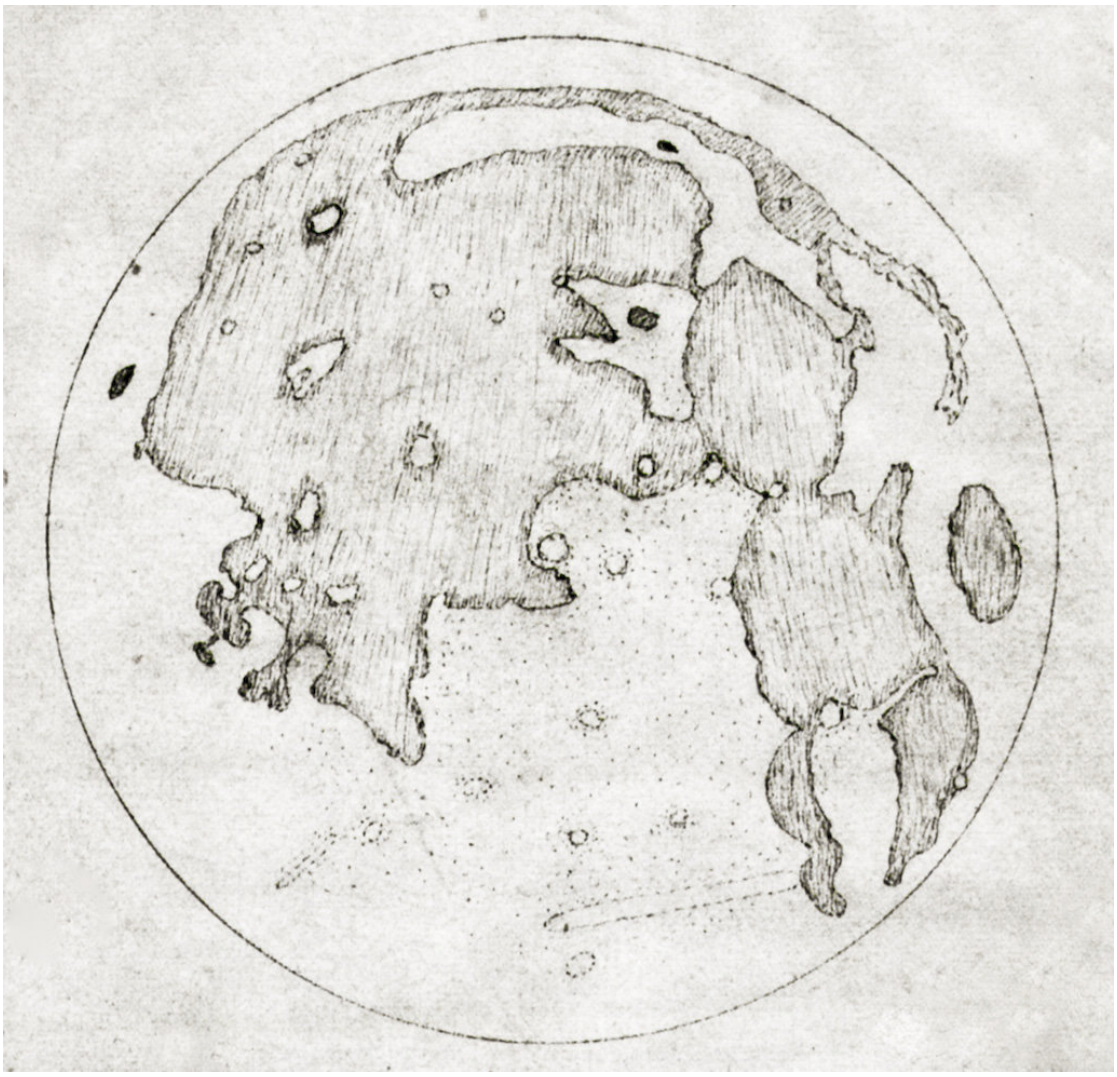
So why isn't Harriot regarded as the father of telescopic astronomy? It's probably because he never published any of his observations, even though he was encouraged to do so many times, and so his discoveries were not widely know outside his circle of friends. And why was he unforthcoming? The likely explanation was the political plight that his second patron, Henry Percy, had suddenly found himself embroiled in a few years previously. Henry's cousin, Thomas Percy, was one of the gunpowder plotters, and when this conspiracy was smashed, in November 1604, the Syon household came under suspicion. Like everyone else in the house, Harriot's rooms were searched, although no evidence was found to implicate him. Nonetheless he too was imprisoned in the Tower of London for a short while. Almost certainly Harriot did not want to bring attention to himself in the succeeding years, and so declined to publish the discoveries he had made.

These include lunar maps of increasing detail, night by night observations of the Moons

Is this the first drawing ever done of the Moon? It is dated 1609 July 26 by Thomas Harriot, when the Moon was 5 days old and shows Mare Crisium, Mare Tranquillitatis, Mare Foecunditatis and perhaps Lacus Somniorum as well as the rough terminator.



The first telescopic drawing of the Moon, 1609 July 26, by Thomas Harriot. The Moon is 5 days old. One can identify Mare Crisium, Mare Tranquillitatis, and Mare Foecunditatis, and perhaps Lacus Somniorum, as well as the rough terminator.



Harriots map of the Moon drawn in 1610. This would have been drawn from several observations over many nights, as the telescopes at that time only would have shown a small area of the lunar surface giving a very restricted view, making drawing to scale and in proportion difficult.

of Jupiter, and an account of the comet of 1607, which was later to be named after the man who predicted its return, Edmund Halley. The most impressive of these accomplishments were his Moon maps. The maps were kept at Petworth House, another property of the Percy family, and were lost for over a century before being rediscovered by a visiting German astronomer, the Count de Bruhl, in 1785.

Harriot's last known observation was of the comet of December 1618. He died in July 1621, from a tumour on his nose, perhaps related to his tobacco consumption. He was buried in the Church of St Christopher le Stocks, Threadneedle Street, with an inscription by the Earl of Northumberland on his memorial stone. The church was demolished in 1784, to make way for the Bank of England. In the 1970's, a new memorial to Harriot, bearing Percy's inscription, was placed outside the Drawing Office of the Bank of England, close to where Harriot was buried. More pertinently for us, since 1970 he also has a crater named for him on the far side of the Moon.

So Harriot is one of history's nearly men. Had he published his observations we might now regard him with the same esteem as Galileo, who was never slow at publicizing his discoveries. Nonetheless his observation of July 26th 1609 deserves to be commemorated, and so, four hundred years later, we gathered to honour his name.

In the grounds of Syon Park there were kids' activities, including rocket launching and comet manufacture; trade stands, and displays by the Society for Popular Astronomy and the Campaign for Dark Skies. Outside the magnificent Conservatory, solar scopes were set up for sun observing, and inside several societies had displays, and the Explorer Dome mobile planetarium was set up for regular sessions. Thomas Harriot himself was strolling around the gardens, looking perky for a 449-year old; an Apollo astronaut, commemorating a more recent anniversary, could also be spotted, bearing a strong resemblance to Greg Smye-Rumsby,

Lord Egremont, current owner of Petworth House, unveiled a plaque.

Astronomy Now's illustrator. There were a series of talks through the day – I attended Ian Ridpath's lecture on the *"Apollo 11: First Men on the Moon"*, but I could have listened to Greg Smye-Rumbsby (*"Return to the Moon"*) or Matt Irvine, a BBC special effects man, on *"Living in Space"*.

My favorite Harriot-related activity was not astronomical at all. The Cantamus singers performed a concert of madrigals in the magnificent Italianate reception hall of Syon Park. Harriot would have recognized some of the songs. At the end of the concert we all piled out of the hall and headed towards the Conservatory. We don't know exactly where Thomas Harriot made his observation from, but it is thought that his house was just to the west of Syon House, approximately where the Conservatory is now. So, on the path connecting the two, a plaque has been erected. It is well-designed, describing Harriot's life and times and work in some detail, and highlighting his drawings of the Moon.

Thomas Harriot –looking perky for a 449-year old

A group of perhaps a hundred gathered around the plaque. There was some urgency to the proceedings, as we could see storm clouds beginning to gather over the park. Cantamus sang another madrigal. Then Lord Egremont, current owner of Petworth House, stepped forward, and unveiled the plaque, to applause and photographs. At last, Thomas Harriot had the recognition he deserved!

Everyone else beetled off to the Garden Marquee, to scoff a buffet and listen to Alan Chapman deliver, in his inimitable style, what I'm sure was an excellent lecture on the life of Thomas Harriot.

But I didn't have a ticket. So I went home instead.

Sources / Further Reading

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