

## **THE EARLIEST COMET PHOTOGRAPHS: USHERWOOD, BOND, AND DONATI 1858**

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Photography has been linked to astronomy since its inception. Even at the astronomer François Arago's announcement of Louis Jacques Mandé Daguerre's new process, at a joint meeting of the French Academy of Sciences and the French Academy of Arts in 1839, he gave the results of Daguerre's unsuccessful attempt to photograph the Moon.<sup>1</sup> Arago further held out great hopes for the future of photography in astronomy. Another astronomical link was the process of 'fixing' an image, supplied earlier by John Herschel and adopted by Daguerre.<sup>2</sup> In fact, it was Herschel who made the first photograph on glass in 1839, a photograph of his 40-foot telescope, and who was involved with many of the early chemical aspects of photography.

Daguerre's process immediately had a competitor. William Henry Fox Talbot's photographic process of making what we now call 'negatives' was announced only a few weeks after Daguerre's. (The terms 'positive' and 'negative' in photography were suggested in 1840 by Herschel.) Also in 1840, the first daguerreotype of the Moon was taken by J. W. Draper in New York. However, the use of large telescopes for photography took nearly a decade; the earliest attempts began at Harvard in 1847 and led to the first telescopic daguerreotype of the Moon in 1850.<sup>3</sup>

The individuals chiefly involved in adapting large telescopes for astronomical photography were William C. Bond, the Director of the Harvard College Observatory, and his son George P. Bond, later to be Director, in collaboration with the Boston daguerreotypists John Adams Whipple and his partner William B. Jones. It was only in 1851, when the ultraviolet focus of the Harvard 15-inch refractor was determined so that the daguerreotype blank could be properly placed, that greatly improved daguerreotypes of stars and of the Moon could be taken. The ultraviolet focus seemed to be half-an-inch behind the visual focus, and was later shown to be almost an inch still farther back.<sup>4</sup> But inadequacies in the telescope's drive prevented photography of faint objects, such as comets, and photography was not attempted at Harvard between 1852 and 1857, when the telescope's drive was rebuilt to provide a higher level of precision.<sup>5</sup> George Bond and Whipple were then joined by the Boston daguerreotypist James Wallace Black.

By the time Giovanni Battista Donati, in Florence, discovered a comet telescopically on 2 June 1858, photography had advanced greatly and was

1858. Sept 28. Donati's Comet Photography  
Took off the micrometer for photographing

236 18 37 Pendulum was lengthened 5 half-turns to regulate the comet's motion

Pendulum <sup>again</sup> lengthened 5 more in all 10 1/2 turns. Clock well regulated. Comet moves 3 in Dec.

Plate II

Exp. 2..00'  
1..00s  
0..30  
2..00

Plate I. had an Exp. of 2"

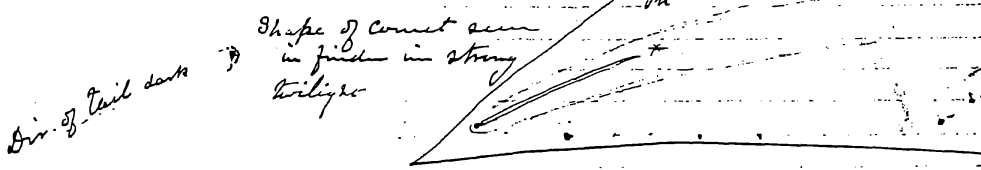
Plate III

Exp. 6..00'

Think this took. On Examination with Microscope. This plate exhibits an undoubted image of 15" diam - Oval.

Very not quite clear & clouded suddenly. Looked by glimpes at Comet. It increases very rapidly. Extremity of tail now reaches 1/2 from nucleus to \* K of 27<sup>th</sup>.

In the Comet seeker the dark outline of axis is distinct for 1° or 2° from nucleus and is 1/2 as broad as whole breadth of tail.



\* I have always seen this dark axis in the Comet seeker nearest to the faint concave side of tail.

FIG. 1. The page from Bond's observing notebook at the Great Refractor at Harvard on 28 September 1858, showing his collodion-plate observations of Donati's Comet.

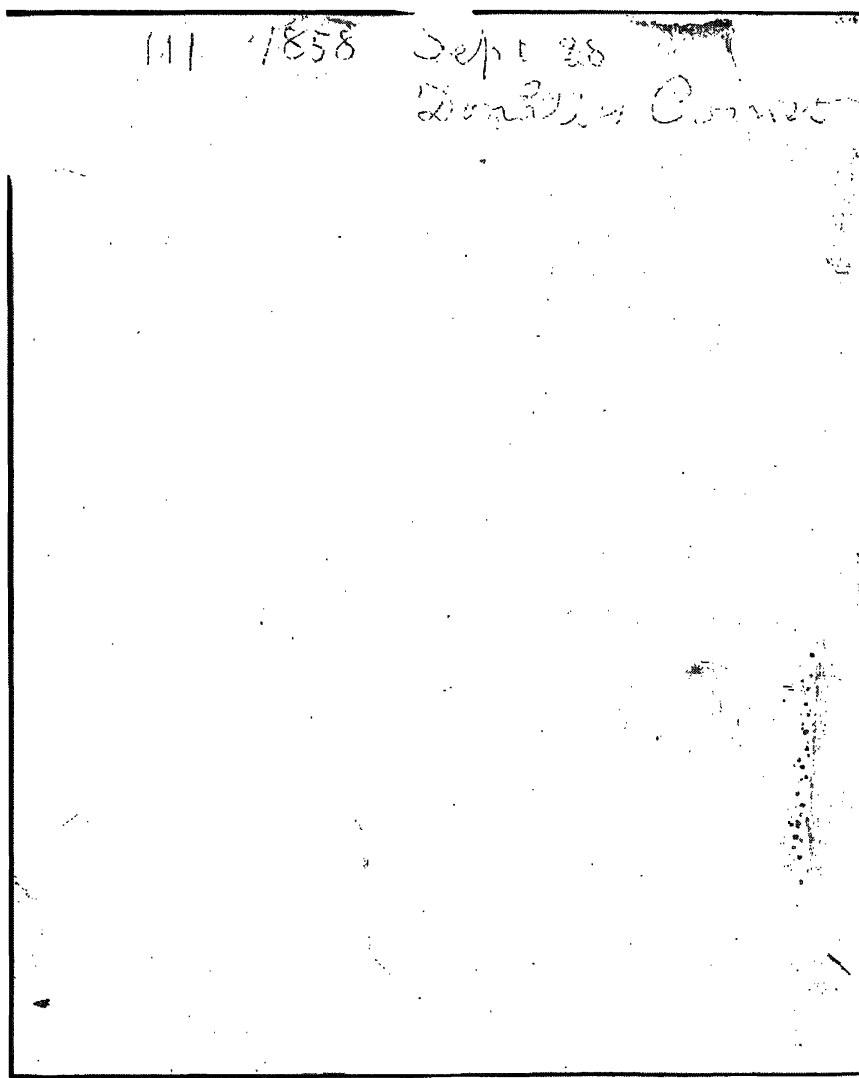


FIG. 2. G. P. Bond's Plate III from 28 September 1858, with the head of Donati's Comet as a tiny smudge in the middle.

undertaken widely. In addition, Donati's Comet (C/1858 L1, formerly 1858 VI) was exceptionally bright and was visible to the naked eye for an exceptionally lengthy period, from 19 August to 4 December, making it a logical object to photograph. At the time, collodion-coated glass plates were proving a better surface than daguerreotypes for astronomical use as they were for other purposes. These 'wet plates' required the application of the collodion, guncotton dissolved in alcohol and ether, just before the exposure was made.

Therefore, it is not surprising that the apparition of Donati's Comet led to the first attempts known to photograph a comet. George Bond tried to photograph the comet on 28 September 1858, at Harvard with the 15-inch refractor. Figure 1 shows a page of Bond's observing notebook,<sup>6</sup> which was kept in pencil with

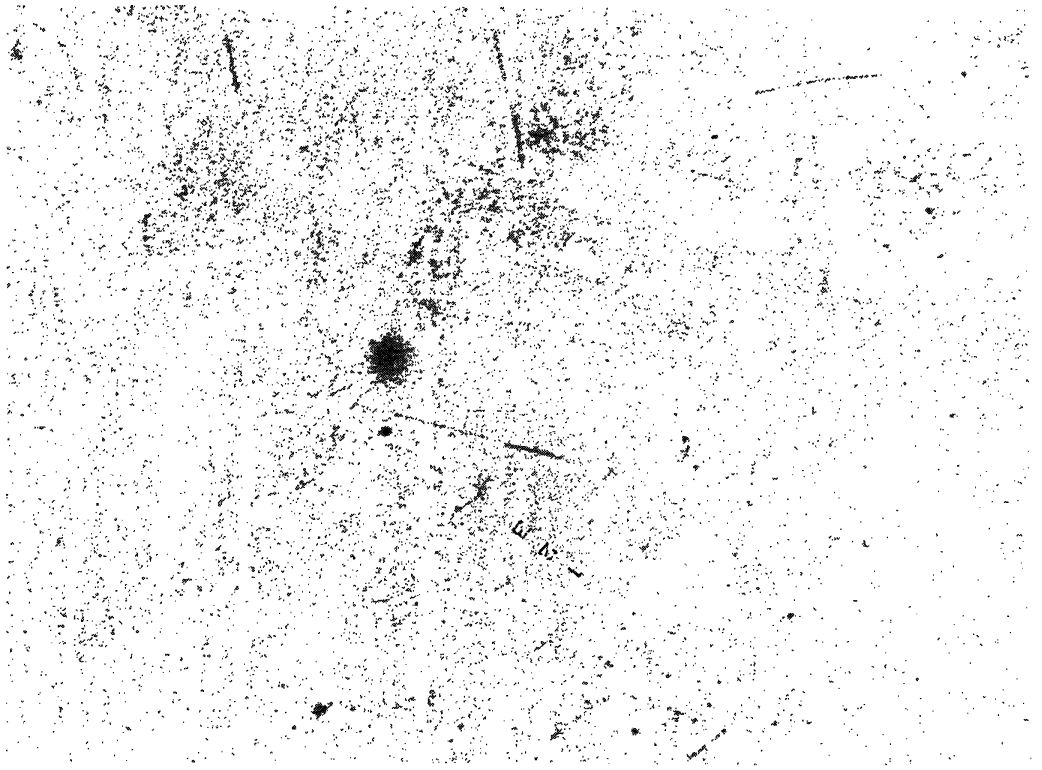


FIG. 3. Detail of the head of Donati's Comet from Bond's Plate III from 28 September 1858.

later comments added in pen, as was the custom at Harvard. Bond originally wrote, in pencil, about the six-minute exposure on his third plate, "Think this took", after unsuccessful  $\frac{1}{2}$ , 1, and 2 minutes exposures on his second plate. Later, he added, in pen, "On Examination with Microscope, this plate exhibits an undoubted image of 15" [seconds] diameter — oval". Bond sketched the comet in this observing notebook as seen in the "Comet Seeker", a smaller telescope with a lower focal ratio. In Bond's *An account of Donati's Comet of 1858*, his only comment on the photograph was "On the 28th, the image of the nucleus in the focus of the large refractor afforded distinct photographic action, but the surrounding luminosity was not intense enough to form a picture".<sup>7</sup> He later reported that an "attempt was made to photograph the image of the Comet in the focus of the Great Refractor, but only the nucleus and a little nebulosity 15" in diameter acted on the plate in an exposure of six minutes".<sup>8</sup>

Bond's Plate III<sup>9</sup> (Figure 2), which is kept at the Harvard College Observatory Plate Stacks, shows the brush marks from spreading the light-sensitive surface. In the middle is a ball of grains representing the comet in this 6-minute exposure. A close-up (Figure 3) shows the comet. Only the head was captured in the image. This is the first time that it has been published.<sup>10</sup>

Bond's photograph was not always remembered. Barnard, near the turn of the century, for example, thought that the first comet to be photographed had been

in 1881,<sup>11</sup> while others primarily recall David Gill's photographs of 1882. We can now supply some new details relevant to the story of the photography of Donati's Comet in 1858.

Most recently, Yeomans described the basics in his book on comets,<sup>12</sup> as had Daniel Norman, Dorrit Hoffleit, and Gérard de Vaucouleurs in their various writings on astronomical photography. It seems that Bond was scooped, the night before, by an English commercial photographer named Usherwood,<sup>13</sup> although nothing else about him, other than his surname, has hitherto been published. For example, in the official *History of the Royal Astronomical Society*, E. H. Grove-Hills reported in 1923 that "the only recorded photograph is one taken by Mr. Usherwood on Walton Common with a stationary camera furnished with a portrait lens of short focus.... We must content ourselves with noting the fact that Mr. Usherwood's was the first photograph taken of a comet."<sup>14</sup>

This report echoes the only published contemporary reference to Mr Usherwood, from the *Monthly notices of the Royal Astronomical Society* in 1859, which characterized him as "an artist residing on Walton Common", who

succeeded in obtaining, in seven seconds, a good negative with a portrait lens of short focus. The camera was stationary, hence the image is somewhat imperfect; nevertheless it bears enlargement of four times tolerably well. Mr. Usherwood's residence is situated about 700 feet above sea-level, and it is possible that his success is in some degree attributable to this



FIG. 4. William Usherwood's shop in Dorking, Surrey. Courtesy of the Surrey Archaeological Society.



FIG. 5. William Usherwood during his retirement, his wife, and two of their thirteen children then living. He survived until the age of 96.

circumstance, but it is chiefly due to the large area of the portrait lens and the relative shortness of its focal distance.<sup>15</sup>

Nothing else about Usherwood or about the observation was published, neither his first name nor the location of Walton Common.<sup>16</sup> Not even the date of his photograph is given.

We have learned<sup>17</sup> that Usherwood had a shop front with his name over the door in Dorking, near Reigate, Surrey. One of the two photographs we have of it (Figure 4) reveals his first initial as ‘W’. Moreover, Usherwood was listed as a portrait painter in the 1862 Dorking Post Office Directory; by 1867 he was a “Portrait Painter and Photographer”, while by 1874 he was listed as a “Photographer” only, thus revealing the ascendancy of photography.<sup>18</sup> Walton Common, which is common land near Walton-on-the-Hill, is close to Reigate, which is some 20 miles south of London.

Usherwood’s obituary in the *Dorking and Leatherhead advertiser*<sup>19</sup> in 1916 gave additional information. “Many people remember the time when the photographic business at Shrub House, now carried on by Mr. J. W. Moorhouse, was

controlled by Mr. William Usherwood, but few there are who remember its establishment in 1860.” His obituary also notes that Usherwood was a painter, revealing an interesting link between art and science, and had made some significant sales. Further, the obituary reproduces a photograph of Usherwood himself. The Dorking & District Museum has another photograph that includes him (Figure 5).

An important discussion relevant to technical aspects of comet photography is found in the correspondence between George Bond and the well-known British amateur astronomer Richard C. Carrington. In a letter that Bond wrote to Carrington on 4 April 1858 on other matters, he mentioned: “We obtained a photograph of the Comet on Sept. 28th. On Oct 5th it was visible in the daytime.”<sup>20</sup>

Carrington later wrote on 26 May 1859: “Herewith I send a copy of Usherwood’s photograph of Donati’s Comet, same size as the original on plate, of which he has obliged me with 4 or 5 copies for distribution.”<sup>21</sup> No mention is made of the date of the photograph, and indeed Bond responded by requesting the date.

Writing to Carrington on 11 June 1858, Bond replied:<sup>22</sup>

I ... am so much interested in the photograph which you had the kindness to send that I cannot help sitting down at once to thank you for the favor.

Here is a very singular fact. The camera lens, with its short focus, affords a strong image of the *nebulosity* of the tail at a point where the *intensity* of the light was probably a thousand times less than that of the nucleus. And this, too, in seven *seconds*.... Whereas, with an object glass of probably eight or ten times the area, we barely obtained an impression of the *nucleus* itself in 360 seconds on the following day, September 28.<sup>23</sup>

There is nothing to tell us why Bond gave priority to Usherwood by one day. Perhaps something was written on the photograph itself. On the next pages, Bond notes:

I have long thought that there was a kind of sympathy in the photographic action[,] light acting at one point rendering neighboring points more sensitive and that possibly a star image slightly out of focus might ‘take’ quicker than when reduced to a minimum area. If this theory be true then a poor telescope would be better than a good one, which would be introducing a new principle in practical astronomy.<sup>24</sup>

(Indeed, astronomers still use out of focus star images for accurately assessing brightnesses.)

Very interesting is Bond’s concluding postscript: “I take the liberty of enclosing two notes with the request that you will forward them. Mr. Usherwood’s address I do not know. I have written to him for particulars about the photograph.”<sup>25</sup>

The Harvard University Archives contains not only a copy of Bond’s letter to

Usherwood written on 11 June 1859, but also, wonderfully, Usherwood's reply, which includes new information about the photograph and the camera that took it. The form of address used by Bond, "— Underwood Esq.", shows that he did not know Usherwood's first name.

Mr Carrington, Secretary of the Royal Astronomical Society, has had the kindness to forward to me a copy of the photograph of the comet taken by you in Sept. last. It has interested me so much that I take the liberty of addressing you for some further particulars respecting it. Will you have the kindness to inform me of the size of the camera, its aperture & focal length. the time of exposure. the date when the picture was taken. Is the copy of the same size with the original and lastly was there any particularity in the preparation of the plates? By an answer to the above you will greatly oblige....<sup>26</sup>

Usherwood's replied with the following details:

I recd your letter of Mr Carrington & in reply I beg to state that the Plate sent to you by Mr C is a copy the same size with the original negative my camera is for plates nine inch square Lens three & a quarter inch. a Portrait Lens twelve inch focal length Time of exposure from seven to nine seconds The Development by Gallic acid and acetate of Lead. then the Collodion was prepared by my self. I think it was on the 27 of Sep<sup>t</sup> last I did the negative.<sup>27</sup>

So the first source we have found for the date of 27 September for Usherwood's photograph (other than Bond's remark) was Usherwood's uncertain memory, from months after the fact. Perhaps Usherwood's tentative statement of the date should make everyone question the chronology.

Usherwood not only provides the value of the focal length but also gives a range for the exposure time: 7 to 9 seconds, instead of the 7 seconds given in the *Monthly notices*. His figures for focal length and objective diameter — which are obviously definitive — give  $f/3.7$ , compared with the  $f/2.4$  that Daniel Norman calculated from Bond's assumption for unknown reasons of 12-inch focal length and 5-inch aperture. Because Usherwood seems unsure of the date of his photograph, it seems possible that it did not even precede Bond's.

The only contemporary reference to Usherwood's photograph in England, in the *Monthly notices* for 1859, did not refer to Bond's photograph.<sup>28</sup> Though Bond mentioned his photograph without qualification to Carrington, he minimized its importance when writing for publication, perhaps because the image was so tiny and because no tail showed. In his *magnum opus* of 1862 on Donati's Comet, he mentioned his photograph in one place<sup>29</sup> and Usherwood's in two places.<sup>30</sup>

As Norman stated in 1938, "Although it has been assumed for many years that Bond took the first photograph ever made of a comet (Donati's comet of 1858), an English commercial photographer named Usherwood actually preceded him by two days [*sic*], and succeeded in photographing the comet's



magnificent tail, where Bond succeeded only in photographing its nucleus”.<sup>31</sup> However, as the correspondence shows, not only is Norman’s “two days” contradicted by Usherwood’s letter, but the order of priority is itself not beyond doubt.

In his article, Norman calculated, on the basis of the relative sizes and focal lengths, that not only was Usherwood’s lens faster but also he must have had a much more sensitive collodion plate.<sup>32</sup> The knowledge that Usherwood’s lens was not in fact as fast as Norman thought strengthens that conclusion. But since an  $f/3.7$  lens is easier to produce than an  $f/2.4$  lens, it may be easier to understand the answer to Norman’s conundrum, “There remains, however, the mystery of where Usherwood obtained a photographic lens of so large an aperture and so small a focal ratio at that early date. Did he make it himself?”<sup>33</sup> Because of its larger focal ratio, the lens that Usherwood actually had was not as difficult to obtain as the lens Norman believed him to have had.

There is no trace today of the Usherwood photograph that was sent to Harvard, a full-size copy (as we learn from Usherwood’s letter) and therefore presumably a contact print onto either paper or another collodion plate. Moreover, we have not encountered, in our searches in England and America, any reference to the present existence of the original or of any copies. In fact, by the turn of the century, the Harvard copy was known to be lost. As Edward S. Holden, Director of the Lick Observatory, wrote in 1897, referring to the print of Usherwood’s photograph that Carrington sent to Bond, “Carrington’s enclosed photograph is not now to be found, I believe. The photograph was unknown to Dr. De la Rue, apparently.... Both these photographs — the first ever made of comets — have remained unnoticed by all the historians of astronomical photography, up to this time, so far as I know.”<sup>34</sup>

Though Warren De La Rue, in England, was very interested in photography, his attempt to make his own photograph of Donati’s Comet with his 33-cm (13-inch) telescope failed.<sup>35</sup> De La Rue, who served as President of the Royal Astronomical Society, was awarded the Society’s Gold Medal for his work on astronomical photography.

... [Mr. De La Rue] informs the Council that he made one attempt to obtain a photograph of Donati’s comet, but that he did not obtain any trace of an image in 60 seconds; this he thinks attributable to the low altitude of the comet at the hour he made the experiment, and not to want of requisite brightness of the comet itself. A severe domestic calamity [!] prevented a repetition of the experiment under more favourable circumstances.

De La Rue had been inspired originally by viewing Bond’s lunar daguerreotypes of 1851 at the Great Exhibition in London, and the next year built his 33-cm reflector. His attempts to photograph the Moon with wet plates failed because he had no drive; he acquired a drive and returned to lunar photography in 1857. As Lankford describes, “During the 1850s various tyros dabbled with

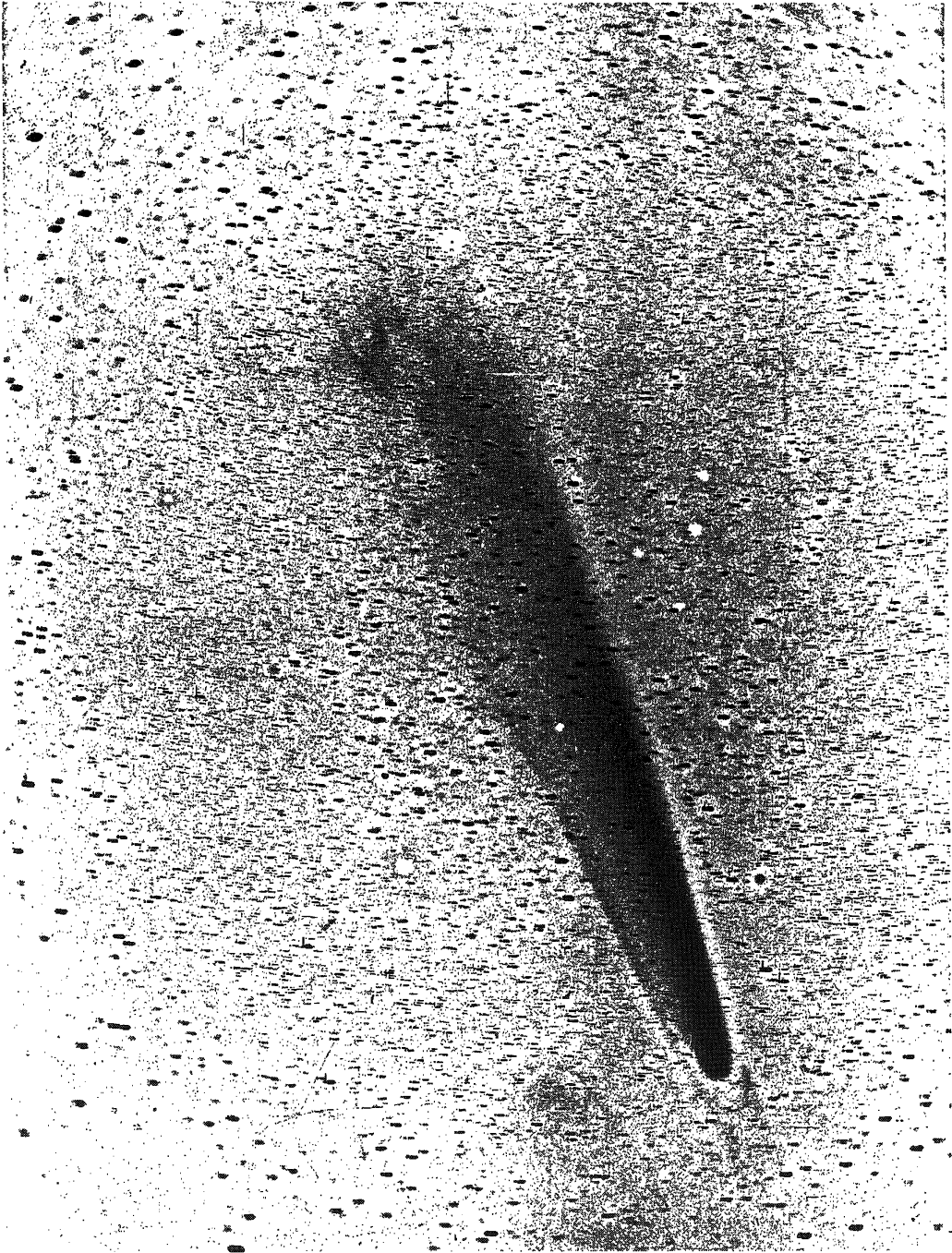


FIG. 6. David Gill's photograph of the Comet of 1882, enhanced in Photolabs of the Royal Observatory, Edinburgh. Copyright 1983 Royal Observatory, Edinburgh.

astronomical photography, but after Bond at Harvard the only sustained investigations were those carried out by De la Rue".<sup>36</sup>

The Royal Astronomical Society, at the time of their only contemporary publication on the photography of Donati's Comet, knew only of Usherwood's photograph, but not that of Bond. "So far as the Council has been informed this is the only instance of a photograph of Donati's comet having been obtained."<sup>37</sup>

After Donati's Comet of 1858, no comet was photographed until Comet Tebbutt in 1881. A. Ainslie Common even wrote in his report on the photography of this later comet, that he thought it was the first comet photograph ever taken:

This is, I believe, the first comet that has been photographed, and it had not been visible very long before attempts were made in America, in France, and here [England] to take its portrait so to speak. M. Janssen in France and Dr. H. Draper in America, as we very quickly heard, soon succeeded. I fear, however, that these pictures are only interesting as an experiment, and unless we get a comet very much brighter and whose motion is more slow (and I hope we shall) the effort to get a useful picture will be of little avail.<sup>38</sup>

Several astronomers photographed Comet Tebbutt (C/1881 K1, formerly 1881 III) and its spectrum.<sup>39</sup> In his book on *Astronomical photography*, the late Gérard de Vaucouleurs reproduced an image by Pierre Jules César Janssen made at Meudon on 30 June 1881.<sup>40</sup> It is a 30-minute exposure on a dry plate with a 20-inch reflector at f/3, and shows the tail nicely, 2.5° in length. Unfortunately, our inquiries at Meudon and Paris did not turn up the original. A query from us to Dr de Vaucouleurs, asking for a photographic print, was on his desk at the time of his death, and, sadly, was recently returned to us. Photographs of this comet by William Huggins and Henry Draper (J. W. Draper's son) were listed in a table by Dorrit Hoffleit in her booklet on early astronomical photography.<sup>41</sup>

De Vaucouleurs also reproduced two photographs of the Great September Comet of 1882 (C/1882 R1) by David Gill, made at the Cape of Good Hope with a 2.5-inch lens at f/4.4, with a 30-minute exposure on 19 October 1882, and a 110-minute exposure on 7 November 1882, respectively.<sup>42</sup> Gill's photographs of this comet are the most widely known of early comet photographs<sup>43</sup> (Figure 6 is a recently enhanced print of one of them<sup>44</sup>). It was these photographs by Gill, which showed many more stars than expected, that led to the Carte du Ciel project, which was to dominate European astronomy for so many years and, as it turned out, impede its development in other areas.<sup>45</sup>

To summarize, Donati's Comet of 1858 was the first comet successfully photographed. The collodion plate taken by Usherwood in 1858 is probably, but not definitively, the earliest comet photograph. In any case, this plate and all prints made from it appear to be lost. Therefore, the oldest extant comet photograph is Bond's collodion plate, which shows only the head of the comet. If Usherwood's recollection of the date of his photograph is slightly off, Bond's plate may even

be the first comet photograph ever taken. Further, the oldest extant photographs we have found that show a comet's tail are three blurred plates by Draper and a reproduction of Janssen's 1881 exposure. The oldest photographic plate or print that we know of that clearly shows a comet's tail is Gill's from 1882. Thus the story of early comet photography is a broken chain indeed.

### *Acknowledgements*

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### REFERENCES

1. F. Arago, "Le Daguerrotypage", *Comptes rendus des séances de l'Académie des Sciences*, ix (1839), 250–67, pp. 262–3, writes: "La préparation sur laquelle M. Daguerre opère, est un réactif beaucoup plus sensible à l'action de la lumière que tous ceux dont on s'était servi jusqu'ici. Jamais les rayons de la lune, nous ne disons pas à l'état naturel, mais condensés au foyer de la plus grande lentille, au foyer du plus large miroir réfléchissant, n'avaient produit d'effet physique perceptible. Les lames de plaqué préparés par M. Daguerre, blanchissent au contraire tel point sous l'action de ces mêmes rayons et des opérations qui lui succèdent, qu'il est permis d'espérer qu'on pourra faire des cartes photographiques de notre satellite." Translated, it reads: "Never had the rays of the Moon, not necessarily in its natural state but condensed in the mechanism of a great lens or a large reflecting mirror, produced any physical or perceptible effect. The plate prepared by M. Daguerre whitens on the contrary to such a point under the action of these very rays and the operations that follow so that we can hope that we will be able to make photographic maps of our satellite." So apparently the disk of the Moon appeared but without features.
2. D. Hoffleit, *Some firsts in astronomical photography* (Cambridge, Mass., 1950), 10. Dr Hoffleit writes (21 January 1996) that her booklet accompanied an exhibition at the Fogg Museum of Harvard University to commemorate the hundredth anniversary of the first stellar photograph. No comet photograph was in the exhibition.
3. M. S. Barger, "The Moon, 6 August 1851", in *1989 annual report, The Christian A. Johnson Memorial Gallery, Middlebury College* (Middlebury, Vermont, 1990), 9. See also B. Z. Jones and L. G. Boyd, *The Harvard College Observatory: The first four directorships, 1839–1919* (Cambridge, Mass., 1971), 71–87. Donald Trombino and John Pazmino inform us (1996) that the daguerreotype of the Moon referred to in Barger's footnote 5 and described in D. F. Trombino, "Dr. John William Draper", *Journal of the British Astronomical Association*, xc (1980), 565–71, matches in detailed markings on the metal plates a set of faded daguerreotypes filed at the New York University Archives and clearly labelled that they were taken by W. C. Draper. The circumstance leaves them no doubt that the daguerreotype Pazmino purchased in a Greenwich Village bookstore in the 1970s is the lost one, the best of Draper's lunar daguerreotypes from 1840 (since the ones at New York University have all faded and show no lunar detail); they conclude that it is the one exhibited at the New York Lyceum and long thought to have been destroyed. Dennis di Cicco (private communication, 1996) holds that the matter is still in doubt because the image shows more features on the Moon than implied by Draper's comments about his daguerreotype.
4. Hoffleit, *op. cit.* (ref. 2), 27–28.

5. D. Norman, "The development of astronomical photography", *Osiris*, v (1938), 560–94, pp. 569–70. Dr Hoffleit writes (21 January 1996) that she discovered this article only when her own pamphlet was in press, and reports "Now, at any rate, it must be said that the two papers were entirely independently researched". Some of the material appears as D. Hoffleit, "The first star photograph", *Sky & telescope*, ix, issue of July 1950, cover and 207–10. She concludes, "But, although the collodion process had proved its superiority, it, too, was apparently abandoned (at least at the 15-inch) after the summer of 1860. Not until dry plates came into use was celestial photography actively resumed at Harvard, when in the 1880's W. H. Pickering's inspiration and E. C. Pickering's foresight and administration started the world's largest library of celestial photographs".
6. The record book for the 15-inch telescope that recorded the photography of Donati's Comet is stored in the Harvard Deposit Library in box no. C0004. (This numbering scheme, in the Harvard Deposit Library, supersedes the older KG 11365.167 call number from the Archives.) The book is numbered H.28 and is entitled "Equatorial Book VII, 1858, Sept. 25 to Nov. 11th". Comments added later were written in ink, but in general the notes are in graphite. At the focus of the 15-inch refractor, 15" corresponds to 0.5 mm. The page is headed by the following inscription: "1858. Sept 28. Donati's Comet. Photography." It seems from Bond's notes that he was working on regulating the rate at which the telescope was driving, to keep up with the comet's motion, which is different from the rate at which the stars move. Later in this passage, Bond added (in ink): "On Examination with Microscope this plate exhibits an undoubted image of 15" diameter — oval." Further down the page, he noted (in pencil), "Looked by glimpses at Comet. It increases very rapidly. Extremity of tail now reaches 2/3 from nucleus to \* K of 27th". Below the sketch he added, "I have always seen this dark axis in the Comet seeker nearest to the faint concave side of tail". Bond has also indicated it in the sketch.
7. G. P. Bond, *An account of Donati's Comet of 1858* (Cambridge, Mass., 1858), 16. (Reprinted from "An account of the comet of Donati. 1858", *Mathematical monthly*, i (1858), 61–67 and 88–116, p. 96).
8. G. P. Bond, "Account of the Great Comet of 1858", *Annals of the Astronomical Observatory of Harvard College*, iii (1862), 210.
9. Plates I and III are in the Harvard College Observatory plate collection; Plate II is missing. We could see an image only on Plate III, matching Bond's comment. The plates and miscellaneous daguerreotypes are in a "Treasure Cabinet" kept in the plate collection. Dorrit Hoffleit (21 January 1996) recalls: "All the antique treasure plates at Harvard used to be kept in Dr. Shapley's office in a special locked Treasure Cabinet. I remember well the pleasure I had going through everything in that sanctified cabinet."
10. Curiously, Bond's 1859 Director's Report of the Harvard College Observatory states, "In addition there have been published:—Notice of a photograph of the Comet of Donati, 1858". This notice does not exist in the Harvard University Archives, nor do the Director's Reports from previous years. No other mention of Donati's Comet appears in this 1859 Director's Report. (G. P. Bond, included in the *Report of the Committee of the Overseers of Harvard College appointed to visit the Observatory in the year 1859* (Boston, 1860), 21; Harvard University Archives HUF 165.59.75. Norman, *op. cit.* (ref. 5), p. 575, refers, incorrectly by one year, to "page 21 of the Report of the Director of the Harvard Observatory for the year 1858".)
11. E. E. Barnard, "The development of photography in astronomy", *Popular astronomy*, vi (1898), 425–55, p. 438.
12. D. K. Yeomans, *Comets: A chronological history of observation, science, myth, and folklore* (New York, 1991), 205, describes Usherwood's and Bond's work and Bond's letter to Carrington thanking him for sending Usherwood's photograph.
13. G. de Vaucouleurs, in *Astronomical photography: From the Daguerreotype to the electron camera*, transl. by R. Wright (London, 1961), 41, writes: "Donati's great comet of 1858 was the first any one tried to photograph; but only the photographer, Usherwood, using a short-focus portrait lens, succeeded in obtaining a small overall view with a 7-second exposure; W. de la Rue could not get an image of it with his 13-inch telescope, whose f/9 focal ratio was too slow for this type of observation, nor did he manage to record the comet of 1861."

14. E. H. Grove-Hills, "The decade 1850–1860", in J. L. E. Dreyer and H. H. Turner (eds), *History of the Royal Astronomical Society 1820–1920* (London, 1923; reprinted Oxford, 1987), 110–28, p. 113.
15. Anonymous, "Report of the Council", *Monthly notices of the Royal Astronomical Society*, xix (1859), 138–9; quoted in Norman, *op. cit.* (ref. 5), 575–6.
16. Usherwood does not appear in the *International guide to nineteenth century photographers* (Boston, 1988), or *Nineteenth century photography: An annotated bibliography, 1839–1879* (Boston, 1990). We thank Pamela Roberts for trying to find any reference to Usherwood at the Royal Photographic Society, Bath, and the National Museum of Film, Photography, and Television, Bradford; and Peter Hingley for checking that Usherwood had not been a Fellow of the Royal Astronomical Society.
17. Notification of our search was widely disseminated in J. M. Pasachoff, "Not so common", *New scientist*, no. 1993 (2 September 1995), 51. We thank especially Jeffrey Hill of Reigate, who provided the conclusive links to Usherwood himself, for finding the photograph of Usherwood's photographic establishment in J. Janaway's book, *Surrey — A photographic record* (Newbury, Berks, 1984), and for photographic prints of these images. In addition, we thank Ted Swystun and Diane Walker, who also made the identifications of name and location, as well as Roger Griffin, Don Simpson, Elliot Aylwin, Mike Rees, and John Goodier, who all identified the location of Usherwood's observing site.  
The photographs are in the Surrey Archaeological Society in *The Lyne scrapbook for Dorking*. We also thank Duncan Mirylees of the Surrey Local Studies Library.
18. We are grateful to Brian Overell of the Dorking & District Museum for the information on Usherwood's directory listings, for providing us with Usherwood's obituary and retirement photograph and with information on how to obtain the photographs of Usherwood's shop, and for information from Alan A. Jackson (ed.), *Around Dorking in old photographs* (Far Thrupp, Stroud, Gloucestershire, 1989). We thank Alan Sutton, the publisher, for his correspondence.
19. Available in a scrapbook in the Dorking & District Museum; no additional information appears, other than the month and year. The photograph of Usherwood used in the obituary was cropped from a photograph of Usherwood and his wife published on the occasion of their 70th wedding anniversary in *The Dorking and Leatherhead advertiser*, 25 October 1913. It was taken by J. W. Moorhouse, the successor in his photographic business. The accompanying article states that "Mr. Usherwood was undoubtedly a master of his craft. He had the honour of painting portraits of Queen Victoria and Princess Alice for the Duchess of Gloucester".
20. Bond mss., Harvard University Archives, UAV 630.6, Carrington folder. Carrington's folder contains many documents, none dated between this letter and Bond's reply.
21. Bond mss., Harvard University Archives, UAV 630.6, Carrington folder.
22. An abridged version appears in E. S. Holden, *Memorials of William Cranch Bond and of his son George Phillips Bond* (San Francisco and New York, 1897), 167.
23. Bond mss., Harvard University Archives, UAV 630.6, Carrington folder, 1. Norman, *op. cit.* (ref. 5), 576, who quotes this section of the letter, adds: "But with a focal ratio of  $f/15$  compared to Usherwood's  $f/2.4$ ." His values for these parameters are based on Bond's letter to Usherwood, which assumed a "12-inch focus and 5-inch aperture", stating in a footnote: "Since Bond had accurate measures of the extent of the comet's tail, he could undoubtedly obtain the focal length of the camera from the photograph, but there is no indication of the data that led him to assume a 5-inch aperture." The advantages of Usherwood's collodion plate over Bond's and the speed of his camera are discussed by R. K. M. [Roy K. Marshall], "Astronomical anecdotes: More photographic 'firsts'; sky surveys", *The sky*, v, issue of September 1941, 16.
24. Bond mss., Harvard University Archives, UAV 630.6, Carrington folder, 2–3.
25. *Ibid.*, 4. Holden, *op. cit.* (ref. 22) does not include the final page with its direct reference to Usherwood. This omission misled Norman, *op. cit.* (ref. 5), who wrote (p. 576), "The only other relevant document [to the *Monthly notices* report] is a letter of Bond's which can refer only to this photograph, although Usherwood's name is nowhere mentioned". The handwritten copies of Bond's letters to Carrington and Usherwood, and Usherwood's original reply, are in the Harvard University Archives, Harvard College Observatory papers, Records of the Director, G. P. Bond,



11 June 1859, UAV 630.6. We thank Virginia Smyers of the Harvard University Archives for her assistance. She informs us that the Usherwood letter, although undated, is filed with Bond's letters to Carrington and from him, and that it is not obvious from how the letters are filed in the Archives what the second letter mentioned by Bond in his letter to Carrington might be. Referring to Bond's letter, Holden writes in a footnote (p. 168), "Until this letter became known, the historians of astronomical photography supposed the first comet photographs to be those of 1881".

26. Bond mss., Harvard University Archives, UAV 630.6, Usherwood folder. The folder contains only Bond's letter to Usherwood and the reply.
27. *Ibid.*
28. Anonymous, "Report of the Council" (ref. 15), 138–9.
29. Bond, *op. cit.* (ref. 8), 210, in the section on "Nucleus and envelopes". The comet's tail was about 20° long at the time, and in the description of 2 October, only five days later, Bond commented that "The Comet's head much brighter than *Arcturus*" (p. 224).
30. Bond, *op. cit.* (ref. 8), for 27 September (p. 23), wrote:

WALTON COMMON, ENG. USHERWOOD. (*Monthly Notices Royal Astr. Soc.*, Vol. XIX, p. 139.)  
A copy from the photograph of the Comet here noticed has been communicated to me by R. C. Carrington, Esq.

In his introductory "List of authorities for observations, drawings, &c. used in this Work" (pp. xvii–xix), he listed:

USHERWOOD, Walton Common, Eng., *Monthly Notices Royal Astr. Soc.*, Vol. XIX. Also copy of photograph of the Comet.

From the correspondence, we now see that the "copy of photograph of the Comet" was the one in Bond's possession and not the one that has sent people looking in vain in the *Monthly notices*.

31. Norman, *op. cit.* (ref. 5), 576.
32. Norman, *ibid.*, also notes that variations in sensitivity of collodion plates at the time were significant.
33. *Ibid.*
34. No one at either the Harvard College Observatory or the Harvard University Archives knows of the photograph. Neither Peter Hingley of the Royal Astronomical Society nor Adam Perkins of the Cambridge University Library, Royal Greenwich Observatory Archives, has been able to locate a copy. Perkins has located (RGO 6/102 f110) a note from Bond to G. B. Airy, the Astronomer Royal, dated 1861 March 14, describing a plate of the comet (RGO 6/102 f111): "Enclosed is a proof from one of the plates to accompany an account of the Great Comet of 1858 which will form the next volume of our Annals. The difficulties of engraving objects of this character are very great but you will see that the artist has succeeded well." However, there is no mention of Usherwood or photography. Such problems of reproduction are dealt with by A. S. Pang, "Victorian observing practices, printing technology, and representations of the solar corona, (1): The 1860s and 1870s", *Journal for the history of astronomy*, xxv (1994), 249–74. The full quotation from E. S. H., "Notices from the Lick Observatory, Photographs of Donati's Comet in September 1858", *Publications of the Astronomical Society of the Pacific*, ix (1897), 89, reads: "Mr. Carrington sends another photograph of the comet to Bond, taken on September 27th by ??? [sic] with an exposure of 7 seconds, using a camera lens.... Carrington's enclosed photograph is not now to be found, I believe. The photograph was unknown to Dr. De la Rue, apparently (see *Monthly Notices*, R.A.S., Vol. XIX, p. 353). Both these photographs — the first ever made of comets — have remained unnoticed by all the historians of astronomical photography, up to this time, so far as I know."
35. Anonymous, "Report of the Council" (ref. 15), 138–9. De La Rue made drawings of Donati's Comet, some of which were engraved in W. De La Rue, "Observations on Donati's Comet. 6: Observations by Mr. Warren De la Rue", *Memoirs of the Royal Astronomical Society*, xxx (1862), 78–84, Plates VII–VIII, Figures 1–9. De La Rue adds on p. 84: "Two attempts were made to obtain photographs of the comet with my Newtonian, but without success, although I allowed on the last occasion five minutes' exposure of the sensitive plate." For a summary of

- De La Rue's work on astronomical photography, see anonymous, "How Mr. De la Rue Photographed the Moon", *The British journal of photography*, xv (1868), 256–7, 270–1, 279–81.
36. J. Lankford, "The impact of photography on astronomy", in *The general history of astronomy*, iv: *Astrophysics and twentieth-century astronomy to 1950*, ed. by O. Gingerich, Part A (Cambridge, 1984), 16–39, p. 17.
37. Anonymous, "Report of the Council" (ref. 15), 139.
38. A. A. Common, "Photography as applied to Comet b 1881", *The observatory*, iv (1881), 232–3, p. 232. In the address awarding him the Gold Medal of the Royal Astronomical Society (*Monthly notices of the Royal Astronomical Society*, xlv (1884), 221–3), the President, E. J. Stone, said: "Thus availing himself of every increase of the sensitiveness of the prepared photographic plates and continually improving the control of the driving-clock, Mr. Common was able, on 1881 June 24, to obtain a photograph of the Comet b, which is probably the earliest successful photograph of any comet (although a photograph of the comet was obtained on the same night by Dr. Draper)..." As for the photograph, Common writes: "I went on to 20 minutes, finding with this latter exposure a result that I ought to have anticipated, but did not; this was that the rapid motion in declination, not being provided for, caused the image to be a trail on the plate some quarter of an inch long. As far as it went the picture was good — that is, it shows the nucleus, head, and part of the tail, more particularly that part, narrow and bright, that proceeded from the nucleus."
39. W. Huggins, "On the photographic spectrum of Comet b 1881", *The observatory*, iv (1881), 233–4 (from the *Proceedings of the Royal Society*, no. 213). The entire contribution of H. Draper, "Photographs of Comet b 1881", *The observatory*, iv (1881), 239, reads:
- SIR, —
- I succeeded in photographing the Comet in Auriga on Friday night, June 24th, 1881. Since then I have taken several photographs of it. One made last night [no date was printed] with an exposure of 2 hours 42 minutes shows the tail about 10° long. There are many stars on the plate, some shining through the tail.
- Yours faithfully,  
HENRY DRAPER, M.D.
- 271 Madison Avenue, New York.
- Draper went on, in "Note on photographs of the spectrum of Comet b 1881", *ibid.*, 252–3, to describe his photographic spectra. Tebbutt described his discovery of the comet in "Appearance of another southern comet (Comet b 1881)", *ibid.*, 239–40. Three images of the comet made by Draper between 24 June and the time of Janssen's image are at the Hastings Historical Society, Hastings-on-Hudson, New York. Taken on 24 June (17 minute exposure), 25 June (41 minute exposure), and 28 June (4[?] minute exposure), they show extreme trailing, so that the tail does not appear clearly, unlike the 2 hour 42 minute exposure cited by Draper, whose whereabouts are unknown. We thank Muriel Olssen of the Society for her assistance. Neither the 2 hour 42 minute exposure discussed by Draper nor any other comet images exist at the Draper Archive at New York University's Bobst Library (for this information we thank Nancy Cricco), nor at the National Museum of American History of the Smithsonian Institution (for this information we thank Steven Turner).
40. De Vaucouleurs, *op. cit.* (ref. 13), Plate 8. He quotes (*ibid.*, 41–43) Janssen's discussion of the difficulty of photographing comets and the importance of the new dry plates and a fast (f/3) telescope.
41. Hoffleit, *op. cit.* (ref. 2), 37. She writes (21 January 1996): "As for Tebbutt's comet III 1881, my references to Huggins and Draper are unfortunately secondary. C. P. Olivier in his *Comets*, 1930, p. 81, notes that it was photographed by Janssen and the spectrum photographed by Huggins on June 24, 1881, and by Draper 'soon after'. In the National Academy Memoir on the life of Henry Draper there is this reference to his paper in the *American Journal of Science*, Ser. III, vol. 22, p. 134, 1881, 'On Photographs of the Spectrum of the Comet of June, 1881'." She draws attention to two items by Huggins and one by Draper listed in J. C. Houzeau and A. Lancaster, *Bibliographie générale de l'astronomie* (Brussels, 1880–89), ii, 1654 and 1678.
- De Vaucouleurs, *op. cit.* (ref. 13), 43–44, writes that Draper's photograph shows 10° of tail.



42. De Vaucouleurs, *op. cit.* (ref. 13), Plate 8.
43. Lankford, *op. cit.* (ref. 25), 25.
44. D. Gill and E. H. Allis, *Enhanced Photograph of the Great Comet of 1882 (1882 II) on the night/day of 13 November / 7 November, 1882*, The Royal Observatory, Edinburgh no. 8343301, from Gill plate C4 no. 12; 100 minute exposure.
45. See, for example, Lankford, *op. cit.* (ref. 25), 32, and O. Gingerich, "The Great Comet and the 'Carte'", in *The Great Copernicus Chase and other adventures in astronomical history* (Cambridge, Mass., and Cambridge, 1992), 189–94, reprinted from *Sky & telescope*, lxiv (1982), 237–9. The American non-participation is further discussed in S. J. Dick, "Americans and the Astrographic Catalogue", *ibid.*, lxxv (1983), 301–2. An earlier discussion of the Great September Comet, the observations of Gill, and the Carte du Ciel, with a mention of the Harvard and Walton Common observations of Donati's Comet, appears in R. K. M., "Astronomical anecdotes: Daytime comets, a portrait lens, and three tons of star map", *ibid.*, iii (1943), 17.