Quetelet and the Discovery of the First Meteor Showers

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The contribution of Adolphe Quetelet to meteor astronomy is important. In 1836 he predicted the return of the Perseids and in 1837 he published the first catalogue of meteors. He was also an independent co-discoverer of the Orionids and the Quadrantids in 1839.

1. Introduction

Adolphe Quetelet (1796–1874) was interested in a large variety of subjects: poetry, mathematics, physics, statistics (of which he is the founder), social sciences, meteorology, astronomy, history of science, ... Beside his numerous scientific papers, he also wrote a dozen books, of which the most original ones deal with social sciences, meteorology, and the history of science. In his *Essai de physique sociale–Sur l'homme et le développement de ses facultés* (1835), he applied scientific methods to problems which were previously considered as belonging exclusively to moralists. He also wrote several books on popular astronomy and physics: his *Astronomie populaire* (1827) is a model of scientific popularization at that time (see, e.g., [1]).

Several commemorative events were organized last year in honor of the 200th anniversary of his birth. This provides a good opportunity to point out the role Quetelet played in meteor astronomy, especially in the discovery of the first meteor showers in the decade 1830–1840.

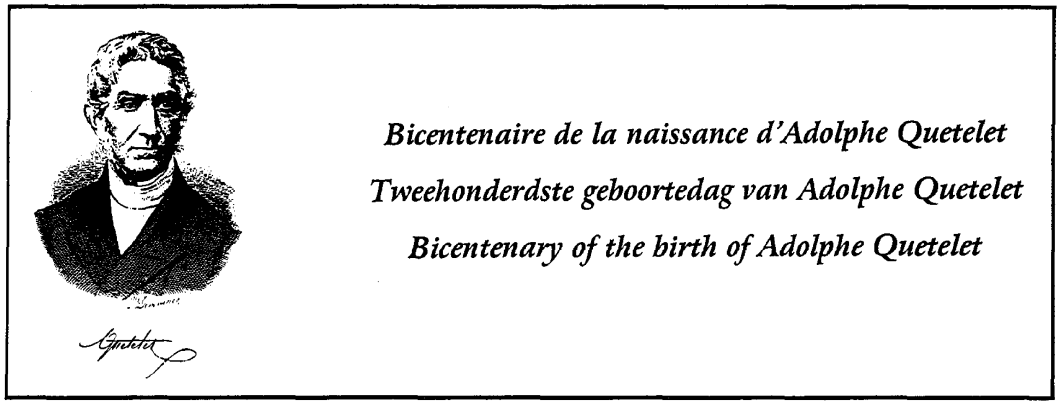


Figure 1 – Adolphe Quetelet (1796–1874)

The contribution of Adolphe Quetelet to meteor astronomy is important. His articles and notes about meteors appeared rather regularly from 1832 till his death: he published a total of about fifty papers about the subject.

His interest in shooting stars began as early as 1824: some years before he became the director of the newly erected Observatory in Brussels, he decided to create a team of a dozen people to make simultaneous observations from different places (Brussels, Liège, and Ghent). Unfortunately, the observations were limited to a few months around 1824–1826, and the results were published only in 1837, when his interest had strongly increased.

His statistical investigations based on his own observations or those of others are by far more important than his theoretical papers. His 1837 paper on the mean number of shooting stars in a normal night [2] was considered as an original study (a standard reference for many years). As another example, we mention his work on the distribution of meteors over different geographical places or over the two parts of the night (before and after midnight). On the other hand, his work on the nature and the origin of shooting stars was not so original and sometimes controversial. He wrongly believed that a correlation could exist between the appearances of shooting stars and other phenomena such as aurorae, earthquakes (and magnetic perturbations), whereas he correctly believed in a correlation with fireballs and aerolites.

He systematically observed and recorded the occurrence of meteors; he also collected reports from everywhere to be published in Belgian scientific periodicals. His main results are the discovery of the Perseids and the co-discovery of two other meteor showers on the basis of his own catalogue of occurrences of meteors in former times. He was the first in 1837 to publish such a catalogue; revised editions appeared in 1839, 1842, and 1861 [3–6] (see also Figure 2). His pioneering work was rapidly followed by catalogues compiled by others (Herrick in the USA, Chasles and Biot in France) [7–9], which proved how useful such catalogues could be.

CATALOGUE

DES

PRINCIPALES APPARITIONS

D'ÉTOILES FILANTES,

PAR A. QUETELET,

DIRECTEUR DE L'OBSERVATOIRE DE BRUXELLES, ETC.

(Mémoire lu à la séance du 8 juin 1839.)

Tom. XII. 1

Ainsi, sur 61 apparitions extraordinaires d'étoiles filantes, 26 appartiennent à des nuits du milieu d'août, et 16 à des nuits du milieu de novembre, tandis que les 19 autres apparitions remarquables appartiennent à différens mois. Il pourrait se faire que, parmi celles-ci, il y en eût aussi de périodiques. Pour pouvoir mieux juger de celles qui, sous ce rapport, mériteraient le plus d'attention, j'ai rangé, dans le tableau suivant, toutes les apparitions remarquables sous le titre des mois auxquels elles appartiennent.

MOIS.	DATES DES APPARITIONS EXTRAORDINAIRES D'ÉTOILES FILANTES.
Janvier	2,1835 — 2,1838.
Février	Pas d'apparition remarquable.
Mars	763 — 18,1811.
Avril	23,1095 — 22,1803.
Mai	Pas d'apparition remarquable.
Juin	17,1777.
Juillet	12,24,26,1784 — 24,1785.
Août	1029 — 9,1779 — 8,1781 — 6,9,1784 — 9,1798 — 9,1799 — 10,1806 — 10,1811 — 11,1813 — 10,1815 — 14,1818 — 6,1819 — 9,1820 — 10 et 15,1823 — 14,1824 — 8,10,14,1826 — 14,1827 — 10,1828 — 14,1829 — 10,1831 — 10,1833 — 10,1834 — 10,1835 — 9,1836 — 10,1837 — 12,1838.
Septembre	2,1820 — 10,1822.
Octobre	902 — 19,1202 — 14,1798 — 23,1805 — 18,1836.
Novembre	23,1741 — 11,1799 — 1812 — 8,1813 — 19,1818 — 12,1820 — 12,1822 — 6,1826 — 13,1831 — 11,13,1832 — 12,1833 — 13,1834 — 13,1835 — 13,1836 — 12,1837 — 13,1838.
Décembre	7,1798 — 7,12,1830 — 6,1838.

Figure 2 – *Left*: Front page of the 1839 edition of Quetelet's catalogue. *Right*: Summary table (Catalogue 1839, p. 20) with the distribution over months for 61 appearances from 763 to 1838.

Among the observers active around 1830–1840 we find (in alphabetical order) François Arago in France, Johann F. Benzenberg and Heinrich W. Brandes in Germany, Edward C. Herrick in the USA, Heinrich W. Olbers in Germany, Denison Olmsted and Alexander C. Twining in the USA, and Louis F. Wartmann in Switzerland in addition to Adolphe Quetelet in Belgium. Already at that time, several amateur astronomers were active observers of shooting stars.

Most of the European observers were in contact with each other; correspondence between American observers was good as well, but little contact existed between the two groups. Quetelet met several observers and kept corresponding with all of them, as can clearly be seen from his Correspondence in the Archives of the Belgian Academy [10]. Most of the American observers published their articles in the *American Journal of Science and Arts* (*AJS*), and so knew all about meteors recorded in America, but most of them were unaware of many European academic publications, or were informed only after some lapse of time. Similarly, most of the European observers ignored many of those American periodicals with a limited circulation. From about 1840 onwards, observers also began to exchange reprints in order to inform each other of their results.

As editor of the *Correspondance Mathématique et Physique* (*CMP*), of which he is the founder in 1825, and of the *Bulletins de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles* (*BARB*), Quetelet published many observational notes from most of the observers mentioned above as well as extracts from their letters. At that time, many original articles were still reprinted (translated and sometimes slightly adapted) in foreign periodicals.

In summary, the group of European observers was were rather well aware of each others results. The same is true for the group of American observers.

2. Criteria for discovering a meteor shower

Even nowadays (150 years later), it still seems difficult to decide impartially who was the discoverer of every shower found between 1834 and 1839. We note that most books about the history of the first discoveries of the meteor streams somewhat disagree as far as the discoverers are concerned: the proposed names differ from one book to another (a selection of books is given in chronological order [11–19]). Furthermore, most of these historical chapters are essentially devoted to the Leonids, the first of the meteor streams to be found, which showed spectacular displays in 1833 and about every 33 years. The history of the other showers is rather limited.

Obviously, any decision about who is the discoverer strongly depends on the adopted criterion. One can choose either

(a) *The discoverer is the first one who announced (suggested or predicted) the annual return, sometimes without any relevant observation, and published his result in a well-known astronomical magazine,* or

(b) *The discoverer is the first one who checked the annual return and who announced the discovery, sometimes in a periodical with a limited circulation or in a non-astronomical book.*

In our opinion, the best criterion to apply should be (a): the discoverer is the one who first announced (generally several months in advance) a date of occurrence of meteors in a scientific periodical, on the basis of certain arguments... even if he was not able to check his prediction himself.

This criterion implies that a critical comparison has to be made between the dates of publication of the original results. Such a search should lead to the first paper which announces the discovery. However, if two results were published within a few weeks or months in distant countries (Europe and the United States, e.g.), we are forced to conclude that there are two independent discoverers, taking into account a delay of at least several months due to the slowness of the information exchange.

We have also to keep in mind that the time elapsed between submission and publication of a manuscript could be exceptionally short for certain authors. Quetelet was the Director of the Observatory and perpetual secretary to the Belgian Academy: therefore his articles in the periodicals edited by these two institutes were published rather rapidly. Similarly, because Herrick was an associate editor of *AJS* and worked on the Yale College campus, his articles appeared more rapidly than those of other American authors.

Quetelet did not contribute at all to the discovery in 1834 of the first meteor stream, the Leonids, but only reported his yearly observations and collected others from around the globe. That explains why we neglect their history here, even if the discovery of the Leonids led to a lot of progress in the interpretation of shooting stars. Details about the discovery of the Leonids can be found in the selection [11–19].

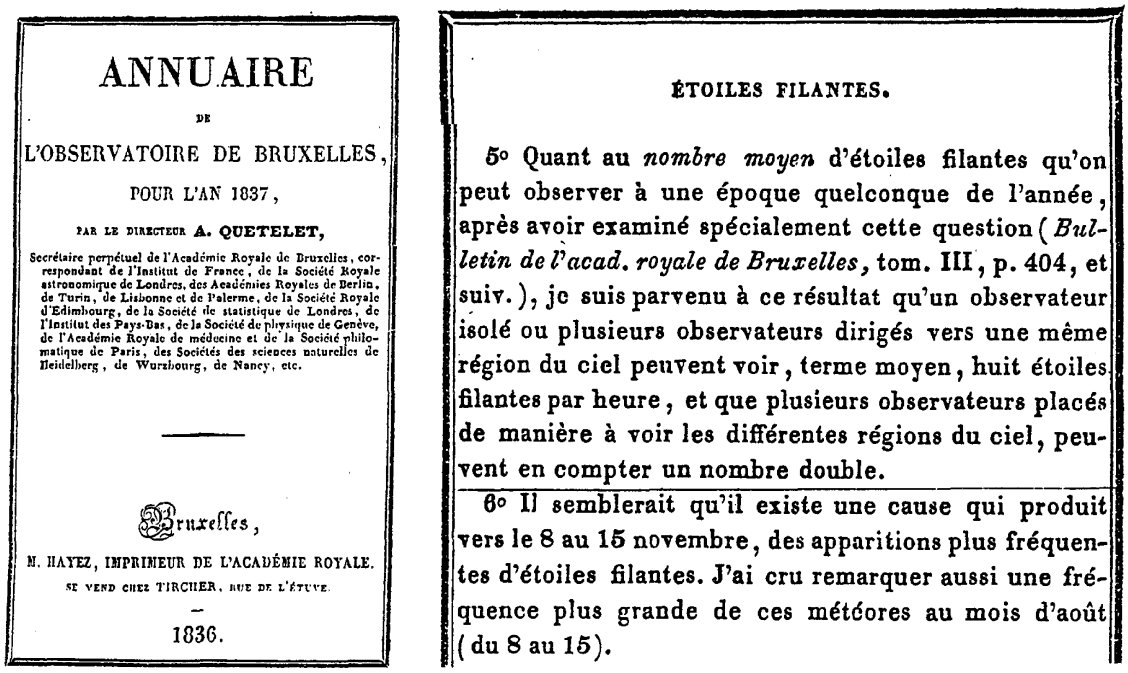
3. The discovery of the Perseids

Several papers about the discovery of the Perseids can also be found in the selection [11–19], as well as in other articles [20,21]. The name of Quetelet is the one most frequently given, but other names (such as Arago, Benzenberg, Forster, Herrick, Locke, and Olbers) are also proposed.

Quetelet's contribution

Starting from November 1835, Quetelet tried to observe the Leonids each year whenever possible. In 1836, Quetelet was already very interested in the observation of periodical natural phenomena of all kinds which were related to plants and animals; and he was really searching for such periodicities in various fields (meteorology, social sciences, geophysics, ...). So it is not surprising that his systematic research in meteor astronomy led to new results about their periodicity.

About the end of 1836 (and not in 1835 as wrongly stated in some books), Quetelet announced that the date of August 9–10 is a very important one for meteors. At a session of the Belgian Academy of December 3, Quetelet draws the attention of physicists to the night of August 10, and in the *AORB* for 1837, Quetelet announces his belief that shooting stars were more numerous from August 8 to 15 (than in other dates) [22] (see also Figure 3). Quetelet reiterated this at later sessions of the Academy in 1837.



ANNUAIRE

DE

L'OBSERVATOIRE DE BRUXELLES,

POUR L'AN 1837,

PAR LE DIRECTEUR A. QUETELET,

Secrétaire perpétuel de l'Académie Royale de Bruxelles, correspondant de l'Institut de France, de la Société Royale astronomique de Londres, des Académies Royales de Berlin, de Turin, de Lisbonne et de Palerme, de la Société Royale d'Edimbourg, de la Société de statistique de Londres, de l'Institut des Pays-Bas, de la Société de physique de Genève, de l'Académie Royale de médecine et de la Société philomatique de Paris, des Sociétés des sciences naturelles de Heidelberg, de Wurzbourg, de Nancy, etc.

Bruxelles,

M. HAYEZ, IMPRIMEUR DE L'ACADÉMIE ROYALE.

SE VEND CHEZ TIRCHER, RUE DE L'ÉTUVE.

1836.

ÉTOILES FILANTES.

5° Quant au *nombre moyen* d'étoiles filantes qu'on peut observer à une époque quelconque de l'année, après avoir examiné spécialement cette question (*Bulletin de l'acad. royale de Bruxelles*, tom. III, p. 404, et suiv.), je suis parvenu à ce résultat qu'un observateur isolé ou plusieurs observateurs dirigés vers une même région du ciel peuvent voir, terme moyen, huit étoiles filantes par heure, et que plusieurs observateurs placés de manière à voir les différentes régions du ciel, peuvent en compter un nombre double.

6° Il semblerait qu'il existe une cause qui produit vers le 8 au 15 novembre, des apparitions plus fréquentes d'étoiles filantes. J'ai cru remarquer aussi une fréquence plus grande de ces météores au mois d'août (du 8 au 15).

Figure 3 – *Left*: Frontispiece of the *Annuaire de l'Observatoire de Bruxelles* (*AORB*) for 1837 (edited in 1836). *Right*: Extract from p. 272 (see particularly Part 6°) [22]

It is clear that his first notes which predicted the annual return of August 9–10 were very short, but very affirmatively worded. It seems to have been the usual style at that time: e.g., Arago also announced the shooting stars of April 20–24, the Lyrids, in one sentence in the *Annuaire du Bureau des Longitudes* (*ABL*) for 1836.

Why was Quetelet so convinced that August 10 was important for meteors?

We can find the reasons for his claim in the introduction to the 1839 edition of his Catalogue [4]:

> *In the process of collecting all available previous occurrences of meteors, I was struck with several events which occurred on August 10: an observation by Brandes in 1823 of a very large number of meteors, another exceptional appearance quoted by Chladni in 1815, and a large number of meteorites or aerolites fallen in August which are listed in Kaemtz.*

By the end of 1836, Quetelet was fully convinced that August 10 was worth drawing attention to, similarly as mid-November. His belief was based on several previous occurrences he collected, some of them being extracted from a new book in meteorology just published in 1836 by Kaemtz [23], with a chronological list of meteorites, and from another by Chladni [24].

Around the end of 1836, Quetelet wrote to other interested observers, such as Arago, Benzenberg, Olbers, and von Humboldt, in order to inform them about his idea (some of these letters and replies were published in *CMP*). Recently, in a search in Quetelet's correspondence at the Royal Academy, we found a 3-page draft letter from Quetelet to Arago dated December 17, 1836 [25].

Quetelet wrote that he was aware of six appearances around mid-August: 1353, 1717, 1815, 1819, 1823, and 1836 (see Figure 4).

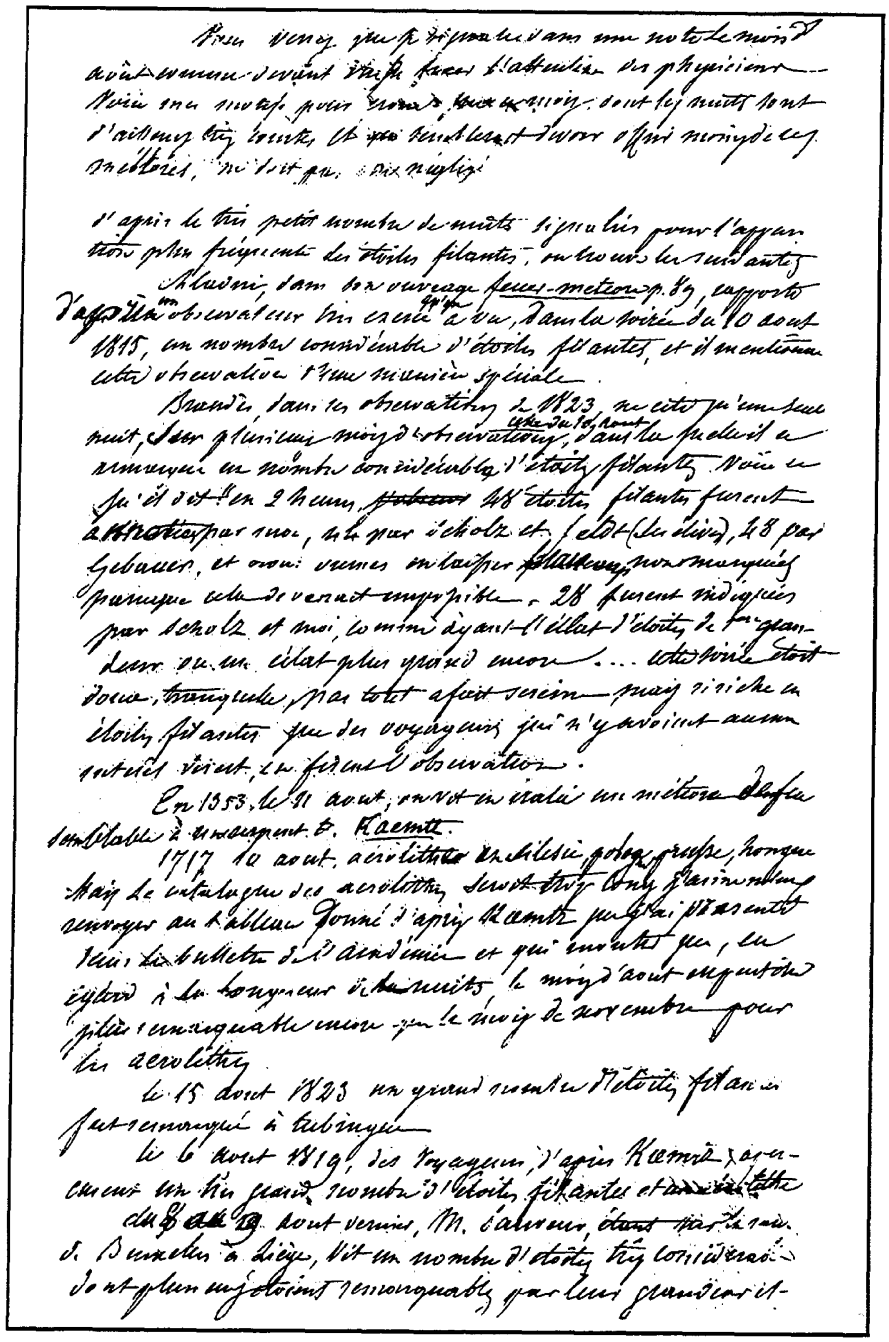


Figure 4 – Extract (2nd page) from a draft letter dated December 17, 1836, from Quetelet to Arago [25] which gives a list of meteor occurrences around mid-August (Archives of the Royal Academy of Belgium).

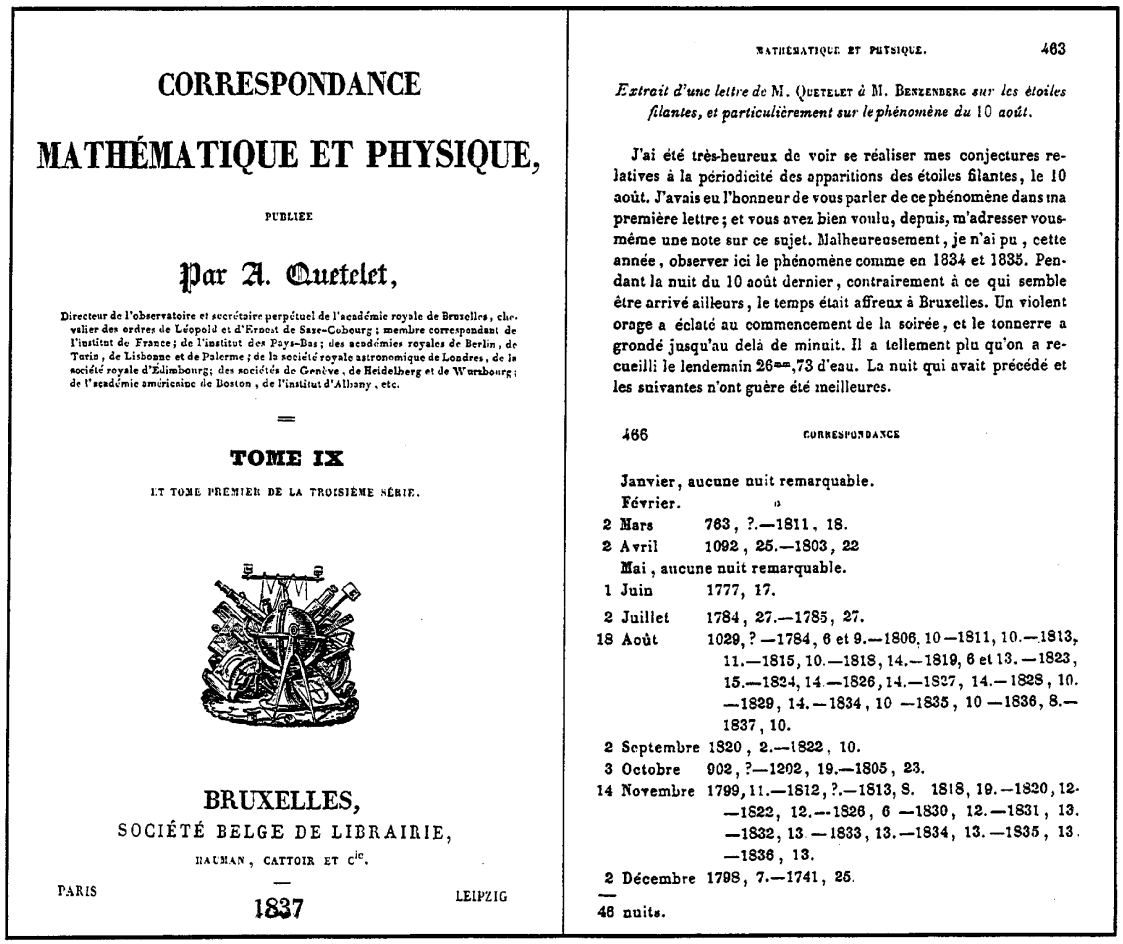
A surprising fact is that Quetelet forgot to mention two earlier meteor observations in August 1834 and 1835 which were recorded in the register of the Observatory: they were later reported at the Academy [26].

The six listed dates in his letter to Arago of December 1836 [25] are the following:

- August 11, 1353 [23, p. 266];
- August 10, 1717 [23, p. 270];
- August 10, 1815 [23, p. 232, 24, p. 89];
- August 6, 1819 [23, p. 287];
- August 10 and 15, 1823 [23, p. 292]; and
- August 8-9, 1836 (observation by Sauveur in Brussels and quoted by Quetelet [22]).

Now we understand much better why Quetelet was so convinced of the August 10 date. We have to recall that the discovery of the first meteor shower, the Leonids, in 1834 by Olmsted and Twining [27,28], was also based on observations of only a few years (1799, 1832, and 1833). We think that the unusually numerous meteors found in November and in August were by far more significant to these observers than the seeming lack of repeatability.

We have to note that Quetelet's preliminary catalogue of star-showers [3] (probably started end 1836–beginning 1837), which was presented on October 1837 at the Academy, already includes no less than 18 appearances around mid-August, out of a total of 46 [29, p. 466] (see Figure 5).



CORRESPONDANCE

MATHÉMATIQUE ET PHYSIQUE,

PUBLIÉE

Par A. Quetelet,

Directeur de l'observatoire et secrétaire perpétuel de l'académie royale de Bruxelles, chevalier des ordres de Léopold et d'Ernest de Saxe-Cobourg; membre correspondant de l'institut de France; de l'institut des Pays-Bas; des académies royales de Berlin, de Turin, de Lisbonne et de Palerme; de la société royale astronomique de Londres, de la société royale d'Édimbourg; des sociétés de Genève, de Heidelberg et de Wurtzbourg; de l'académie américaine de Boston, de l'institut d'Albany, etc.

TOME IX

LE TOME PREMIER DE LA TROISIÈME SÉRIE.

BRUXELLES,

SOCIÉTÉ BELGE DE LIBRAIRIE,

HAUMAN, CATTOIR ET C^ie.

PARIS — LEIPZIG

1837

MATHÉMATIQUE ET PHYSIQUE. 463

Extrait d'une lettre de M. Quetelet *à* M. Benzenberg *sur les étoiles filantes, et particulièrement sur le phénomène du* 10 *août.*

J'ai été très-heureux de voir se réaliser mes conjectures relatives à la périodicité des apparitions des étoiles filantes, le 10 août. J'avais eu l'honneur de vous parler de ce phénomène dans ma première lettre; et vous avez bien voulu, depuis, m'adresser vous-même une note sur ce sujet. Malheureusement, je n'ai pu, cette année, observer ici le phénomène comme en 1834 et 1835. Pendant la nuit du 10 août dernier, contrairement à ce qui semble être arrivé ailleurs, le temps était affreux à Bruxelles. Un violent orage a éclaté au commencement de la soirée, et le tonnerre a grondé jusqu'au delà de minuit. Il a tellement plu qu'on a recueilli le lendemain 26mm,73 d'eau. La nuit qui avait précédé et les suivantes n'ont guère été meilleures.

466 CORRESPONDANCE

	Janvier, aucune nuit remarquable.	
	Février.	»
2	Mars	763, ?.—1811, 18.
2	Avril	1092, 25.—1803, 22
	Mai, aucune nuit remarquable.	
1	Juin	1777, 17.
2	Juillet	1784, 27.—1785, 27.
18	Août	1029, ? —1784, 6 et 9.—1806, 10—1811, 10.—1813, 11.—1815, 10.—1818, 14.—1819, 6 et 13.—1823, 15.—1824, 14.—1826, 14.—1827, 14.—1828, 10. —1829, 14.—1834, 10 —1835, 10 —1836, 8.—1837, 10.
2	Septembre	1820, 2.—1822, 10.
3	Octobre	902, ?—1202, 19.—1805, 23.
14	Novembre	1799, 11.—1812, ?.—1813, S. 1818, 19.—1820, 12. —1822, 12.—1826, 6 —1830, 12.—1831, 13. —1832, 13.—1833, 13.—1834, 13.—1835, 13. —1836, 13.
2	Décembre	1798, 7.—1741, 25.
46	nuits.	

Figure 5 – *Left*: Frontispiece of Volume IX, 1837 of *CMP*. *Right*: Extracts from p. 463 (*top*) about meteors of August 10, 1837, and from p. 466 (*bottom*) showing a table with the distribution over months for 46 appearances [29]

In the night of August 10, 1837, all meteor observers recorded a large number of shooting stars, as predicted by Quetelet. Unfortunately for Quetelet, the weather was very bad that night and the following nights in Brussels: it was awfully bad, rainy, and stormy. Quetelet was not able to observe them... to check his prediction. He had to wait for positive reports from observers of neighboring countries (France, Germany, ...) who all fully confirmed his prediction: meteors had been numerous everywhere indeed. Quetelet was happy to hear their observational reports and so the meteor stream of August 10 was confirmed, one of the most regular showers in fact (later called the Perseids, with its radiant in the constellation of Perseus). In 1866, Schiaparelli identified 109P/Swift-Tuttle (orbital period presently 137 years) as the associated comet.

Several indication of the knowledge of the August meteors were then searched for and found in ancient documents. In the introduction to his preliminary Catalogue in 1837 [3], Quetelet notes that in December 1836 he was unaware of some ancient writings (books, almanacs, journals) which already mention the presence of meteors during the night of August 10. First, in the chapter entitled *De Meteoris Igneis* of a book by van Musschenbroek [30, p. 1061], there is a statement about many *stellae (cadentae)* in August, which should be meteors. In another book, *Ephemerides rerum naturalium*, which was written by a monk at the end of the 18th century, there is a statement that *meteorodes* were frequent on August 10. Thomas Forster, an English physician who lived in Belgium, reproduced this statement in his books (calendars and an encyclopedia) [31–33].

Finally, some popular traditions seem to show that August has long had a reputation for lots of meteors. Let us only quote the "tears of St. Lawrence" whose festival happened to come on August 10; this tradition is especially known among the Catholics in Germany and in England.

Other contributions: Arago, Benzenberg, Forster, Herrick, Locke, and Olbers

The original papers by Olbers, Benzenberg, Forster, Herrick, and others were consulted in order to compare their respective contribution. We also made use of Roggemans's bibliographic catalogue of meteors [34].

T. Forster had grown into the habit of systematically reporting his own meteorological observations in a personal (unpublished) Journal starting from around 1800; he also included his accidental observations of meteors, especially those seen around mid-August from 1806 and was convinced from 1811 (as he stated later) of their annual return. These observations in August 1806, 1811, 1813, 1817, 1824, and 1828 were published only in 1837 [33], after the publication of Quetelet's preliminary catalogue; the latter included them in later editions of his catalogue. Many letters from Forster to Quetelet are also kept [10], but without any mention of this return, which is rather puzzling.

J. Locke should also be mentioned in relation to the discovery of the Perseids. Indeed, in an article in a local newspaper, the *Cincinnati Daily Gazette* of 8 and 10 August 1834, Locke, a physician and headmaster of a school, announced that his observations show the radiant to be near Algol, in Perseus. Locke was aware of the results by Olmsted and others about the Leonids. That very interesting result was, unfortunately, published in a local newspaper only, but it proves that the annual return was already suspected and noted in 1834 by a skilled observer.

Edward C. Herrick, who first worked in a bookstore in New Haven and thereafter became the librarian at Yale College, was a very enthousiastic observer. He was interested in aurorae and in other celestial and natural phenomena of any kind. His interest in meteors started from the display of meteors accidentally observed on August 9, 1837 [35]. He was aware of results about meteors which were published in *AJS*, but not of most of the European observations. His own observations and other facts *appear to me sufficient to render highly probable the periodical occurrence of an unusually large number of shooting stars on or about the 9th of August* [35, p. 177]. He really thought to be the first to announce this new meteor shower, and he was somewhat disappointed when he heard that the discovery has already been made one year before by at least one other person. In his second paper [36], he collected several additional facts which

confirmed his opinion of a meteoric shower in August and he quoted Quetelet who independently suspected a meteoric shower in August. In a third note [37], dated December 15, 1837, Herrick added new information about Quetelet's announcement in 1836, and he wrote the following: *At the time when the last number of this Journal was published, I was not aware that any person in Europe, or elsewhere, had ever advanced the idea of a meteoric shower in August.* Note that the article by Littmann [21] gives much information about this contribution. Herrick is in fact an independent co-discoverer of most of the first meteor streams (see later and Table 1). His discoveries were a reward for his careful observations. From 1840, Herrick and Quetelet began to correspond with each other, and this fruitful correspondence continued till Herrick's death in 1861. About 15 letters from Herrick to Quetelet are in the Archives of our Academy [10].

From a search in papers by *F. Arago*, it appears that he cannot be considered as a possible discoverer of the Perseids. The letter dated December 17, 1836, from Quetelet to Arago [25], quoted earlier, clearly shows that Quetelet had first announced his belief to him. In this letter, Quetelet also asked Arago to report his announcement at the next session of the French Academy (this anecdote is also reproduced elsewhere, e.g., in [38, p. 176]). Arago forgot to report Quetelet's announcement, but reported it later, at the session of October 16, 1837 [39]. Arago wrote *your predictions* whenever he addressed Quetelet. In all his later papers and books, without any doubt, Arago attributes this discovery to Quetelet.

According to a report on meteors published in Schumacher's *Jahrbuch* for 1837 (also translated in *CMP* [40]), *Heinrich W. Olbers* wishes that a search be made for meteors around mid-August. One year later, Olbers [41] wrote the following: *The predictions by Quetelet, Benzenberg, and myself about the date of the mid of August have been fully confirmed in August 1837 ... M. Quetelet can thus claim with much confidence a positive prediction.* Therefore, Olbers seems to attribute to Quetelet the whole merit of this discovery.

In 1837, *Johann F. Benzenberg* wrote [42] that he had the idea of this annual return too; in a book published in 1839 [43], he reported his observations of August 1837.

Our conclusion about the discoverers of the Perseids

From a comparison of original results from various observers at that time, we conclude that Quetelet is the first in 1836, among all the known meteor observers, to announce his discovery, especially to inform the astronomical community, with the help of the well-known scientific periodicals. In our opinion, this method is the best way to announce a scientific discovery. At that time, he was unaware of other results (Forster, Locke, and older writings).

Among other "professional" observers, Olbers and Benzenberg seem to have published their results quite independently in European journals, but somewhat later than Quetelet, and so both could be regarded as co-discoverers, too.

With regard to the two "non-professional" observers, Forster and Locke, our conclusion is more difficult. We have to account for their inexperience in publishing a scientific result. Forster could probably claim that he was the first in 1824 to announce this shower through a calendar and in 1827 through a pocket encyclopedia, but he omitted to publish a short note on the subject in a scientific journal. However, we note that his large correspondence (39 letters [10]) from 1833 with Quetelet about meteors never reveals his discovery, which is rather surprising. On the other hand, we have to point out that his discovery was essentially based on his own observations over a period of two decades, which is a remarkable result. J. Locke, as early as August 1834, drew the right conclusion from his careful observations. Unfortunately, he only published his interesting result in a local newspaper with a rather limited circulation. However, we know that he had read the articles by Olmsted in *AJS* [13], and so he could have published it in such a well-known periodical.

Our final opinion is that each of the five observers derived the same correct conclusion: all of them should deserve to be recognized as independent co-discoverers, even if we give Quetelet preference on the basis of rational arguments.

Quetelet's final comments are expressed with a sense of humor in his book on the history of sciences [44, p. 575]:

> *Once the annual return of August 10 announced and reported, some wanted to confiscate it to their benefit; others claimed that it was not new; they found traces of it in all nations and in all times. It was known to the Irish, the Greeks, even to the Chinese. Well, but why did they not say so before?*

4. The discovery of other meteor streams around 1835–1840

The discovery of the first two streams in 1834 (meteors of November 11) and in 1836 (August 10) respectively had probably pushed Quetelet and others to search for other periodical returns. His pioneering catalogue of 1837, based on a historical research of ancient records, enabled Quetelet to predict several other moments in the year when meteors are unusually numerous.

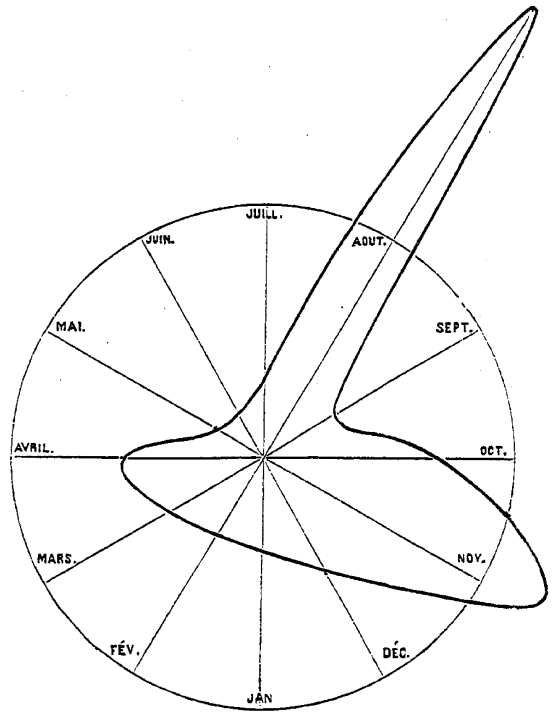


Figure 6 – Figure extracted from the 1861 edition of Quetelet's catalogue [6, p. 318] showing the distribution of meteors over the year. The maxima due to the Perseids in August, the Leonids in November, the Lyrids in April, and the Orionids in October are clearly seen

Already in 1837, just after his preliminary catalogue [3], Quetelet published another note including a summary table with the distribution over months (and days): several appearances do occur at the same dates [29, p. 466]. In his 1839 edition [4, pp. 21–26], Quetelet lists *the nights which deserve the most attention from observers.* In addition to the nights of August 9-10 (26 appearances) and of November 11-12 (16 appearances), Quetelet quotes *four other interesting dates in the year: the nights of April 20–26 (with 2 appearances), the night of December 7 (3 appearances), the night around mid-October (5 appearances) and the night of January 2 (2 appearances).* Next, Quetelet reviews each of these dates and explains his opinion.

In an article, dated December 1838, which appeared the first months of 1839, Herrick also mentioned several dates in one sentence, but without any detailed references [28, p. 366]: *There are other seasons in the year at which meteors may possibly be found unusually numerous: some of these are Oct. 8-15, June 10–20, Jan. 2, Feb. 15, July 28, Sept. 11, Nov. 8. It is not worth while to give the details of the various accounts from which these dates are taken. They are generally vague, and mostly reported by those who had no just ideas concerning the average number of meteors. Of this list, the two first appear the most worthy of attention.* We have to point out that his catalogue of 39 appearances in former times [7] will only appear in 1841. Anyway, the two papers by Herrick and Quetelet were probably published within a few months of each other.

In 1835, Arago [46] also suggested the nights of mid-April (correct) and of the 17th of June as two interesting dates (the latter was based on a single observation by Messier in 1777, but this suggestion was not confirmed).

We would just like to comment here on the four dates quoted by Quetelet, which were all confirmed within the next year(s): they are related to the Andromedids, Lyrids, Orionids, and Quadrantids respectively. The exact references of the original results are given in Table 1.

Table 1 – Discoveries of the first six meteor showers: 1834–1839. The names of our proposed discoverers are written in bold. Abbreviations in the references are explained at the end of the article.

Nights (~ 1835)	Current	Year disc.	Proposed discoverer	Reference (periodical, book)	Associated comet (orbital period)
Nov 11–12	Leonids	1834	**Olmsted**	*AJS* 26, 132–174	55P/Tempel-Tuttle
		1834	**Twining**	*AJS* 26, 320–352	(~ 33 years)
		1835	**Arago**	*CR* 1, 395; *ABL* 1836, 293	
		1836	Olbers	in *Die Sternschnuppen* VII	
Aug 09–10	Perseids	1836	**Quetelet**	*BARB* III, 412	109P/Swift-Tuttle
		1837	Forster	*CMP* IX, 448–453; 467–468	(~ 137 years)
		1837	Arago	*CR* Oct 16 (V, 553)	
		1837	Olbers	*CMP* IX, 392–419	
		1837	Benzenberg	*CMP* IX, 388–391	
		1838	Herrick	*AJS* 33, 176–180	
Apr 20–26	Lyrids	1835	**Arago**	*ABL* 1836, 297 (footnote)	C/1861 G1 Thatcher
		1838	**Herrick**	*AJS* 34, 398; 35, 366; 36, 358	(~ 415 years)
		1838	Benzenberg	*Die Sternschnuppen*, 253	
		1839	Quetelet	*Catalogue* 1839, 23	
Jan 02	Quadrantids (Bootids)	1839	**Herrick**	*AJS* 35, 366	96P/Machholz 1 ?
		1839	**Quetelet**	*Catalogue* 1839, 26	(5.2 years)
		1841	Wartmann	*BARB* VIII, 226	
Oct 08–15	Orionids	1839	**Benzenberg**	*Die Sternschnuppen*, 244	1P/Halley
		1839	**Herrick**	*AJS* 35, 366	(~ 76 years)
		1839	**Quetelet**	*Catalogue* 1839, 25	
Dec 07	Andromedids (Bielids)	1838	**Benzenberg**	*Die Sternschnuppen*, 331	3D/Biela
		1839	**Herrick**	*AJS* 35, 366	(6.6 years)
		1839	Quetelet	*Catalogue* 1839, 25	

The Quadrantids

On the basis of observations on January 2, 1835 and 1838, by M. Wartmann (*Observatoire de Genève*), Quetelet and Herrick suggest quite independently the night of January 2 for an abundance of meteors. Numerous meteors were recorded in 1839 and in 1840 (especially in Belgium), which fully confirmed this date. In our opinion, Herrick and Quetelet are the two independent co-discoverers as also stated by Lovell and Kronk [19], but Lovell (p. 249) writes

that Quetelet claimed first publication. Wartmann announced only in 1841 this annual return, two years after the others, which is unfortunate for him, because he could have been the first if he had correctly interpreted his original observations. This shower, which is called either Quadrantids (after a now obsolete constellation) or Bootids (from Bootes), is rather rich (hourly rate of about 110). Recently, the associated comet might have been discovered: 96P/Machholz 1 (orbital period of about 5 years).

The Orionids

The nights of mid-October are quoted both by Herrick and Quetelet as rich in shooting stars. Quetelet based his suggestion on observations on October 14, 1798, by Brandes and Benzenberg, on October 23, 1805, and on October 18, 1838. Observations by Benzenberg of October 13 to 15, 1837, confirm this date. Kronk [19] writes that Herrick is the discoverer of this shower without any mention of Quetelet. In our opinion, Herrick, Benzenberg, and Quetelet are to be considered as the three independent co-discoverers. Comet 1P/Halley is known from 1911 to be associated with this shower with radiant in Orion.

The Andromedids

The history of this stream has been clearly written by Quetelet in the 1839 edition of his catalogue. From 1838, Herrick was searching if the night of December 7 was rich in meteors. His belief was based on a remarkable observation on December 7, 1798, by Brandes. Herrick hoped also to record many shooting stars in 1838. He succeeded in recording a large number of meteors, whereas other European observers in Belgium (M. Bouvy in Brussels), France, and Italy, recorded many from December 6 to 15. So this meteor stream was confirmed. On the other hand, Benzenberg recorded very few meteors on December 6, 1837 and 1838. Herrick is the discoverer of this shower, but the contribution of Benzenberg is not quite negligible. Comet 3D/Biela, which split in 1846, has the same orbit as this meteor stream and is thus associated with it. Nowadays, very few meteors, if any at all, can be recorded.

The Lyrids

The nights of April 20–24 were first mentioned by Arago in 1835. His suggestion was based on observations made around April 20, 1803, in Virginia. In 1837, Olbers recalled Arago's suggestion, and Benzenberg tried to record meteors from April 20 to 26, 1838, but they were not as numerous as in 1803. Olbers concluded that this return was not exceptional. On the basis of the spectacular display in 1803, Herrick (who was probably unaware of Arago's idea) also suggested in 1838 a new meteor shower in April: *This shower ought to be re-discovered....* He made arrangements for observations around April 20, 1838 and 1839, at several places in the United States. Unfortunately, very few observations were recorded in 1838 (bad weather!); in 1839, he concluded that *no unusual display of meteors was visible in this country on the mornings of the 19th and 20th April, 1839. It is to be regretted that no thorough observation was made on the mornings of the 21st and 22nd.* Benzenberg confirmed the suggestion of Arago, whereas Herrick independently discovered the shower: Arago and Herrick can be considered as co-discoverers. Quetelet did not contribute to this discovery, because his suggestion had already been made four years before by Arago.

5. Conclusion about Quetelet's contribution to meteors

As we showed, most of the discoveries of the first showers have resulted from the work of a small group of observers (Arago, Benzenberg, Herrick, Quetelet, ...), and are generally due to two or more independent co-discoverers.

In 1836, Quetelet discovered the Perseids, a rather well known fact today. In 1837, he had the original idea to publish the first catalogue of occurrences of meteors in former times, which enabled to predict other dates when meteors are numerous. He was also one of the independent co-discoverers of the Orionids and of the Quadrantids in 1839, a fact which is little known nowadays, even in Belgium.

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Abbreviations used

AARB: Annuaire de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles
ABL: Annuaire du Bureau des Longitudes (Paris)
AJS: The American Journal of Science and Arts
AORB: Annuaire de l'Observatoire de Bruxelles
BARB: Bulletins de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles
CMP: Correspondance Mathématique et Physique
CR: Comptes Rendus des Séances de l'Académie des Sciences (Paris)
MARB: Mémoires de l'Académie Royale des Sciences et Belles-Lettres de Bruxelles