

Notes and references.

Chapter 1.

- 1) Prentice, J. P. M. 1931. *Journal of the British Astronomical Association*. **42**, 36 - 40.
- 2) Phillips, T. E. R. 1931. *Observatory* magazine, **54**, 276 - 282. Many obituaries were written for Denning, and in addition to those by Prentice (Ref. 1) and Phillips further accounts can be found in the *Monthly Notices of the Royal Astronomical Society*, **92**, 1932, 248 - 250., and *Nature*, **128**, 1931, 12 - 13. Denning in fact used his knowledge of cricket on at least one occasion (*Nature*, **51**, 1895, 320 - 321) to illustrate his frustration at the manner in which some observatories set about making meteoric observations. He noted "it seems to be the fashion at certain observatories to set a number of observers (some of whom have perhaps never registered a meteor path before) watching and recording meteors, and then to investigate their results as though they could be thoroughly depended upon. It is similar to placing a man, who has never played in a cricket match before, as wicket-keeper to fast bowlers like Mold, Richardson and Woods, and expect his performance to be creditable." The analogy is in fact a good one, and Denning was often critical of the many poor observational accounts that found their way into the astronomical literature.
- 3) These comments were found in an article entitled "A self-made English Astronomer", published in the *North British and Ladies Journal*, April 4th, 1904.
- 4) Beech, M. 1992. The Herschel - Denning Correspondence. *Vistas in Astronomy*, **34**, 425 - 447.
- 5) See the *Astronomical Register*, **6**, 1868, 92., for Denning's very first publication. This article was concerned with Observations of Jupiter's Satellites. Further notes by Denning are found in the same volume of the Register on pages 137, 256, and 266.
- 6) Johnson, P. 1990, The Astronomical Register, *Journal of the British Astronomical Assoc.*, **100**, 62 - 66.
- 7) Denning, W. F. 1869, The Supposed New Planet Vulcan, *The Astronomical Register*, **7**, 89. The first supposed sighting of Vulcan was made on March 29th, 1859 by the French country doctor Edmond Lescarbault. Denning seems to have been very interested in re-discovering this planet, and he even alluded to having seen it himself. Writing in 1871 (*Astronomical Register*, **9**, 287) Denning commented "some years ago, I saw, what I supposed must have been, a planetary body in transit across the Sun." Denning's memory was not too clear on when his observation was made, but he noted "it must have been between June, 1860, and June 1863, and I imagine the season was either spring or autumn." In the years stated Denning would have been between 12 and 15 years old. Denning was later to write of Lescarbault (see Ref. 16. p. 350.) that he "obviously lacks the experience and caution necessary to command credit." These comments followed in the wake of Lescarbault's announcement that he had discovered a "new star" in Leo on the night of January 11th, 1891. Incredibly, this "new star" was not a nova but the planet Saturn, and indeed, Denning's comments seem apt.
- 8) Newall, H. F. 1987, in *History of the Royal Astronomical Society: 1820 - 1920*. p. 135. Blackwell Scientific Publications, Oxford.
- 9) Anonymous review in *Nature*, **4**, 1872, 261 - 262.
- 10) Denning, W. F. 1972, *Nature*, **6**, 94.
- 11) Denning, W. F. 1872, Observations of Luminous Meteors, *Monthly Notices of the Royal Astronomical Society*, **33**, 93 - 95.
- 12) Hingley, P. (Royal Astronomical Society Librarian) 1990, personal communication.
- 13) Denning, W. F. 1876, Radiant - Points of Shooting Stars, *Monthly Notices of the Royal Astronomical Society*, **37**, 282 - 284.
- 14) Denning, W. F. 1878, Suspected Repetition, or Secondary Outbursts from Radiant Points; and the Long Duration of Meteor Showers, *Monthly Notices of the Royal Astronomical Society*, **38**, 111 - 114.
- 15) That meteoroid streams could be produced through cometary decay was realized in the mid 1860s. The Italian astronomer Giovanni Schiaparelli first demonstrated this in 1866 when he found that the Perseid meteoroid stream had orbital parameters similar to those of periodic comet Swift - Tuttle. A more detailed understanding of the cometary - meteoroid stream formation process did not become available until well into this century. This work was initiated by Fred Whipple during the 1950s. A general introduction to

cometary physics is given by Brandt, J. C., and Chapman, R. D. C. 1981, in *Introduction to Comets*, Cambridge University Press, Cambridge.

16) Denning, W. F. 1891, in *Telescopic Work for Starlight Evenings*, Taylor and Francis, London., p. 79.

17) Report from the Seventh Annual Meeting, 1888, July 9. The *Observatory* magazine, **11**, 309 - 311.

18) Anonymous review in *Nature*, **44**, 1891, 467.

19) The first President of the BAA was Captain William Noble, and his comments concerning Denning can be found in the *Memoirs of the British Astronomical Association*, **36**, (2), 1948, p. 10.

20) Denning, W. F. 1891, *Journal of the British Astronomical Association*, **1**, 490.

21) Denning's fellowship was announced in the *Trans. Physical Society of Toronto*, 1891, **2**, 45.

22) Beech, M. 1990. William Frederick Denning: in quest of meteors, *Journal of the Royal Astronomical Society of Canada*, **64**, (6), 383 - 396.

23) Denning's award of the Valz Prize was announced in *Nature*, **53**, 1896, 215.

24) The Presidents address at the presentation of Denning's Gold Medal is reproduced in the *Monthly Notices of the Royal Astronomical Society*, **63**, 1898, 242 - 253. Denning did not attend the presentation due to poor health. Denning's Gold Medal is presently on display in the Royal Astronomical Society's Fellows Room at Burlington House in London.

25) Wells, H. G. *The War of the Worlds*, Pan Classics, Pan Books Ltd, London, 1975.

26) This book was based on a collection of articles previously published in the *Observatory* magazine. A favourable review was given to the volume in *Nature*, **57**, 1897, 7. Denning was to later produce another book that was based on collected *Observatory* magazine articles. This book, *The Planets Mercury and Venus*, appeared in 1916, and was reviewed in the *Observatory*, **39**, 1916, 469.

27) *Memoirs of the Royal Astronomical Society*, **53**, 1899, 203 - 292.

28) House of Commons paper 201, 1905. The British Government Archives.

29) Denning, W. F. 1907, *Nature*, **76**, 202.

30) Ref. 16. p. 56.

31) Denning, W. F. 1920, *Nature*, **105**, 838. A review of observations collected at the Greenwich Observatory, London concerning this nova is given by Luyten, W. J. 1920, *Monthly Notices of the Royal Astronomical Society*, **81**, 61 - 65. See also Beech, M., 1993. Denning on Novae, *Journal of the British Astronomical Association*, **103**, 130.

32) I am indebted to Maurice Brain for making copies of several letters by Denning available to me.

33) Muirden, J. 1989, personal communication.

34) Wright, E. C., Registrar and Secretary, University of Bristol, 1987, personal communication. Although the award given by Bristol University was to be the last Denning received while alive, he was posthumously honoured by having craters on the far side of the Moon, and the surface of Mars named after him.

35) Denning, W. F. 1931, Autumnal Meteors, *Observatory*, **54**, 271 - 272

36) Memorial speech by H. Knox Shaw reproduced in the *Western Daily Press*, December 19, 1931.

37) Macpherson, H. 1905, in *Astronomers of Today*, Gall and Inglis, London, p, 172 - 178.

38) Brain, M., 1989, personal communication.

39) Derrett, A., Assistant Registrar to the Royal Archives, Windsor Castle. 1989, personal communication.

40) Maddocks, H. 1931, Mr. W. F. Denning: Doyen of Amateur Astronomy, in the *Times* newspaper, Thursday, June 11th, page 16, column b.

41) This reference is based on a newspaper cutting among the Denning archives of the British Astronomical Association's Meteor Section. The article was clearly published in a newspaper, but it is not clear whether it was a national or provincial paper. The article was seemingly written circa 1900.

42) Denning, W. F. 1900, Notes on Saturn and His Markings, *Nature*, **67**, 237.

43) Beech, M. 1989. Meteor Imagery in English Poetry. *New Comparison*, **7**, (2), 99 - 112.

44) As with Ref. 41 this quotation is taken from a cutting in the Denning archive. This article was written circa 1895.

45) Denning, W. F. 1915, The Claims of Meteoric Astronomy, *Journal of the Royal Astronomical Society of Canada*, **9**, 57 - 60.

46) Cook, A. G. 1931, *Journal of the British Astronomical Association*, **42**, 1931.

Chapter 2.

- 1) Several good texts on meteor physics are available, and that by A. C. B. Lovell, *Meteor Astronomy*, The Clarendon Press, Oxford, 1954., can be recommended as a detailed guide. D. W. Hughes', *The History of Meteors and Meteor Showers, Vistas in Astronomy*, 1982, **26**, 325 - 345 is also highly recommended. A general discussion of meteor showers may be found in G. W. Kronk's, *Meteor Showers: A Descriptive Catalogue*. Enslow Publishers, Aldershot, 1988.
- 2) Pritchard, C. 1864, *Monthly Notices of the Royal Astronomical Society*, **24**, 139.
- 3) Experiences During thirty years Star Gazing, in *Tit Bits* magazine, August 31st, 1895.
- 4) Denning, W. F. 1876, Radiant-Points of Shooting Stars, *Monthly Notices of the Royal Astronomical Society*, **36**, 283 - 285.
- 5) Denning, W. F. 1876, Radiant Points of Shooting Stars, *Nature*, **15**, 158.
- 6) Denning, W. F. 1879, Shooting Stars, in *Proceedings of the Bristol Naturalists Society*, **2**, 264 - 278.
- 7) Denning, W. F. 1891, *Telescopic Work for Starlight Evenings*, Taylor and Francis, London., p. 78.
- 8) Denning, W. F. 1877, The Radiant Centre of the Perseids, *Nature*, **16**, 362.
- 9) Denning, W. F. 1884. The Long Duration of Meteoric Radiant Points, *Monthly Notices of the Royal Astronomical Society*, **45**, 93 - 116.
- 10) Denning, W. F. 1877, Radiant Points of Shooting Stars. From Captain Tupman's unreduced Observations 1869 - 71. *Monthly Notices of the Royal Astronomical Society*, **37**, 349 - 351.
- 11) Denning, W. F. 1878, Radiant Points deduced from the Paths of 4,143 Shooting Stars observed by the Members of the Italian Meteoric Association in the year 1872. *Monthly Notices of the Royal Astronomical Society*, **38**, 315 - 317.
- 12) Ref. 6., p. 271. It is one of those sad ironies that virtually all of Denning's hard work on meteor trail projection is of little contemporary value.
- 13) That meteors were once thought to be observed in the Moon's supposed atmosphere is another example of the philosophical parallel.
- 14) Hughes, D. W. 1990, *Monthly Notices of the Royal Astronomical Society*, **245**, 198 - 203.
- 15) Phipson, T. L. 1867, *Meteors, Aerolites, and Falling Stars*, p. 160 - 161. Lovell Reeve, and Co, London.
- 16) Denning, W. F. 1885, The Great Shower of Andromedes, November 26, 27, 28, and 30, 1885. *Monthly Notices of the Royal Astronomical Society*, **46**, 67.
- 17) Lockyer, J. N. 1890, *The Meteoritic Hypothesis*, Macmillan and Co., London. p. 135.
- 18) Denning, W. F. 1899. General Catalogue of the Radiant Points of Meteoric Showers and of Fireballs and Shooting Stars observed at more than one Station. *Memoirs of the Royal Astronomical. Society*, **53**, 203 - 292.
- 19) Hawkins, G. S. 1958, Catalogues of Meteor Radiants. *Smithsonian Contr. Astrophys.*, **3**, (2), 7 - 8.
- 20) Ref. 7 p. 68. Denning's estimate that only 100 hours of good seeing is available to British observers follows the earlier remarks on the same subject by Sir William Herschel.
- 21) Denning, W. F. 1890. Catalogue of 918 Radiant Points of Shooting Stars Observed at Bristol. *Monthly Notices of the Royal Astronomical Society*, **50**, 410 - 467.
- 22) Denning did claim that the skies were sufficiently clear over Bristol that the aurora could be plainly seen on many nights (*Nature*, **33**, 1885, 152). Suffice it to say here that this claim is quite impossible.
- 23) Only one of Denning's meteor observing note books appears to have survived to the present day. This journal, which contains his observations for the year 1922 is held in the Denning archive of the British Astronomical Association's Meteor Section. Several other note books have survived, but these contain various planetary, and meteor observations along with newspaper and journal cuttings.
- 24) Many aids for visual meteor observing have been developed over the years. James Challis of Cambridge University Observatory, for example, designed a Meteoroscope to observe the 1866 Leonid meteors (*Monthly Notices of the Royal Astronomical Society*, **27**, 1867, 75 - 77). This was the forerunner of Denning's 'meteor-wand', and consisted of a pointer mounted on a tripod. The idea was to use the pointer to 'mark' the altitude and azimuth positions of the beginning and end points of a meteor's train. Later, Ernst Opick was to advocate the use of wire grids, or reticules (*National Academy of Sciences*, **18**, 1932, 16 - 23) to record meteor beginning and end points. Other observers have suggested the use of a flexible string, or wire to aid in identifying meteor paths (see, for example, Prentice, J. P. M, 1948, *Memoirs of the British*

Astronomical Association, **36**, (2), 107). Such aids are not in common use today, and observers tend to simply mark observed paths on specially drawn star charts.

25) Denning's celestial globe was donated to the Royal Astronomical Society's archive in 1942 (*Quarterly Journal of the Royal Astronomical Society*, **27**, 1986, 212 - 236), and can be found in the societies library. The fate that befell Denning's several telescopes is not so clear. It is likely that they may no longer exist as functioning instruments.

26) Beech, M. 1991, The Stationary Radiant Debate Revisited, *Quarterly Journal of the Royal Astronomical Society*, **32**, 245 - 264.

27) Ref. 7, p. 66. Denning's views on the education, and instruction of novice astronomers are further explored in chapter 3.

28) Olivier, C. P. 1925, *Meteors*, Williams and Wilkins, Baltimore.

29) Beech, M. 1992, The Herschel - Denning Correspondence. *Vistas in Astronomy*, **34**, 425 - 447.

30) Denning, W. F. 1907, Professor A. S. Herschel, F.R.S, *Nature*, **76**, 202 - 203.

31) The constraints on orbital dynamics are explained, for example, in J. C. Brandt and R. D. Chapman's *Introduction to Comets* (1981, Cambridge University Press, Cambridge) p. 61 - 65.

32) A summary of the early work on meteor physics is given by Opick, E. 1958, *Physics of Meteor Flight in the Atmosphere*. Interscience Publishers, Inc, New York.

33) Lindemann, F. A., and Dobson, G. M. B., 1922. A Theory of Meteors, and the density and Temperature of the Outer Atmosphere to which it leads. *Proc. Royal Society*, **102**, 411 - 437.

34) Halley's early discussion on meteor origins are further explored in Beech, M. Halley's Meteoric Hypothesis, *The Astronomy Quarterly*, **7**, 1990, 3 - 18.

35) Denning, W. F. 1909, Fall of an Aerolite in Mokoia, New Zealand, on November 26, 1908. *Nature*, **80**, 128. It is not clear what happened to the sample that Denning received. Inquiries to the City Museum at Bristol have revealed that it was not donated to their collection (Clark, R. D., Assistant Curator, Geology, 1991. Personal communication).

Chapter 3.

1) Denning, W. F. *Telescopic Work for Starlight Evenings*, 1891, Taylor and Francis, London. p. 74.

2) Discussion reprinted in the *Observatory* magazine, **11**, 1888, 181 - 182.

3) Denning, W. F. 1883, Amateurs and Astronomical Work. *Nature*, **27**, 434 -436.

4) Ref. 1, p. 78. Interestingly, Sir Arthur Conan Doyle had his famous character Sherlock Holmes echo the very same sentiments. In *A Scandal in Bohemia* Holmes chides his companion Dr. Watson with the words "you see, but you do not observe." That Denning, and the character Holmes should express such beliefs is natural, since both were interested in discovering the true facts behind an observation.

5) Denning, W. F. 1897, Organized or Sectional Work in Astronomy, *Nature*, **56**, 9 -10.

6) Denning, W. F. 1918, A Few Notes on Amateur Observers and Observations, *Journal of the Royal Astronomical Society of Canada*, **12**, 157 - 159.

7) Ref. 1, p. 33.

8) Ref. 1, p. 71.

9) Denning, W. F. 1874, Naked-eye Observations of Jupiter's Satellites, *Monthly Notices of the Royal Astronomical Society*, **34**, 309 - 310.

10) Ref. 1, p. 71. While Denning's claim is really a statement of personal belief, it is certainly true that some astronomers have been renowned for their visual acuity.

11) Ref. 1, p. 75. In some ways this is an interesting claim, since Denning suffered many bouts of ill health in his later life. He did comment, however, in one interview (*Tit Bits*, August 31st, 1895, 386) that "When I commenced habitual night-work I was very sensitive to cold, and the winter usually found me with a troublesome cough." He continued, however, "on the whole I think that 'star-gazing' may be beneficial to health, as well as intellectually profitable."

12) Denning, W. F. 1897, Longevity of Astronomers, *Observatory*, **20**, 206. , and Denning, W. F. 1917, Longevity of Astronomers, *Observatory*, **40**, 132 - 133.

13) This quotation is from a hand-written article entitled Recent Astronomical Discoveries. The article was destined for the journal *Knowledge*, and was written in 1928. The article forms part of the Denning archive in the British Astronomical Association's Meteor Section.

- 14) Ref. 1, p. 29.
- 15) Ref. 1, p. 60. Denning bemoaned the state of his telescope in his observing journals as well. One entry, May 31st, 1898 states, "Cleared up in afternoon after rain. Air very transparent, sky deep blue - swept up Jupiter at about 6. 45 with power 32. Observed planet with 312 but though definition was good the image was too faint for details to be certainly seen - Had the mirror had a good surface it would have been different. Windy NW and very cold -" (This extract is from Denning's Jupiter note book held in the library archives of the Royal Astronomical Society (*Quarterly Journal of the Royal Astronomical Society*, **22**, 1981, 219).
- 16) The long running debate concerning Martian markings is able discussed by William Sheehan in his book *Planets and Perception: Telescopic Views and Interpretations, 1609 - 1909*. The University of Arizona Press, Tucson, 1988.
- 17) Ref. 1, p. 162. Chapter 4 of *Telescopic Work for Starlight Evenings* is devoted to the study of Mars.
- 18) Denning, W. F. 1882, Comet-Seeking, *Observatory*, **5**, 285 - 289.
- 19) Denning, W. F. *Astronomical Phenomena in 1872*, Wyman and Sons, London. This book, as we outlined in chapter 1, was not well received by the reviewer in *Nature*, **4**, 1872, 261 - 262. Denning was to completely change his opinions of comets, and comet-seeking shortly after the publication of this book. He was later to remark, for instance, that "comet-seeking is the most exciting work of any in which I have indulged." (*Tit Bits*, August 31st, 1895, 386)
- 20) Denning, W. F. 1894, The Discovery of comets, *Monthly Notices of the Royal Astronomical Society*, **54**, 544 -546.
- 21) Denning, W. F. 1922, Observation of Comets, *Nature*, **109**, 613.
- 22) See Ref. 20. Denning, did comment in his *Telescopic Work for Starlight Evenings* (Ref. 1, p. 341), however, that "the discovery of new nebulae offers an inviting field to amateurs." Denning would on occasion publish detailed observations of the nebulae that he came across while comet searching. In his first list (*Monthly Notices of the Royal Astronomical Society*, **51**, 1890, 96 - 97) of ten new nebulae he gives detailed positions and descriptions. Interestingly he has enlisted the help of several professional astronomers to determine accurate coordinates. M. Charlois of the Nice Observatory, France even made observations at Denning's request. Further descriptions are given in *Transactions of the Astronomical and Physical Society of Toronto*, **2**, 1891, 69 -70., and *Observatory*, **15**, 1892, 104 - 106.
- 23) Denning, W. F. Variations in Nebulae, *Observatory*, **14**, 196 - 197.
- 24) Denning, W. F. 1900, Mercury as a Naked eye Object, *Nature*, **61**, 430.
- 25) Denning, W. F. 1883, Note on Observations of Mercury, *Monthly Notices of the Royal Astronomical Society*, **43**, 300 - 301.
- 26) Ref. 1, p. 141.
- 27) Ref. 1, p. 170. On the issue of poetic description Denning remarked in one archived article (Ref. 15.) "poets who exercise their muse on matters scientific are often put out of date and rendered seriously inaccurate by the progress of discovery. Thus Blackmore has written, 'Four second planets his domain own, And around him turn, as round the earth the Moon'. While Baker has expressed himself in the following lines:- 'Four friendly moon's with borrow'd lustre rise, Below their beams benign, and light his skies'."
- 28) Denning, W. F. 1899, Early History of the Great Red Spot on Jupiter, *Monthly Notices of the Royal Astronomical Society*, **54**, 574 - 584.
- 29) Denning, W. F. 1920, The Great Red Spot on Jupiter, *Nature*, **105**, 423 - 424.
- 30) Sanchez-Lavega, A. 1989, Saturn's Great White Spots. *Sky and Telescope* magazine, **78**, 141 - 142. The white spots observed on Saturn occur each Saturnian year (29.51 years), and are seemingly the result of seasonal heating of the planets northern hemisphere.
- 31) Denning, W. F. 1876, Notes on Saturn and His Markings, *Nature*, **62**, 237 - 238.
- 32) For an historical study on the discovery of nova see, R. R. Stephenson and D. H. Clark, *Applications of Early Astronomical Records*, chapter 3. 1978, Oxford University Press, New York.
- 33) Ref. 1, p. 315.
- 34) Denning, W. F. 1918, Observations of Nova Aquilae, *Monthly Notices of the Royal Astronomical Society*, **78**, 570.
- 35) Denning's discovery is announced in Nature's "Our Astronomy Column", *Nature*, **105**, 1920, 838.
- 36) Luyten, W. J. 1920, Visual and Photographic Observations of Nova Cygni-3, made at the Royal Observatory, Greenwich. *Monthly Notices of the Royal Astronomical Society*, **81**, 61 - 65.

- 37) Brain, M. 1989, personal communication. The letters (that have so far been found) from Denning to his niece date from November 25th, 1919, September 4th, 1923, and September 26th, 1923.
- 38) Davis, H. V. 1916, Scarcity of Wasps, *Nature*, **98**, 109.
- 39) Denning, W. F. 1916, Letter to the Editor, *Nature*, **98**, 149.
- 40) Denning, W. F. 1920, Wasps, *Nature*, **105**, 328.
- 41) Denning, W. F. 1915, Birds that Pass in the Night, *Observatory*, **38**, 220 - 221.
- 42) Records are not available to determine the exact date when Denning applied for Fellowship (Harris, E, Honorary Librarian, Royal Meteorological Society, 1991, personal communication.)
- 43) See, for example, Denning, W. F. 1914, Lunar Rainbows, *Meteorological Magazine*, **49**, 147 - 147. In this article Denning reports the observation of two lunar rainbows on successive nights, August 2nd, and August 3rd. He also notes the observation of a Mock Moon, or paraselene, on August 7th. Interestingly, Denning comments that he cannot recall the appearance of so many rare phenomena, in such a short period of time, in "an observational experience extending from 1865." This comment is consistent with his claim, discussed in chapter 1, that he began regular night time observing in 1865.
- 44) Denning, W. F. 1885, letter to the Editor, *Nature*, **33**, 152.
- 45) Livesey, R. 1989, The Visibility of Auroral Light In Southern England, *Quarterly Journal of the Royal Astronomical Society*, **30**, 489 - 491.
- 46) For a modern day discussion on rain seeding by the residue of meteoroid ablation see Dean Fyfe, J. D., and Hawkes, R. L. *Planetary and Space Science*, **34**, 1986, 1201 - 1212.
- 47) Denning, W. F. 1915, The Seasons - Recurring Cold Periods. *Meteorological Magazine*, **50**, 44 - 45.