THE BAA OBSERVERS' WORKSHOPS

Cambridge	Winchester	York
2003 February 15	2003 April 26	2003 September 6

Dr David Gavine unravels some of the mysteries of recording and reporting your aurora observations.

Observing the aurora

by Dave Gavine

Workshop No. 3:
York
2003 September 6

Introduction

Although auroral and upper-atmosphere research is carried out mainly in polar regions by professional scientists, it is still worthwhile for the amateur to observe this beautiful and sometimes spectacular phenomenon for its own sake. Occasionally, however, the BAA Aurora Section is called upon to supply information on displays to a variety of professional organisations, and so it has become important to receive reports, to log them in a standardised method and to maintain a continuous archive which can be consulted by interested persons. Through the kindness and foresight of the late Dr Michael Gadsden this has been done – all our auroral and noctilucent cloud data from the time of Director James Paton in the 1940s up to the present is preserved in the special Balfour Stewart Archive at the Library of Aberdeen University.

It used to be thought that the aurora was a feature of the polar regions, or at least the far north of Scotland. Not at all! The last few years, especially the months of 2003 October and November, have witnessed some of the most awesome displays ever seen, visible in the South of England and photographed by many, as demonstrated in our own *Journal, Astronomy Now* and other magazines. These huge displays, the result of coronal mass ejections hurling matter Earthwards and seriously disturbing our magnetic field, are still comparatively uncommon compared to the small, quiet so-called 'Scottish' aurorae associated with coronal holes and smaller disturbances in the solar wind. Details of the physics of these can be found in the extensive literature.

Where can the aurora be seen? In general the further north the better, up to the Auroral Maximum zone which is an oval of almost perpetual light through Northern Norway, Iceland, Hudson's Bay and Alaska. As this oval comes further south into the American continent the best places to go are Alberta, Saskatchewan, and North Dakota, where at about 48ºN Jay Brausch sees far more aurorae than Inverness at 57º. Iceland and Shetland suffer from cloud – many a hopeful observer has gone there and seen nothing. The best skies for aurorae in Britain are probably along the Moray Firth coast.

For continuity, the aurora is best described according to simple instructions worked out during the International Geophysical Year 1957–'58 and set forth in the *International Auroral Atlas*.

Preliminaries

The geographical latitude and longitude of the observer should be given, with the year and the month, and the date is always rendered as the 'double-date' to identify a night, that is, Nov 16/17 means the evening of the 16th and the morning of the 17th. Time is always recorded in UT but if an observer outside the British Isles gives the local time the time zone must be made clear, being careful also to allow for summer time shifts. It is not necessary to give a minute-by minute account of an aurora, just the salient times when there is a change, onset or cessation of activity or major brightenings.

Measurement of the maximum elevation of a display above the northern true horizon, (indicated like this: ↑22º) and of the base of an auroral arc, (indicated h.12º) can be done by a simple cloud alidade or a similar device made from a protractor and a ruler (Figure 1), or by using the human hand – the fully extended thumb and fingers subtend about 17° at arm's length, and three knuckles of the fist make about 6°. A protractor can be used to estimate rough azimuths of the limits of the display from true north. Since the base of a homogeneous arc (*q.v.*) is nearly always 100km above the Earth's surface, its elevation in degrees enables an investigator studying the development of an individual display to fix it in geomagnetic latitude. It is best not to describe auroral forms with respect to stars or constellations as this involves unnecessary and tedious calculations, as the stellar background differs from each location.

Simple 'jamjar' or more elaborate 'fluxgate' magnetometers can, in experienced hands, act as an early-warning system and this is well explained in the literature, although sometimes a magnetic disturbance does not produce a visible aurora, or an aurora may appear when the field is relatively quiet. Some astronomical societies have set up a warning system by phoning around. Some warning of auroral conditions is given on the internet but those sites of North American origin tend to apply mostly to that continent, which is at a higher geomagnetic latitude relative to the geographical equivalent in Europe.

Finally, dress as warmly as possible, especially the feet, keep the head covered (most heat is lost this way), get away from street or artificial light, use a clipboard, and a red torch to preserve your dark adaptation. Hot drinks are fine but avoid alcohol except to celebrate with afterwards!

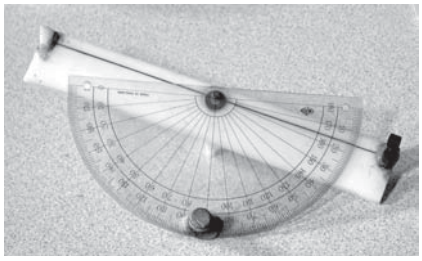


Figure 1. A simple alidade constructed from a protractor and ruler may be used to measure the height of a display above the horizon.

The auroral forms

Rather than give a wordy description I recommend the observer uses a standard shorthand code based on the *International Auroral Atlas*. See also Figure 7.

N: Auroral light of unspecified or uncertain form, usually seen in cloud breaks, or a glow on the northern horizon, the top of a display further north over the horizon.
A: Arc, like a curving arch or a low rainbow which follows the curvature of the Earth, usually pale green or white.
B: Band. Like an arc but with one or more kinks or folds.
P: Patch, a diffuse cloud of light without sharp edges.
V: Veil, an extensive diffuse luminosity, fainter than Patch, usually as a background to other forms, normally white but may be pink or red.
R: Ray, a vertical shaft of light like a searchlight beam.

Figure 4. Quiet homogeneous arc with red veil above (QHA2c + V1d). *D. Gavine, Edinburgh, 1999 Jan 13/14.*

Symbols which qualify or describe the forms

m: Multiple, e.g. m_3P means three patches.
f: Fragmentary, a part only of an arc or band sometimes after it breaks up, e.g. fA
c: Coronal: rays or patches converge like spokes of a wheel during very big displays, in the magnetic zenith which is several degrees (in UK) southeast of the true zenith.

Structure of forms

H: Homogeneous, lack of internal structure, usually uniform in brightness.
S: Striated, horizontal banding or filaments often at high altitude, uncommon in UK.
R: Rayed, addition of rays to other forms, such as RA rayed arc, RB rayed band, RP rayed patch. Rays alone are denoted RR. Lengths of rays may be indicated by R_1, R_2 & R_3 for short, (up to 20º), medium, and long (60º+). E.g. R_3B is a rayed band with long rays.

Condition of forms

Q: Quiet, no appreciable variations in brightness, movement or shape.
a: 'Active': forms move position or change shape quickly, in the order of a few seconds; this is subdivided as
a_1: folding of boundaries of bands;
a_2: rapid changes in lower borders of individual forms;

Figure 2. Long red and white rays, slow pulsations (p_1R_3R3e). *D. Gavine, Edinburgh, 2001 Nov 5/6.*

Figure 5. Rayed band with blue sunlit tops, horizontal movement of fold along base (a_1R_2B2f). *Lorna McCalman, Edinburgh, 2001 Apr 11/12.*

Figure 3. Pulsating green homogeneous patch (p_1HP2c). *D. Gavine, Fort Augustus, 1978 Aug 29/30.*

Figure 6. Red flaming coronal rays (p_2mcR_3R2d). *Lorna McCalman, Soutra, Midlothian, 2003 Oct 30/31.*

a_3: rapid horizontal movement of rays in either direction;
a_4: refers to the display as a whole, in which forms fade rather quickly while new, similar or different forms appear in other parts of the sky; usually seen in late stages of big displays.

p: 'Pulsing'; brightness changes, often rhythmical, from a fraction of a second to a few minutes. Subdivided as
p_1: pulsating, uniform changes of brightness;
p_2: flaming, dramatic surges of light sweeping upward from the horizon to the zenith lighting up the forms;
p_3: flickering, very rapid light variation like flames, rare in UK;
p_4: streaming, irregular change in horizontal brightness along homogeneous forms.

Brightness

1: Faint, comparable with the Milky Way and below the threshold of colour vision.
2: comparable with moonlit cirrus cloud.
3: comparable with moonlit cumulus cloud.
4: much brighter than 3, seldom seen in UK, casts shadows.

Colour

a: upper part red (630.0nm), lower part green (557.7nm).
b: red lower border, mainly below green arc or band (several emission lines of excited nitrogen)
c: white if faint, (below the eye's colour threshold), or if brighter, the common green 557.7nm oxygen emission. Bright white or yellow is due to a mixture of green, red and blue emissions. (The green auroral line can be seen in a spectroscope, or detected in light-polluted skies with a 557.7nm interference filter, but even a green glass or clear plastic sheet will enhance the aurora.)
d: high altitude red, 630.0 and 636.4nm oxygen emission at heights above 150km.
e: mixed red and green, e.g. red and green rays irregularly distributed horizontally.
f: blue in upper parts, purple if mixed with red, the brightness is enhanced if the tops of the rays are in sunlight.

The symbols are used in the order: Condition, Qualifier, Structure, Form, Brightness, Colour.

Examples

QHA2c: quiet homogeneous arc, brightness 2, white or green (see Figure 4).
$p_2$mcR_3R3d: multiple long red rays, brightness 3, forming corona and flaming (see Figure 6).

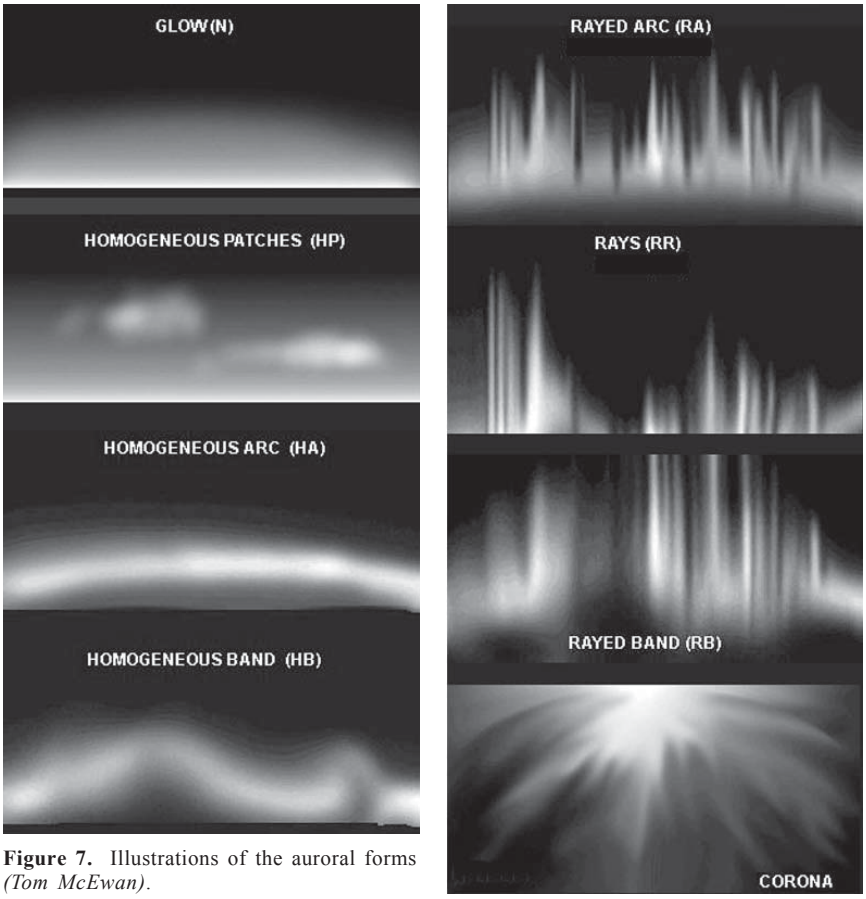


Figure 7. Illustrations of the auroral forms *(Tom McEwan)*.

Reporting

Report forms are available from the Section Director but you can make up your own, like the example by one of our best observers given in Figure 8. If you are unhappy with the above coding system a sensible description in words will do. It is of particular value to include sketches showing the main auroral structures with their times of appearance.

Photographing the aurora

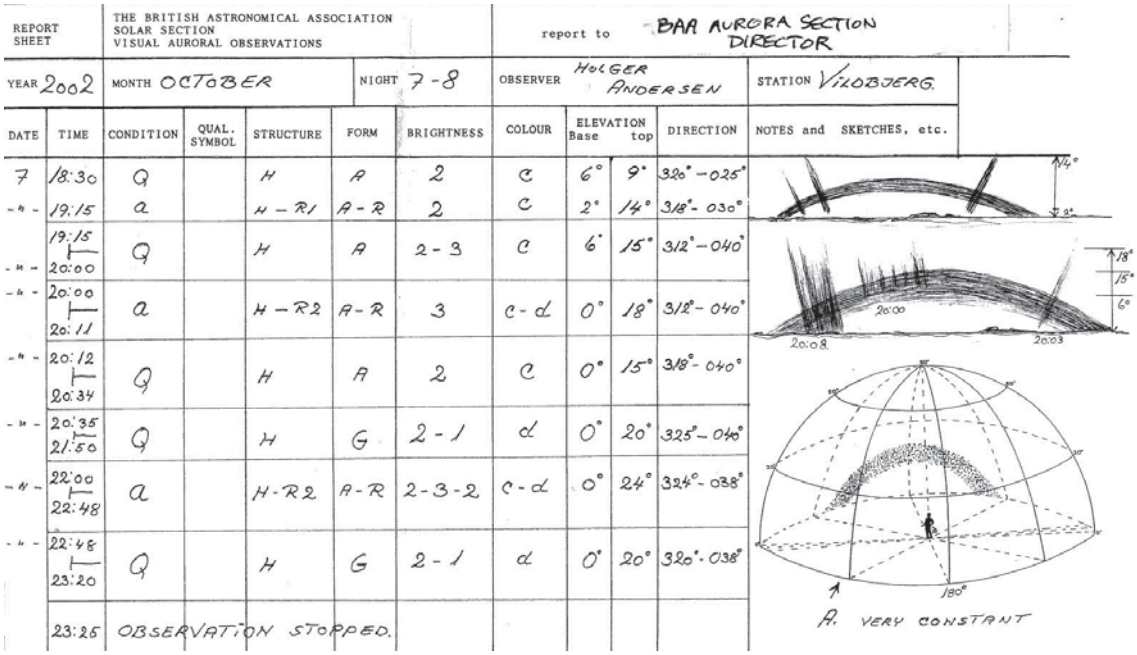
With modern lenses and emulsions it is not difficult to photograph the aurora, but if the display is very active and fast-moving like the huge event of 1989 March 13/14, the result can often be just a blur of light. The trick is to match the length of exposure with the movements of the auroral forms.

You will need a tripod, a cable release and a ball and socket head enabling the 35mm camera to point to the zenith. Get well away from street lights, especially sodium. A wide-angle lens, say 28mm focal length, working at f2.8 or better will enable a large section of a display to be captured, but an all-sky lens such as 16mm or even 8mm will give spectacular pictures of an entire auroral scene. Favourite slide films are 400 ISO Fuji or Ektachrome which are sensitive to the red and green auroral emissions and render them in the truest colours. In general 5 or 10 seconds will do for bright aurorae, 20 to 60 seconds for faint structures. Jim Henderson of Aberdeenshire, a professional photographer with many years' experience of the aurora, gives the best advice. The huge displays of 2003 were also captured by observers with digital cameras, with very pleasing results, so it is worth experimenting. Always make a note of the times and lengths of your exposures, and if possible the azimuth in which the camera is pointing; this is particularly useful for analysis of photographs of noctilucent clouds, for which 3–5 seconds at f2.8 on ISO 400 has been found to give the best results.

Useful sources of information

The internet

The BAA Aurora Section maintains a website: **www.baa-aurora.fsnet.co.uk** which has full instructions with illustrations on how to observe aurora and noctilucent cloud, a selection of recent photographs, a



REPORT SHEET — THE BRITISH ASTRONOMICAL ASSOCIATION SOLAR SECTION VISUAL AURORAL OBSERVATIONS — report to BAA AURORA SECTION DIRECTOR

YEAR 2002 | MONTH OCTOBER | NIGHT 7-8 | OBSERVER HOLGER ANDERSEN | STATION VILDBJERG

DATE	TIME	CONDITION	QUAL. SYMBOL	STRUCTURE	FORM	BRIGHTNESS	COLOUR	ELEVATION Base	ELEVATION top	DIRECTION	NOTES and SKETCHES, etc.
7	18:30	Q		H	A	2	C	6°	9°	320°–025°	
–"–	19:15	a		H–R1	A–R	2	C	2°	14°	318°–030°	
–"–	19:15 – 20:00	Q		H	A	2–3	C	6°	15°	312°–040°	
–"–	20:00 – 20:11	a		H–R2	A–R	3	C–d	0°	18°	312°–040°	
–"–	20:12 – 20:34	Q		H	A	2	C	0°	15°	318°–040°	
–"–	20:35 – 21:50	Q		H	G	2–1	d	0°	20°	325°–040°	
–"–	22:00 – 22:48	a		H–R2	A–R	2–3–2	C–d	0°	24°	324°–038°	
–"–	22:48 – 23:20	Q		H	G	2–1	d	0°	20°	320°–038°	
	23:25	OBSERVATION STOPPED.									

Figure 8. Example of an observing report from Holger Andersen of Denmark.

bibliography and links to other auroral and geomagnetic sites. One of the best is the site maintained by Aurorawatch UK at the University of Lancaster, which gives magnetograms from the University of York: **www.dcs.lancs.ac.uk.**

A select bibliography

Bone N., *The aurora: Sun-Earth interactions,* Wiley, Chichester, 2nd edn, 1996

Bone N., 'Lights in the sky', *Astronomy Now,* June 2000

Bone N., 'Two weeks that shook space', *ibid.* January 2004

Burtnyk K., Eather R. H. & Odenwald S., 'Fire in the sky', *Sky & Tel.,* March 2000

Henderson J. & MacNicol J., *The aurora: An introduction for observers and photographers,* Crooktree Images, Aboyne, 1997

International Auroral Atlas, International Union of Geodesy and Geophysics, Edinburgh, 1963

Gavine D., 'Aurorae and noctilucent clouds' in P. Moore *(ed.), The Observational Amateur Astronomer,* Springer–Verlag, London, 1995

Livesey R. J., 'A 'jamjar' magnetometer', *J. Brit. Astron. Assoc.,* **93**, 17–19 (1982)

Livesey R. J., 'The visibility of the aurora from the United Kingdom', *ibid.* **105**, 179–181 (1995)

Pettitt D. O., 'A fluxgate magnetometer', *ibid.* **94**, 55–61 (1984)

Smillie D. J., 'Magnetic and radio detection of aurorae', *ibid.* **102**, 16–20 (1992)

Cover photographs, *ibid.* **114**, 1–2, (2004)

Acknowledgments

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