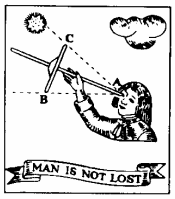
ASTRONOMICAL INFORMATION SHEET No. 6



Prepared by

HM Nautical Almanac Office

THE UNITED KINGDOM HYDROGRAPHIC OFFICE

Admiralty Way, Taunton, Somerset, TA1 2DN

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A Note on the Prediction of the Dates of First Visibility of the New Crescent Moon

This note describes the methods that HM Nautical Almanac Office adopts for predicting first sighting of the new crescent moon from astronomical calculations.

It is not possible to predict accurately the dates on which the new crescent moon will first be seen from a particular place for any month.

There is a list of 295 observations, which are well documented, covering the period 1859 to 1996, that are useful for testing theories of prediction. See Schaefer, B.E., (1988), *Quarterly Journal of the Royal Astronomical Society*, **29**, 511-523, Doggett, L.E., and Schaefer, B.E., (1994), *Icarus*, **107**, 388-403, and Schaefer, B.E., (1996), *Quarterly Journal of the Royal Astronomical Society*, **37**, 759-768. This record of observations is helpful for testing theories in cases of low to medium latitudes where sightings are made one or two days after conjunction (new moon). The MoonWatch Project (www.crescentmoonwatch.org) has been instigated to address the need for further observations of first sighting of the new crescent moon to be made at high latitudes when the Moon is several days old and the first sighting is in daylight, not twilight. However observations are encouraged each month from all latitudes.

There are many factors that affect the chance of seeing the new crescent moon. It depends slightly on the distance of the Moon from the Earth, being greater when the Moon is closest to the Earth. Local conditions, especially the height of the observer above sea level, the character of the surrounding surface and the height of the horizon relative to the observer are also important. Even when the sky is free from cloud there are considerable variations in the clearness of the atmosphere from one day to another. In fact the direction of the wind is often important, and a change in the wind direction can change the clarity of the air considerably. The visual acuity and age of the observer is also significant. The sightings, especially if they are visual, should be made by a number of independent observers, because there is always a chance of making an unintentional false sighting.

There are various parameters that are used to predict first sighting. For example, the age of the Moon at sunset, measured from the time of astronomical new moon, is often used. As a rough guide the new crescent moon cannot be seen without optical aid when the age is less than 14 hours, and it is usually visible by the time the age is 30 hours. This parameter often gives reliable predictions, and it is simple to calculate, however, it cannot always be relied upon. The lag time in minutes between moonset and sunset is another indicator that is often used, it is slightly more difficult to calculate, and again it cannot always be relied upon. A lag time of 50 minutes or more is usually a good indication that the new crescent moon can be seen during twilight. A geometrical rule that applies in most situations is that it is unlikely that the new crescent moon will be seen with the unaided eye unless the elongation exceeds 10° and the altitude of the Moon exceeds 5° when the depression of the Sun is 3°. Another important fact that should be taken into account is that the new crescent moon can always be seen 30 days after the previous one and in half the cases it can be seen 29 days after, because the length of the synodic month is 29·53 days.

This office uses the parameter q that is based on the Indian method, and is expressed in the form of a table of limiting altitudes of the Moon at sunset as a function of the difference in azimuth between the Sun and

the Moon. A detailed explanation of the method, with references, will be found in **NAO Technical Note No. 69**, *A Method for Predicting the First Sighting of the New Crescent Moon*, Yallop B.D., 1998 April.

The value of the parameter *q* indicates for example whether the new crescent moon can be seen easily, or only if the atmospheric conditions are very good, or whether optical aid, such as binoculars or a telescope are necessary to help identify the Moon initially. In critical cases it is still a wise precaution to examine quantities such as the age of the Moon at sunset, the altitude of the Moon at sunset and the lag time, before making the final decision.

The ranges for the *q*-test have been calibrated empirically by comparing the visibility code Schaefer used for the 295 observational records referred to in the second paragraph of this note, with a similar code derived from the calculated values of *q*. It has also been found necessary to use theoretical arguments to obtain some of the limiting values for *q*. This office uses six visibility codes, designated types A to F, that are determined from the calculated values of *q*. The circumstances that apply to the visibility codes are given in the table below. Note that *ARCL* is the geocentric elongation of the Moon from the Sun, and that the Danjon limit is an extrapolated limit, below which the new crescent moon cannot be seen.

Visibility Code	Description of the Visibility Code
A	Easily visible, $ARCL \geq 12°$
B	Visible under perfect conditions
C	May need optical aid to find new crescent moon
D	Will need optical aid to find new crescent moon
E	Not visible with a telescope, $ARCL \leq 8{\cdot}5°$
F	Not visible, below Danjon limit, $ARCL \leq 8°$

The MoonViz output produced by this office (see http://websurf.nao.rl.ac.uk) contains the date, time (Universal or Standard Time as requested) and day of the week of the new moon (i.e. the instant of conjunction). This is followed by a record for each evening from the Birth Date until the new crescent moon is considered to be easily visible (code A), or is easily visible under perfect atmospheric conditions (code B) and the age of the Moon exceeds 22 hours. Note that the Birth Date is the date of the first evening when the Sun has set after conjunction.

The evening record begins with the number of days from the Birth Date (headed Birth Date +), the day of the week and the date and time of sunset. This is followed by the azimuth (Az) of the Sun, the age of the Moon, the topocentric altitude including refraction (Alt) and the azimuth (Az) of the Moon, the difference of the azimuth of the Moon minus azimuth of the Sun (DAZ), the magnitude (Mag) and elongation (El) of the Moon, all calculated at the time of sunset. The record continues with the time of moonset and the lag time, which is the interval in minutes from sunset to moonset. The remainder of the record contains the best time (BEST TIME) for making the observation, and the last column contains the visibility code which is calculated at the best time. The best time is four ninths of the lag time after sunset.

Revised BDY
1998 April 2

At the time this sheet was produced, HMNAO believes the information to be accurate.