

**COMPUTING THE EARLIEST VISIBILITY OF LUNAR CRESCENT FOR
DETERMINING THE BEGINNING OF THE RAMADHAN AND EID DATES
IN 2012**

Moonsighting Committee

ABSTRACT:

This report explains how to determine the beginning of the month Ramadhan and the Eid Dates for Germany by calculating the visibility of the lunar crescent .

INTRODUCTION:

There are several methods described in the astronomic literature which can be used to define the criteria when an earliest moon sighting is possible based on statistical data collected over the last two centuries. Each of them has different accuracy resulting out of the formula used to describe the considered statistical data.

The criterias for moonsighting have been an object of research for centuries. Accordingly many methods were developed such as Mounders, arabian, indian etc.

The Yallop criteria developed by B. D. Yallop for the Nautical Almanac Office UK is considered as the most accurate.

MOON SIGHTNING CRITERIAS:

The Arab astronomers described that a crescent can be seen if the age of the moon is older than 24 hours and its altitude at apparent sunset is more than 8 degrees so the lag (time difference between sun and moon set) is more than 45 minutes.

The new Maunders method describes that there is still a possibility to see the moon if it appears far enough from the sun at the time of sunset. So the Maunders criterion also considered the difference between the azimuths (Horizontal Positions) of both the moon and the sun.

The Indian method just modifies these criteria by more precise values in the formula.

The Bruins method, known to be the most exact and based on the Yallop criteria also considers the phase (width and brightness) of the crescent at the sunset. So the Yallop criteria says if the crescent is big enough, the minimum distance between the azimuths of moon and sun can be 11.47 Degrees, still considering the altitude (height) of the moon.

This criterion can be evaluated at different times of the sunset. Normally it is calculated at three times, namely: at apparent sunset (when the sun touches the horizon), at a time described as the ,best time‘ (see appendix I) and also at the time when its altitude is less than -5° degrees under the horizon.

Yallop describes the Visibility in five codes depending upon the value of the parameter “q”. As for as the first two Visibility codes (A: Easily visible and B: Visible under perfect conditions) are concerned, they may be considered as reliable for the visibility of the first crescent. However the third code (C: May need optical aid) in which the position of the crescent be spotted by optical aid initially and then it may be visible with unaided eyes, is not reliable. In such cases the value of “q” has to be examined very carefully. According to the actual observations listed by Schäfer the crescent was visible in a couple of cases when the value of “q” was less than (-0.014) but bigger than (-0.110), however in almost none of the cases it was visible with unaided eye when it’s value was lower than (-0.110). Therefore, we may consider the crescent as visible if the value of “q” is more than this otherwise not. The geological and astronomical coordinate data is documented in Appendix II. Formulas for the above mentioned Criteria are documented in Appendix I.

RESULTS:

For predicting the beginning of Ramadhan and Eid Dates we considered the third method named Yallop which is to be known as the most accurate and precise method. The results were the following:

Ramadhan Begin: The new Moon will be born on the 19. July at 06:24GMT+2. On the 20. July is no visibility possible. On the 21. July the moon can be easily seen in all evaluated cities.

Eid ul Fitr: The new Moon will be born on 17. August at 17:54GMT+2. On 18. August there will be no visibility. On the 19. August there will be a good chance to see the moon in Sonthofen (Code A) and if the conditions are perfect then in Frankfurt am Main and Aachen too (Code B).

Eid ul Adha: The new Moon will be born on 15. October at 13:02GMT+1. On the 16. October there will be no visibility in all evaluated cities considering the above mentioned visibility ranges and evaluations times. On the 17th October, the moon can be observed easily in all evaluated cities.

CONCLUSION:

Basing on these results, we determined following dates for Germany.

Ramadhan Begin 2012: **22. July 2012**

Eid – ul – Fitr 2012: **20. August 2012**

Eid – ul – Adha 2012: **27. October 2012** (1. Zil Hadsch 18. Oktober 2012)

27. November 2011

Tahir Mahmood
(President Moonsighting Committee)

APPENDIX I: Formulas / Definitions

Alt = Altitude , Azi = Azimuth

dAzi = Differenz of Azimuths = | Current Sun Azi - Current Moon Azi |

Maunder's

Alt Min = (11 - (dAzi / 20) - ((dAzi ^ 2) / 100))

if Current Moon Alt > Alt Min then its visible else not

Indian

Alt Min = (10.3743 - (0.0137 * dAzi) - 0.0097 * (dAzi ^ 2))

if Current Moon Alt > Alt Min then its visible else not

Best Time

BestTime = SunsetTime + ((4/9) * Lag)

Astronomical Time

$$\text{GMST at } 0^{\text{hrs}} \text{ U.T.} = 24110^{\text{sec}}.54841 + 8640184^{\text{sec}}.812866 * T_u + 0^{\text{sec}}.093104 * T_u^2 - 6^{\text{sec}}.2 * 10^{-6} * T_u^3 \quad (2.8)$$

$$\text{where } T_u = (\text{JD} - 2451545.0) / 36525 \quad (2.9)$$

$$\text{LMST at } H^{\text{hrs}} M^{\text{min}} S^{\text{sec}} = \text{GMST} + L(\text{in time measure}) + \text{Local Time} + (3^{\text{min}} 56^{\text{sec}}) * (\text{Local Time}) / 24 \quad (2.10)$$

Yallop

$$\begin{aligned} \text{pi} = & 0.9508 + (0.0518 * \text{Cos}(134.9 + (477198.85 * T0))) \\ & + (0.0095 * \text{Cos}(259.2 - (43335.38 * T0))) \\ & + (0.0780 * \text{Cos}(235.7 + (890534.23 * T0))) \\ & + (0.0028 * \text{Cos}(269.9 + (954397.7 * T0))) \end{aligned}$$

$$\text{SD} = 0.2725 * (\text{pi} * 57.295779513)$$

$$\text{ARCV} = \text{Altitude} + |\text{Sun.Altitude}|$$

$$\begin{aligned} \text{If } \text{ARCV} > 22 \text{ Then } \text{ARCL} = & \text{aCos}((\text{Cos}(\text{ARCV}) * \text{Cos}(\text{dAzi})) * 0.0174532925) \\ \text{Else } \text{ARCL} = & (\text{ARCV}^2 + \text{dAzi}^2)^{0.5} \end{aligned}$$

$$W = \text{SD} * (1 - (\text{Cos}(\text{ARCL})))$$

$$q = (\text{ARCV} - (11.8371 - 6.3226W + 0.7319W^2 - 0.1018W^3)) / 10 \quad (4.9)$$

(For more details see Appendix III a)

APPENDIX IIa: Astronomical & Geological Coordinate Data for the 20 July 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 21:44:41
Apparent Moonset: 21:44:29
,Best Time': 21:44:36

q @ BT : -0.604 => Not Visible
q @ SS : -0.560 => Not Visible
q @ -5 : N/A => Not Visible

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 21:26:37
Apparent Moonset: 21:39:01
,Best Time': 21:32:08

q @ BT : -0.428 => Not Visible
q @ SS : -0.399 => Not Visible
q @ -5 : -0.424 => Not Visible

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 21:14:50
Apparent Moonset: 21:32:14
,Best Time': 21:22:34

q @ BT : -0.347 => Not Visible
q @ SS : -0.387 => Not Visible
q @ -5 : -0.322 => Not Visible

APPENDIX IIb: Astronomical & Geological Coordinate Data for the 20 July 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 21:12:20
Apparent Moonset: 21:18:50
,Best Time': 21:15:13

q @ BT : -0.525 => Not Visible
q @ SS : -0.486 => Not Visible
q @ -5 : -0.535 => Not Visible

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 21:18:54
Apparent Moonset: 21:24:52
,Best Time': 21:21:33

q @ BT : -0.531 => Not Visible
q @ SS : -0.506 => Not Visible
q @ -5 : -0.539 => Not Visible

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 21:35:29
Apparent Moonset: 21:39:05
,Best Time': 21:37:05

q @ BT : -0.557 => Not Visible
q @ SS : -0.508 => Not Visible
q @ -5 : -0.577 => Not Visible

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 21:40:35
Apparent Moonset: 21:51:29
,Best Time': 21:45:26

q @ BT : -0.448 => Not Visible
q @ SS : -0.427 => Not Visible
q @ -5 : -0.445 => Not Visible

APPENDIX IIc: Astronomical & Geological Coordinate Data for the 21 July 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 21:43:12
Apparent Moonset: 22:04:16
,Best Time': 21:52:34

@ Best Time:
q – Value: 0.344
-> *Code A => Easily visible*

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 21:25:26
Apparent Moonset: 22:03:11
,Best Time': 21:42:13

@ Best Time:
q – Value: 0.618
-> *Code A => Easily visible*

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 21:13:46
Apparent Moonset: 21:58:22
,Best Time': 21:33:35

@ Best Time:
q – Value: 0.747
-> *Code A => Easily visible*

APPENDIX II: Astronomical & Geological Coordinate Data for the 21 July 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 21:11:01
Apparent Moonset: 21:41:03
,Best Time': 21:24:22

@ Best Time:
q – Value: 0.471
-> Code A => *Easily visible*

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 21:17:34
Apparent Moonset: 21:46:53
,Best Time': 21:30:36

@ Best Time:
q – Value: 0.461
-> Code A => *Easily visible*

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 21:34:06
Apparent Moonset: 22:00:08
,Best Time': 21:45:40

@ Best Time:
q – Value: 0.417
-> Code A => *Easily visible*

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 21:39:22
Apparent Moonset: 22:15:02
,Best Time': 21:55:13

@ Best Time:
q – Value: 0.585
-> Code A => *Easily visible*

APPENDIX IIe: Astronomical & Geological Coordinate Data for the 18 August 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 20:48:04
Apparent Moonset: 20:29:20
,Best Time': 20:39:45

Moonset before Sunset => No visibility

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 20:39:48
Apparent Moonset: 20:31:02
,Best Time': 20:35:54

Moonset before Sunset => No visibility

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 20:31:56
Apparent Moonset: 20:27:30
,Best Time': 20:29:58

Moonset before Sunset => No visibility

APPENDIX IIf: Astronomical & Geological Coordinate Data for the 18 August 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 20:21:14
Apparent Moonset: 20:07:38
,Best Time': 20:15:12

Moonset before Sunset => No visibility

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 20:27:18
Apparent Moonset: 20:13:22
,Best Time': 20:21:06

Moonset before Sunset => No visibility

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 20:41:53
Apparent Moonset: 20:26:01
,Best Time': 20:34:50

Moonset before Sunset => No visibility

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 20:52:26
Apparent Moonset: 20:42:31
,Best Time': 20:48:02

Moonset before Sunset => No visibility

APPENDIX IIg: Astronomical & Geological Coordinate Data for the 19 August 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 20:45:45
Apparent Moonset: 20:48:29
,Best Time': 20:46:58

@ Best Time:
q – Value: -0.116
-> *Code C => May need optical Aid*

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 20:37:50
Apparent Moonset: 20:54:49
,Best Time': 20:45:21

@ Best Time:
q – Value: 0.106
-> *Code B => Visible if conditions perfect*

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 20:30:07
Apparent Moonset: 20:53:23
,Best Time': 20:40:27

@ Best Time:
q – Value: 0.219
-> *Code A => Easily visible*

APPENDIX IIIh: Astronomical & Geological Coordinate Data for the 19 August 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 20:19:07
Apparent Moonset: 20:29:17
,Best Time': 20:23:38

@ Best Time:
q – Value: -0.017
-> Code C => *May need optical Aid*

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 20:25:10
Apparent Moonset: 20:34:50
,Best Time': 20:29:28

@ Best Time:
q – Value: -0.022
-> Code C => *May need optical Aid*

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 20:39:40
Apparent Moonset: 20:46:28
,Best Time': 20:42:41

@ Best Time:
q – Value: -0.059
-> Code C => *May need optical Aid*

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 20:50:25
Apparent Moonset: 21:05:38
,Best Time': 20:57:11

@ Best Time:
q – Value: 0.083
-> Code B => *Visible if conditions perfect*

APPENDIX III: Astronomical & Geological Coordinate Data for the 16 Oct 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 18:21:26
Apparent Moonset: 18:31:04
,Best Time': 18:25:43

@Sunset: q – Value: -0.580 -> Code F => Not visible
@ -5: q – Value: -0.507-> Code F => Not visible
@ Best Time: q – Value: -0.503 -> Code F => Not visible

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 18:33:31
Apparent Moonset: 18:52:09
,Best Time': 18:41:48

@Sunset: q – Value: -0.456 -> Code F => Not visible
@ -5: q – Value: -0.367-> Code F => Not visible
@ Best Time: q – Value: -0.345 -> Code F => Not visible

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 18:35:05
Apparent Moonset: 18:58:00
,Best Time': 18:45:16

@Sunset: q – Value: -0.447 -> Code F => Not visible
@ -5: q – Value: -0.297-> Code F => Not visible
@ Best Time: q – Value: -0.260 -> Code F => Not visible

APPENDIX IIj: Astronomical & Geological Coordinate Data for the 16 Oct 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 18:05:48
Apparent Moonset: 18:19:48
,Best Time': 18:12:01

@Sunset: $q - \text{Value: } -0.529 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ -5: $q - \text{Value: } -0.451 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ Best Time: $q - \text{Value: } -0.439 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 18:11:05
Apparent Moonset: 18:25:00
,Best Time': 18:17:16

@Sunset: $q - \text{Value: } -0.543 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ -5: $q - \text{Value: } -0.453 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ Best Time: $q - \text{Value: } -0.438 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 18:21:08
Apparent Moonset: 18:33:12
,Best Time': 18:26:30

@Sunset: $q - \text{Value: } -0.541 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ -5: $q - \text{Value: } -0.472 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ Best Time: $q - \text{Value: } -0.404 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 18:43:28
Apparent Moonset: 19:01:20
,Best Time': 18:51:25

@Sunset: $q - \text{Value: } -0.475 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ -5: $q - \text{Value: } -0.378 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$
@ Best Time: $q - \text{Value: } -0.357 \rightarrow \text{Code } F \Rightarrow \text{Not visible}$

APPENDIX III: Astronomical & Geological Coordinate Data for the 17.Oct 2012

North to South

54° 47' N, 9° 26' O, 12 m - Flensburg

Apparent Sunset: 18:19:05
Apparent Moonset: 19:09:38
,Best Time': 18:41:33

@ Best Time:
q – Value: 0.832
-> Code A => *Easily visible*

50° 7' N, 8° 41' O, 112 m - Frankfurt am Main

Apparent Sunset: 18:31:31
Apparent Moonset: 19:34:54
,Best Time': 18:59:41

@ Best Time:
q – Value: 1.114
-> Code A => *Easily visible*

47° 31' N, 10° 17' O, 1100 m - Sonthofen

Apparent Sunset: 18:33:14
Apparent Moonset: 19:42:43
,Best Time': 19:04:07

@ Best Time:
q – Value:
-> Code A => *Easily visible*

APPENDIX III: Astronomical & Geological Coordinate Data for the 17.Oct 2012

East to West

52° 21' N, 14° 33' O, 40 m – Frankfurt an der Oder

Apparent Sunset: 18:03:32
Apparent Moonset: 18:28:56
,Best Time': 19:00:34

@ Best Time:
q – Value: 0.956
-> Code A => *Easily visible*

52° 31' N, 13° 24' O, 115 m - Berlin

Apparent Sunset: 18:08:54
Apparent Moonset: 19:05:43
,Best Time': 18:34:09

@ Best Time:
q – Value: 0.955
-> Code A => *Easily visible*

53° 33' N, 10° 0' O, 6 m - Hamburg

Apparent Sunset: 18:18:52
Apparent Moonset: 19:12:57
,Best Time': 18:42:54

@ Best Time:
q – Value: 0.902
-> Code A => *Easily visible*

50° 47' N, 6° 5' O, 173 m - Aachen

Apparent Sunset: 18:41:25
Apparent Moonset: 19:43:41
,Best Time': 19:09:05

@ Best Time:
q – Value: 1.090
-> Code A => *Easily visible*

APPENDIX III: Literature / Websites

a)

COMPUTATIONAL ASTRONOMY AND THE EARLIEST
VISIBILITY OF LUNAR CRESCENT

Muhammad Shahid Qureshi

http://www.icoproject.org/pdf/qureshi_2005.pdf

b)

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A Method for Predicting the First Sighting of the New Crescent Moon

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<http://astro.ukho.gov.uk/download/NAOTN69.pdf>

c)

Her Majesties Nautical Almanac Office

<http://websurf.hmnao.com>

d)

Moon Calculator 6.0

<http://www.ummah.com/ildl/mooncalc.html>