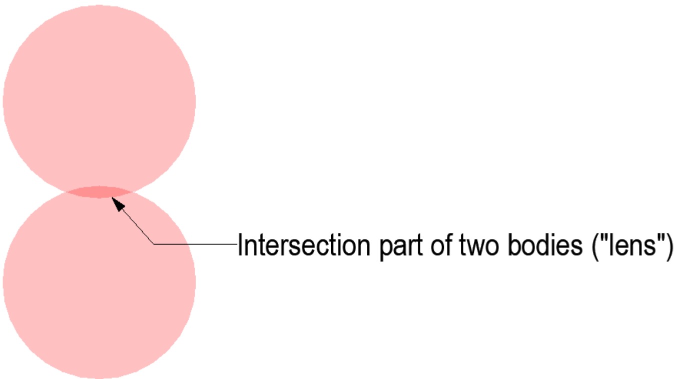
LUNARS. POINT OF CONTACT BETWEEN TWO CELESTIAL BODIES

Everyone who has ever tried to take lunar distance sight knows that essential part of Lunar observation is making two celestial bodies in perfect contact in the field of view of sextant's telescope. But there is one very interesting aspect that fascinates me very much: the ability to visually find the moment when the bodies are in exact contact depends not only on such obvious factors as power of the telescope, contrast and brighteness of the objects, weather conditions etc., but also on the shape and size of celestial bodies. The best results can be achieved when two circular limbs of about same size are observed. This is a situation when typical Sun/Moon lunar distance is observed.

This two limb "kissing" phenomen is really fascinating. When limbs are overlaping, the common intersection part of both celestial bodies can be seen as brighter, distinct geometric shape similar to convex lens.



The more two bodies are overlaping, the more this "lens" becomes noticable. This "lens" allows us to find the moment of perfect point to point contact beating sextant accuracy limits. Let's supose that limbs are distinctly overlaping about 1 minute of arc and the Moon is traveling off the Sun (in the field of view of telescope, of course). I don't touch the micrometer but only look through the sextants telescope. What will I see? The overlaping "lens" becomes smaller and smaller. Finally I won't be able to recognise lens shape, but will see only small bright spot, that will indicate the limbs are still overlaping. Then the bright spot will disapear. This moment is point to point contact configuration.

The "lens" serves as an great assistant to help identify the moment of contact. Sextatnt does not allows to measure such small angles as the tiny overlaping part of limbs (when I can distinctly see they are still overlaping). Let's wait a moment when the Moon travels the same value of the angle off the Sun. Is it possible to see that small gap? NO! At least I am not able. I should make the gap between two bodies at least 0,2'-0,25' to see it clearly with 7X power telescope. But the "lens" can still be seen when the overlap is much smaller.

It means that it is possible to see very small angle and at the same time it is impossible to see an equal very small angle! Paradoxies are always intriguing.

“Lens” is an aid something like vernier scale which allows us to make readings of extreme accuracy (compered with situation when vernier scale is not used).

Is there any method how to evaluate the deviation from ideal limb to limb contact point? Let’s suppose I have made a set of Sun lunar observations (for example 6 measurements) from known position. How can I measure this deviation? At first glance it seams obvious that I should compare the measured angles with calculated angles and any difference between measured/calculated angles will show how much I was off. But is it true? Most probably – no. Sextant errors and calculated angles both may contain errors that does not allow to evaluate how good I was in making the limbs to be in perfect contact. Is there any method how to measure offset angle from ideal contact point?

I use methodology described in details bellow.

The time period during one lunar observation set is comparetively small. Lunar distance during this period of time changes only some minutes of arc. Therefore all typical sextant errors may be considered as constant (index error, arc error, micrometer error etc.), because unlikely these values change a lot during such a small time interval and small angle range. If I calculate the difference between sextant angle and calculated angle, the result includes all sextant, observation and software errors. I take mean value of these errors. Then I calculate difference between each individual observation error and this mean error. As a result I get deviation from the mean value of each individual measurement of the set. This value aproximately indicates the angular offset from limb to limb tanget point. This value allows me to check how accurate was my visual estimation of tangent point.

I have attached 4 examples below. The first two are Sun lunars, but the third and the fourth are Jupiter lunars. All these are excelent observations. But Sun lunars beat the records.

Generaly good results are when difference of each individual measurement (the last column in the tables attached at the end of this article) does not exceed about 0,2’. If this difference exceeds 0,3’ (especially for multiple individual sights in the set) it means that the lunar observations for some reasons were complicated and it was hard to get good contact between the bodies. All these numerical values are intuitive, based on my individual experience.

I have documented all the sights I have taken during 4 year period. Therefore I have a possibility to analise a wide range of data. For example I have taken only 16 Jupiter lunar sets in this time period. 4 of them are within 0’-0,1’ range from mean error (these may be clasified as excelent results).

But I have taken much, much more Sun lunars and I can say that accuracy of tanget point can be achieved extremly high (and most important—repeatably). Of course someone would object that this methodology is not perfect, but I don’t claim all this to be scientifically correct.

14.05.2023. Moon-Sun

Sextant angle with index correction applied		Calculated angle		Error (minutes of arc)	Mean error (minutes of arc)	Difference from mean error (minutes of arc)
degrees	minutes	degrees	minutes			
68	34,83	68	34,86	0,03	0,05	0,02
68	33,59	68	33,67	0,08		-0,03
68	32,73	68	32,8	0,07		-0,02
68	31,63	68	31,66	0,03		0,02
68	31,01	68	31,05	0,04		0,01
68	29,63	68	29,69	0,06		-0,01

15.05.2023 Moon-Sun

Sextant angle with index correction applied		Calculated angle		Error (minutes of arc)	Mean error (minutes of arc)	Difference from mean error (minutes of arc)
degrees	minutes	degrees	minutes			
55	40,98	55	40,95	-0,03	-0,04	-0,01
55	40,26	55	40,14	-0,12		0,08
55	39,59	55	39,57	-0,02		-0,02
55	38,81	55	38,82	0,01		-0,05
55	38,31	55	38,29	-0,02		-0,02
55	37,81	55	37,75	-0,06		0,02

31.01.2023. Moon-Jupiter

Sextant angle with index correction applied		Calculated angle		Error (minutes of arc)	Mean error (minutes of arc)	Difference from mean error (minutes of arc)
degrees	minutes	degrees	minutes			
70	29,23	70	28,49	-0,74	-0,77	-0,03
70	30,13	70	29,42	-0,71		-0,06
70	30,78	70	29,97	-0,81		0,04
70	31,23	70	30,48	-0,75		-0,02
70	31,73	70	30,95	-0,78		0,01
70	32,48	70	31,55	-0,93		0,16
70	32,83	70	32,14	-0,69		-0,08

22.02.2023. Moon-Jupiter

Sextant angle with index correction applied		Calculated angle		Error (minutes of arc)	Mean error (minutes of arc)	Difference from mean error (minutes of arc)
degrees	minutes	degrees	minutes			
4	18,06	4	17,99	-0,07	-0,165	-0,09
4	17,31	4	17,08	-0,23		0,07
4	16,16	4	16,05	-0,11		-0,06
4	15,31	4	15,06	-0,25		0,09

Modris Fersters

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