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# Limb Shortening and the Limiting Elongation for the Lunar Crescent's Visibility

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ABSTRACT

The practical Danjon's limiting elongation limit remains close to 10·5° for the crescent's earliest visibility irrespective of the cause of the phenomenon.

## INTRODUCTION

Since I raised the matter of limb shortening with Dr McNally (**1**), I seem to have got a little more understanding on the subject-matter (**2**). In this note, I should like to make a few comments on Dr McNally's paper which would help to clarify the matter from a practical point of view as well as establish a practical lowest limiting elongation value.

## DISCUSSION

There are several facets of this problem within the context of lunar visibility which we need to separate out. The main aspects are:

the observed phenomenon of the crescent's limb shortening (**3, 4**);
the factor(s) that lead to the apparent limb shortening;
the magnitude of the effect and the limiting elongation;
the practical limiting elongation for lunar visibility, and
the calendrical utility of the limiting elongation.

There is no doubt that the phenomenon, as identified and studied by Danjon (**3, 4**), is real. Danjon attributed it to the lunar mountain's shadowing effect at the smaller elongations (see, e.g. **5, 6**). On the other hand, McNally (**1**), having re-examined the matter, has suggested the cause being atmospheric 'seeing'. McNally's model does seem to run into the problems of magnitude especially at the larger elongations. However, from the crescent's earliest visibility point of view, the cause itself is not of immediate interest. What is of interest is the magnitude of the effect, especially the limiting elongation at which the crescent would apparently become invisble. Danjon made use of the observational data (**3, 4, 7**) in developing the relation between the amount of shortening (deficiency arc) and lunar elongation and estimated the limiting elongation by extrapolation at 7°. In a recent re-examination of his data (see fig. 1 in (**2**)) it was

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found that a more appropriate (experimental) estimate is close to 10·5°. This revised value is found to be consistent with the figure obtained from the earliest visibility criterion of Maunder based on the observational data and the independently theoretical criterion of Bruin (**5**) and this very limiting value formed the main point of discussion in an earlier paper (**8**).

On the other hand, the magnitude of the limiting elongation, in the McNally model of 'atmospheric seeing', is proposed to be about 5° and is thus somewhat inconsistent with the observationally practical value. It may be that the 'atmospheric seeing' effect is responsible but not singularly and some other side-effect – including perhaps Danjon's shadowing phenomenon – comes into the picture.

At this point, what seems certain is the 10·5° value for limiting elongation which I have referred to as the 'practical Danjon limit' for visibility and which implies that for the direct sighting of the crescent (naked eye), the elongation must be more than this value. Besides the fact that this value may be derived directly from the observational criterion (**2**) (which has also led to consistent 'age' and 'moonset lag' criteria (**9, 10**), in the mathematical model of Bruin (**5**) at elongations smaller than this the crescent width is too small to produce sufficient contrast above the (average) eye's threshold. Thus, without disputing the value of limiting elongation derived on the basis of shadowing/seeing or other effect(s), the practical limit for (naked-eye) visibility remains close to 10·5°.

The limiting elongation does not provide a sufficient condition for visibility for use in a lunar calendar and one should either use a two-parameter universal criterion (**11**) (the Maunder or Ilyas versions) or simpler latitude-season dependent 'age' and 'moonset lag' criteria (**9, 10**). Nevertheless, as pointed out earlier (**2**), the limit does provide a general guide by way of a minimum – although not sufficient – requirement for earliest visibility and is thus of some value.

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