



## Isolated total lunar eclipses

From Mr Tony West

I am replying to Alex Vincent's letter in the *JBAA* 2012 October, regarding my paper on *Isolated total lunar eclipses* (ITLEs) in *JBAA* 2012 August.

The Meeus–Mucke *Canon of Lunar Eclipses* (1979) gives an umbral magnitude of 0.998 for the 2015 April 4 eclipse, making it a partial eclipse. If this was the case then this would make the following lunar eclipse, which is total, of September 28 an ITLE. I have been in contact with Jean Meeus and he advises me that the Meeus–Mucke

canon was produced using the lunar theory of Brown with modifications, and its publication in 1979 came before the modern French lunar theory of Chapront (the ELP) of 1982. Also this canon was calculated using a method that although giving good results, was not rigorously exact, so there might be small discrepancies, although not significant for historical research.

*The Canon of Lunar Eclipses* by Bao-Lin Liu & Fiala (1992) whilst using modern theories does not, for the calculation, retain coefficients less than one arcsecond for the longitude of the Sun and Moon. Also it uses the traditional 1/50 rule for the enlargement of the Earth's shadow, so its magnitude for the 2015 April 4 eclipse is 1.003.

The *Five Millennium Catalogue of Lunar Eclipses* (2009) by Fred Espenak & Jean Meeus uses modern theories and a more accurate method

of calculation. The enlargement of the Earth's shadow is to the 'French' rule and so gives a magnitude of 1.0008 for the April 4 eclipse.

The traditional rule of 1/50 used for the enlargement of the Earth's shadow gives umbral magnitudes that are about 0.005 larger than the 'French' method. The Espenak–Meeus canon would give a magnitude of 1.0054 if using the 1/50 rule, instead of 1.0008, whereas the Bao-Lin Liu magnitude of 1.003 is slightly too small by 0.002, possibly due to not enough periodic terms being used in the calculation.

The 2015 April 4 eclipse is therefore just total in the umbra at magnitude 1.0008 for just 4.7 minutes (Espenak–Meeus 2009), but it would be interesting to see whether its visual appearance looks total. This eclipse is not visible from Europe and Africa as it is centred over the Pacific.

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## Uncertainty in the classification of eclipses

From Mr Peter Macdonald

Alex Vincent raises an interesting point in the October *Journal* (p.314) when he mentions the uncertainty which can arise, in a small number of critical cases, in the classification of a lunar eclipse as total or partial.

With regard to *solar* eclipses, that of 2013 November 3 is listed in the *BAA Handbook* as annular–total, presenting the annulus for a brief period at the beginning of the track and becoming total for the remainder.

However, in their calculation of the Besselian elements, HM Nautical Almanac Office have adopted a larger, IAU-recommended value of  $k$ , the ratio of the Moon's radius to the Earth's equatorial radius. This results in totality along the entire track, hence in the *Astronomical Almanac* this eclipse is classified as total.

Peter Macdonald

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