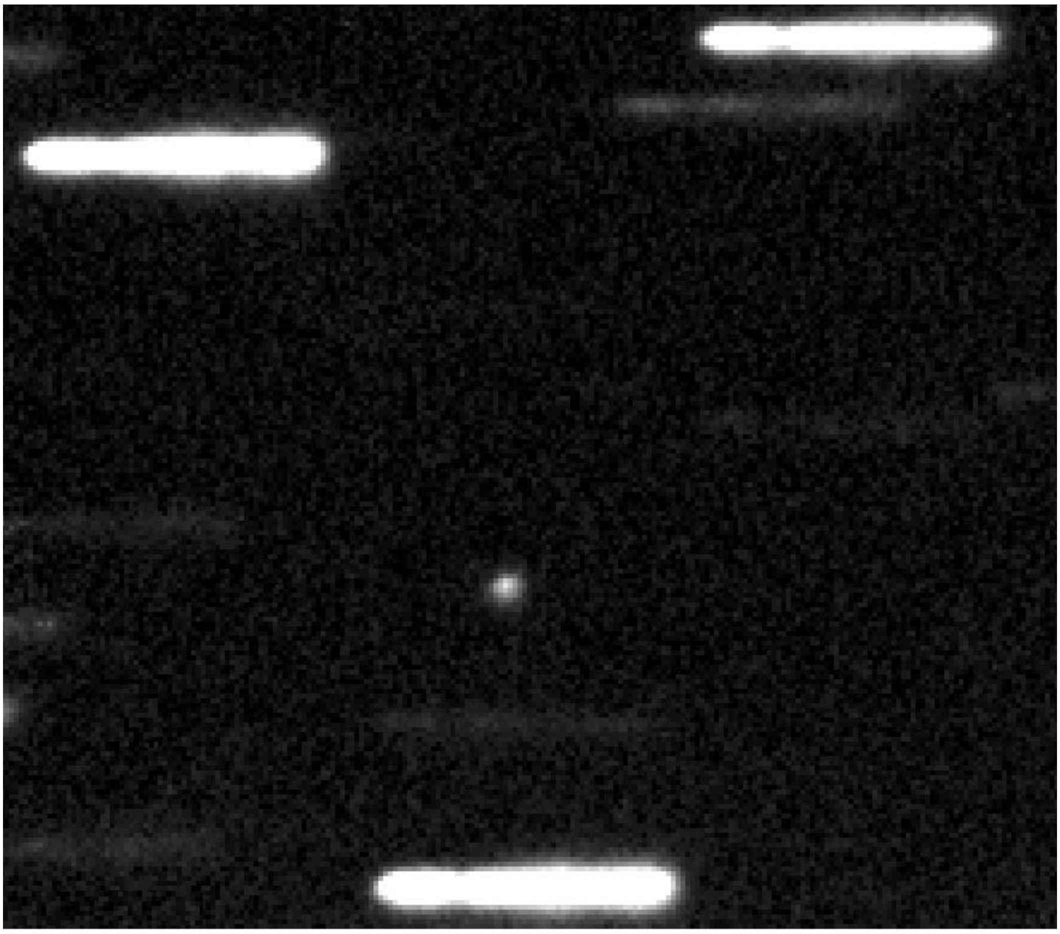
Asteroids and Remote Planets Section

Project NeilBone: A great success!

Last October, the Section initiated a new observing project to make photometric observations of asteroids which reach a phase angle of 0.20° or less at opposition. The stimulus for this followed the naming last year of asteroid (7102) in honour of Neil Bone, our recent Meteor Section director, sadly no longer with us. It turned out that (7102) would reach opposition on January 18 this year at an unusually low phase angle – just 0.03 degrees. This is so small an angle that if you were standing on the asteroid on this date, you would be able to see the Earth transiting across the face of the Sun! The probability that (7102) attains such a low phase angle is about once in several hundred years. So the project was set up with a view to observe its namesake along with a selection of thirteen other asteroids, which also happen to pass through very low phase angle at their opposition during the period, 2009 October – 2010 March.



ASTEROID (7102) NEILBONE
imaged from the UK nine hours before opposition at a phase angle of 0.1 degrees
Stack of 200 x 30 sec exposures, 0.28-m SCT + V filter
Mid-time of stack: 2010 January 17 23:59 UT
Field of view: 3.2 x 3.6 arcmin, Mean V magnitude = 17.48 +/-0.025
R. Miles, Golden Hill Obs., Dorset

Figure 1: (7102) Neilbone at opposition imaged from Dorset

Thanks to the Faulkes Telescope (FT) Project, Darryl Sergison and I were able to use the 2.0-m FT North in Hawaii and the 2.0-m FT South in Australia to image (7102) at various times during November through March. Despite the fact that (7102) was extremely faint, just 17-18th magnitude, we obtained a series of excellent images including one taken live at the BAA Christmas Meeting on December 12 (see Page 8 of the 2010 February issue of the *Journal*).

The most crucial time comprised the hours leading up to and following the moment of opposition on January 18.3 during which period it was essential to have clear skies. From the UK, the night of the 17/18th proved clear and so I did my best to obtain images even though I had to use a V filter, which cuts out a large fraction of the light thus making the 17th magnitude target seem even fainter. Fortunately, during the two hours that images were taken the trajectory of (7102) avoided any stars or galaxies and so it was possible to obtain a pristine image of the object and hence to measure its brightness – see stacked image. Later the next day when it was daytime in the UK, it was also clear in Hawaii and so the FT North was used to obtain the all-important, high signal-to-noise images at the time of opposition – a great success - one that Neil would have been no doubt proud.

In all, some 39 observing runs were made using Faulkes, some involving only a single image, others being a series of images, and covering in total some 29 nights. The brightness of the asteroid and nearby comparison stars selected from the Sloan Digital Sky Survey were analysed using the software, *AstPhot32* written by professional astronomer, Stefano Mottola. The composite lightcurve shown was obtained by reducing the magnitudes to the standard distance of 1 AU from the Earth and 1 AU from the Sun whilst also allowing for a change in brightness with phase angle. Once the magnitudes had been reduced to an absolute value in this way, it was found that all of the data folded nicely onto a single curve having an unambiguous repeat period of 6.1781 hours. Thus we now know that (7102) Neilbone spins once on its axis every six hours or so.

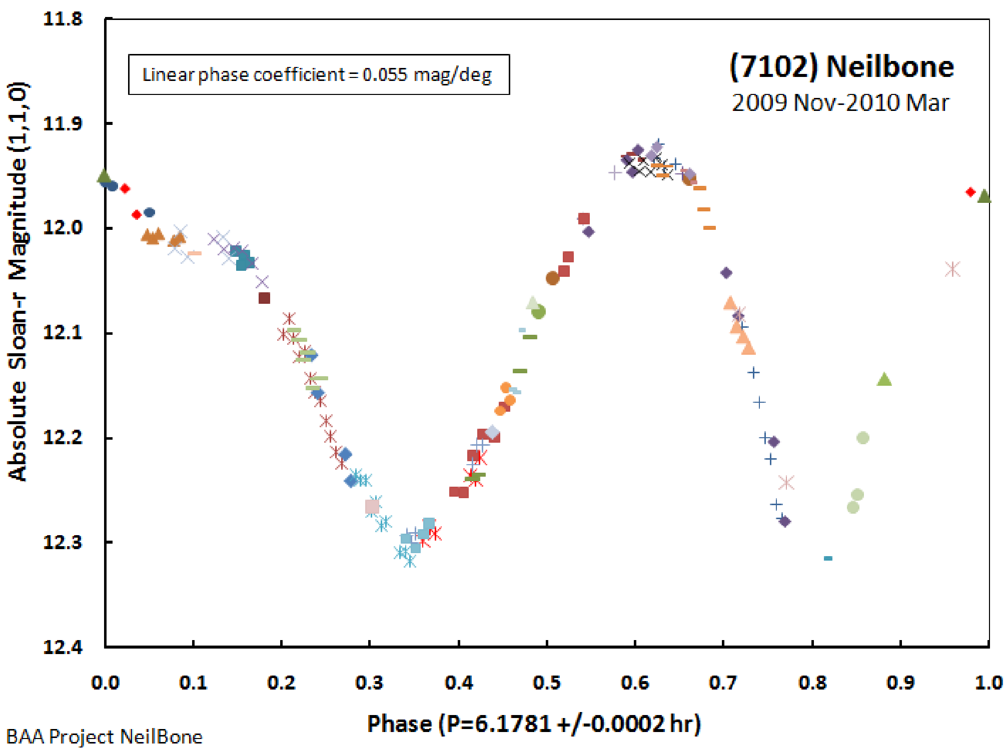


Figure 2: Composite lightcurve of (7102) Neilbone showing asymmetric maxima and minima

To generate the composite lightcurve, it was necessary to apply a linear correction versus phase angle of 0.055 mag/deg. Furthermore, at phase angles of less than 2 deg, a small opposition effect was required for the data to properly fit on the rotational lightcurve (see the Figure depicting the extent to which the phase curve departs from the linear phase coefficient). The shape of this opposition effect has been defined with high accuracy and along with results on the other 13 asteroids in the program, the results of Project NeilBone should substantially add to the body of knowledge in this area.

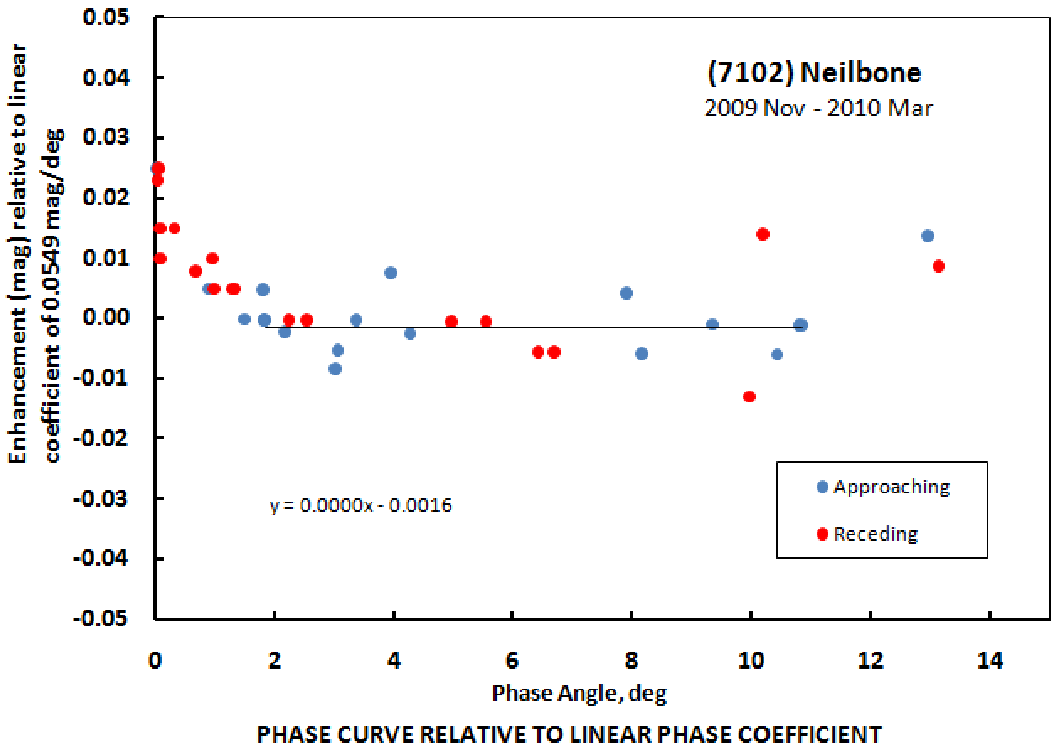


Figure 3: Phase curve showing a very small 0.02 magnitude opposition effect at zero phase angle

From our work, (7102) Neilbone appears to be a C-type object seemingly having a very low albedo. In April, the NASA WISE spacecraft made a dozen observations of (7102) using four infrared filters. These observations will furnish an accurate measure of its albedo, the value of which is an important parameter in modelling the light-scattering properties of any asteroid.

Recently, it was announced that the C-type asteroid (24) Themis has been found to harbour water ice on its surface (H. Campkins et al., *Nature* **464**, 1320-1321, 29 April 2010). This finding is very important since it backs up the distinct possibility that the Earth's current supply of water was delivered by asteroids some time after the collision that produced the Moon. Accurate measurement of the opposition effect for various C-type asteroids is a sensitive way of studying the reflection properties of their surfaces. (24) Themis unusually shows a rather large opposition effect, which may be a consequence of the presence of ices on its surface. Further studies of other C-types may reveal other examples of anomalous scattering characteristics. Thanks to our team of keen observers, Project NeilBone has already amassed a large amount of data on 14 asteroids, analysis of which will no doubt reveal some exciting new findings.

Richard Miles, *Director*
[arps@britastro.org]