# Report to the Planetary Society:
# Recent Activities at the Palmer Divide Observatory

Brian D. Warner
Palmer Divide Observatory
17995 Bakers Farm Rd.
Colorado Springs, CO 80908
719 481-0557
brian@MinorPlanetObserver.com
http://www.MinorPlanetObserver.com

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## Introduction

In March 2007, Brian D. Warner was awarded a Gene Shoemaker NEO grant for the sum of $4000. The funds were to be used for the acquisition of a 0.35m SCT automated telescope, which was to be used for a dedicated study of the Hungaria family/group and brighter NEOs. This study was to determine the absolute magnitude (H) and phase slope parameter (G) of as many asteroids as possible. Furthermore, where possible, the V-R color index was to be found for each asteroid.

## Project Status

The funds were used to support the purchase of a 0.35m SCT as well as a 102 mm f/6 guide telescope and used SBIG ST-7E CCD camera. The latter two are to be used on the 0.35m instrument for guiding during long exposures.

Custom software written by the author is being modified to control the two cameras simultaneously. Previously, the software was able to control two cameras as long as they were not both SBIG brand. The use of two SBIG cameras required modification to the code so that neither camera's exposure control, timings, or data downloads would interfere with the other's. This has proved to be a less than trivial problem and so the telescope has been guided using a different camera combination, one not quite as efficient but still effective.

Far more of a problem has been the weather. 2007 has been the worst year since 1999 for observing at the Palmer Divide Observatory. In 2005, observations were made on more than 180 nights. That number fell to just more than 150 in 2006. Through early September, 2007, only 65 nights have yielded useful data. This has severely impacted the observing programs at PDO. Even if the remaining months produce 15 nights each, a somewhat optimistic forecast, this means 2007 will see between 100 and 120 useful nights.

However, should that forecast hold, the last quarter of 2007 should produce a significant body of data for analysis. This is based on the work done soon after the receipt of the Shoemaker Grant. From March through mid-May 2007, V and R images were obtained of more than 60 brighter, main-belt asteroids as a "proof of concept" for the project and the reduction methods. This work

resulted in the determination of the V-R color indices and H-G values for more than 50 asteroids. The results were submitted in a paper to the *Minor Planet Bulletin* and have been accepted for publication. The paper will appear in MPB 34-4, due out in mid-September 2007. A copy of the paper follows at the end of this report.

The MPB paper compared the derived H magnitudes with those given in the Minor Planet Center's MPCORB file. Agreement was excellent in most cases and showed some deviations in others. Discussions with members of the professional community indicate that the MPCORB magnitudes are often suspect and that the values being obtained through the PDO dedicated H-G program will be of significant use for estimating populations of various-sized asteroids that might be too bright for the larger surveys.

Also in the paper, new formulae for converting J-K to BVRcIc magnitudes were presented. The development of these formulae was also covered in a poster presentation made to the American Astronomical Society at its 210$^{th}$ annual meeting in Honolulu, HI. In both cases, acknowledgement was given to the Planetary Society for its support. That acknowledgement was also given in presentations made to the Society for Astronomical Sciences Symposium on Telescope Science in May 2007 at Big Bear, CA, and at a meeting on binary asteroids at Steamboat Springs, CO, in August 2007. All lightcurve papers submitted to the *Minor Planet Bulletin* carry the acknowledgement as well.

## Future Plans

Observations will continue using the dedicated 0.35m telescope. However, only Clear observations will be used in order to extend the limiting magnitude 1.0-1.5 mag fainter. This will allow smaller and/or fast NEAs to be covered. Reduction methods have been devised to convert the Clear observations to V magnitudes with 0.03 mag accuracy in most cases. The 0.5m Ritchey-Chretien telescope at PDO will be used to obtain B, V, and R observations and so derive the B-V and V-R color indices of asteroids. Since the asteroids will be covered over a large range of phase angles, it's hoped to use some of the observations to determine the amount of phase-reddening for asteroids of different taxonomic classes. This effect is expected to be seen in changing B-V values. How much, if any, change occurs in V-R remains to be seen.

For H-G reductions, an assumed value of V-R = 0.40 will be used, until and unless the actual value is determined. Assuming a V-R in the range of 0.3 – 0.5 mag for most asteroids and the approximate transform of –0.065(V-R) for the system in use, this amounts to a maximum error of about ±0.01 mag in the actual V-R (other errors notwithstanding), which is at or below the observational standard of the project.

This report (less the MPB paper) will be posted on the PDO web site. Another update on the project will be issued approximately March 1, 2008.