SPACEWATCH®
Astrometry of Asteroids and Comets with the Bok 2.3-m and Mayall 4-m Telescopes.

Poster 414.17:
AAS 46th Mtg of the DPS, 2014 November

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Photo of 4-m Mayall Telescope:
NOAO/AURA/NSF
Why we get time on bigger telescopes

- Improve knowledge of the **orbits and magnitudes** of high priority classes of Near Earth Objects (NEOs) and other small bodies in need of recovery that cannot be reached with the Spacewatch 1.8-m telescope.
2012 HG31 (APO) on 2014 Jan 10, R=24.2
2.3-meter Bok Telescope of Steward Observatory on Kitt Peak

90Prime mosaic camera:
FOV \(\sim 1 \text{ deg}^2\)
0.45\(^\prime\)/pixel.
V mag limit \(\approx 24\).

\(~ 24 \text{ nights per year.}~
\sim 3 \text{ objects per hour.}\)
3.5-m telescope of Wisconsin-Indiana-NOAO (WIYN) on Kitt Peak, Az.

Used in 2010 to recover selected faint NEOs discovered by the Near-Earth Object Wide-field Infrared Survey (NEOWISE) spacecraft mission.

Photo: NOAO/AURA/NSF; copyright WIYN Consortium, Inc., all rights reserved.
Targets

• NEOs with **virtual impact** solutions.
• Future targets of **radar**.
• Orbits & albedos suggesting **cometary** activity.
• Potential destinations for spacecraft (**NHATS** list).
• Returning NEOs w/ diameters determined by **NEOWISE**.
• Faint Potentially Hazardous Asteroids (**PHAs**).
Capabilities

• Faintest V mag observed so far = 24.4.

• Smallest elongation angle observed = 46 deg.
Output, 2010-2014

• The MPC has accepted from us:
  
  • 1316 lines of astrometry on
    – 207 different NEOs.
    – including 84 different PHAs.
    – 343 observations of PHAs with V>=22.
Calendar Arc Extensions

• Average calendar span extension on large PHAs (with H<=17.75) is **184 days**, which is 2x longer than the next most effective observing station.

• Extend span of calendar coverage on PHAs an average of **3.8x**.

• For 38 of the 72 PHAs we **added another observed opposition**.
Reducing Uncertainties

• Analysis of our astrometry by MPC (G. Williams 2014 private communication).

• We’ve been reducing uncertainties of orbital elements an average of a **factor of 6**.

• Reducing the uncertainty of time of perihelion passage $T$ an average of a **factor of 19**.
Table 1. Effects of observations by Spacewatch COD ^695, 2010 Jun - 2014 May on Uncertainties of PHA Orbital Elements. Analysis by MPC.

- $f(\text{parameter}) = \frac{\text{uncertainty before}}{\text{uncertainty after}}$.

<table>
<thead>
<tr>
<th>% Span</th>
<th>$f(T)$</th>
<th>$f(\text{Peri})$</th>
<th>$f(e)$</th>
<th>$f(\text{Node})$</th>
<th>$f(\text{Incl})$</th>
<th>$f(q)$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minima</strong></td>
<td>0.00</td>
<td>0.91</td>
<td>0.90</td>
<td>0.91</td>
<td>0.81</td>
<td>0.83</td>
</tr>
<tr>
<td><strong>Maxima</strong></td>
<td>4027.27</td>
<td>596.29</td>
<td>11.14</td>
<td>43.57</td>
<td>40.96</td>
<td>17.40</td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td>384.66</td>
<td>19.29</td>
<td>2.38</td>
<td>6.89</td>
<td>2.95</td>
<td>3.37</td>
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</tbody>
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Acknowledgements

• NASA’s NEO Observation Program.
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