Optical Observations of Space Debris

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GEO Stationkeeping Satellites
All Cataloged Objects at GEO
Cerro Tololo Inter-American Observatory
MODEST – Michigan Orbital DEbris Survey Telescope
the telescope formerly known as the Curtis-Schmidt

0.61/0.91-m Schmidt telescope
GEO debris survey began February 2001
MODEST Data Sample
Examples of Detections
Use of STK for Observation Planning
GEO Debris Observations with Two Telescopes

- Limitations of single telescope – incomplete survey or short arc for orbit.

- March 2007 – began observations with two telescopes at Cerro Tololo, Chile:
  - MODEST survey telescope: 0.6/0.9-m Schmidt
  - CTIO 0.9-m telescope for follow-up

- Goal – characterization of complete sample of faint GEO debris selected on basis of angular rates and brightness.
  - Orbits
    - What fraction of objects selected on basis of magnitude and angular rates are really at GEO?
  - Brightness variations
  - Colors in standard astronomical filters.
CTIO 0.9-m

• 0.9-m Cassegrain
• 0.22 deg FOV (small!)
• Track objects at their angular rates.
• Existing telescope and CCD.
• Debris project can obtain several weeks during the year of time on this telescope for GEO observations.
Techniques and Results

• Typical time between last MODEST observation and 1st 0.9-m observation less than 20 minutes. MODEST observations fit to circular orbit and prediction generated for 0.9-m.

• Recovery rate of MODEST detections on 0.9-m greater than 80%.

• After initial acquisition and follow-ups on 0.9-m: determine full six parameter orbit including eccentricity.

• Track objects from night to night
  – Longest track is six nights on multiple objects in March 2007, March & August 2008.
  – Primary reason for loss of track is object moves too far east or west to be tracked from Chile.
• Use all available information from all sources to determine distribution of all objects found in MODEST survey strips.

• Bright objects found by MODEST not followed up by 0.9-m due to time constraints:
  – Magnitudes from MODEST survey observations.
  – Orbits from public Space Command catalog.

• Faint objects found by MODEST and followed up by 0.9-m:
  – Magnitudes from MODEST survey observations to ensure on same system as bright objects (CTs) from catalog.
  – Orbits from full six parameter fit from both MODEST and 0.9-m observations.

• A few bright objects with known orbits tracked by 0.9-m and orbits compared with catalog. Excellent agreement.

• Following slides show March 2007 data – analysis complete.
Magnitude versus Eccentricity

- **Survey CTs**
- **Night to Night Objects**
Mean Motion vs Eccentricity

- Survey CTS
- Night to Night Objects
Future

• **Most pressing goal** - follow-up observations after several weeks with MODEST – determine A/M using ODTK.

• **Goal** – characterization of complete sample of faint GEO debris selected in a well defined, consistent manner.