Prediction of Occultations by TNOs (and Centaurs)

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**Introduction I**

- TNO/KBO region beyond Neptune is populated by $\approx 10^5$ Objects with diameter $D > 100$ km (Jewitt, Luu, Trujillo, AJ 115, 2125, 1998).

- Kuiper Belt Objects (KBOs/TNOs) are of special interest for our understanding of the solar system and his formation.

- They are studied intensively by (professional) solar system scientists.

- In-situ observations are very unlikely within the next two decades (Pluto Express !?).
Introduction II

- Physical data like diameter calculated indirectly from H value (problem: in general albedo=4% assumed).

- Only for a couple of known objects more reliable data derived from combining thermal and photometrical observations.

- Such observations need large telescopes because $R \approx 22 - 23$ mag.
Introduction III

With exception of Chiron, Pluto and Charon no occultation by KBOs or Centaurs have ever been observed
Motivation

- Occultation observations could provide us with physical data like diameter, shape, albedo and possible satellites.

- But: ”Classical” prediction very difficult. Large uncertainties (discussed later).
  
  => the successful prediction/observation of a TNO occultation is a big challenge to calculators and observers . . .
Some statistics

About 800 KBOs listed at the MPC (Aug.04):

- 385 @ >1Opp, (50000) Quaoar (11Opp)
- More than 50% short arc: < 150d

Orbital revolution times $\approx 10^2 - 10^3$ years $\Rightarrow$ even for Quaoar no full revolution covered.
Uncertainties

- The formal ephemeris uncertainty is rather large because of the short observational arc.

- Even small errors on the sky plane imply rather big shifts/errors on the Earth because of the large geocentric distance of the KBO.

Eg: to achieve a ground track accuracy of about 100 km on Earth, the ephemeris of a TNO ($a = 45$ AU) must have an accuracy of a few mas!!
Strategies

• "Ordinary" predictions give only hints about possible events. Without last-minute astrometry the uncertainty on Earth is rather large (not to say "a guess"). Problem: larger telescopes are needed for astrometry updates.

• For a given density number of TNOs you should have n occ/timeunit up to a certain limiting magnitude. Monitor (a subset of) these stars permanently with a tricky setup of telescopes (to be able to separate the occultations by TNOs) => e.g. TAOS project.

• Other techniques => see F.Roques talk
(Unsuccessful) attempts in 2004 reported on planoccult

- (55565) 2002 AW197 on January 11 (UK)
- 2001 QD298 on August 9 (DE, IT)
## Outlook

<table>
<thead>
<tr>
<th>Date</th>
<th>Object</th>
<th>Note</th>
</tr>
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<tbody>
<tr>
<td>2004 Aug 30</td>
<td>2004 PA44</td>
<td>CEN</td>
</tr>
<tr>
<td>2004 Oct 27</td>
<td>(10199) Chariklo</td>
<td>CEN, Namibia</td>
</tr>
<tr>
<td>2005 May 26</td>
<td>2003 WN188</td>
<td>CEN, arc=234d</td>
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Don’t give up

Even the chances are small to catch an occultation by TNOs you should try it, whenever an event is announced.

Just don’t be discouraged when you have a miss (but report it!)