Linking meteoroid streams to their parent bodies by means of orbital association software tools

JOSE MARIA MADIEDO University of Huelva

www.meteoroides.net
Opens the possibility to:

- Increase knowledge about origin of meteoroid streams.
- Extract chemical information.
- Infer information on physical processes (cometary activity, disruptions, ....).
Linking meteoroid streams to parent objects

Dissimilarity criteria:

- Define adimensional parameter to measure the similarity between two orbits.
- Southworth and Hawkins D criterion (a, e, i only).
- $D_{SH}$ criterion (ascending node and longitude of perihelion also).
- Other criteria: Drumond, Jopek, Valsecci and Jenniskens.
ORAS: ORbital Association Software

NEOs Database Browser

Matched NEOs

Software engineering: Prof. Dr. Jose M. Madiedo (Copyright)
Main Features:

- C++, MS-Windows platforms (XP, Vista, 7).
- NeoDys and MPC databases.
- Different dissimilarity criteria are available.
Parent body of the $\gamma$-Ursae Minorids

$\gamma$-Ursae Minorids:

- Included in IAU working list of meteor showers.
- Parent body: unknown.
Parent body of the $\gamma$-Ursae Minorids

$\gamma$-Ursae Minorids:

- Included in IAU working list of meteor showers.
- Parent body: unknown.

Mag. -5 $\gamma$-Ursae Minorid fireball imaged on Jan. 20, 2011 at 20h40m03.2±0.1s UT
Parent body of the $\gamma$-Ursae Minorids

$\gamma$-Ursae Minorids:

- Included in IAU working list of meteor showers.
- Parent body: unknown.

Orbital analysis:

- Potential parent: 2007 BJ.
- Southworth and Hawkins: $D_{sh}=0.14$.
- Jopek $D=0.08$.
Integration backwards in time (Mercury6):
χ-Orionid meteoroid stream:

- Part of the Taurid complex (Jenniskens, 2006).
- Has northern (ORN) and southern (ORS) branches.
- ORN activity period: Nov.16 to Dec.16 (max. on Dec.10).
- ORN accepted parent body: 2002XM35.

V. Porubčan, L.Kornoš, I.P.Williams (2006)
χ-Orionid meteoroid stream:

- Part of the Taurid complex (Jenniskens, 2006).
- Has northern (ORN) and southern (ORS) branches.
- ORN activity period: Nov.16 to Dec.16 (max. on Dec.10).

ORN accepted parent body: 2002XM35.


Mag. -7±1 SPMN061211 ORN fireball (Dec.6, 2011, 20h32m59.4±0.1s UT).
χ-Orionid meteoroid stream:

- Part of the Taurid complex (Jenniskens, 2006).
- Has northern (ORN) and southern (ORS) branches.
- ORN activity period: Nov. 16 to Dec. 16 (max. on Dec. 10).

- ORN accepted parent body: 2002XM35.

Orbital analysis result:

- 2002 XM35 (Dsh=0.14).
- 2008 XM1 (Dsh=0.05).

Mag. -7±1 SPMN061211 ORN fireball (Dec. 6, 2011, 20h32m59.4±0.1s UT).
Integration backwards in time (Mercury6):

<table>
<thead>
<tr>
<th></th>
<th>a (AU)</th>
<th>e</th>
<th>i (°)</th>
<th>ω (°)</th>
<th>Ω (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPMN061211</td>
<td>2.2</td>
<td>0.79</td>
<td>3.2</td>
<td>281.5</td>
<td>254.2322</td>
</tr>
<tr>
<td>ORN (N=7)</td>
<td>2.143</td>
<td>0.779</td>
<td>3.3</td>
<td>280.4</td>
<td>256.8</td>
</tr>
<tr>
<td>2002XM35</td>
<td>2.3304</td>
<td>0.8361</td>
<td>3.0845</td>
<td>313.4382</td>
<td>229.2701</td>
</tr>
<tr>
<td>2008XM1</td>
<td>2.3679</td>
<td>0.7822</td>
<td>4.9954</td>
<td>276.1411</td>
<td>259.8564</td>
</tr>
</tbody>
</table>
Parent body of the Northern $\chi$-Orionids

Integration backwards in time (Mercury6):

<table>
<thead>
<tr>
<th></th>
<th>$a$ (AU)</th>
<th>$e$</th>
<th>$i$ (°)</th>
<th>$\omega$ (°)</th>
<th>$\Omega$ (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPMN061211</td>
<td>2.2</td>
<td>0.79</td>
<td>3.2</td>
<td>281.5</td>
<td>254.2322</td>
</tr>
<tr>
<td>ORN (N=7)</td>
<td>2.143</td>
<td>0.779</td>
<td>3.3</td>
<td>280.4</td>
<td>256.8</td>
</tr>
<tr>
<td>2002XM35</td>
<td>2.3304</td>
<td>0.8361</td>
<td>3.0845</td>
<td>313.4382</td>
<td>229.2701</td>
</tr>
<tr>
<td>2008XM1</td>
<td>2.3679</td>
<td>0.7822</td>
<td>4.9954</td>
<td>276.1411</td>
<td>259.8564</td>
</tr>
</tbody>
</table>
Conclusions

- We have developed a software tool to establish the potential parent bodies of meteoroid streams.

- ORAS (ORbital Association Software) package can browse both, the NeoDys and the Minor Planet Center (MPC) databases.

- The results obtained by this software can be checked and confirmed by performing an integration backwards in time (Mercury 6).

- One of the latest results obtained in this way is the likely association between the Northern χ-Orionid meteoroid stream (ORN) and the Potentially Hazardous Asteroid 2008XM1.

- This analysis also suggests a plausible dynamic link between both NEOs, 2008XM1 and 2002XM35.
I thank Iwan Williams (University of London) for his input in this research.
I thank Iwan Williams (University of London) for his input in this research.

Thanks for your attention!