Characterization of NEAs in the frame of NHATS program using the 10.4m Gran Telescopio Canarias

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NHATS began in September 2010 to identify any known NEOs that might be accessible by future human space flight missions.

- High-priority targets are identified and alerts are sent out to the observing community requesting observations.
- Best observed during discovery apparition --> need from fast response (in particular for small NEAs)
- Large aperture telescopes are best suited
Observing with the 10.4m Gran Telescopio Canarias (GTC)

The 10.4m Gran Telescopio Canarias (GTC) is located at the El Roque de Los Muchachos Observatory (La Palma), managed by the Instituto de Astrofísica de Canarias (IAC).

We started this observational program in 2014 for 3 semesters. It was resumed in 2019 and is currently on-going.

OSIRIS camera-spectrograph | 2 CCD detectors 2K x 4K | FOV 7.4’ x 7.4’ | Long-slit | R300 grism | λ \sim 0.001 \mu m | 0.48 – 0.92 \mu m
Observing with the 10.4m Gran Telescopio Canarias (GTC)
Observing with the 10.4m Gran Telescopio Canarias (GTC)

<table>
<thead>
<tr>
<th>Asteroid</th>
<th>Discovery date(^1)</th>
<th>Observation date</th>
<th>(m_v)</th>
<th>(\alpha) (°)</th>
<th>(H)(^1)</th>
<th>(p_v)^2</th>
<th>Tax(^3)</th>
<th>(D) (km)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>350523</td>
<td>Mar 3, 2000</td>
<td>Jun 1, 2019</td>
<td>20.5</td>
<td>23.1</td>
<td>21.0</td>
<td>0.148</td>
<td>R</td>
<td>0.218</td>
<td></td>
</tr>
<tr>
<td>2013 RV9</td>
<td>Sep 3, 2013</td>
<td>Mar 9, 2019</td>
<td>20.7</td>
<td>33.6</td>
<td>23.6</td>
<td>0.211</td>
<td>S</td>
<td>0.055</td>
<td></td>
</tr>
<tr>
<td>2014 UV210</td>
<td>Oct 25, 2014</td>
<td>Dec 16, 2014</td>
<td>18.7</td>
<td>5.8</td>
<td>26.9</td>
<td>0.047</td>
<td>X</td>
<td>0.025</td>
<td>Fast rotator (&lt; 1 h)</td>
</tr>
<tr>
<td>2015 BG92</td>
<td>Jan 19, 2015</td>
<td>Jan 26, 2015</td>
<td>18.6</td>
<td>25.6</td>
<td>25.1</td>
<td>0.048</td>
<td>D</td>
<td>0.058</td>
<td>Fast rotator (&lt; 0.2 h)</td>
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<tr>
<td>2015 DU</td>
<td>Feb 17, 2015</td>
<td>Feb 28, 2015</td>
<td>19.1</td>
<td>19.5</td>
<td>26.6</td>
<td>0.211</td>
<td>S</td>
<td>0.014</td>
<td>Fast rotator (&lt; 0.1 h)</td>
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<tr>
<td>2017 PV25</td>
<td>Jul 24, 2017</td>
<td>Mar 10, 2019</td>
<td>20.7</td>
<td>18.0</td>
<td>24.7</td>
<td>0.129</td>
<td>Xc</td>
<td>0.042</td>
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</tr>
<tr>
<td>2019 JU5</td>
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<td>Jun 2, 2019</td>
<td>20.7</td>
<td>31.5</td>
<td>24.0</td>
<td>0.211</td>
<td>S</td>
<td>0.045</td>
<td></td>
</tr>
<tr>
<td>2019 UO1</td>
<td>Oct 19, 2019</td>
<td>Oct 28, 2019</td>
<td>21.0</td>
<td>15.5</td>
<td>25.0</td>
<td>0.050</td>
<td>C</td>
<td>0.059</td>
<td></td>
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<tr>
<td>2019 WV</td>
<td>Nov 21, 2019</td>
<td>Nov 25, 2019</td>
<td>19.2</td>
<td>27.8</td>
<td>24.9</td>
<td>0.129</td>
<td>Xc</td>
<td>0.038</td>
<td>(P_{\text{rot}} = 1.25) h</td>
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<tr>
<td>2019 YV</td>
<td>Dec 19, 2019</td>
<td>Dec 27, 2019</td>
<td>18.9</td>
<td>39.7</td>
<td>23.6</td>
<td>0.042</td>
<td>T</td>
<td>0.123</td>
<td></td>
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</tbody>
</table>

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1 JPL Small-Body Database Browser (https://ssd.jpl.nasa.gov/sbdb.cgi#top) and IAU Minor Planet Center
2 When no albedo information is available, we use the average albedo for the taxonomical class from Mainzer et al. (2011)
3 Taxonomical classification is done using the M4AST on-line tool (http://spectre.imcce.fr/m4ast/index.php/index/home, Popescu et al. 2012)
Some preliminary results

A total of 24 NEAs have been observed so far.

![Taxonomical distribution diagram]

- 2; 8% D-type
- 3; 13% T-type
- 3; 13% C-complex
- 2; 8% Xc-type
- 4; 17% X-type
- 1; 4% Xe-type
- 6; 25% S-complex

![Diameter distribution bar chart]

- 0-20
- 20-40
- 40-60
- 60-80
- 80-100
- 100-120
- 120-140
- >140

![Diameter distribution box plots]

- S-complex, R, Xe
- C-complex, Xc, X
- End members: T, D
Conclusions

- We have an on-going observational program to obtain visible spectra of NEAs using the 10.4m Gran Telescopio Canarias (GTC), in the frame of the NHATS program.

- So far, we have observed 24 NEAs.

- We find a bit more primitive (59%) than rocky (41%) NEAs, and a total of 2 D-types and 3 T-types.

- The majority of the targets (83%) have diameters < 100m. Some of them are fast rotators ($P_{\text{rot}} < 1\text{h}$). We do not see any tendency between taxonomical classes and diameters.