Examining the Relationship between Color and Activity of Centaurs
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Introduction

Centaurs are a group of icy asteroids on eccentric orbits spanning the region between Jupiter and Neptune that originated from the Kuiper belt and are known to be bimodal in color (red and very red). Recently, it has been found that some Centaurs display activity through the emission of gases, resulting in visible comae. All known active Centaurs with measured colors have been found to be red, an observation which has major implications for our understanding of the chemical and physical properties of these objects. This research project is focused on studying the relationship between the surface color and activity level of Centaurs.

Objectives

The objective of this study was to monitor the visible color and activity level of Centaurs. In particular, we were interested in searching for objects that had previously been active and had become inactive, which allow us to measure colors without possible coma contamination and place constraints on the cause of the activity. The research is also aimed at studying whether very red Centaurs can become active when at smaller heliocentric distances.

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Observations and Methods

Astrometry

Photometry

Table 1 Measured Colors of 5 Centaurs

<table>
<thead>
<tr>
<th>Centaur</th>
<th>B-V</th>
<th>V-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>167P</td>
<td>0.15</td>
<td>0.25</td>
</tr>
<tr>
<td>2012 Q1</td>
<td>Very Red</td>
<td>Red</td>
</tr>
<tr>
<td>2012 Q2</td>
<td>Red</td>
<td>Very Red</td>
</tr>
<tr>
<td>2012 Q3</td>
<td>Red</td>
<td>Very Red</td>
</tr>
<tr>
<td>2012 Q4</td>
<td>Red</td>
<td>Very Red</td>
</tr>
</tbody>
</table>

Results and Analysis

Apparent Magnitude of Coma: 24.2
Cross Section of Coma Particles within Projected Annulus: 1.052e+08 m^2
Time of Residence: 2.94e+04 sec
Total Mass of Particles: 4.21e+06 kg
Production Rate: 140 (kg/sec)

As seen in the figures above and confirmed in several previous studies of Centaurs, the objects are separated into two groups of color, one red and the other very red. The targets we observed fit the bimodal distribution of the objects. Notably, all known active Centaurs are in the red group, consistent with the trend demonstrated in earlier works. In contrast, Crantor, which has never shown any level of activity, is very red. In our observations, 174P, P/2008 CL94, and 167P did not demonstrate any measurable activity, as seen the flux density by aperture plots. Meanwhile, C/2012 Q1’s surface brightness profile seems to indicate some level of activity.

Discussion

The lack of significant activity on previously-active Centaurs has provided us with a unique, uncontaminated view of the targets’ nuclei. The results indicate that despite becoming inactive the target red Centaurs remained similar in color. This indicates that the measured colors of Centaurs in previous studies were not significantly affected by Rayleigh Jeans scattering. In other words, the presence of a detectable coma around active Centaurs does not appear to noticeably contaminate the color measurement. The very red object Crantor in this study was shown to be inactive, in agreement with the general trend that there are no very red active Centaurs. C/2012 Q1 shows signs of moderate activity within large errors. The measured color of C/2012 Q1 lies somewhat intermediate between the two classes of color, though consistent with the red group at the 1-sigma level.

References