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Are 2P/Encke, the Taurid complex NEOs and CM chondrites related?

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Abstract

Comet 2P/Encke is a short-period comet that was discovered in 1786 and has been extensively observed and studied for more than 200 years. It has an orbital period of 3.3 years and its orbit is dynamically decoupled from Jupiter's control due to gravitational interaction with terrestrial planets [6]. It is the only comet known on such an orbit, making it unique. Capture from the outer solar system onto its current orbit is very unlikely and even a continuous smooth dynamical evolution has a low probability as this requires a continuous period when it is dormant in order to avoid the volatiles from the nucleus becoming exhausted and making the current observed activity impossible. An origin in the asteroid belt is a possibility especially in view of the recently discovered main belt comets. The nucleus of 2P/Encke is dark (geometric albedo of 0.047 ± 0.023 [3]), has an effective radius of 2.4 ± 0.3 km [3] and it has polarimetric properties that are unique compared to other measured types of solar system objects, such as asteroids, TNOs, cometary dust, Centaurs [2]. The colors of 2P/Encke's nucleus are typical for comets, but no spectra of the nucleus in the visible wavelength range exist so far. The Taurid meteoroid stream has long been linked with 2P/Encke, but the activity of the comet is not strong enough to explain the number of observed meteors. It has been suggested that the meteoroid stream was caused by the break up of a larger parent body, which left comet 2P/Encke and other various small bodies along with a stream of dust. Various small near-Earth objects (NEOs) have been discovered with orbits that can be linked with 2P/Encke and the Taurid meteoroid stream [1]. Though many of the associations are spurious due to the low inclination of 2P/Encke's orbit, many NEO's have evolved in a similar way to 2P/Encke over a period of 5000 years [8] suggesting some relationship.

In addition to dynamical properties, common taxonomic properties can also provide an indication of a common origin for small bodies in the solar system. Taxonomic properties are poorly known for cometary nuclei and only few comets have measurements in the visible wavelength range. The existing spectra of bare nuclei are generally featureless and display different reddening slopes. Given the poor S/N ratio that is usually obtained in observations, more subtle features, such as ones from hydrated minerals, are beyond the detection limit in most cases.

If the Taurid complex NEOs are fragments of the same body as 2P/Encke, we expect them to have the same spectral properties as the comet nucleus. Furthermore, it would be reasonable to expect that these NEOs could show cometary activity.

Maribo is a type CM carbonaceous chondrite that fell in Denmark on 17 January 2009 [5]. The pre-atmospheric orbit of the object places it in the middle of the Taurid meteor stream [4], which raises the intriguing possibility that comet 2P/Encke could be the parent body of CM chondrites, meaning that these meteorites are potentially samples of cometary material we can study in the laboratory. CM chondrites show signs of extensive aqueous alteration, which suggest that the parent body was an icy body that was at least partially molten at some point. It is therefore possible that the parent body of the CM chondrites is a comet [7]. In order to investigate whether a relationship between comet 2P/Encke, the Taurid complex associated NEOs and CM chondrites exists, spectroscopic studies of these objects were performed. Here we present ground-based observations, in the visible wavelength range, of 2P/Encke and 12 candidate Taurid NEOs obtained on 2 August 2011 at the ESO-VLT in Chile, using the FORS2 instrument. We obtained the first optical spectrum of the inactive nucleus of comet 2P/Encke and optical spectra of the selected candidate Taurid NEOs. In addition we obtained deep

images in the R filter of each NEO to search for activity and of 2P/Encke to confirm that the comet was not active at the time of the observation.
Preliminary analysis shows that 2P/Encke has a star-like profile, confirming that no cometary activity was present at the time of the observation. Its spectrum is flat and does not show any obvious absorption or emission feature in the wavelength range $400 - 950$ nm. The spectra of the 12 Taurid NEOs are featureless as well and two of them show moderate reddening. Using deep R-filter images we will investigate the presence of weak activity around the asteroids. We will look for similarities between the spectrum of 2P/Encke and the ones of the selected NEOs to test the link between the comet and the Taurid complex associated NEOs. Moreover, a comparison between chondritic meteorite spectra and that of 2P/Encke will provide information about the possible link between 2P/Encke and CM chondrites.

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