ARE ASTEROID 2003 EH1 AND COMET C/1490 Y1 DYNAMICALLY RELATED?

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Abstract. The orbit of asteroid 2003 EH1 is very similar to the mean orbit of the Quadrantid meteoroid stream so that a close relationship between the two is very likely. It has already been suggested that Comet C/1490 Y1 could be the parent of the Quadrantids. If this is the case, then some relationship between the comet and the asteroid might be expected. The orbit of C/1490 Y1 is based on a short observing arc of about 6 weeks and all the observations were with the naked eye, so that its elements are very poorly determined. Hence, forward integration to determine whether asteroid 2003 EH1 represents the re-discovery of the dormant nucleus of C/1490 Y1 is not feasible. Instead we choose to integrate back in time the orbit of 2003 EH1, which is far better determined, and a family of 3500 clones, all of which are moving on an orbit that is consistent with the present known orbit of 2003 EH1. We compare the results primarily with the recorded observations of the comet rather than the orbit of the comet derived by Hasegawa. We find that one clone is consistent with these observations.

Keywords: Asteroids:individual-2003 EH1, comets:individual-C/1490 Y1

1. Introduction

The Quadrantid shower is a prolific and regular shower seen at Northern latitudes around the beginning of January. It is arguably the only major meteor shower that does not have a body that is generally accepted as being its parent. Part of the problem of identifying the parent undoubtedly lies in the fact that orbits in this region of the Solar System evolve very rapidly so that claims can be made based on a similarity of orbits at some epoch in the past. Equally, a similarity of orbits at the current time alone is not a proof of parenthood. The history of the Quadrantid meteoroid stream, including a discussion of most of the suggested parent bodies can be found in Williams et al. (2004).

One of the suggestions for the parent of the Quadrantids is comet C/1490 Y1 (Hasegawa, 1979), the claim being based on orbital similarity around AD 1490. The comet was a naked eye object between 1490 December 30 and 1491
February 15 and its positions on the sky recorded by Chinese, Korean and Japanese astronomers (Ho, 1964). Orbits for the comet, based on these observations, have been derived by Hind (1846), Peirce (1846) and Hasegawa (1979). These orbits differ significantly from each other, especially in inclination, which ranges from $52^\circ$ to $105^\circ$. We give the orbital elements derived by Hasegawa (1979) as it was the latest to be derived. Here and throughout, unless otherwise stated we use equinox J2000.

\[ q = 0.761, \quad i = 73.4^\circ, \quad \Omega = 280.2^\circ, \quad \omega = 164.9^\circ. \]

The observing arc is too short for the derivation of the eccentricity and Hasegawa assumed that the orbit was parabolic. Based on the possibility that C/1385U1 was the same comet, Williams and Wu (1993) suggest that a value around 0.75 was a better value for the orbital eccentricity. The orbital elements of the Quadrantid stream at the present time, given by Wu and Williams (1992) are

\[ q = 0.974, \quad e = 0.684, \quad i = 71.4^\circ, \quad \Omega = 282.89^\circ, \quad \omega = 169.2^\circ. \]

As can be seen, they are quite similar.

However, it must be realized that the orbital elements of C/1491 Y1 are poorly determined and there are two main reasons for this. First, the elements are based on the observations of the comet for a single arc of approximately 6 week duration. Secondly, the observations are not precise positions and timings but descriptions of what was seen. A translation of the Chinese descriptions, taken from Ho (1964), are reproduced below. The Korean and Japanese records are similar.

31st December 1490 On a Wu-Hsu day in the 11th month of the third year of the Hung-Chih reign-period a (hui) comet appeared at the south of Thien-Chin with its tail pointing NE. It trespassed against Jen-Hsing and passed Chhu-Chiu. On a Wu-Shen day the first day in the 12th month (10th January 1491) it entered the Ying-Shih (13th lunar mansion). On a Keng-Shen day (22 January) it trespassed against Thien-Tshang.

The orbits as determined by Hasegawa, Hind and Pierce are based only on these descriptions and any other orbit that produces a path across the sky consistent with these descriptions is and equally valid orbit for comet C/1491Y1.

It was first pointed out by Jenniskens (2004) that asteroid 2003 EH1, discovered by LONEOS, is moving on an orbit that is remarkably similar to that of the Quadrantid stream. Both Jenniskens (2004) and Williams et al. (2004) numerically integrated the orbit of asteroid 2003 EH1 published in MPEC 2003-E27 back to 1491 and found that the orbit then was similar to that of the comet. They also found that the derived orbit in 1491 was very sensitive to the orbit assumed for asteroid 2003 EH1 in 2004, so that a fairly wide range of orbital parameters were possible for the orbit in 1491.