THE MARIBO CM2 FALL: RADAR BASED ORBIT DETERMINATION OF AN UNUSUALLY FAST FIREBALL.

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Introduction: The Maribo CM2 meteorite fell Jan 17th 2009 and a 25 g fragment of the meteorite was found March 4th, 2009 [1]. The fireball was observed widely across Northern Europe and recorded by a surveillance camera in Southern Sweden, an all-sky camera in the Netherlands, and two meteor radar stations at Juliusruh and Kühlingsborn in Germany [1,2]. The radar stations tracked the meteor from an altitude of 110 km down to 80 km and the Swedish video recorded the fireball between altitudes of 80 and 30 km.

Results: The radar data allow us to determine the azimuth, declination and velocity of the fireball shortly after it entered the atmosphere. The Doppler shift of the returned meteoroid head echo gives an entry velocity of 28.5 km/s at an altitude of 99 km. This is the highest velocity ever recorded for a meteorite producing fireball. The second highest is 20.9 km/s (Pribram and Neuschwanstein). The maximum entry velocity a meteorite can survive is not well constrained. Theoretical models can be used to estimate an upper limit of 30 km/s [3] but it is possible that material could survive even higher entry velocities [4].

The atmospheric trajectory and initial velocity of the meteor allow us to determine the orbital parameters of the object prior to atmospheric entry. We find a semimajor axis a = 2.23 AU, an eccentricity e = 0.80, and an inclination i = 0.26°.

Discussion: Maribo had a semimajor axis and inclination within a sparsely populated region close to the inner edge of the asteroid belt. The closest larger group of asteroids is the S-type Flora asteroids and the S-type Nysa family. None of these are likely to be parents of CM chondrites. Nysa includes the subgroup Polena that are F-type asteroids. These are probably related to carbonaceous chondrites but lack an absorption feature due to hydrated minerals they are unlikely to be related to the hydrated CM chondrites. CM chondrites are spectrally related to G-type asteroids such as 19 Fortuna (a, I, e = 2.44, 1.57, 0.16) and 13 Egeria (a, I, e = 2.57, 16.5, 0.088). Due to their large size (> 200 km), proximity to the 3:1 resonance and spectral properties these two asteroids have been suggested as likely parent bodies for CM chondrites [5].

A connection between CM chondrites and Fortuna and Egeria is supported by the similarity between their orbits and Maribo. Although the semimajor axis of Maribo is less than that of Fortuna and Egeria, the very high eccentricity and low inclination of Maribo´s orbit gave it a high probability of encounters with Venus, Earth, and Mars prior to its fall. It likely that the orbit of Maribo was perturbed through planetary encounters and the orbit we have determined for Maribo is therefore consistent with an origin on Fortuna as well as Egeria.

References: [1] Haack H. et al. 2009. Abstract # 5267. 72nd Meeting of Meteoritical Society. pp A83. [2] Keuer D. et al. 2009. Abstract, MST12 Conference. [3] ReVelle D.O. 1979. J. Atmospheric Terrestrial Phys. 41, pp. 453-473. [4] Takagi Y. 1988. Abstract, 21st Lunar and Planetary Sci, Conf. pp 1169-1170. [5] Burbine T.H. et al. 2002. In Asteroids III, eds. Bottke W.F. et al., pp. 653-667.