Trajectory analysis for the nucleus and dust of comet C/2013 A1 (Siding Spring)

D. Farnocchia[1], P. Chodas[1], S. Chesley[1], P. Tricarico[2], and M. Kelley[3]

[1]Jet Propulsion Laboratory, California Institute of Technology
[2]Planetary Science Institute
[3]Department of Astronomy, University of Maryland

Comet C/2013 A1 is going to experience a close encounter with Mars on Oct 19, 2014 at a distance of 135,000 km ± 5000 km from the planet center. Because of its near parabolic retrograde orbit, C/2013 A1 has a high relative velocity with respect to Mars of about 56 km/s. There is increasing interest in analyzing the close encounter both for the comet nucleus and the dust tail. We analyze the nucleus trajectory and model the contribution of nongravitational forces, which can significantly affect comet dynamics. Since the astrometry does not yet provide any constraint on nongravitational accelerations, our analysis relies on what we know of the whole comet population. It turns out that the nucleus cannot reach Mars even in the case of unexpectedly large nongravitational perturbations. On the other hand, dust released because of cometary activity can reach Mars if the emission velocity is large enough. For given size and density of the emitted dust particles we compute the required emission velocity needed to reach Mars as a function of emission epoch. Comparing our results to the current modeling of C/2013 A1's cometary activity suggests that impacts are possible only for millimeter to centimeter size particles released more than 20 au from the Sun. However, cometary activity that far from the Sun is considered extremely unlikely. Ejection velocity larger than currently modeled could allow dust particles to reach Mars if ejected more than 3 au form the Sun. In this case the impact times peak around 100 min after the nominal close approach around the time that Mars crosses C/2013 A1's orbital plane.