A Dynamical Analysis of Cometary Dust Tails Observed by WISE/NEOWISE

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Introduction: As some of the most pristine objects in the Solar System, comets present an excellent opportunity to understand the mechanics and chemistry of the planetary formation era. By studying a large number of comets in different dynamical classes, we can better understand their ensemble properties.

To this end, we present here a preliminary analysis of a large sample of comets serendipitously observed by the Wide-field Infrared Survey Explorer (WISE) mission. WISE surveyed the sky in four infrared wavelength bands (3.4, 4.6, 12 and 22 μm) between January 2010 to February 2011 [1, 2, 3]. By covering the entire sky, WISE serendipitously observed over 130 comets; most of these were detected by the augmentations to the WISE data processing pipeline collectively known as NEOWISE. About half of the comets observed by WISE displayed a significant dust tail in the 12 and 22 μm (thermal emission) bands. An example of the data is shown in Figure 1 a-d.

To date, this data set is the largest survey of infrared emission from comets. It contains more objects than the Spitzer SEPPCoN survey [4], IRAS, COBE, MSX and Akari missions. Additionally, the comets in this study sample a range of heliocentric distances (including over 50 beyond the nominal 3 AU water-sublimation limit) and dynamical classes (about 1/3 are long-period comets and about 2/3 are short-period comets) allowing conclusions to be drawn about variations in activity across different populations.

Approach: We present here preliminary dynamical models [5] which constrain the particle sizes and ages of the dust tails of a selection of objects. The main parameter in the dynamical models is the ratio of solar radiation pressure to solar gravity, called β, which is also proportional to radiation pressure efficiency over grain radius. Figure 1e shows an example of the results of this analysis technique.

For objects where the comet is visible in both of the thermal wavelength bands, we will measure the color temperature of the dust to determine whether it is consistent with the expected equilibrium temperature. We will also be able to use these data to constrain dust production rates more effectively than with optical data, since infrared imaging is more sensitive to larger particles. A related paper by Bauer et al. [6] provides initial estimates of nucleus size and albedo distributions for a selection of the comets observed by WISE.

We will present dynamical dust models of a few of the most dramatic comets imaged by WISE, and a preliminary review of the ensemble properties of the objects under consideration. We expect that there will be a difference in the properties of the dust between the long-period and short-period comets observed in the survey, due to differences in their dynamical evolution, similar to previous studies [7].

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References: [1] Mainzer, A. et al. (2011) *ApJ*, **731**:1 [2] Wright, E.L. et al. (2010) *AJ*, **140**. [3] Mainzer et al. (2012) *ACM* abstract. [4] Kelley, M.S. et al, *Icarus*, submitted. [5] Lisse, C.M. et al. (1998) *ApJ* **496**. [6] Bauer, J.M. et al. (2012) *ACM* abstract. [7] Lisse et al. (2002) *IAU Colloquium 181*.

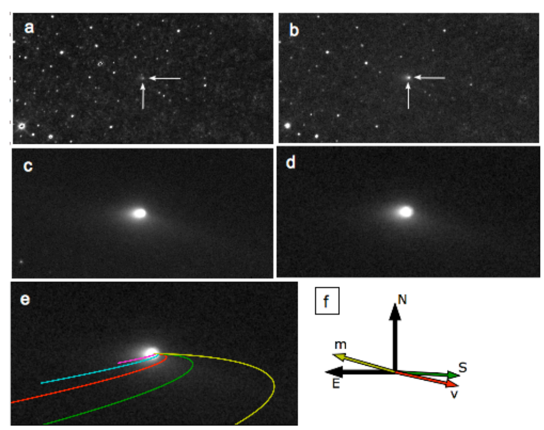

Figure 1: Mosaic images of comet 30P/Reinmuth 1 from the WISE data set. (a) 3.4 μm, (b) 4.6 μm, (c) 12 μm, and (d) 22 μm data; (e) sample dynamical model (syndynes) plotted on top of the 22 μm data where yellow is β=0.001, green is β=0.003, red is β=0.01, cyan is β=0.03 and magenta is β=0.1; (f) coordinate axes, where N is north, E is east, S is the sunward direction, v is the heliocentric orbit velocity and m is the apparent motion.