Searching for evidence for different activity drivers in long- and short-period comets from the WISE/NEOWISE data set

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Introduction: The Wide-field Infrared Survey Explorer (WISE) mission surveyed the sky in four infrared wavelength bands (3.4, 4.6, 12 and 22 µm) between January 2010 and February 2011 [1,2]. During the mission, WISE serendipitously observed over 150 comets, including 21 newly discovered objects. About half of the comets observed by WISE displayed a significant dust tail in the 12 and 22 µm (thermal emission) bands. The Figure below shows a sampling of six comets in the 22 µm band, showing the range of activity levels and dust morphology present in the data. Since the observed objects are a mix of both long-period (LP) and short-period (SP) comets, differences in activity can be used to better understand the thermal processing that each of these populations has undergone.

Approach: For the comets that displayed a significant dust tail, we have estimated the sizes and ages of the particles using dynamical models based on the Finson-Probstein method [3,4]. The main parameter in these models is the ratio of solar radiation pressure to solar gravity, called β. We have then compared these models to the data using a novel tail-fitting method that allows the best-fit model to be chosen analytically rather than subjectively. For comets that were observed multiple times by WISE, the particle properties were estimated separately, and then compared.

Results: The ages of the dust tails seen vary in age from a few months to several years, with the average for both SP and LP comets being between 1–2 years. While many of the dust tails are comprised of grains emitted near perihelion, several comets exhibit tails that depart from this trend significantly. For both the SP and LP comets, the median β value was about 0.01, suggesting that the tail particles are on the order of tens of microns in size. Our preliminary analysis suggests that while the sizes and ages of the particles that comprise the dust tails of LP and SP comets are similar, the heliocentric distance at which activity begins is quite different for these two populations. For the comets under consideration for this study, on average, cometary activity begins approximately 2 au further from the sun for LP comets than for SP comets. This suggests that long-period comets are less depleted in hypervolatiles than short- period comets, which has significant implications for the long-term thermal evolution of these bodies.

A related paper by Bauer et al. (2014) provides a detailed analysis of the nucleus size and gas (CO/CO_2) production rates for the comets in the WISE data, and a paper by Stevenson et al. (2014) discusses comets found during the restarted NEOWISE mission.

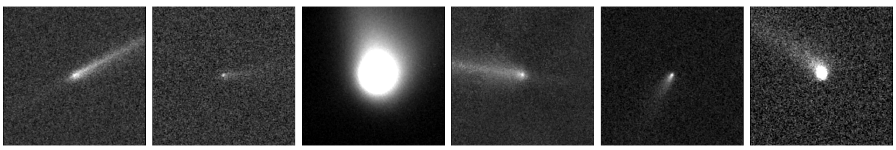

Figure: Montage of six comets observed by WISE, showing the variety of activity levels present in the data. The images are in 22 µm, and each image is 10' across.

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