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Studying Jupiter-Family Comets and Long Period Comets Detected by WISE/NEOWISE

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Abstract

The WISE mission surveyed the sky in four infrared wavelength bands from Jan. 2010 to Feb. 2011. By covering the entire sky, WISE serendipitously observed a large number of active comets. We will present preliminary results from the analysis of several Jupiter-family comets and long period comets (listed in Table 1). The analysis will characterize various properties of each body, including dust production rate, grain properties, nucleus size estimates, albedo constraints, and constraints of the CO/CO_2 gas emission. Several of these objects were also observed as part of the Spitzer SEPPCoN program, allowing comparisons to be made between these two studies.

1. Introduction

One of the most fundamental goals of astronomy is to understand the formation of Earth and our Solar System. Since it is impossible to observe our Solar System in its early stages, the next best thing is to study bodies which have remained relatively unchanged since its formation. Comets have remained relatively unchanged since their birth as icy planetesimals in the early days of the Solar System, and so they can help us to understand the mechanics and chemistry of the planetary formation era. However, comets are not pristine; they have still undergone physical and chemical alterations via various processes such as collisions [2] and insolation [3]. These changes require that we study cometary evolution to fully understand what the primordial comets were like.

Studying cometary activity can be a useful way to understand cometary evolution. The properties of gas and dust present near a comet indicate the history of its activity. It is expected that the highly-evolved Jupiter-family comets (JFCs) will display different activity properties than the less-evolved long period (LP) comet population.

2. Data

The data used in this research were collected by the Wide-field Infrared Survey Explorer (WISE, [5]). WISE is a NASA Medium Class Explorer Mission that surveyed the sky between January 2010 to February 2011 [4, 5]. The WISE Preliminary Data Release, made in April 2011, contains images and extracted source data from the first 57% of the sky observed by WISE. The WISE Final Data Release will take place in the Spring of 2012 and will include data covering the entire sky. WISE collected data in four infrared bands at wavelengths of 3.4, 4.6, 12 and 22 μm. It is useful to note that light from the comets in the 3.4 μm band is mostly reflected light, while light from the comets in the 12 and 22 μm bands is thermal emission. The light from the comets in the 4.6 μm band is a combination of reflected light and thermal emission, but also contains emission lines from CO and CO_2, thereby allowing the production rates for these gasses to be constrained [1]. Six Jupiter-family comets and two LPCs were selected for this study, as listed in Table 1. Figures 1 and 2 show representative (single snapshot) images of two Jupiter-family comets, 30P/Reinmuth 1 and 118P/Shoemaker-Levy 4, in the four WISE bands. Significant activity can been seen even in these images, suggesting that there is substantial emission occurring. There are about 12 more images available for each comet, which will be combined into a mosaic image. Note that the WISE data are well-suited to study comet-to-comet and group-to-group variations in properties since it is an all-sky survey to a common sensitivity limit; no one class of object was necessarily targeted for study.

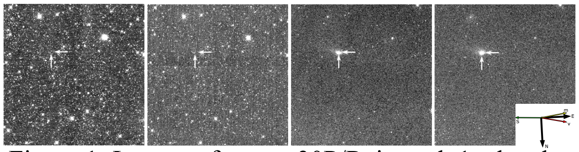

Figure 1: Images of comet 30P/Reinmuth 1 taken by WISE. The field of view in each is approx. 46'x46', and the spectral bands shown are (from left to right) 3.4, 4.6, 12 and 22 μm.

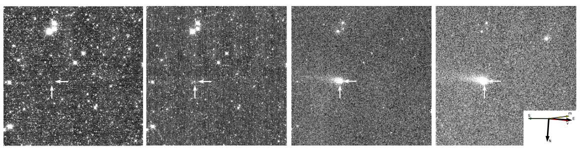

Figure 2: Same as Fig. 1, but for 118P/Shoemaker-Levy 4.

Table 1: Target bodies

Name	Class	Approx. R at Obs. (AU)	Obs. by Spitzer?
30P	JFC	2.1	N
31P	JFC	3.6	Y
47P	JFC	3.4	Y
118P	JFC	2	Y
137P	JFC	2.9	Y
C/2009 U3	LP	1.7	N
C/2007 VO53	LP	4.9	N

3. Results

Since the data span several wavelength bands, several results can be obtained. Surface brightness maps will be generated to characterize the morphology of the coma, allowing constraints to be placed on dust production and mass loss rates. Dynamical modeling will then be used to characterize the dust grains located in cometary tails. These models will give us information about the size, velocity and age of the dust particles. Albedo estimates can be obtained from the 3.4 μm band data, using this band data to constrain the reflected light component of the dust signal. Constraints on CO/CO_2 gas emission can be obtained from the 4.6 μm band data, as described in Section 2. This has been previously been done for only a handful of JFCs, most recently with 103P [1]. We can also constrain nucleus sizes, which when combined with the production rates will give an estimate of the fraction of the nucleus that is active. The results obtained here from the WISE data will be compared to results obtained by the Spitzer SEPPCoN program. The individual comets were observed at different heliocentric distances in each data set, so differences in activity can be studied and characterized.

Acknowledgements

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