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Investigation of the Fragments of Split Comet 73P

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Abstract

Comet 73P/Schwassmann-Wachmann 3 (73P) has been observed to fragment on several occasions, however the cause of its fragmentation is poorly understood. Using mostly unpublished archival Hubble Space Telescope data taken in 2006, we analyzed about 120 images and studied the properties of the fragments of 73P in order to understand its fragmentation mechanism. In particular, we studied fragments 73P-C, 73P-B, and 73P-G. For the main nucleus, 73P-C, the literature presents a wide range of reported rotational periods from ~3 hours [1] to ~27 hours [3]. The low end suggests the nucleus might have split due to rotational instability. However, we find the most likely value of the rotation period to be ~10.4 hours, much longer than the critical period for rotational instability for any reasonable nucleus density. We find strong cyclic variations of ~0.3 magnitudes in the light from the nucleus, with smaller variations apparent in the surrounding dust coma. This modulation of the mass loss rate is compatible with an outflow dust speed of ~107±9 m/s as seen in Figure 1. We also measured the nucleus' radius r ~ 0.4±0.1 km, which is comparable to Arecibo (12.6 cm) and Goldstone (3.5 cm) radar data stating the nucleus is at least 1 km in diameter [2] and with the radius estimated by Toth et al. (2005) of 0.68±0.04 km [4]. We will present the results of similar measurements of 73P-B and 73P-G. 73P-G is pictured in Figure 1. The archival data show dozens of fragments in 73P-G and 73P-B [5], therefore we use careful photometry to accurately measure the size distribution of fragments. We will present measurements of the relative motion of these fragments in order to determine their speed and acceleration on the plane of the sky. This will allow us to determine whether the fragmentation process was staggered over time or impulsive. Understanding the breakup mechanism of 73P will have implications on not only this comet, but other similar comets as well. From this work, we rule out rotational instability as potential breakup mechanism for 73P and provide a deeper analysis of its fragmentation evolution.

1.Figures

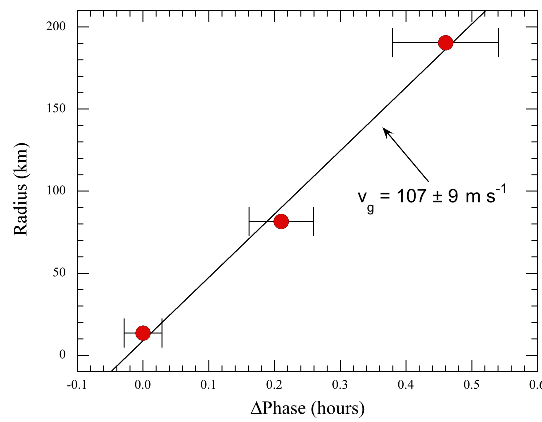

Figure 1: The relative phase shift plotted against the distance from the center of the nucleus, where the reference phase measured from the lightcurve of the nucleus is set to zero. From left to right, the red points then represent the relative phase at the nucleus, 82 km from the nucleus into the coma, and 190 km from the nucleus into the coma with their 1-sigma errors.

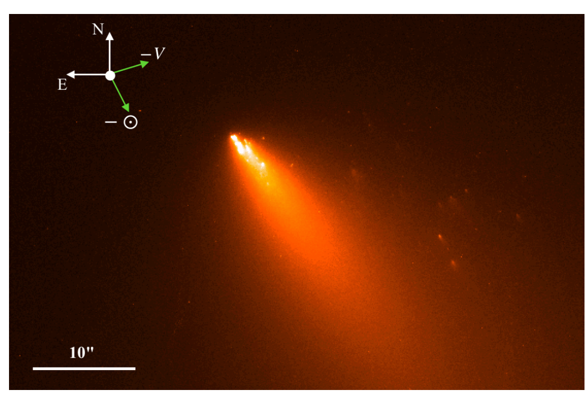

Figure 2: Stack of five images of 73P-G taken with HST's ACS WFC instrument in the F606 filter with exposures of 400 second on April 18, 2006. The pixel scale is 0.05 x 0.05 square arcseconds. At a distance of 0.23 AU from the Earth, 1 arcsecond corresponds to 167 km. The projected antisolar direction and negative velocity are represented by the vectors labeled -⊙ and −V respectively.

Acknowledgements

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References

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