Dust Production of Comet 21P/Giacobini-Zinner using Broadband Photometry. R. C. Blaauw[1], R. M. Suggs[2] and W. Cooke[2], [1]Dynetics Technical Services/MITS, Huntsville, AL, USA, 35812. Rhiannon.C.Blaauw@nasa.gov, [2]NASA/MSFC, Huntsville, AL, USA, 35812.

Introduction: Comet 21P/Giacobini-Zinner is a Jupiter family comet, approximately 2 km in diameter, and is established to be the parent of the Draconids, a meteor shower known to outburst. In 1933 and 1946 up to 10,000 meteors per hour were reported for the Draconids [1], and 2011 saw a minor Draconid outburst. Meteor stream modeling/forecasting being a primary focus for the NASA Meteoroid Environment Office, it was decided to monitor 21P for three purposes: firstly to find the apparent and absolute magnitude with respect to heliocentric distance; second to calculate *Afρ* [2], a quantity that describes the dust production rate and is used in models to predict the activity of the Draconids; thirdly to detect possible increases in cometary activity, which could correspond to future Draconid meteor outbursts.

A similar study was done for 21P during its 2004-2006 close approach to the Sun in which apparent and absolute magnitudes were found with various heliocentric distances as well as the dust production [3]. When 21P was 2.32 AU from the Sun they found an apparent magnitude of 17.05 and *Afρ* of 83 cm, and when it was 1.76 AU from the sun, they found an apparent magnitude of 15.91 and *Afρ* of 130.66 cm.

Method: Images of 21P were were obtained in the Johnson R-filter from May 20, 2011 until October 24, 2011 (3.04 to 1.77 AU heliocentric distance) using a 0.5-meteor f/8.1 Ritchey-Cretien telescope on a German equatorial mount with an Apogee CCD camera located in the mountains of southern New Mexico. Analysis was done with Astrometrica [4] and FoCAs (FOtometria Con AStrometrica or Photometry with Astrometrica) [5], a program allowing multi-aperture photometry. Comparison of results obtained from this process was made with those produced by Wafrho, created by CARA (Cometary ARchieve for Afρ) [6] as a verification step. Corrections for phase angle were applied to all data, normalized at opposition [7].

Results: In the five months 21P was imaged we saw results that were in rough agreement with Pittichova et al's 2008 results, which covered 21P's previous orbit [3]. We found 21P went from an apparent magnitude of 19.6 to 15.7, corresponding to an absolute magnitude of 15.1 to 12.1. This correlated to an *Afρ* of 6.88 cm to 284.17 cm as presented in Figure 1. There were no significant outbursts during this time.

Dust production of 21P followed a logarithmic slope of -4.468 with respect to heliocentric distance. We can extrapolate this slope out to the perihelion (1.038 AU) of 21P to find an $Af\rho_q$ of 3824 cm.

Figure 1. Dust production of comet 21P from May 20, 2011 to October 24, 2011. All data is corrected for phase angle.

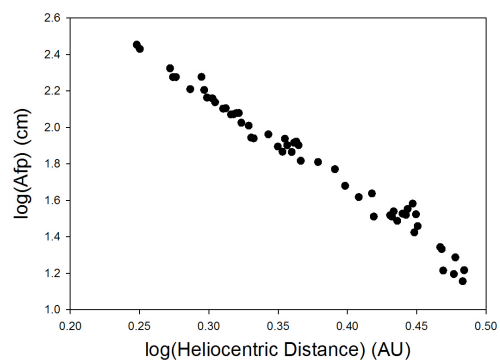

Table 1: Dust production of comet 21P with various apertures.

ρ (km)	9000	18000	27000
Afρ at 3.04 AU (cm)	16.48	11.07	7.64
Afρ at 1.77 AU (cm)	284.17	262.51	211.85

We measured the dust production with 3 apertures, the quantity *ρ* describing the radius of the aperture in kilometers. As seen in Table 1, when 21P is 3.04 AU from the Sun, and nearly a point source in our images, the dust production falls off significantly with increasing aperture size. However by 1.77 AU from the Sun, 21P has grown a pronounced coma, which extends into larger apertures. Data found with an aperture with *ρ =9000 km,* as it provided the peak *Afρ,* was used for analysis in this paper.

Performing multi-aperture photometry also allows one to see the coma of a comet growing with decreasing heliocentric distance. This is seen in Table 1 with a greater percentage of *Afρ* seen in greater apertures as 21P approaches the Sun.

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