THE DUST TRAIL OF COMET 67P/CHURYUMOV-GERASIMENKO NEAR APHELION. J. Agarwal[1], M. Mueller[2], M. V. Sykes[3], W. T. Reach[4], H. Boehnhardt[5], and E. Gruen[6,7], [1]ESA/ESTEC/RSSD (Postbus 299, 2200 AG Noordwijk, The Netherlands. E-mail: jagarwal@rssd.esa.int), [2]ESA/ESOC (Robert-Bosch-Str. 5, 64293 Darmstadt, Germany. E-mail: michael.mueller@esa.int), [3]Planetary Science Institute (1700 East Fort Lowell, Suite 106, Tucson, AZ 85719, USA. E-mail: sykes@psi.edu), [4]IPAC/SSC/Caltech (MS 220-6, 1200 East California Blvd., Pasadena, CA 91125, USA. E-mail: reach@ipac.caltech.edu), [5]MPI fuer Sonnensystemforschung (Max-Planck-Str. 2, 37191 Katlenburg-Lindau, Germany. E-mail: boehnhardt@mps.mpg.de), [6]MPI fuer Kernphysik (Saupfercheckweg 1, 69117 Heidelberg, Germany. E-mail: eberhard.gruen@mpi-hd.mpg.de), [7]Laboratory for Atmospheric and Space Physics, University of Colorado (1234 Innovation Drive, Boulder, CO 80303-7814, USA. E-mail: eberhard.gruen@lasp.colorado.edu).

Introduction: Cometary dust trails consist of mm- to cm-sized dust particles emitted by a comet. Due to their low emission speeds and the weak influence of radiation pressure, these particles remain on orbits similar to that of the parent comet for many revolutions around the Sun, appearing to the observer as a thin extended structure along the cometary orbit. The emission of large dust particles is the principal mechanism by which a comet loses refractory mass to the interplanetary dust environment [1]. Trails of eight short-period comets were observed with IRAS in 1983 [2,3]. An dedicated survey with Spitzer revealed trails associated to more than 80% of the observed Jupiter family comets [4]. The dust trail of Rosetta target comet 67P/Churyumov-Gerasimenko (CG) was among the original IRAS-detected trails, and it has since been observed at both visible and mid-infrared wavelengths [5,6,7,8]. We present here observations of the CG trail made between 2004 and 2006 when the comet was close to aphelion. Comparison to simulated images allows us to put constraints on the dust properties and on the emission of large particles by this comet.

Observations: We observed the trail of comet CG in visible light in April 2004 with the Wide Field Imager at the ESO/MPG 2.2m-telescope on La Silla, and in the mid-infrared (24 micron) in August 2005 and April 2006 with the MIPS instrument [9] on board the Spitzer Space Telescope of NASA. Each observation covered about half a degree in projection along the cometary orbit. The comet was at heliocentric distances of 4.7 AU in April 2004, 5.7 AU out-bound in August 2005, and 5.7 AU in-bound in April 2006.

Model: In our model we assume that dust is emitted up to a heliocentric distance of 3AU. We expect, therefore, that all dust grains smaller than 100 micron have left the fields of view of our observations due to the influence of radiation pressure. We take into account dust emitted during all seven perihelion passages since the last close encounter of CG with Jupiter in 1959. The dependence of the dust production rate on heliocentric distance is described by a power-law fitted to the observed dust activity of the comet. Likewise, the time-evolution of the emission speeds are derived via a hydrodynamic coma model based on the observed water production rate. The dust size distribution is described by a power law, and the strength of radiation pressure relative to gravity is inversely proportional to the particle size. The scattering of visible light and the thermal radiation are described by geometric optics and blackbody emission, respectively. Dust in our model is emitted isotropically from the comet. Images are simulated using a generalisation of the method introduced by Finson and Probstein [10]. Our model has the following five free parameters: the exponent of the differential size distribution, the absolute value of the emission speeds (related to the dust bulk density), the absolute value of the radiation pressure parameter, the dust production rates, and the dust albedo.

Results: We find that we can best reproduce our observations if we assume a size distribution exponent of -4 and bulk densities on the order of 0.5 g/cm^3. The dust geometric albedo is 4% if the dust is assumed to be in thermal equilibrium, but 9% if the thermal flux is derived from the excess colour temperatures observed with IRAS [1]. To reproduce the observed surface brightness we require dust production rates of about 200 kg/s. This implies that a significant contribution to the total brightness of the dust coma near perihelion stems from particles larger than 100 microns.

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