# The dust environment of comet C/2012 S1 (ISON)

F. Moreno[1], F. Pozuelos[1], F. Aceituno[1], V. Casanova[1], R. Duffard[1], J. J. López-Moreno[1], A. Molina[1], J. L. Ortiz[1], P. Santos-Sanz[1], A. Sota[1], P. Yanamandra-Fisher[2], and the Amateur Astronomical Association Cometas-Obs[*]

[1]Instituto de Astrofísica de Andalucía, CSIC, Glorieta de la Astronomía s/n, 18008, Granada, Spain
[2]Space Science Institute, Boulder, CO 80301, USA

A Monte Carlo comet dust tail model has been applied to extract the dust environment parameters of comet C/2012 S1 (ISON) from both Earth-based and *Solar and Heliospheric Observatory* (SOHO) calibrated observations, performed from about 6 Astronomical Units (au) inbound, to right after perihelion passage, when just a small portion of the original comet nucleus survived in the form of a cloud of tiny particles. The early $Af\rho$ and image data are consistent with particle ejection from an extended active area occupying a large region between latitudes 35°N to 90°N (for a prograde rotating nucleus), with the spin axis having a large obliquity ($I \approx 70°$). This configuration fits nicely the early images and $Af\rho$ data until approximately 3.9 au inbound, where the emission should become isotropic in order to fit the data. This isotropic ejection model perfectly mimics the minimum in the $Af\rho$ data found observationally 60 days before perihelion and the steep rise afterwards owing to the strong outburst of activity detected by many observers during the first hours of November 14, 2013. The comparison of the derived dust loss rates with water production rates implies a dust-to-gas ratio which generally decreases with increasing heliocentric distance, and a particle ejection velocity law that is close to a $r_h^{-2}$ dependence. The analysis of SOHO LASCO C3 images around comet's perihelion reveals that, assuming an original nucleus of $R_N = 500$ m with $\rho = 1000$ kg m$^{-3}$, at least half of the mass of the nucleus was vaporized when the comet was at about 17 solar radii inbound. We conclude that at that time the nucleus suffered a cataclysmic fragmentation releasing a huge amount of material of $2.3 \times 10^{11}$ kg, for a particle density of 1000 kg m$^{-3}$, equivalent to a sphere of 380 m in radius. The model results on a later pre-perihelion image at about 5.5 solar radii implies a further reduction in mass of about 300 to that at 17 solar radii, a consequence of vaporization of comet material. However, the total mass contained in the post-perihelion tails analyzed are about the same of that at 5.5 solar radii pre-perihelion, but with much smaller particles in the distribution, implying that the dominating process at perihelion was particle fragmentation. The total mass contained in the last SOHO LASCO C3 post-perihelion image analyzed, at 27.5 solar radii post-perihelion, the surviving ISON material is just $6.7 \times 10^8$ kg or a sphere of 54 m in radius with the density of 1000 kg m$^{-3}$. The dust contained in the post-perihelion tails is very small in size, with particles having 0.1–50 µm in radius, distributed following a power law of index –3.5.